Appendix D
Document Management Tags Database Information

Pieces of wreckage were tagged with color-coded and numbered tags that corresponded to the debris field from which they were recovered. The color-coded tags were usually attached to items promptly upon recovery and before items were transported to the hangar; however, in some cases, items were not tagged until they arrived at the hangar.[674] A data management team consisting of Safety Board investigators, party representatives, and representatives from the Navy and its contractor Oceaneering Advanced Technology, Inc.,[675] compiled a database from wreckage logs completed when recovered items were tagged. Subsequently, the team cross-checked the information in this database against all available sources of recovery information, including diver logs, ship records, photographs, videotapes, target assignments, FBI evidence records, and identification of parts made by investigative team members, to ensure that the most valid information was contained in the tags database system.

Of the 3,168 recovered items that received color-coded identification tags on the ships, 645 items were recovered from the red zone, 462 items were recovered from the yellow zone, and 1,885 items were recovered from the green zone. In addition, 176 items were recovered from other locations (orange), were found floating (blue), or were recovered from unknown locations (white).[676] Additionally, 1,444 recovered items arrived (or were discovered) at the hangar without tags. Of the 1,444 hangar tags, 1,210 were assigned to items recovered during the dive operation, and 234 were assigned to items recovered during the trawling operation.[677] Untagged pieces were tagged, if necessary.

When each piece of wreckage arrived at the hangar in Calverton, it was examined by members of the Structures Group, who, when possible, identified the portion of the airplane from which the wreckage piece had originated. A log number was generated for

[674] Although most pieces of wreckage were ship-tagged, during salvage and reconstruction efforts it occasionally became necessary to cut or separate objects (previously tagged as a whole) into more than one piece, leaving some untagged portions. Additionally, some objects were extracted from an entangled group of debris (recovered and tagged as a unit); in some cases, pieces were received in a bag, net, or box full of other items with one tag assigned to the container. Finally, some parts simply broke during handling/transport, leaving some parts untagged. In all of these situations, the recovery position information on the ship tag from the original object or group of objects was transferred to the hangar tag(s) assigned to the separated object(s). All large and small pieces of wreckage that were identifiable and considered significant were tagged.

[675] Representatives from the Federal Bureau of Investigation (FBI) and the Structures and Airplane Interior Documentation Groups also participated in this effort at various times, as needed.

[676] Some floating and/or washed ashore items received blue tags, and others received white tags.

[677] Tags that were color coded to reflect the debris zones (red, yellow, or green) were assigned to trawled items based on the zone in which the item was recovered. Color-coded tags were also assigned to the remaining 1,210 items tagged in the hangar. Of these, 145 corresponded to the known recovery zone, and the remaining 1,065 were assigned color-coded tags based on the probable recovery zone, which was identified by cross-referencing the FBI lot number of the previously untagged item with the ship-tagged items in the same lot.

the pieces that could be structurally identified, and pieces were further examined, sketched, and photographed, as appropriate. Log numbers were written on the piece of wreckage and on a separate tag that was attached to the piece. Log number classifications subdivided the wreckage into 12 subgroups and used the following nomenclature (XX denotes the number assigned to an individual piece):

LF-XX	Left fuselage
RF-XX	Right fuselage
LW-XX	Left wing
RW-XX	Right wing
H-XX	Horizontal stabilizer (both sides)
LE-XX	Left elevator
RE-XX	Right elevator
V-XX	Vertical stabilizer
R-XX	Rudder
CW-1XX	Wing center section (WCS)—upper skin
CW-2XX	WCS—lower skin
CW-3XX	WCS—right side-of-body rib
CW-4XX	WCS—left side-of-body rib
CW-5XX	WCS—front spar
CW-6XX	WCS—spanwise beam (SWB) 3
CW-7XX	WCS—SWB2
CW-8XX	WCS—mid spar
CW-9XX	WCS—SWB1
CW-10XX	WCS—rear spar
CW-11XX	WCS—butt line zero rib
FBM-XX	Floor beam
LG-XX	Landing gear

This wreckage documentation was maintained in a massive database that was cross-referenced by investigative groups during the investigation. This database contained details related to each piece, such as recovery location, extent and type of damage, photographs, sketches, and Boeing's engineering drawings depicting the part's location on the airplane.

Migration of TWA Flight 800 Debris

During the first few days of recovery efforts, investigators used ocean current data to predict where pieces of wreckage would have come to rest on the ocean floor. After confirming wreckage locations through the use of side-scan sonar (SSS) equipment, investigators and recovery crews were able to focus their recovery efforts productively. Pieces of wreckage important to the investigation (sequencing and trajectory efforts) were located and recovered during the first month after the accident in the positions initially identified by SSS equipment. However, as recovery efforts continued, it was necessary to expand the area searched by the SSS equipment, in part, because ocean currents resulted in the continual shifting of the sediment on the ocean floor and migration (and/or concealment) of pieces of wreckage.[678]

[678] Although the positions of heavier pieces of wreckage would be less affected by ocean currents than those of lighter pieces, such items would be subject to concealment by shifting sediment on the ocean floor.

Appendix E
Accident Airplane Maintenance Records

The National Transportation Safety Board's review of the accident airplane's maintenance records revealed numerous fuel system-related maintenance writeups during the 2 years before the accident. The accident airplane's maintenance records described the following discrepancies, which occurred during refueling, and the resultant maintenance actions:

- Nonroutine Maintenance Record—December 16, 1995. The airplane would not accept fuel. The volumetric control was replaced, and the system operation checked normal.
- Nonroutine Maintenance Record—April 21, 1996. The airplane would not accept fuel. The four main fuel tanks were pressure-fueled. A followup check indicated that the system operated normally during ground fueling.
- Aircraft Maintenance Log—April 28, 1996. The airplane's wing refueling valves closed continuously for no apparent reason. The fueler was able to fuel by moving the fuel switch back and forth between the normal and battery positions. The connector at the fueling panel was cleaned, and the anomaly was listed on the Open Item Work Sheet to correct, as required.
- Aircraft Maintenance Log—April 30, 1996. The airplane's fueling system shut down, and the airplane would not accept fuel. The item was deferred until May 1, 1996, when the fueling panel magnet was replaced, and the system operation checked normal.
- Aircraft Maintenance Log—May 2, 1996. (This writeup references the April 30, 1996, logbook entry above.) The airplane's No. 4 main fuel gauge volumetric switch shut off at "22.4," and the volumetric switch in the main electrical service bay shut off all the fueling valves at the under-wing fueling station. The item was deferred until May 5, 1996, when the R118 ground handling No. 2 relay was replaced because there was "no power at B2 terminal, and only 19 vdc [volts direct current] on the external power output." The system operation checked normal.
- Nonroutine Maintenance Record—May 15, 1996. The fuse and fuse holder were missing from the volumetric controller. Both fuses were replaced.
- Nonroutine Maintenance Record—May 23, 1996. The airplane would not accept fuel. The fueling panel magnet was replaced, the panel was secured, and the system operation checked normal.
- Nonroutine Maintenance Record—June 4, 1996. The airplane's fueling system shut down while fueling. The volumetric switch and valves were cycled several times, and the system subsequently checked normal. When the

auto-fuel shut off about 80,000 to 85,000 pounds, the overfill circuit breaker was pulled to continue fueling. Maintenance personnel suspected that the No. 1 reserve or main refuel valve was not shutting completely.

- Aircraft Maintenance Log—July 7, 1996. All fuel valves shut off during fueling and did not open electrically. The surge tank was sumped; all of the valves then operated normally.

The accident airplane's three logbook entries regarding fuel leaks indicated the following:

- Aircraft Maintenance Log—September 23, 1995. During the preflight walk-around inspection, the flight engineer observed fuel dripping from the left wing dump chute while fueling was in progress. The drip stopped when fueling was terminated. The aircraft maintenance log entry contained the following engineering note: "this is an abnormal condition, possible dump valve problem. Pressure fuel system." No further leaks were noted.
- Nonroutine Maintenance Record—June 18, 1996. The No. 3 engine was removed because of an overtemperature, and a replacement engine was installed. The maintenance record indicated that maintenance personnel checked the operation of the cross-feed valve as part of the replacement engine installation in accordance with the maintenance manual instructions. During this procedure, an eight drop-per-minute leak was noted at the fuel shut-off valve. The logbook entry indicated that this leakage was within the limits specified in the maintenance manual, which states that leakage cannot exceed 20 drops per minute.
- Aircraft Maintenance Log—July 10, 1996. A small amount of fuel was found dripping from the flap assembly on the left wing behind the No. 2 engine. Maintenance personnel tightened the No. 1 main control fueling valve core mounting screws; no further leaks were noted.

The following text describes the 25 logbook entries regarding fuel flow; fuel gauge indications, inaccuracies, and fluctuations; and inoperable fuel system equipment and the corrective actions taken:

- Aircraft Maintenance Log—July 9, 1994. The "total fuel indication drums hang up and rotate along with the gross weight drums when gross weight is adjusted with set knob." The item was deferred until July 12, 1994, when the fuel totalizer indicator was replaced and the system was calibrated in accordance with the maintenance manual; the system subsequently passed a functional test.

- Aircraft Maintenance Log—July 30, 1994. The flight engineer's No. 2 engine fuel flow read higher than the other engines. A cross-feed check with the fuel used indicator and a quantity decrease confirmed a high fuel flow. All other engine parameters were normal. The fuel flow power supply was replaced, and the system passed a functional test.
- Aircraft Maintenance Log—August 1, 1994. Repeat of July 30, 1994, writeup. The item was deferred until August 3, 1995, when the No. 1 engine fuel flow transmitter was removed and replaced. The engine was run and fuel flow transmitter operation appeared normal; no leaks were noted.
- Aircraft Maintenance Log—August 4, 1994. The No. 1 reserve fuel tank lost fuel during flight. Maintenance personnel checked under the wing and the fuel transfer valve for leaks; none were found. The fuel quantity gauge reading matched the drip stick quantity indication. The fuel tank sumps were drained.
- Aircraft Maintenance Log—August 10, 1994. The No. 1 reserve fuel tank lost fuel during flight. The fuel tank sumps were drained, and the fuel quantity gauge reading matched the drip stick quantity indication. The item was deferred until August 18, 1994, when the No. 1 reserve fuel tank successfully completed an operational check.
- Aircraft Maintenance Log—November 21, 1994. The No. 1 reserve fuel quantity indicator was inoperative. The indicator connector was cleaned and reseated, and the indicator operation checked normal.
- Aircraft Maintenance Log—February 3, 1995. The fuel totalizer indication was inaccurate. The ramp indicator indicated 241,200 pounds of fuel on board, and the fuel totalizer indicated 246,700 pounds. Maintenance personnel indicated that fuel totals were within maintenance manual limits.
- Aircraft Maintenance Log—February 3, 1995 (after another flight). The fuel totalizer indication was inaccurate. The ramp indicator indicated 187,500 pounds of fuel on board, and the fuel totalizer indicated 191,400 pounds. During flight, the totalizer indication was consistent with the total of the individual gauge quantity indications. The item was deferred until February 5, 1995, when the totalizer was recalibrated in accordance with the maintenance manual procedures, and its operation checked normal.
- Aircraft Maintenance Log—February 11, 1995. The captain's No. 2 fuel flow indication was inaccurate (high). The fuel used indication was high from engine start until takeoff. Maintenance personnel tested the fuel flow module, and its operation checked normal.
- Aircraft Maintenance Log—April 28, 1995. The fuel temperature indication was lower than the actual temperature in all positions (15° low on Nos. 1, 3, and 4 engines; 20° low on No. 2 engine). The item was deferred until April 29, 1995, when the fuel temperature indicator was removed and replaced.

