NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, DC 20594

January 13, 1997

STRUCTURES GROUP - WING FACTUAL SUMMARY

ACCIDENT	:	**DCA96MA070**
Location	:	**East Moriches, New York**
Date	:	**July 17, 1996**
Time	:	**2031 Eastern Daylight Time**
Airplane	:	**Boeing 747-131, N93119**
		Operated as Trans World Airlines (TWA) Flight 800

GROUP

	Name/Organization
Chairman	**Deepak Joshi** **NTSB** **Washington, DC**
Member	**Dave Orth** **Boeing Commercial Airplane Group** **Seattle, WA**
	Other Boeing Members **Roy Hurlbut** **Barry Smith** **Lewis Thomson** **Bob Whittington**
Member	**Steve Green** **Air Line Pilots Association (ALPA)** **Herndon, VA**
Member	**Dennis Santiago** **International Association of Machinists (IAM)** **JFK Intl Airport, NY**
Member	**Dan Rephlo** **Terry McKinney** **Trans World Airlines (TWA)** **Kansas City, MO**
Member	**Tom Todino** **Federal Aviation Administration** **Garden City, NY**

1.0 WING

The wings were fractured into numerous pieces. A small percentage of fuselage and wing center wing tank were still attached to the wing structure when recovered. The wing landing gears and engines (covered in other summaries) were not connected to the recovered wing debris. The vast majority of the left wing pieces and all of the right wing pieces were found in the Green debris field. Some small pieces of the left wing were found in the Red and Orange areas. The right wing sustained fire and soot damage on the exterior of the upper and lower skin surfaces. The left wing lower surface showed sooting and some fire damage, generally between engines #1 and #2. The sooting and fire damage are covered extensively in the Fire and Explosion Group's Report. Most pieces of the leading and trailing edge flaps, ailerons, and spoilers were found in the Green debris area; however, some pieces were found floating and were not associated with a debris field.

1.1 Right Wing

The right wing had separated into two major sections. The inboard section includes approximately 20 inches of center wing tank, a portion of fuselage, and the wing outboard to approximately wing station (WS) 1224. The outboard wing section measured approximately 29 feet and comprised the wing from approximately WS 1242 (at front spar and leading edge) to the wing tip. The wing structure between the inboard and outboard sections (WS 1224 to WS 1482) had broken into several pieces. Fire and soot damage was observed mainly on the inboard wing section, with some limited fire and soot damage on the other pieces.

1.1.1 Inboard Right Wing Section

The upper and lower wing skins of the inboard wing section remained together on the ocean bottom. Underwater video of the entire piece as originally found on the ocean bottom showed the wing resting on its lower skin. As a safety precaution to personnel, the wing skins were cut and split at several locations after recovery from the ocean. Both upper skin (RW8) and lower skin (RW3) show an inboard-to-outboard wave shape along the entire span (lower skin has a more pronounced wave). The inboard ends of the upper and lower skins remained attached to portions of the center wing upper and lower skins; the inboard end of the upper skin was also attached to a portion of the fuselage (BS 1140 to BS 1340, RF17). The attached piece of center wing upper skin (CW104) exhibited upward bending. The attached piece of center wing lower skin (CW201) and the inboard right wing lower skin exhibited pronounced upward bending. Most of the stringers remained attached to the lower skin and were bent in an "S" shape spanwise taking the shape of the damaged wing skin. Sooting is prevalent along the length of the external surfaces and the upper skin inside the vent stringer area.

The front spar from WS 1196 to the SOB had mainly separated from the upper and lower skins and was found in many pieces of various sizes. Only a 15-foot section outboard of engine #3 and a 10-foot section inboard of engine #4 remained attached to the lower skin (RW3).

The majority of the mid spar of the right wing was missing from its attachments on the upper and lower skin and was found in small pieces.

A large section of the rear spar between the #3 and #4 engines remained attached to the lower skin and exhibited fire and impact damage (RW3). A 10-foot section of the rear spar between WS 440 and WS 560 (including the main landing gear "H" fitting) remained attached to the upper skin (RW8), and a 6-foot section of the rear spar between WS 582 and WS 650 remained attached to the lower wing skin (RW3).

There is evidence of fire and soot damage to the upper wing skin and associated stringers immediately outboard of engine #4 exhibiting heavy soot and some fire damage (RW8). The inner surface of the upper skin inboard of the #4 engine exhibited soot in vent stringer passages but no fire damage (reference to Fire and Explosion Group notes).

1.1.2 Outboard Right Wing Section

The outboard wing section, which measures from approximately WS 1242 (at front spar and leading edge) to the wing tip, was found floating on the ocean surface (RW1 and RW4). The exact recovery location of this section is unknown. However, due to the recovery of the right hand HF antenna (RW22) (which was originally attached to the wing tip) in the Green debris area, it was determined that this section was also recovered from the Green area. The front spar lower chord fracture surface at WS 1243 exhibited tensile failure characteristics and the upper chord fracture surface at WS 1242 exhibited compression failure characteristics. The front spar web was deformed aft from the fracture areas to WS 1280.. There was no evidence of any soot damage, fire damage, or pre-existing cracking or corrosion on this wing structure.