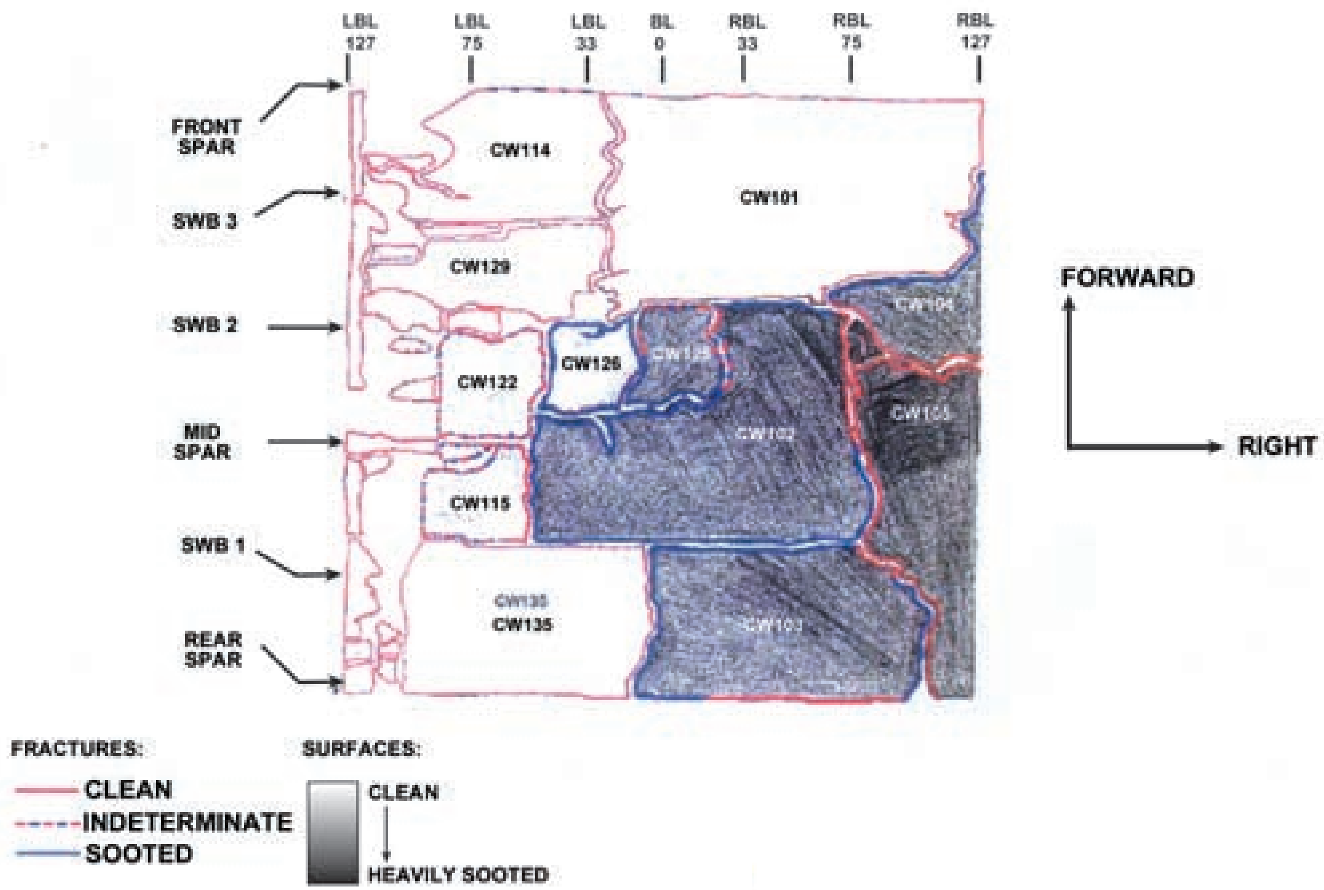
- Aircraft Maintenance Log—May 5, 1995. The fuel temperature indication for engine No. 2 was higher than the actual temperature. The item was deferred until May 6, 1995, when the fuel temperature bulb was removed and replaced.
- Aircraft Maintenance Log—May 18, 1995. The gross weight/total fuel weight indication was inaccurate. This gauge indicated 1,500 pounds less than the sum of the individual tank gauges. The item was deferred until May 21, 1995, when the indicator checked within maintenance manual limits.
- Aircraft Maintenance Log—July 20, 1995. The No. 1 main fuel tank quantity indicator was inaccurate. The item was deferred until August 5, 1995, when the No. 1 main fuel tank quantity indicator was removed and replaced. Full and empty capacitance was checked, and the indicator and totalizer were calibrated per maintenance manual references. All of the systems checked normal.
- Aircraft Maintenance Log—August 3, 1995. An engineering note stated that the No. 1 fuel gauge should be placarded inoperative because of an "existing fuel problem. Suspect possibility of fuel siphoning from the number 1 tank (when boost pumps are off) into fuel manifold." No external fuel leaks were noted, and no transfer of fuel occurred when the fuel manifolds were pressurized. Engine fuel burn appeared normal. The item was closed out on August 21, 1995.
- Aircraft Maintenance Log—August 4, 1995. An engineering note stated that the center wing fuel tank (CWT) fuel quantity indicator showed 1,300 pounds when the analog fuel quantity needle indicated that the tank was empty. The item was deferred until August 5, 1995, when the CWT fuel quantity indicator was removed and replaced. Full and empty capacitance was checked, and the indicator and totalizer were calibrated per maintenance manual references. All of the systems checked normal.
- Aircraft Maintenance Log—August 15, 1995. The flight engineer's fuel flow indicator was inoperative. Examination revealed no problems with the fuel or the forward panel fuel flow indicator. The No. 4 fuel flow indicator was removed and replaced, and the system checked normal.
- Aircraft Maintenance Log—August 23, 1995. The flight engineer's No. 4 fuel flow indicator stuck at 7,900 pounds. The pilot's fuel flow gauges were normal. The item was deferred until August 24, 1995, when the fuel flow indicator was removed and replaced.
- Aircraft Maintenance Log—October 9, 1995. An engineering note indicated that the wing quantity gauges and the flight engineer's fuel quantity gauges were to be checked against the actual fuel quantity before the airplane was fueled because of fuel quantity discrepancies. According to the note, all operations checked normal.
- Nonroutine Maintenance Record—December 1, 1995. The No. 1 engine fuel flow indicator was inoperative. Maintenance personnel checked the fuel flow, and all operations checked normal.

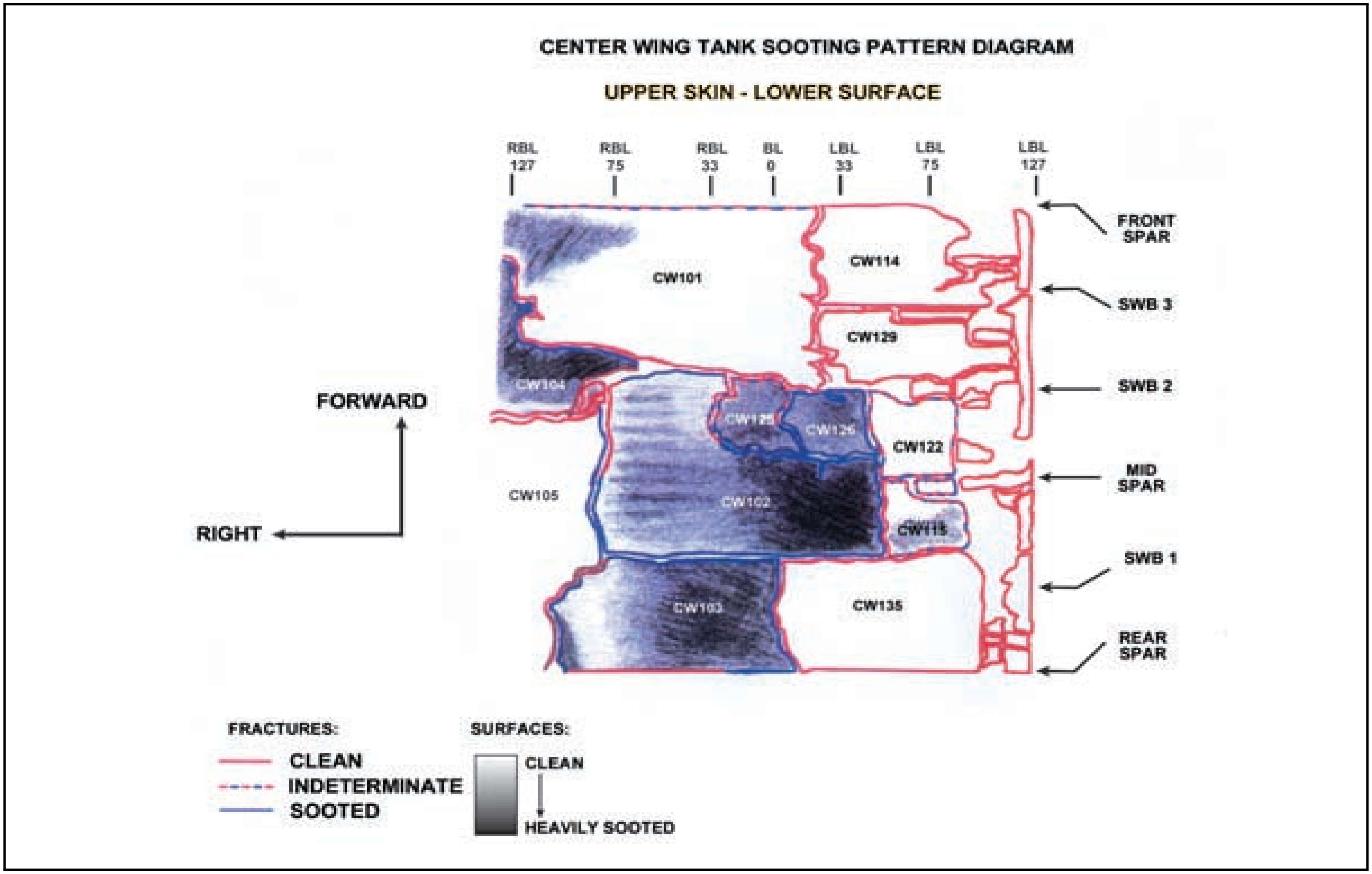
- Aircraft Maintenance Log—December 4, 1995. The flight engineer's No. 1 engine fuel flow indicator was inoperative. The fuel flow indicator was replaced, the No. 1 fuel flow transmitter connector was cleaned, and the indicator appeared to operate normally.
- Aircraft Maintenance Log—December 17, 1995. The No. 4 reserve fuel tank quantity indicator was inoperative. The item was deferred until December 17, 1995, when the wing and cockpit indicators were replaced. The cockpit and wing indicators' full and empty indications were calibrated, and volumetric operations checked normal.
- Aircraft Maintenance Log—December 17, 1995. The CWT fuel quantity gauge indication was erratic and fluctuated between 0 and 2,000 pounds when the CWT was empty. The indicator calibration full/empty volumetric totalizer was replaced, and the gauge appeared to operate normally.
- Aircraft Maintenance Log—December 28, 1995. The No. 1 engine fuel flow indication fluctuated. The item was deferred until January 1, 1996, when a byte check was performed on the fuel flow amperage.
- Aircraft Maintenance Log—April 27, 1996. The No. 1 engine fuel flow numerals indicated 10,000 pounds per hour above the pointer value. The fuel used and pilot's gauges appeared to indicate normally. The No. 1 engine fuel flow indicator was replaced and appeared to operate normally.
- Aircraft Maintenance Log—May 13, 1996. Both of the No. 4 engine fuel flow indicators were pegged high and inoperative. The item was deferred until May 15, 1996, when maintenance personnel performed a byte check on the electronic unit. All tests were passed, and maintenance personnel suspected wiring. On May 16, 1996, maintenance personnel cleaned and secured the fuel flow transmitter connector with no improvement noted. On May 18, 1996, maintenance personnel replaced the No. 4 transmitter, and the engine fuel flow operation checked normal.