1.1.3 Right Wing Between Inboard and Outboard Sections

The wing structure between the inboard and outboard sections had broken into several pieces. The upper wing skin measured from WS 1224 (just outboard of #4 engine) to WS 1280 and had broken into numerous sections (RW11, RW19, RW20, RW21, and RW37). Layout of these pieces showed upward bending, and also panel segments (RW11, RW20, and RW21) were buckled in compression and bent upwards at the inboard and outboard ends. No evidence of fire damage or soot accumulation was observed on these pieces, although some stringers that remained attached to the upper skin (RW8) in this area, exhibited heavy sooting and some fire damage. A separated rib at WS 1252 (RW24) exhibited heavy fire damage, and an adjacent 10 foot piece (RW25), which includes segments of the WS 1280 rib, a vent stringer, and a Z-stringer, was less sooted and burned. The lower wing skin piece (RW10) from WS 1224 to WS 1482 shows a general spanwise curl downwards and is twisted over its length. Most of the stringers show a buckling of the free flange. There was no evidence of any pre-existing cracking or corrosion on these pieces of wing skin.

1.2 Left Wing

The left wing was more severely fragmented and the lower panel had a more pronounced

spanwise curl than the right wing. Generally, the left wing had separated into upper skin pieces and lower skin pieces; only one piece outboard of the #1 engine (LW5&6) had upper and lower skins still attached. Most of the upper skin was found, but in small fragments. Almost all of the lower skin was recovered and comprised of larger pieces.

The left wing outboard of about WS 1230 (outboard of engine #1) broke into eight larger pieces and numerous smaller pieces. Layout of these pieces showed upward bending outboard of about WS 1230 (LW8 & LW42) and possible downward bending outboard of WS 1360 (LW5&6, LW44). Both upper and lower wing skin panels between WS 1230 and WS 1360 showed upward curling at the inboard end (upper panel LW42 and lower panel LW8). The front spar fracture at WS 1242 exhibited buckling damage to the upper chord and web. The lower wing panel outboard of WS 1360 shows downward curling at the inboard end and one large crease near WS 1423 (LW44), with both ends of the local panel bent downward about the crease. Buckled stringer upper chords (free flanges) were observed on panels LW8, LW44, and LW5.

The upper and lower skin (LW5&6) remained attached to the front spar between WS 1440 to WS 1548. The inboard end of the lower skin (LW5) at WS 1440 exhibited evidence of downward bending, and towards the outboard end, (WS 1548), the front spar is fractured and the skin panel end is bent down over the outboard 10 inches (LW5).

There is evidence of sooting on the lower skin inner surface at WS 1230 near the front spar (LW9). A section of the front spar that remained attached to the lower skin and the corresponding fracture surfaces of the spar and the skin also exhibited evidence of sooting. The adjacent section of the lower skin (LW8), which is bent upward at the inboard end, exhibited no evidence of sooting. These localized sooting areas show soot on the inside surface only but not on the inside surface of the mating pieces. In some cases, the soot extends to and onto the fracture face, but is not evident on the mating piece or its fracture face.

The lower wing skin inboard of approximately WS 1230 was broken into numerous large pieces. These pieces exhibit a pronounced downward bending condition. There is evidence of exterior sooting on the lower skin pieces from WS 400 to WS 1200. There is no evidence of sooting on the inner surface of the wing lower skin, except on some curled pieces near the rear spar and #1 engine (LW40 and LW41) and in a small (2 square foot) area near the front spar just outboard of the #1 engine (LW9 outboard end).

The upper wing skin from the SOB out to approximately WS 1200 broke into many small segments. These segments vary from a few square inches to a maximum of twenty square feet. Most of the larger pieces are curled upward from an inboard to outboard direction (opposite the direction of the lower skin). There is no evidence of any soot or fire damage to the inner or outer surface of these upper wing skin segments.

The left wing SOB pickle fork fitting (CW1015) and a portion of the terminal fitting attached to small pieces of the rear spar (CW1024) exhibit bending in the aft direction. The fracture features are consistent with bending in the aft direction at both the middle of the pickle fork and the middle of

the terminal fitting. The areas around the left wing rear spar upper surface and the left SOB where the pickle-fork fitting is attached suffered severe damage.

The majority of the stringers (including vent stringers) from the SOB to WS 1220 had separated from the upper and lower skin. These stringers were bent and curled in various directions and were pulled from the skin.

The entire mid spar had separated from the wing upper and lower skin. Some of the mid spar was found in small segments.

Small segments of rear spar remained attached to the lower skin at WS 1230 (3 feet, on LW8) and WS 1485 (5 feet, on LW5). The remaining rear spar was missing or found in small pieces.

Five segments of the front spar remained attached to the lower skin from #1 engine outboard to WS 1280 (LW8 and LW9). Another segment of the front spar remained attached to the lower skin from WS 1400 To WS 1530 (LW5). A third piece of front spar remained attached to a piece of upper wing skin from WS 1280 to WS 1400 (LW10). The remaining front spar was missing or found in small segments.

1.3 Wing Control Surfaces

Most pieces of the leading and trailing edge flaps, ailerons, and spoilers were found in the Green debris area; however, some pieces were found floating and were not associated with a debris field. These pieces showed general impact damage. Many portions of the trailing edge flaps, ailerons, and spoilers and some portions of the leading edge flaps showed fire and/or soot damage.

1.3.1 Flaps

Most of the right-hand wing trailing edge flaps were identified/recovered. The inboard flaps separated into large pieces and show little or no fire or soot damage. There is evidence of severe impact damage, including damage to the honeycomb and associated skin (RW16, RW34, RW33). The outboard flaps separated into numerous smaller pieces and show heavy fire damage. The entire outboard flap sections were recovered and identified, except for a very small area (RW26 to RW32).

The left side inboard fore flap broke in three distinct pieces (LW25). All of these pieces suffered fire damage and severe impact damage. A large section of the inboard mid flap remained attached to the flap track assembly (LW21). The mid flap box suffered severe impact damage. The upper and lower surfaces of the mid flap section also exhibited evidence of fire damage. Only a very small area of the left-hand outboard flaps were identified (a few square feet), and these small pieces were not individually documented.