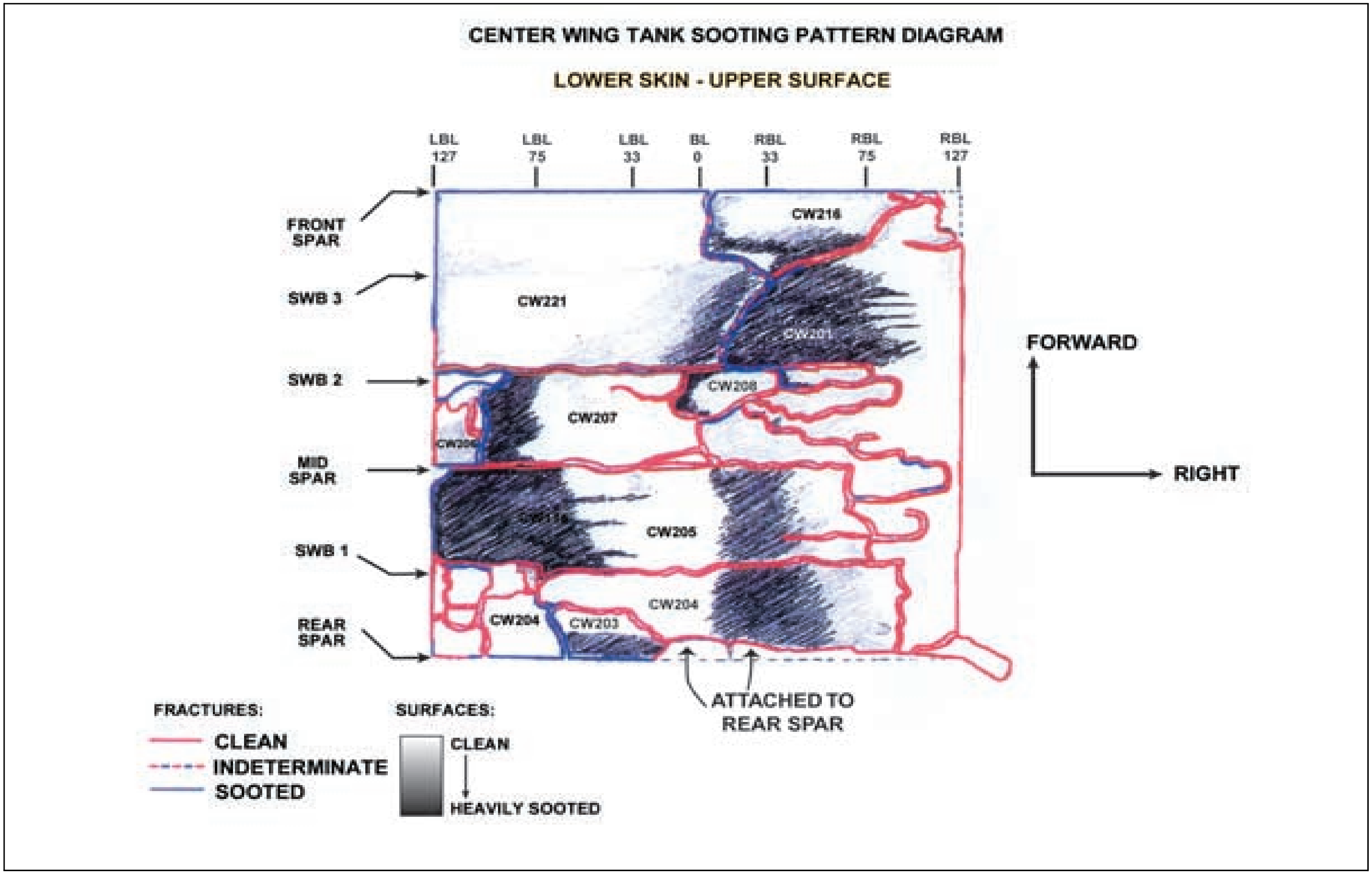
Appendix F
Sooting and Fracture Diagrams

CENTER WING TANK SOOTING PATTERN DIAGRAM

UPPER SKIN - UPPER SURFACE

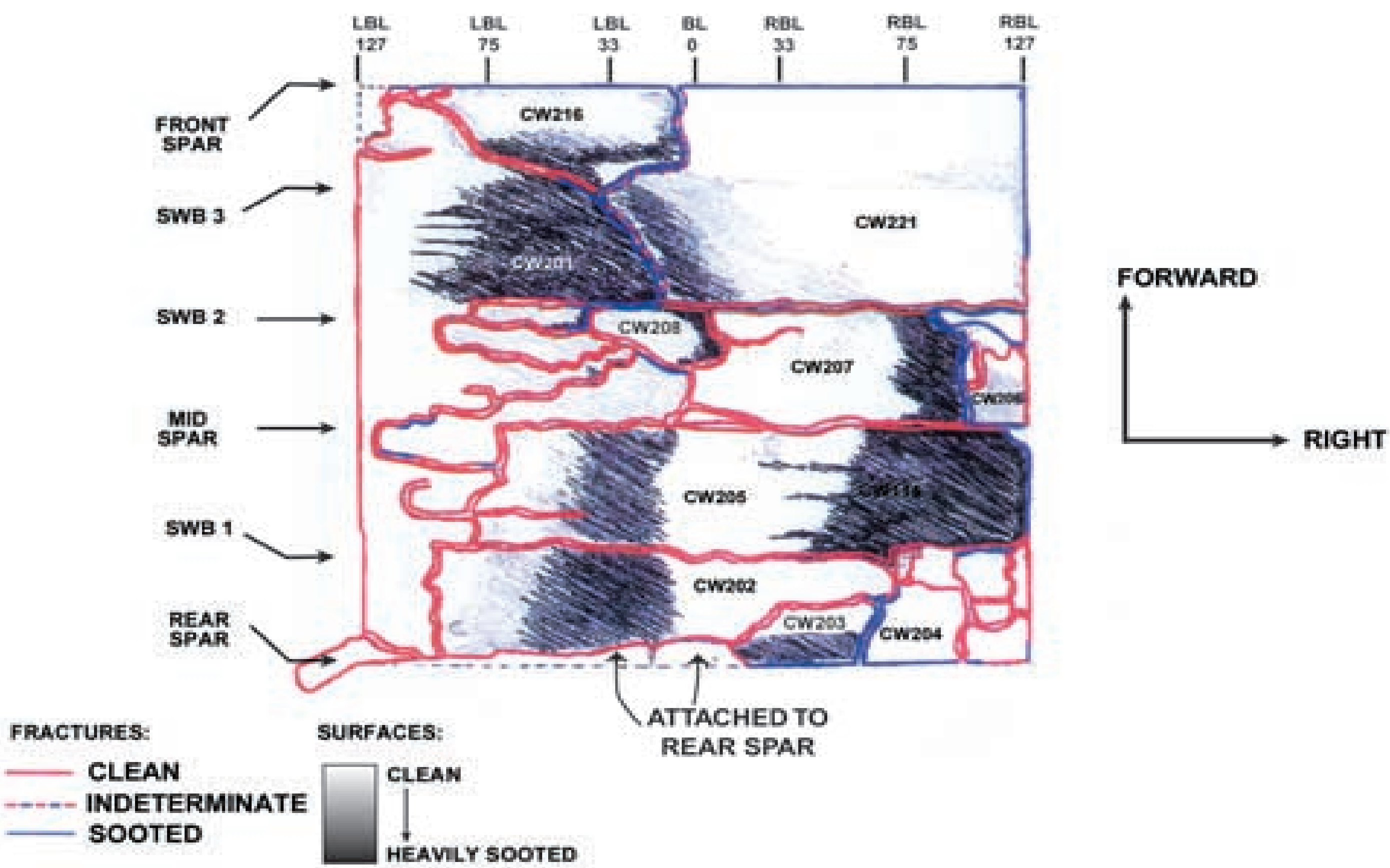


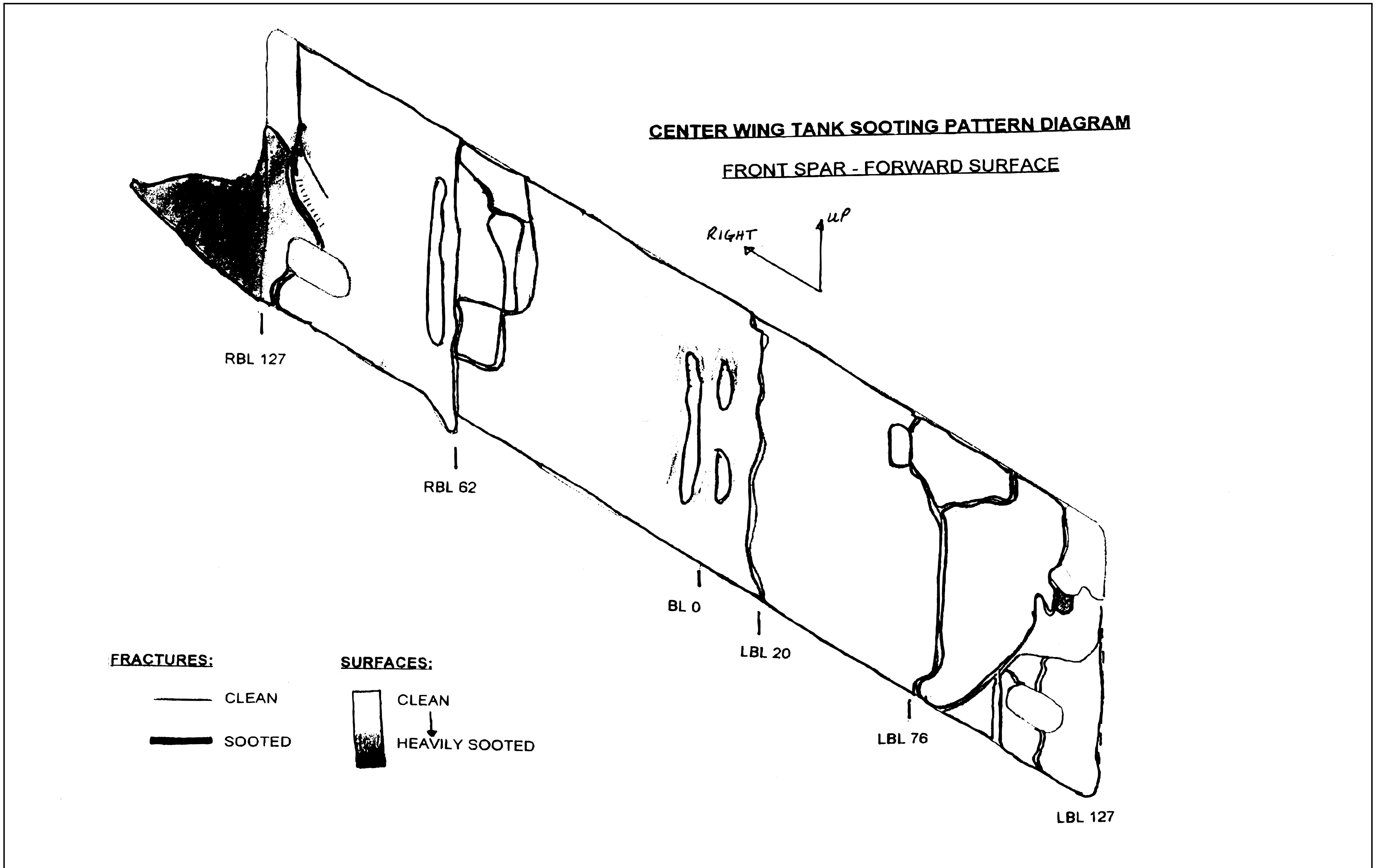

CENTER WING TANK SOOTING PATTERN DIAGRAM
UPPER SKIN - LOWER SURFACE
RBL 127
RBL 75
RBL 33
BL 0
LBL 33
LBL 75
LBL 127
FRONT SPAR
SWB 3
SWB 2
MID SPAR
SWB 1
REAR SPAR
CW101
CW114
CW129
CW104
CW125
CW126
CW122
CW105
CW102
CW115
CW103
CW135
FORWARD
RIGHT
FRACTURES:
CLEAN
INDETERMINATE
SOOTED
SURFACES:
CLEAN
HEAVILY SOOTED

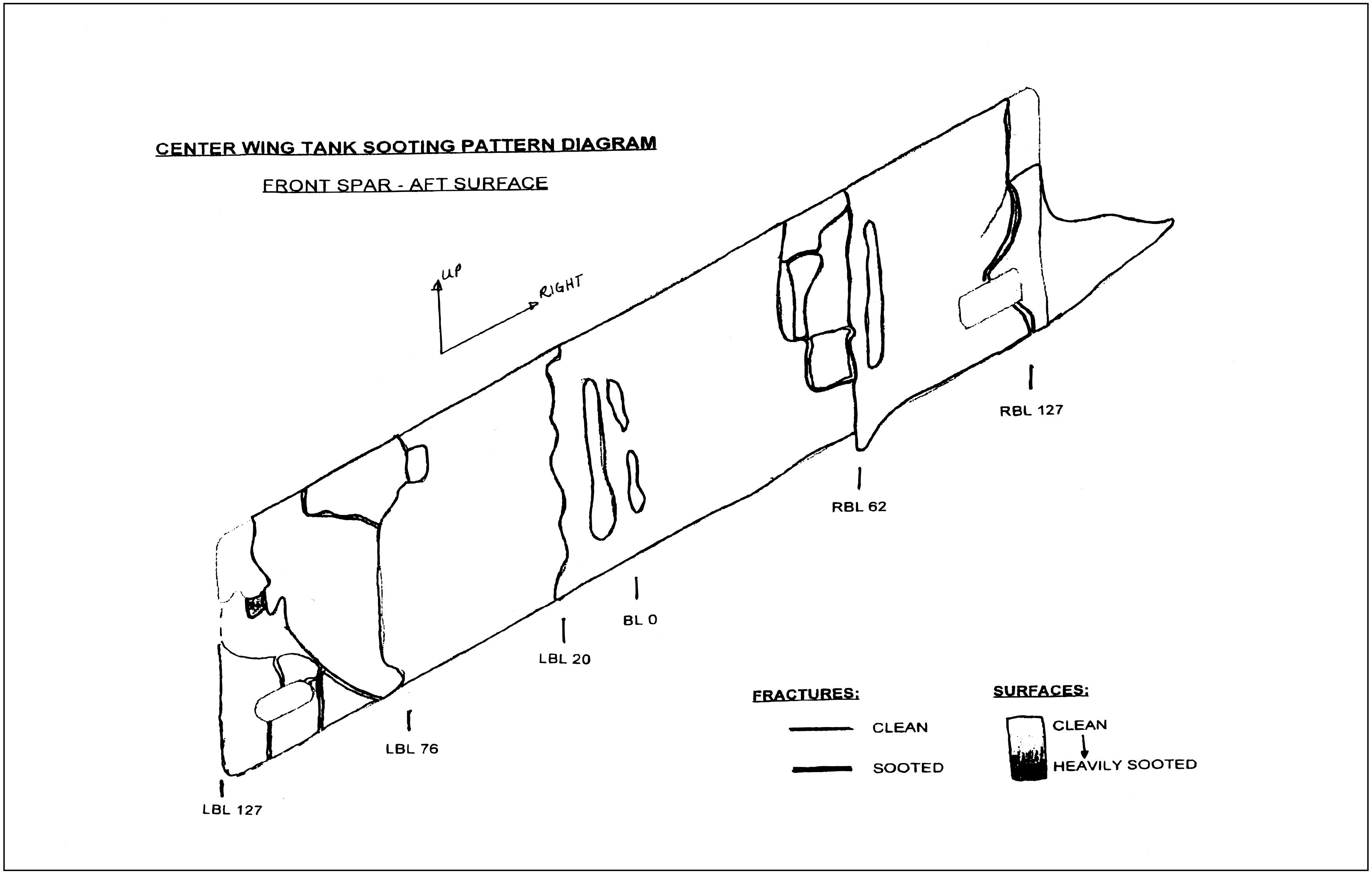

CENTER WING TANK SOOTING PATTERN DIAGRAM
LOWER SKIN - UPPER SURFACE
LBL 127
LBL 75
LBL 33
BL 0
RBL 33
RBL 75
RBL 127
FRONT SPAR
SWB 3
SWB 2
MID SPAR
SWB 1
REAR SPAR
CW216
CW221
CW201
CW208
CW207
CW205
CW204
CW204
CW203
FORWARD
RIGHT
ATTACHED TO REAR SPAR
FRACTURES:
CLEAN
INDETERMINATE
SOOTED
SURFACES:
CLEAN
HEAVILY SOOTED

CENTER WING TANK SOOTING PATTERN DIAGRAM

LOWER SKIN - LOWER SURFACE

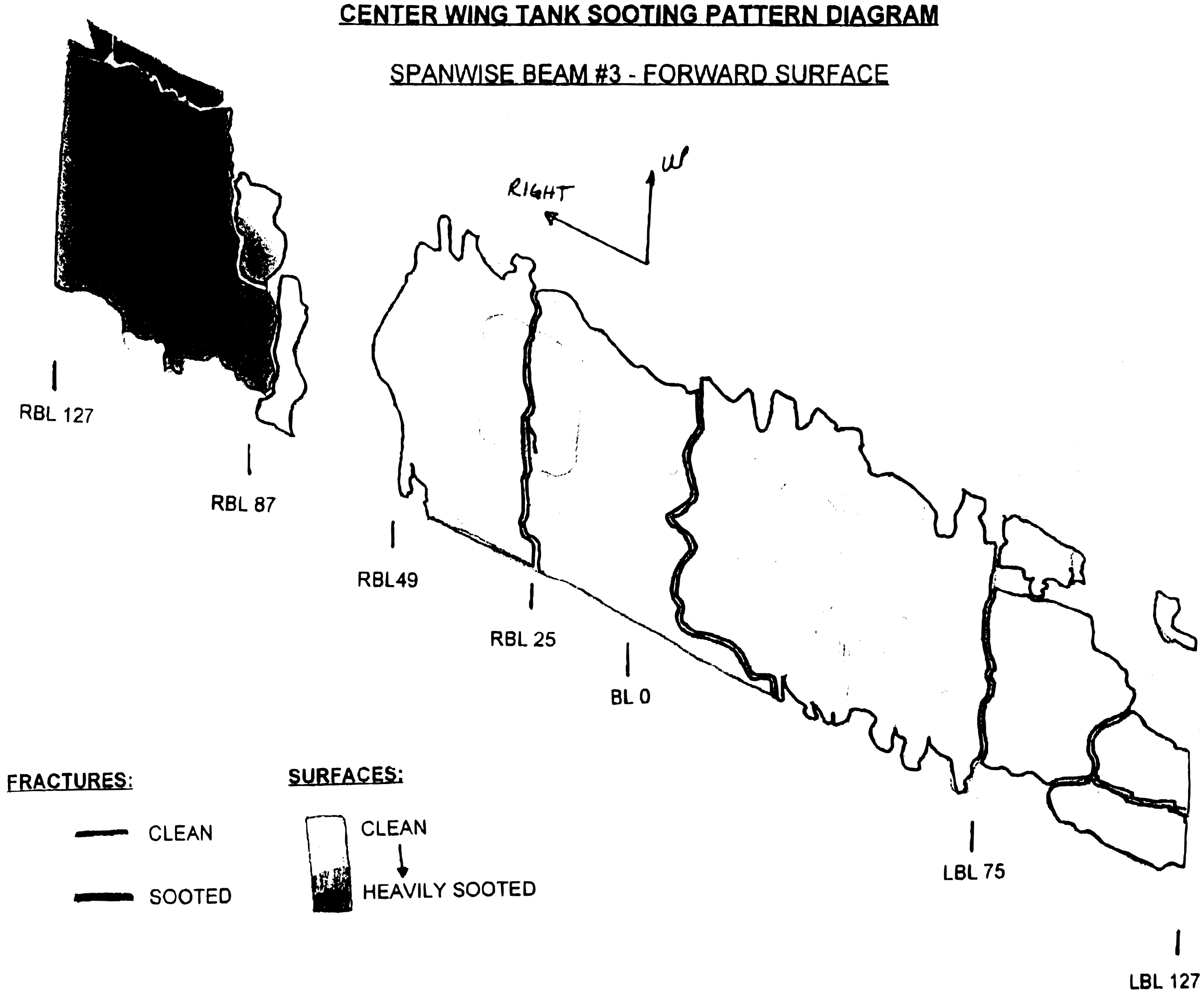



CENTER WING TANK SOOTING PATTERN DIAGRAM
FRONT SPAR - FORWARD SURFACE
RIGHT
UP
RBL 127
RBL 62
BL 0
LBL 20
LBL 76
LBL 127
FRACTURES:
CLEAN
SOOTED
SURFACES:
CLEAN
HEAVILY SOOTED


CENTER WING TANK SOOTING PATTERN DIAGRAM
FRONT SPAR - AFT SURFACE
UP
RIGHT
LBL 127
LBL 76
LBL 20
BL 0
RBL 62
RBL 127
FRACTURES:
CLEAN
SOOTED
SURFACES:
CLEAN
HEAVILY SOOTED