1.3.2 Flap Tracks

All 8 trailing edge main flap support tracks were recovered (Trailing edge flap support

tracks are numbered, left wing outboard (#1) to right wing outboard (#8)). Left wing flap tracks #1, #2, and #3 exhibited impact damage, with fractures occurring mostly in the forward sections. Flap track assemblies #1 (LW23), #2 (LW43), #3 (LW22) separated from the aircraft primary structure from their forward and aft mounts as individual pieces. All these pieces exhibited evidence of sooting. Flap track #4 (LW21) remained with a section of the mid flap and exhibited sooting. The right wing flap track assemblies, #5 (RW13), #6 (RW23), #7 (RW14), and #8 (RW18), separated from the aircraft primary structure from their forward and aft mounts as individual pieces. Very small portions of the mid flap remained attached to flap track #7 and #8. There is no evidence of fire damage to any of these flap track structures.

1.3.3 Ailerons

All four ailerons were found in pieces, with the largest varying in length from 4 to 8 feet. The left outboard aileron broke in several pieces (LW47, LW34, LW33, LW32) and exhibited evidence of fire damage on some pieces. The inboard aileron broke into two sections near the middle (LW35 and LW36) and had been severely damaged by impact and fire. The right outboard aileron broke into three distinct pieces (RW15). These three sections suffered minor impact damage on the skin surfaces but no fire damage. The inboard aileron actuator and associated mounting bracket (RW17) were recovered from the Green area. The actuator and a small section of aileron structure separated from the remaining aileron structure. No evidence of fire damage was documented.

1.3.4 Spoilers

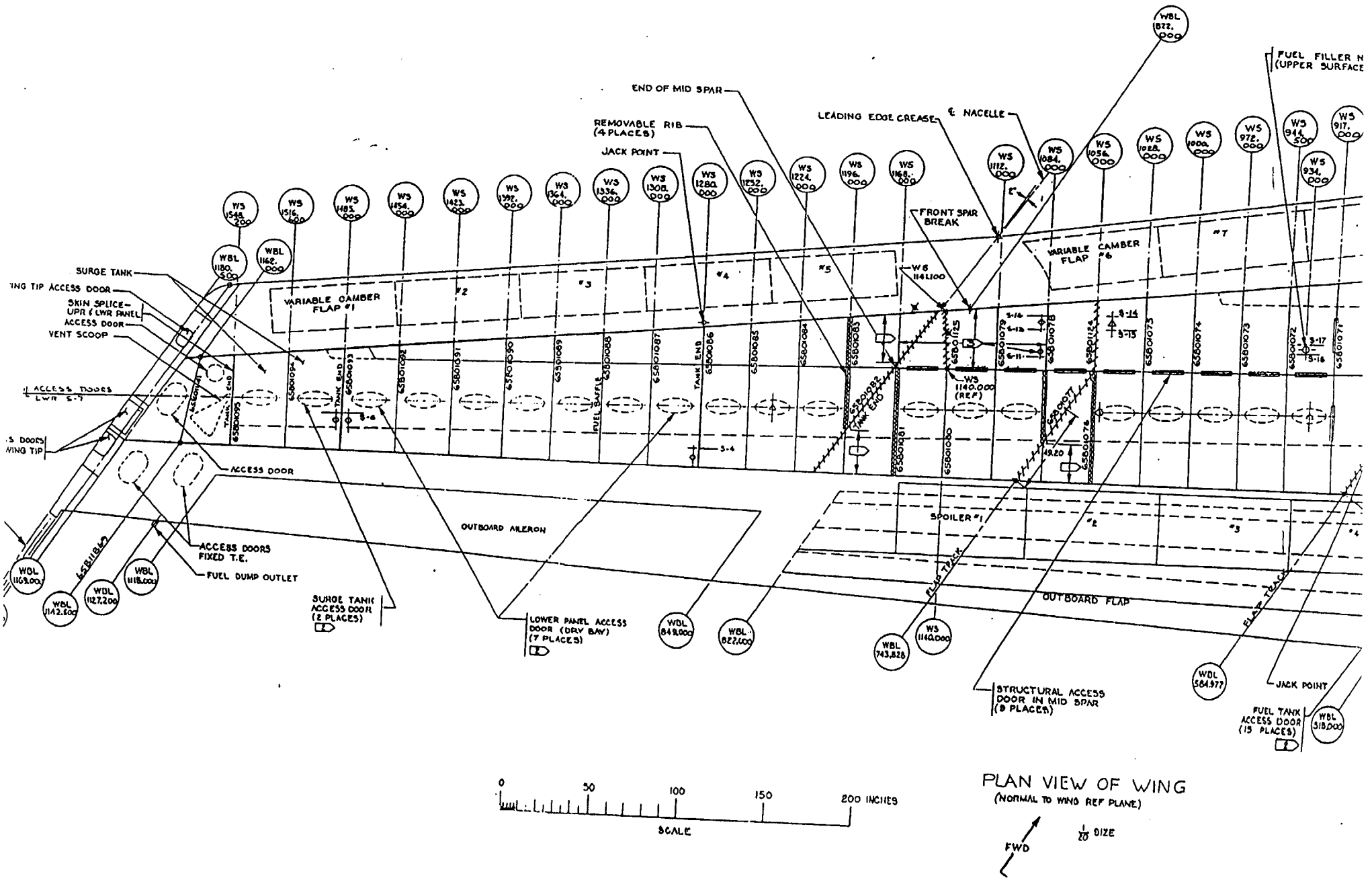
All four inboard spoilers and their actuators were recovered. The inboard-most on each wing (LW24 and RW35) show fire and soot damage, and the outboard-most on each wing show impact tearing and fracture damage.