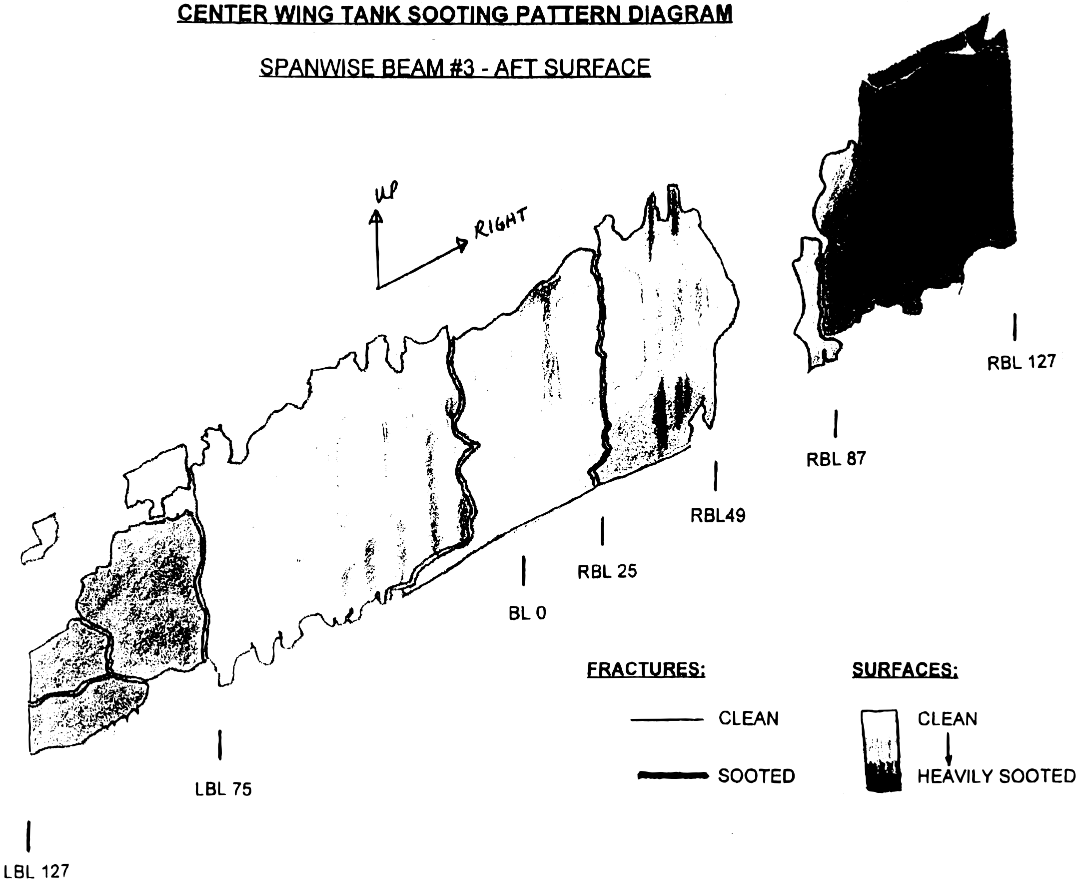
CENTER WING TANK SOOTING PATTERN DIAGRAM

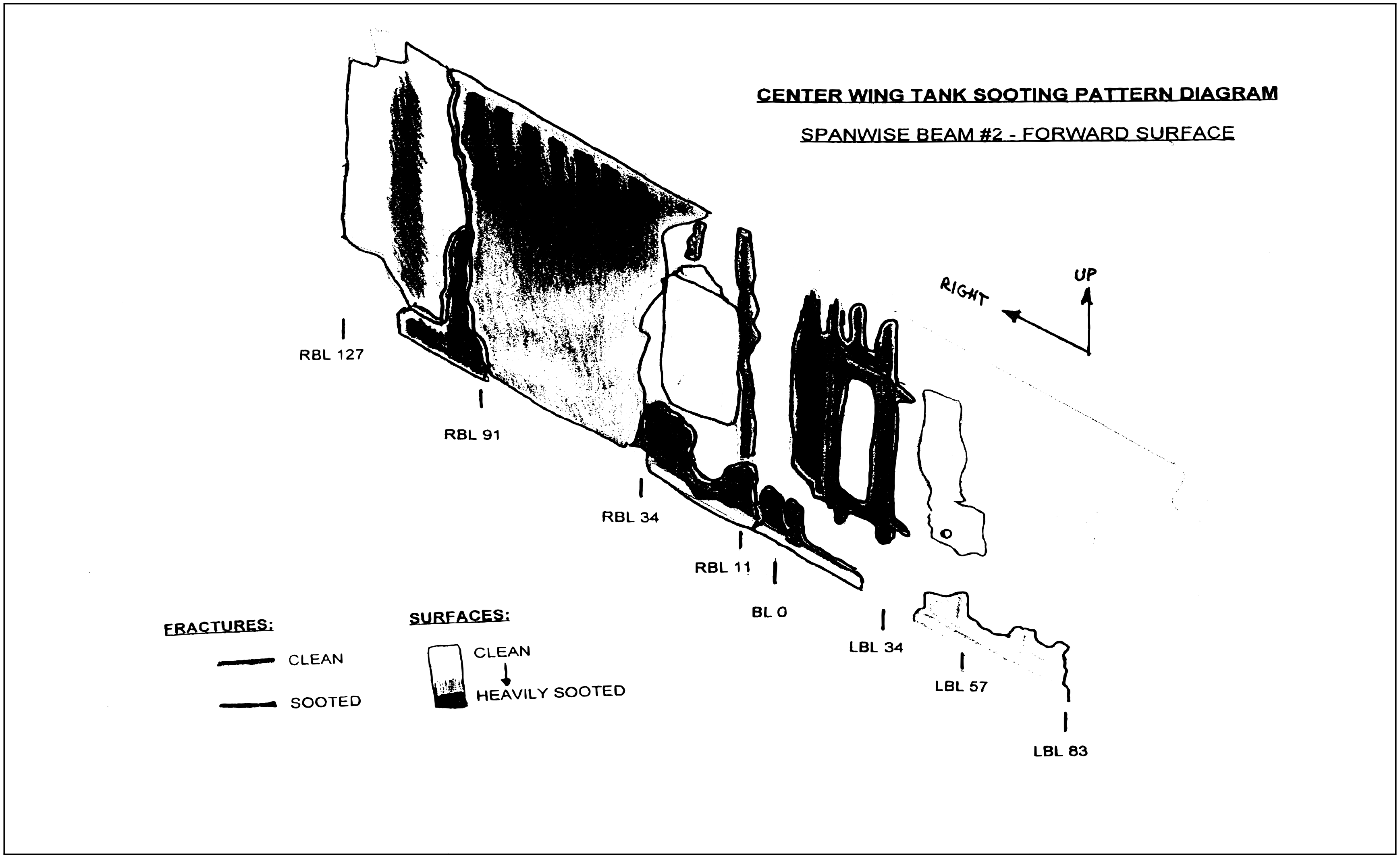
SPANWISE BEAM #3 - FORWARD SURFACE



CENTER WING TANK SOOTING PATTERN DIAGRAM

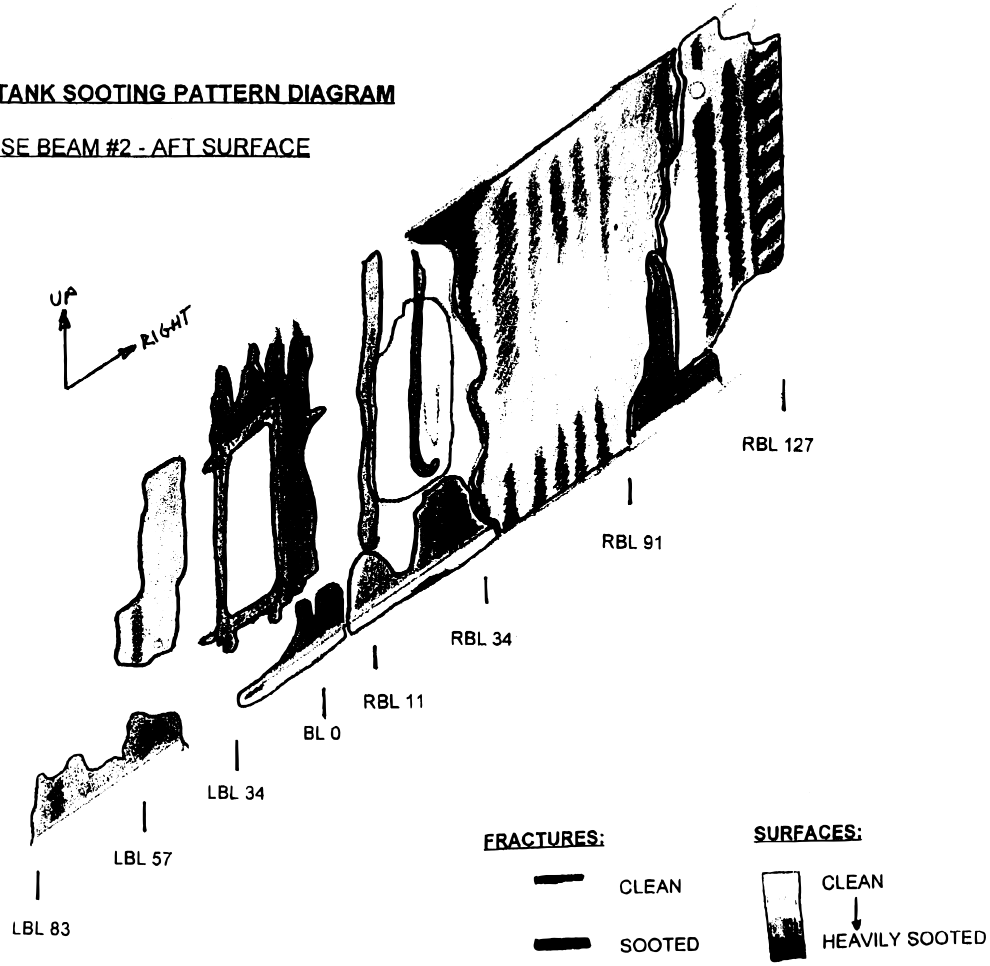
SPANWISE BEAM #3 - AFT SURFACE

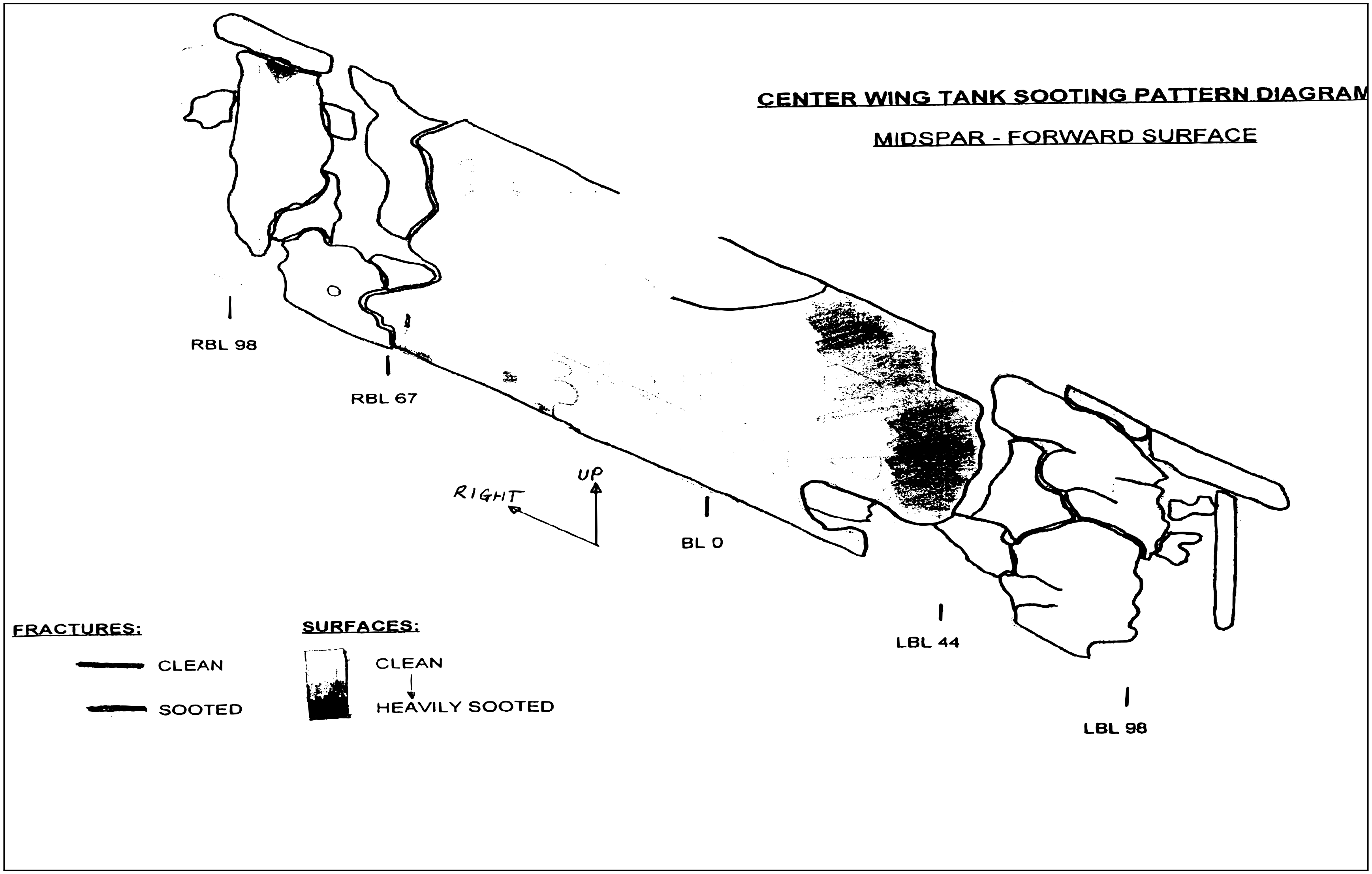



CENTER WING TANK SOOTING PATTERN DIAGRAM
SPANWISE BEAM #2 - FORWARD SURFACE
RIGHT
UP
RBL 127
RBL 91
RBL 34
RBL 11
BL 0
LBL 34
LBL 57
LBL 83
FRACTURES:
CLEAN
SOOTED
SURFACES:
CLEAN
HEAVILY SOOTED

CENTER WING TANK SOOTING PATTERN DIAGRAM

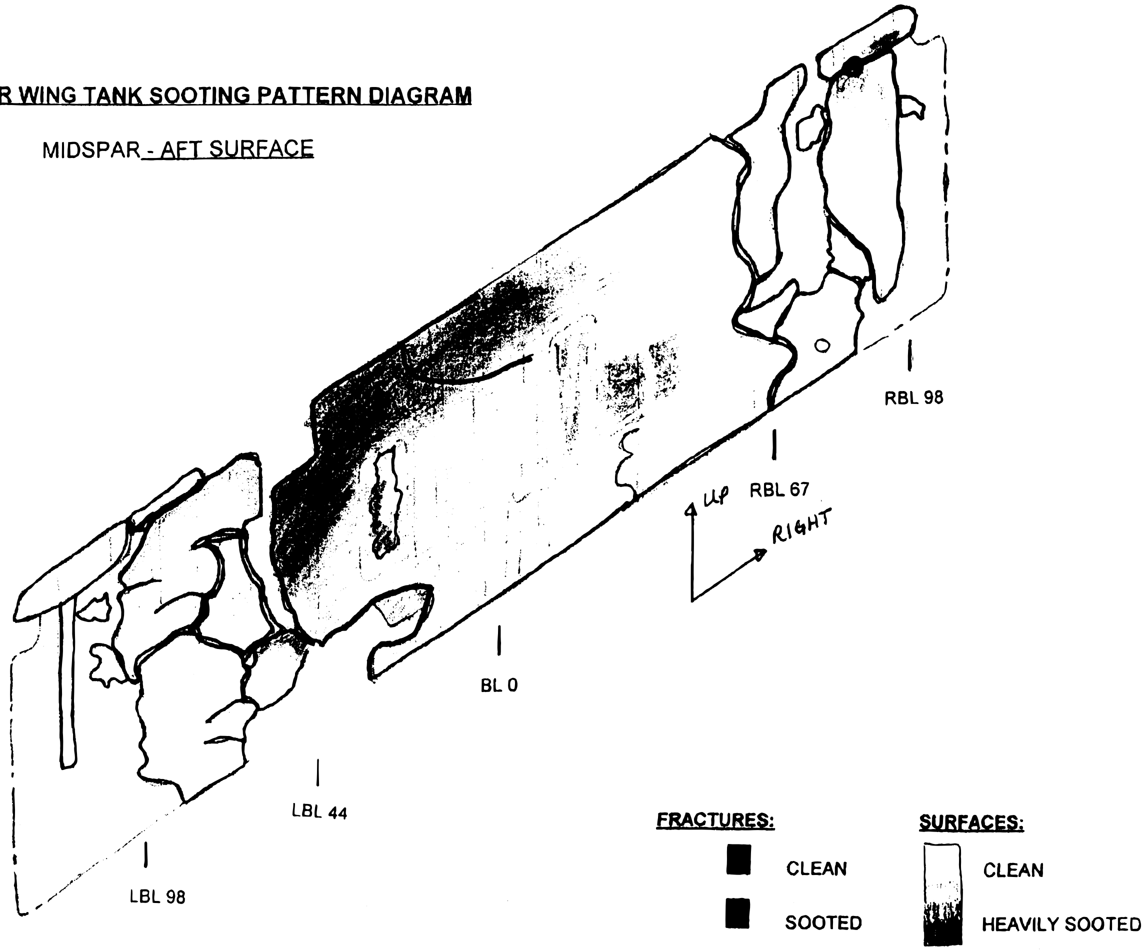
SPANWISE BEAM #2 - AFT SURFACE

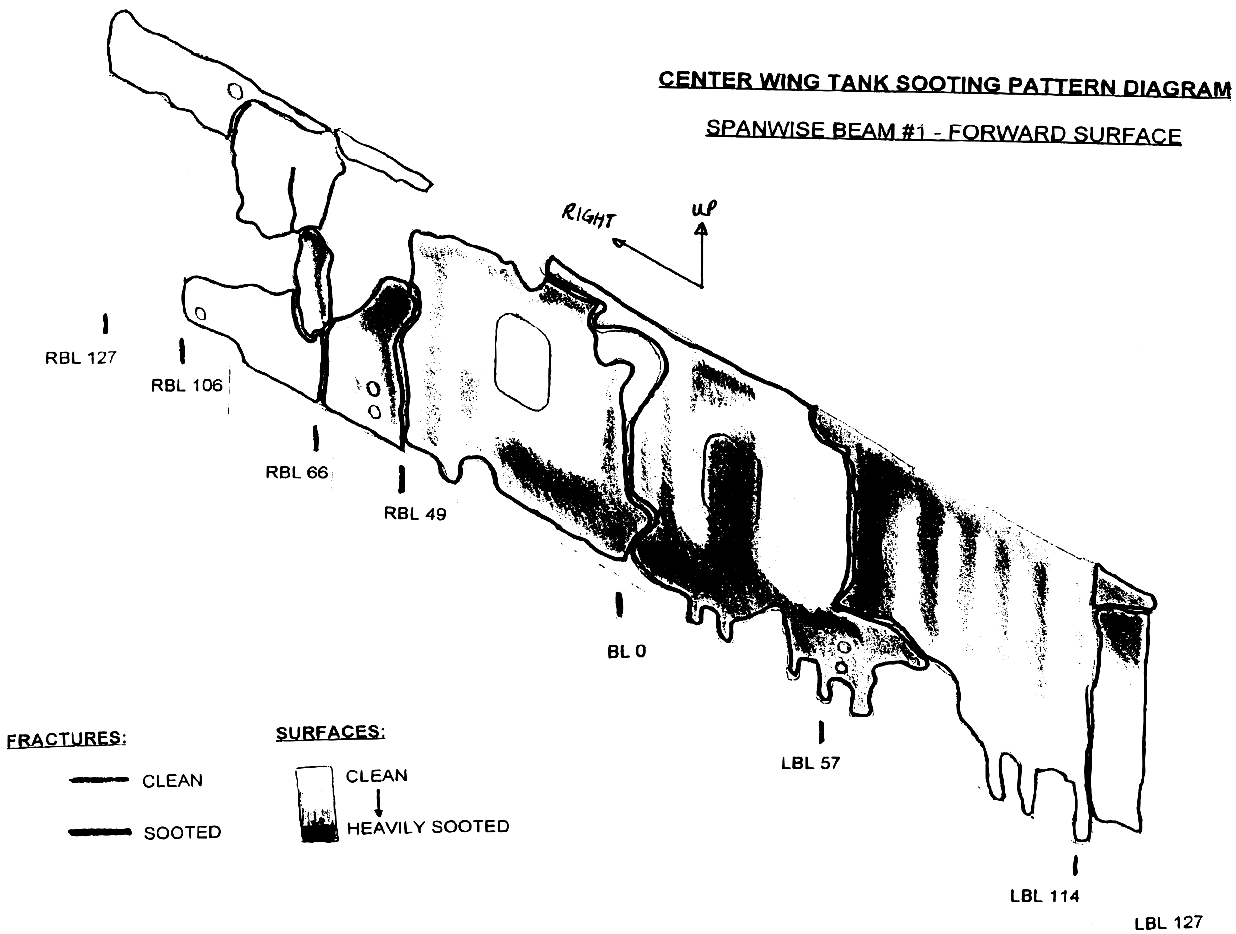



CENTER WING TANK SOOTING PATTERN DIAGRAM
MIDSPAR - FORWARD SURFACE
RBL 98
RBL 67
RIGHT
UP
BL 0
LBL 44
LBL 98
FRACTURES:
CLEAN
SOOTED
SURFACES:
CLEAN
HEAVILY SOOTED