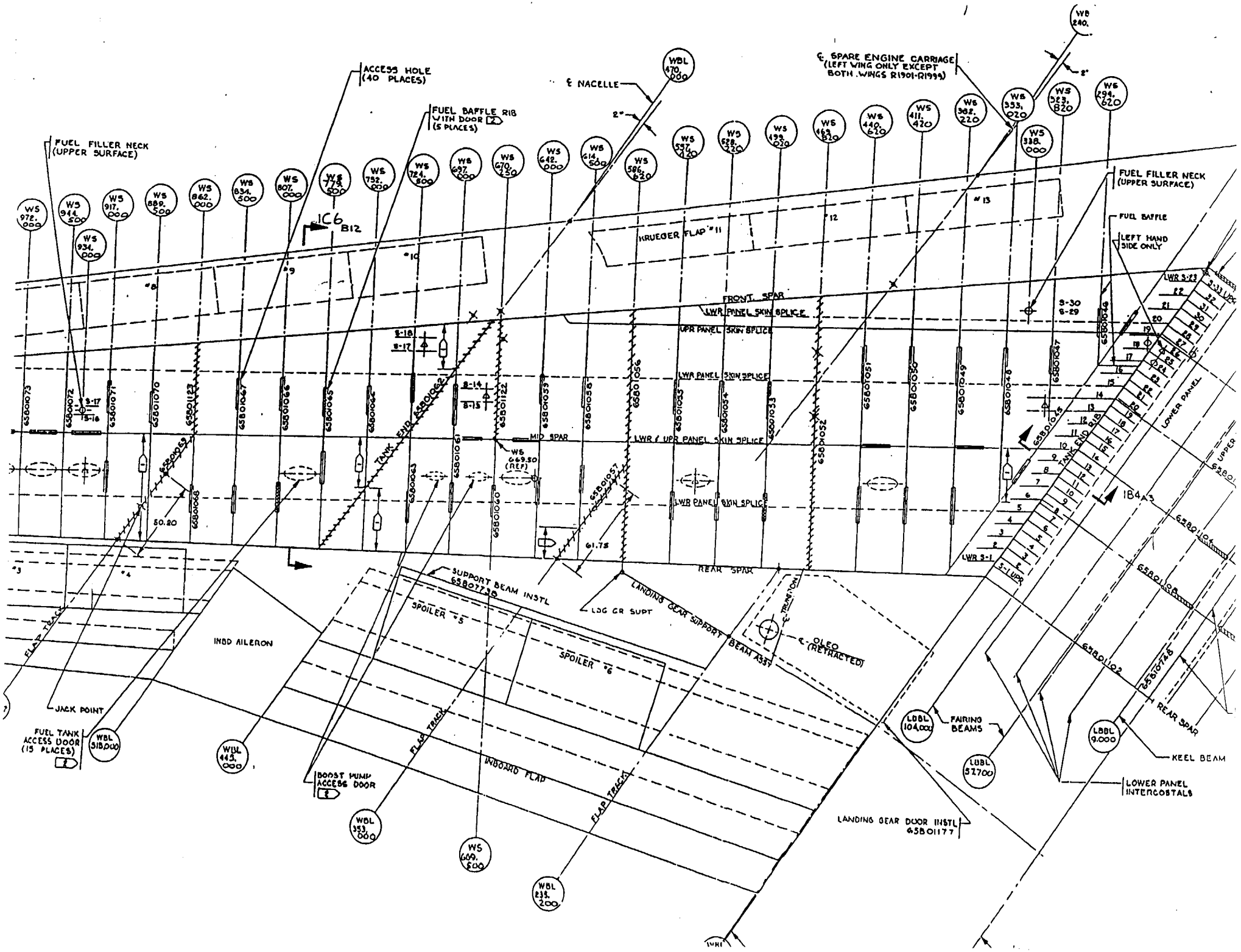
The outboard spoilers on the right wing were still attached to the rear spar (RW3) but were badly burned. The outboard spoilers on the left wing were not identified.

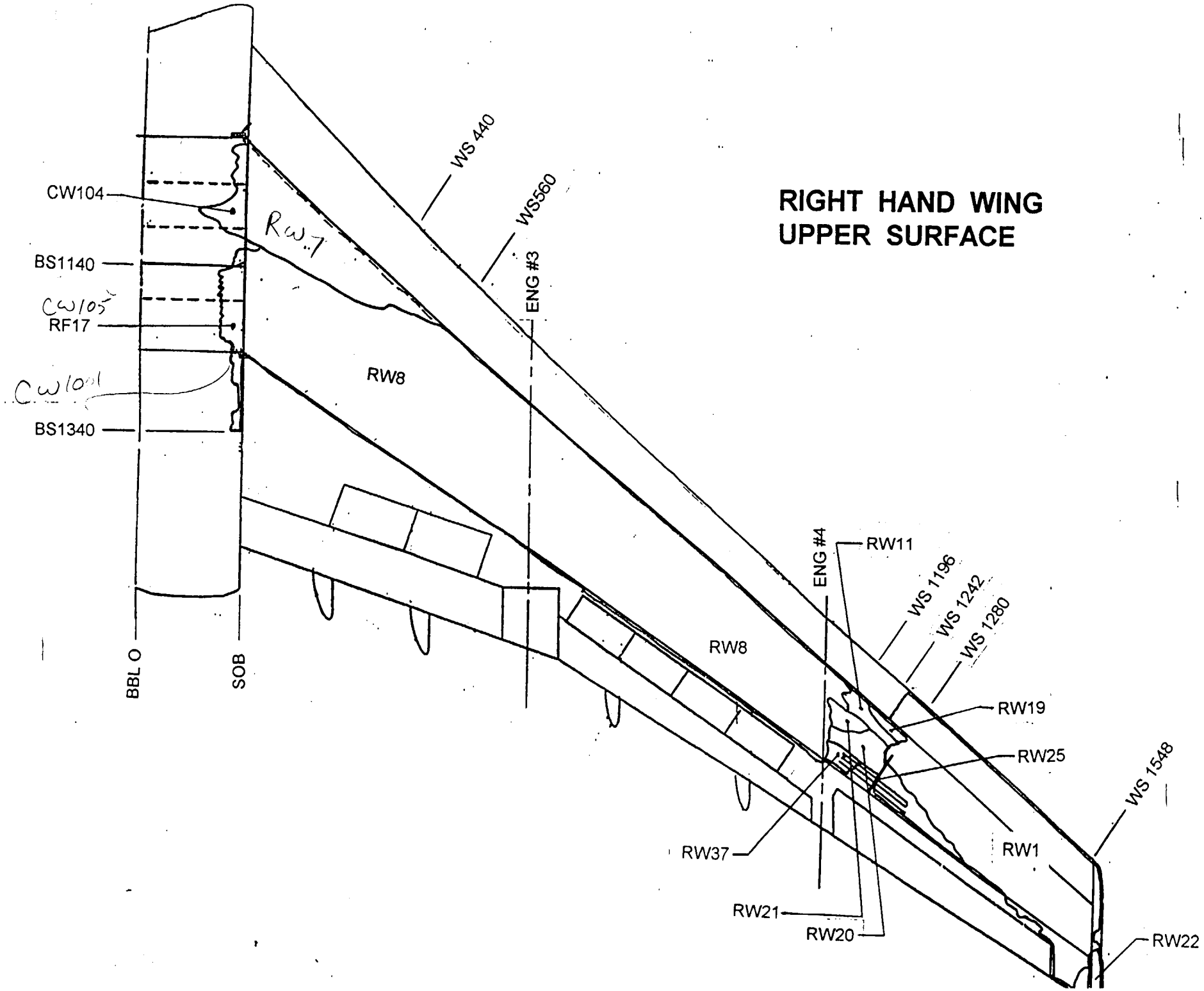
1.3.5 Leading Edge Structure and Fixed Trailing Edge Structure

Fixed trailing edge structure, including supports for panels, spoilers, ailerons, etc., have not been specifically assembled or catalogued. There are many torn, fractured, and/ or burned pieces in the hangar.

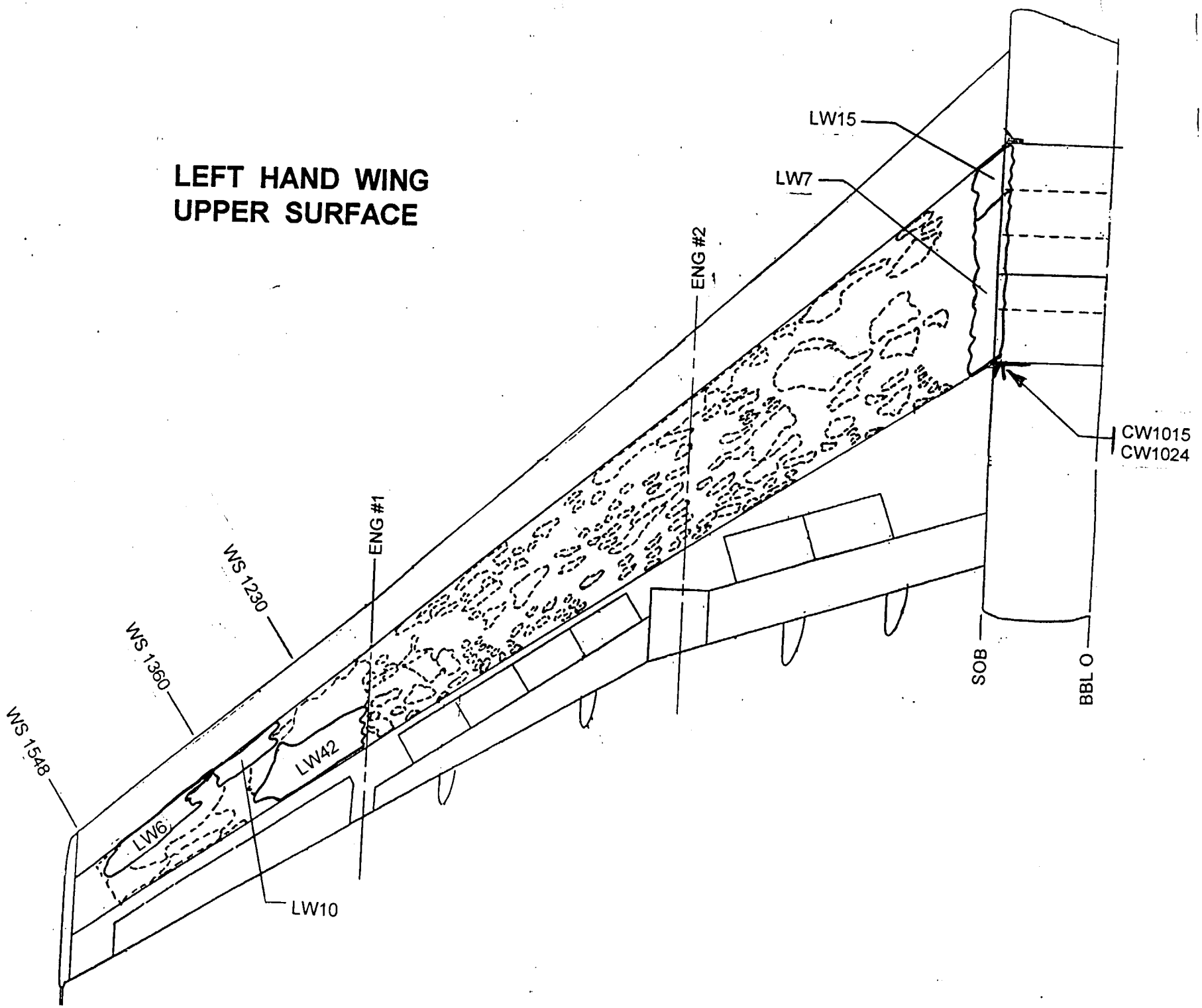
Some leading edge structure, both flaps and fixed components, were assembled (mostly for the left wing), but no significant patterns were observed. Numerous pieces of the right wing leading edge were identified but were not assembled or catalogued. Some pieces have significant fire damage.