CENTER WING TANK SOOTING PATTERN DIAGRAM

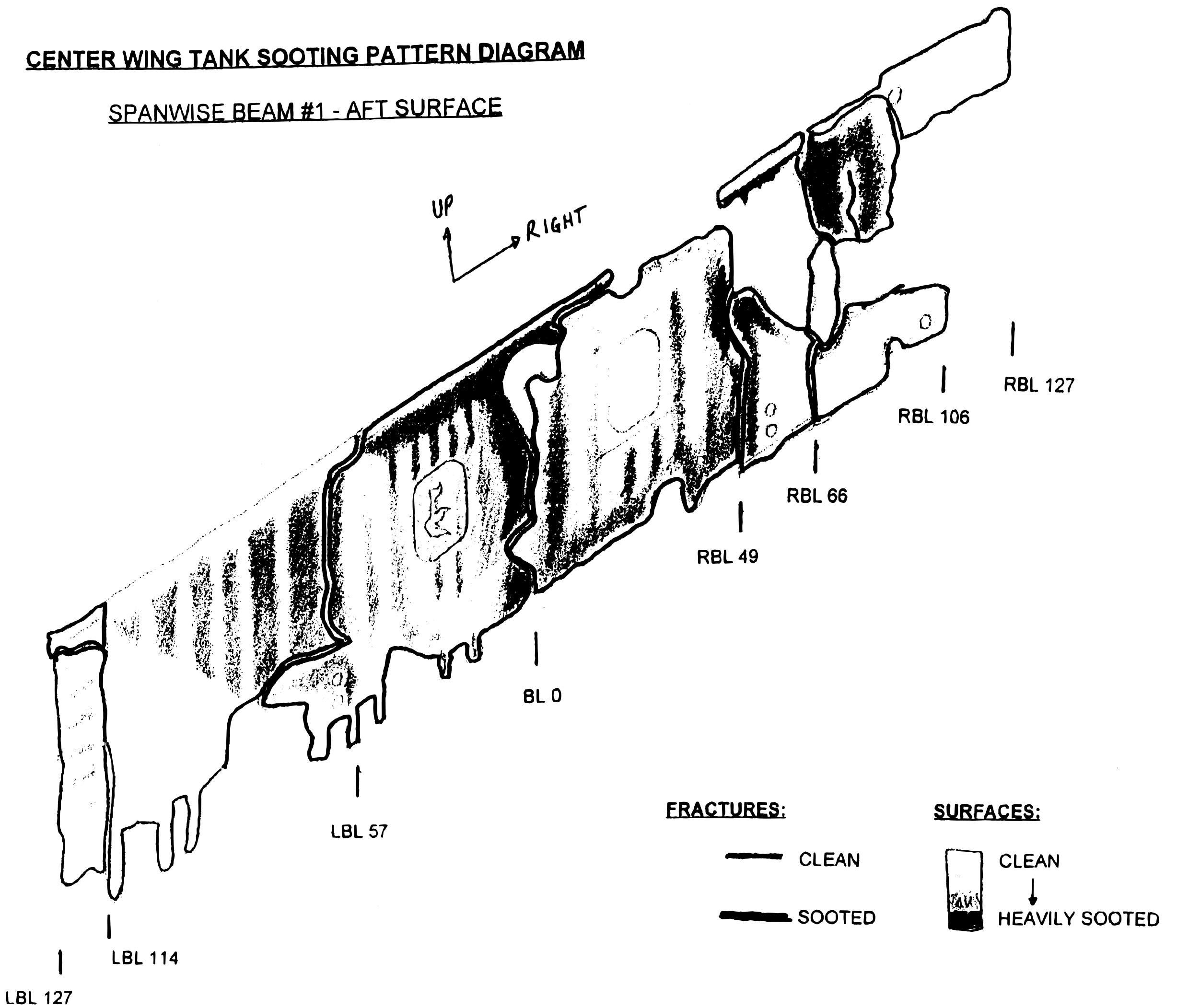
MIDSPAR - AFT SURFACE

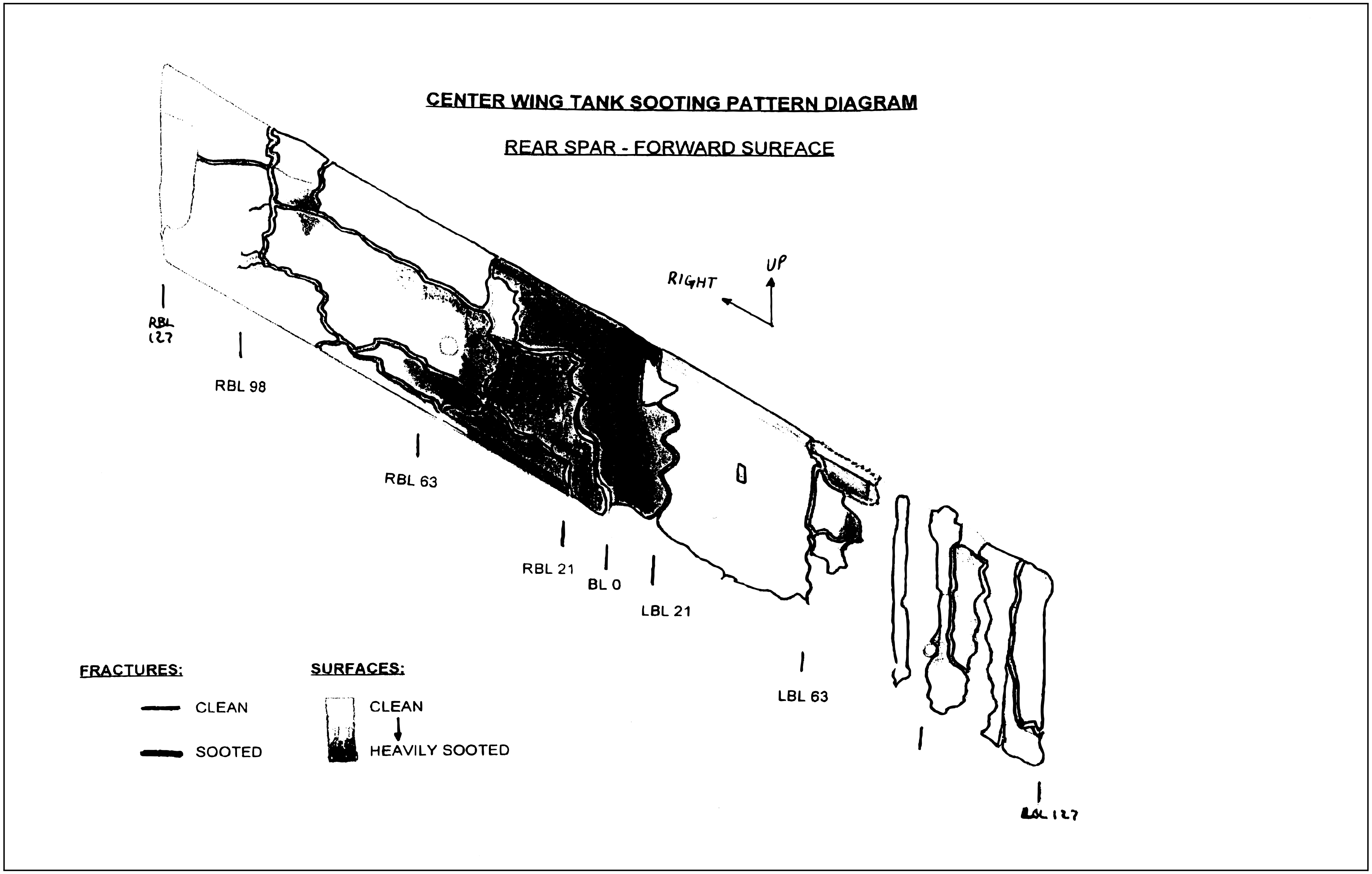



CENTER WING TANK SOOTING PATTERN DIAGRAM
SPANWISE BEAM #1 - FORWARD SURFACE
RIGHT
UP
RBL 127
RBL 106
RBL 66
RBL 49
BL 0
LBL 57
LBL 114
LBL 127
FRACTURES:
CLEAN
SOOTED
SURFACES:
CLEAN
HEAVILY SOOTED

CENTER WING TANK SOOTING PATTERN DIAGRAM

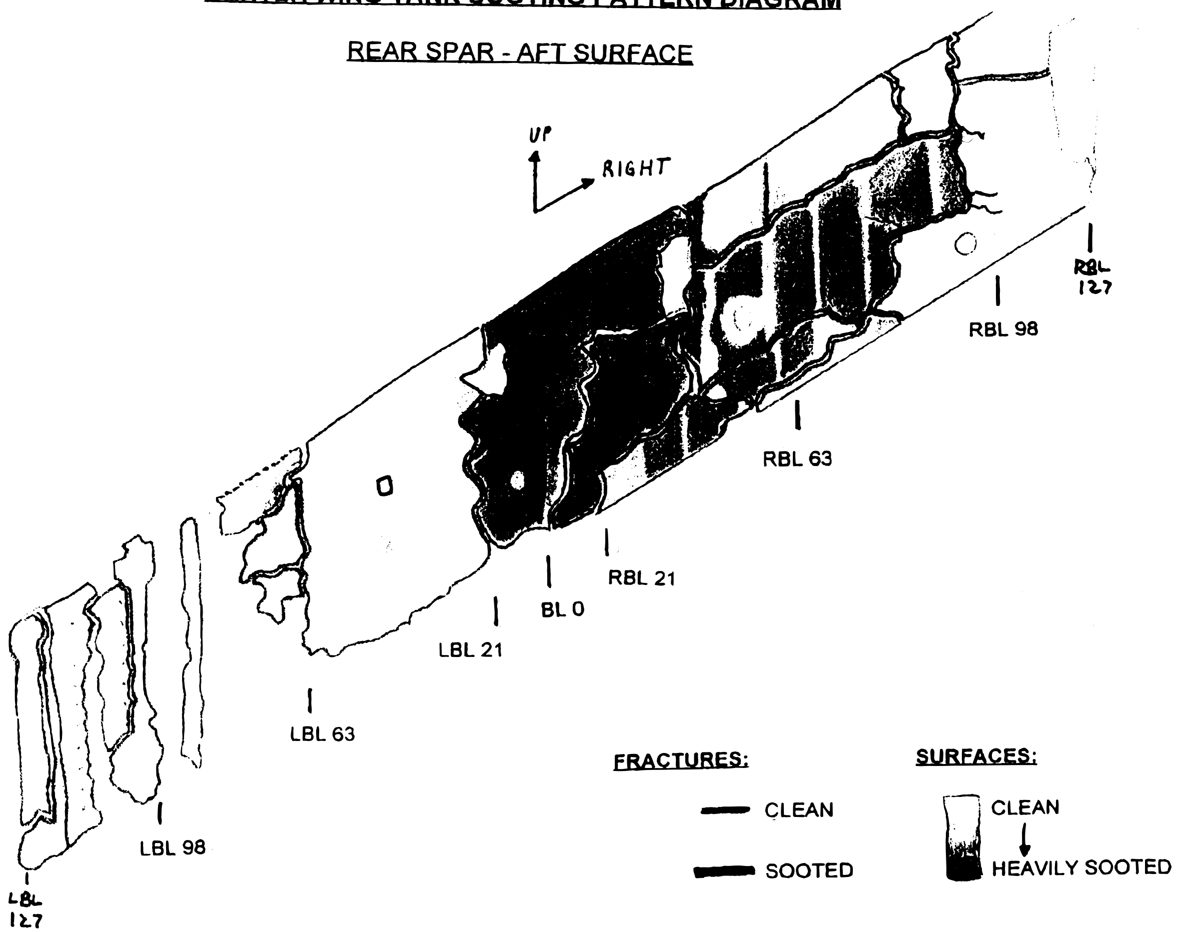
SPANWISE BEAM #1 - AFT SURFACE




CENTER WING TANK SOOTING PATTERN DIAGRAM
REAR SPAR - FORWARD SURFACE
RIGHT
UP
RBL 127
RBL 98
RBL 63
RBL 21
BL 0
LBL 21
LBL 63
LBL 127
FRACTURES:
CLEAN
SOOTED
SURFACES:
CLEAN
HEAVILY SOOTED