END OF MID SPAR
REMOVABLE RIB (4 PLACES)
JACK POINT
LEADING EDGE CREASE
℄ NACELLE
FRONT SPAR BREAK
FUEL FILLER N (UPPER SURFACE
SURGE TANK
WING TIP ACCESS DOOR
SKIN SPLICE - UPR & LWR PANEL
ACCESS DOOR
VENT SCOOP
VARIABLE CAMBER FLAP #1
VARIABLE CAMBER FLAP #6
#2
#3
#4
#5
#7
WS 1140.000 (REF)
ACCESS DOORS LWR S-7
ACCESS DOOR
OUTBOARD AILERON
ACCESS DOORS FIXED T.E.
FUEL DUMP OUTLET
SURGE TANK ACCESS DOOR (2 PLACES)
LOWER PANEL ACCESS DOOR (DRY BAY) (7 PLACES)
SPOILER #1
OUTBOARD FLAP
FLAP TRACK
STRUCTURAL ACCESS DOOR IN MID SPAR (9 PLACES)
JACK POINT
FUEL TANK ACCESS DOOR (15 PLACES)
0
50
100
150
200 INCHES
SCALE
PLAN VIEW OF WING
(NORMAL TO WING REF PLANE)
FWD
1/10 SIZE

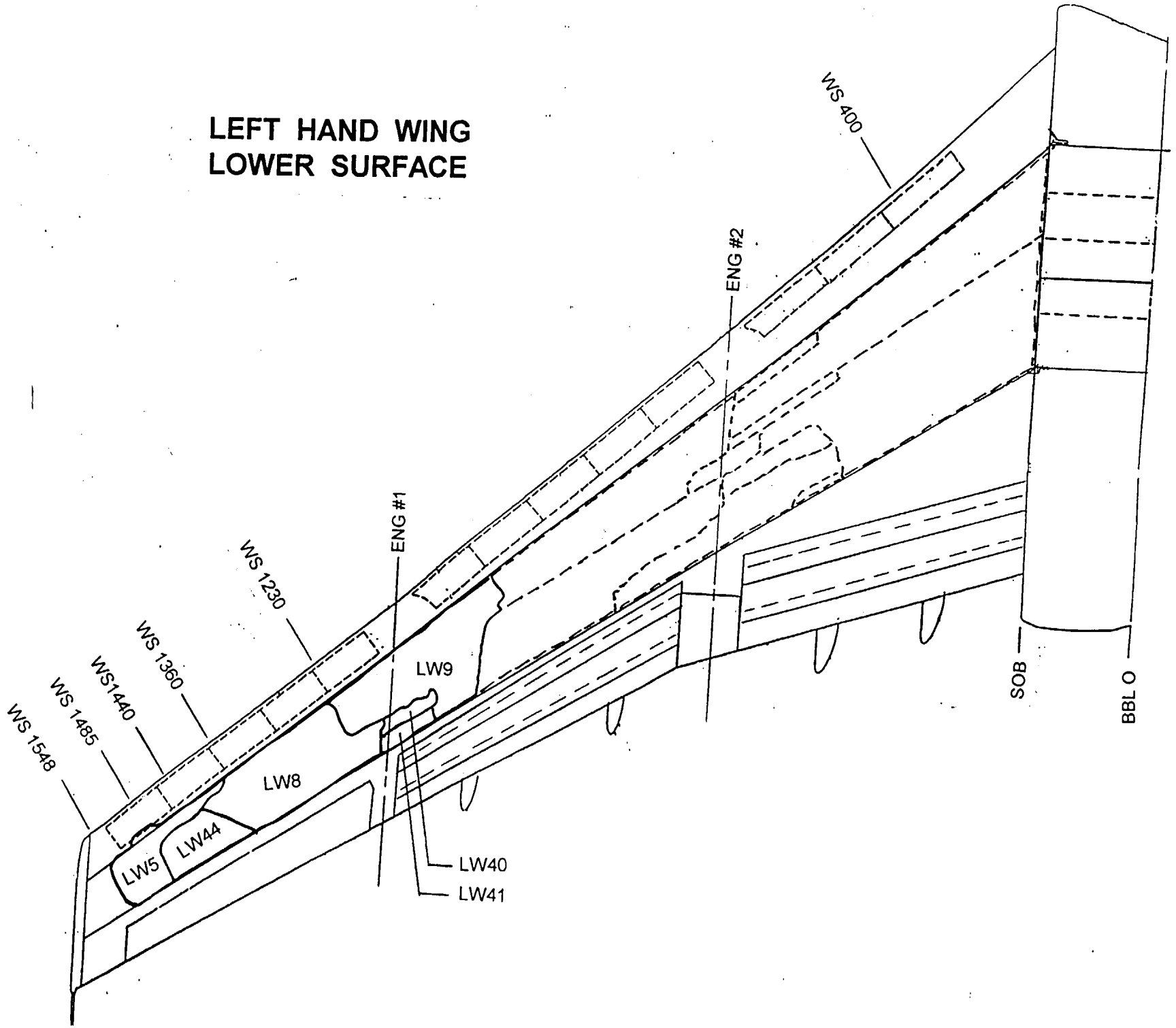

ACCESS HOLE (40 PLACES)
FUEL BAFFLE RIB WITH DOOR (5 PLACES)
℄ NACELLE
℄ SPARE ENGINE CARRIAGE (LEFT WING ONLY EXCEPT BOTH WINGS R1901-R1994)
FUEL FILLER NECK (UPPER SURFACE)
FUEL BAFFLE
LEFT HAND SIDE ONLY
KRUEGER FLAP #11
FRONT SPAR
LWR PANEL SKIN SPLICE
UPR PANEL SKIN SPLICE
MID SPAR
LWR / UPR PANEL SKIN SPLICE
REAR SPAR
TANK END RIB
LOWER PANEL
SUPPORT BEAM INSTL 65807736
LDG GR SUPT
LANDING GEAR SUPPORT BEAM ASSY
℄ TRANSITION
℄ OLEO (RETRACTED)
SPOILER #5
SPOILER #6
INBD AILERON
FLAP TRACK
INBOARD FLAP
JACK POINT
FUEL TANK ACCESS DOOR (15 PLACES)
BOOST PUMP ACCESS DOOR
FAIRING BEAMS
KEEL BEAM
LOWER PANEL INTERCOSTALS
LANDING GEAR DOOR INSTL 65801177
WS 669.50 (REF)
50.20
61.75

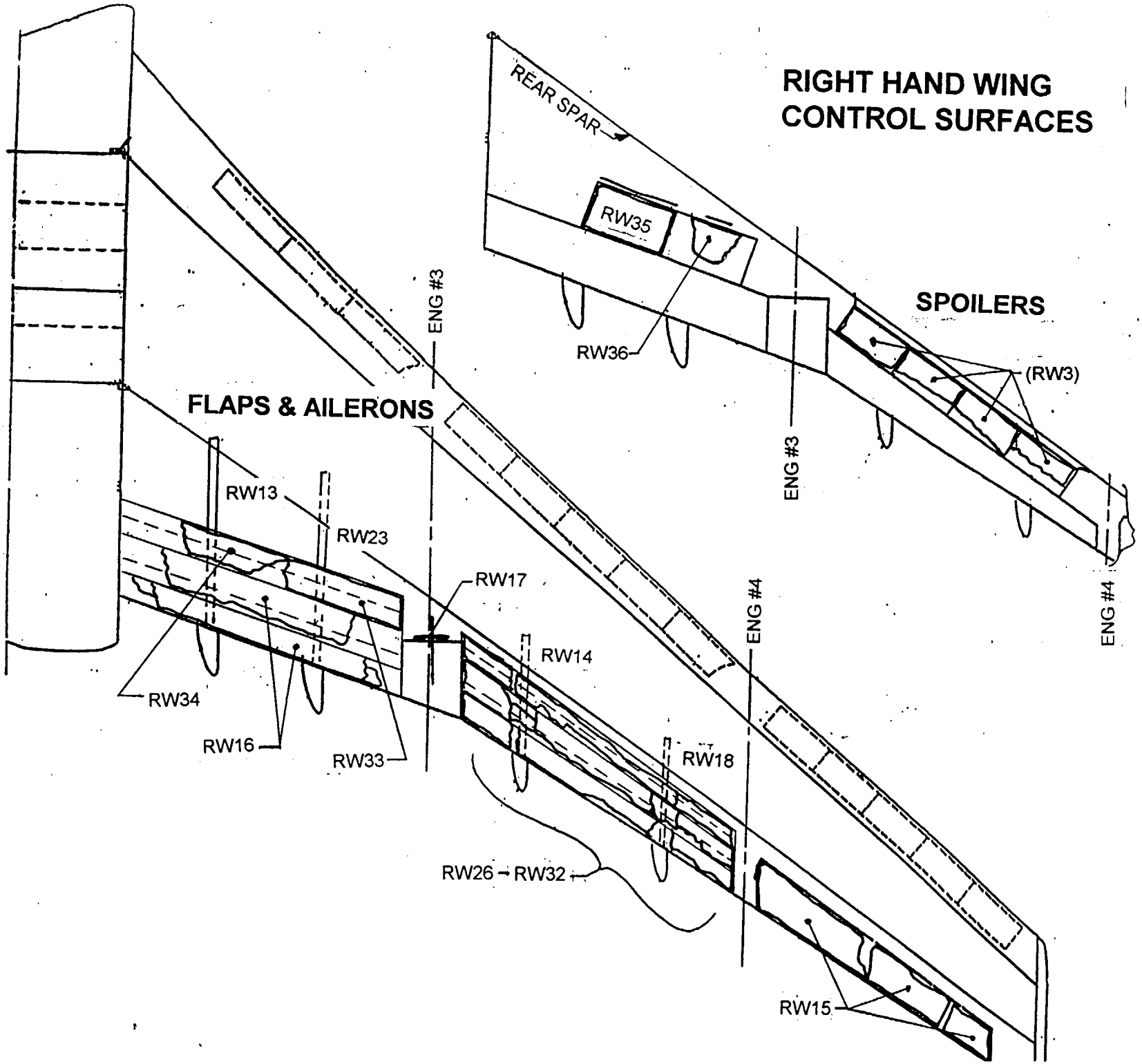

RIGHT HAND WING
UPPER SURFACE
CW104
BS1140
CW105
RF17
CW101
BS1340
BBL O
SOB
WS 440
WS560
ENG #3
RW7
RW8
RW8
ENG #4
RW11
WS 1196
WS 1242
WS 1280
RW19
RW25
WS 1548
RW1
RW37
RW21
RW20
RW22

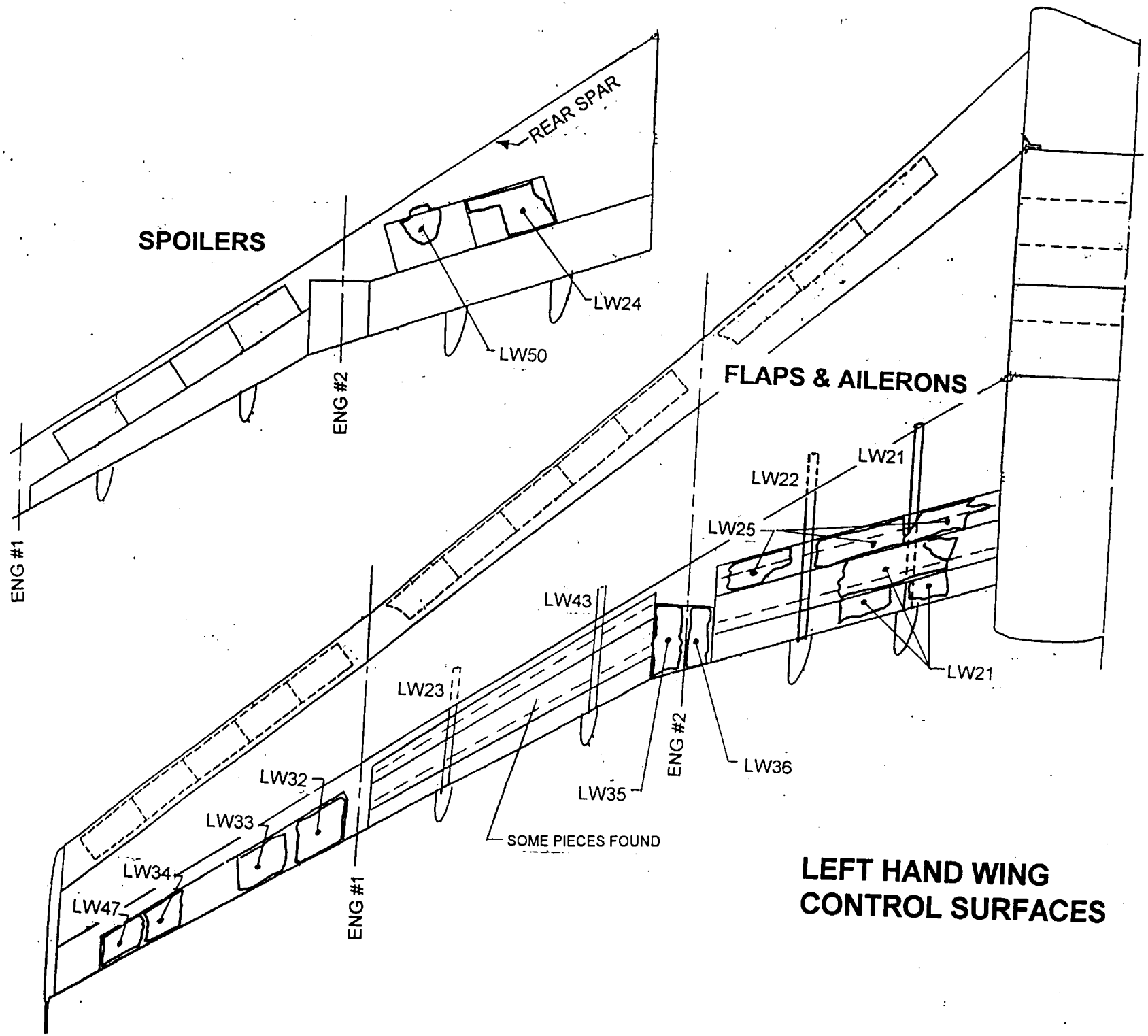
RIGHT HAND WING
LOWER SURFACE


LEFT HAND WING
UPPER SURFACE
LW15
LW7
ENG #2
ENG #1
WS 1230
WS 1360
WS 1548
LW42
LW6
LW10
CW1015
CW1024
SOB
BBL O

LEFT HAND WING
LOWER SURFACE




RIGHT HAND WING
CONTROL SURFACES
REAR SPAR
RW35
RW36
SPOILERS
(RW3)
ENG #3
ENG #3
ENG #4
ENG #4
FLAPS & AILERONS
RW13
RW23
RW17
RW14
RW34
RW16
RW33
RW18
RW26 - RW32
RW15


SPOILERS
REAR SPAR
LW24
LW50
ENG #2
ENG #1
FLAPS & AILERONS
LW21
LW22
LW25
LW43
LW23
LW21
LW32
LW33
LW34
LW47
LW35
ENG #2
LW36
SOME PIECES FOUND
ENG #1
LEFT HAND WING
CONTROL SURFACES