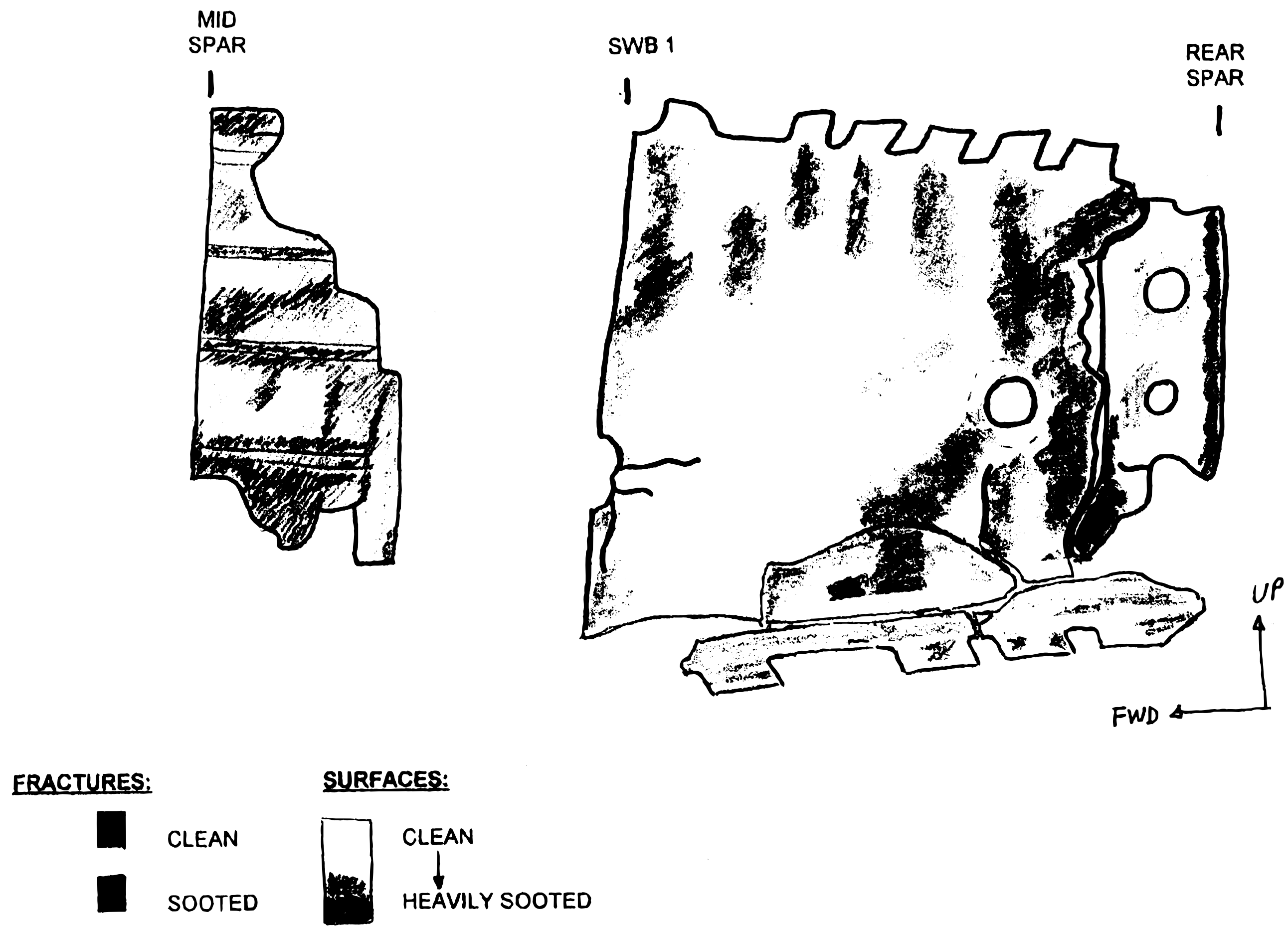
CENTER WING TANK SOOTING PATTERN DIAGRAM

REAR SPAR - AFT SURFACE



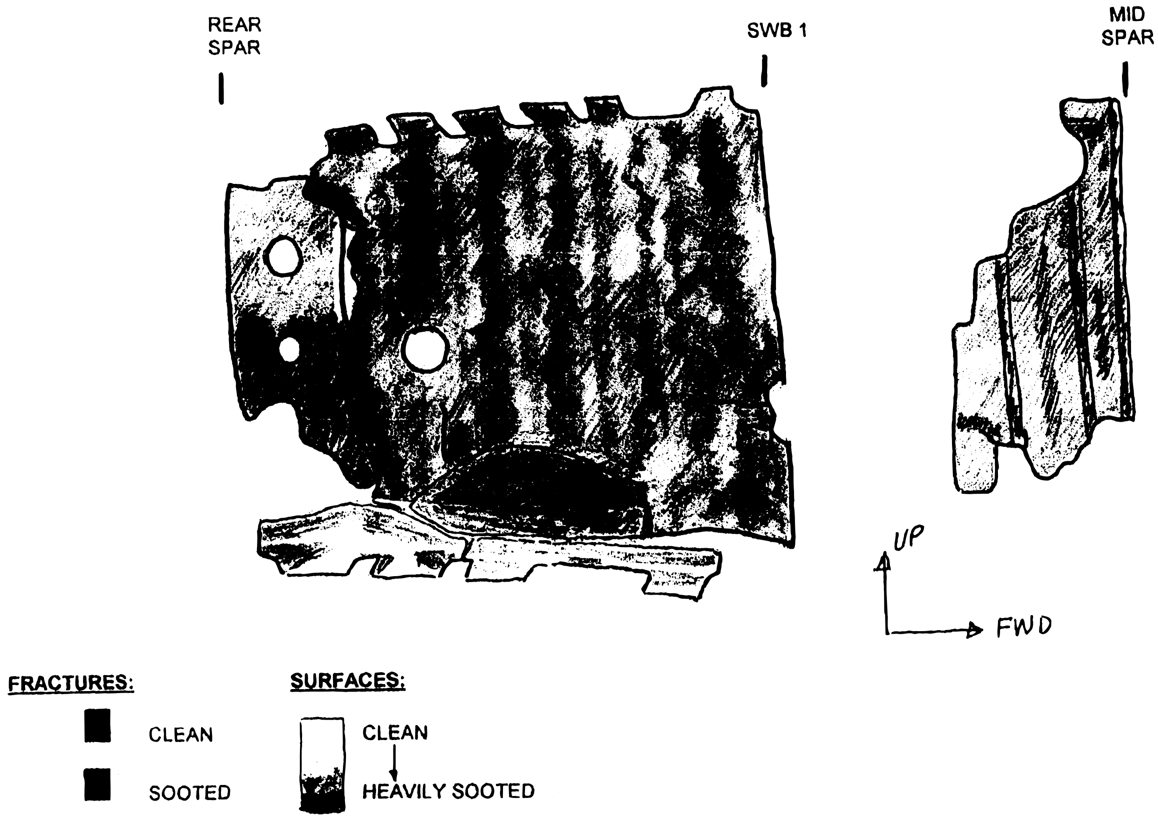
CENTER WING TANK SOOTING PATTERN DIAGRAM

BL 0 RIB - LEFT SURFACE



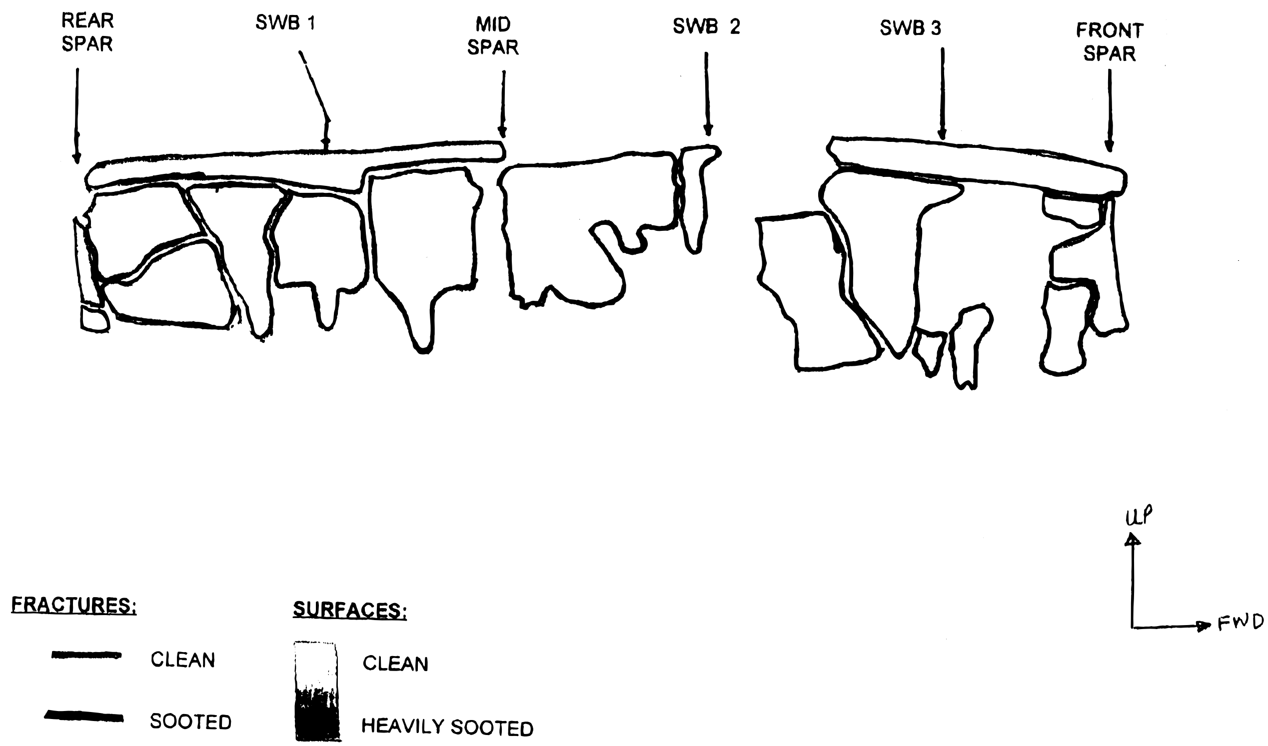
CENTER WING TANK SOOTING PATTERN DIAGRAM

BL 0 RIB - RIGHT SURFACE



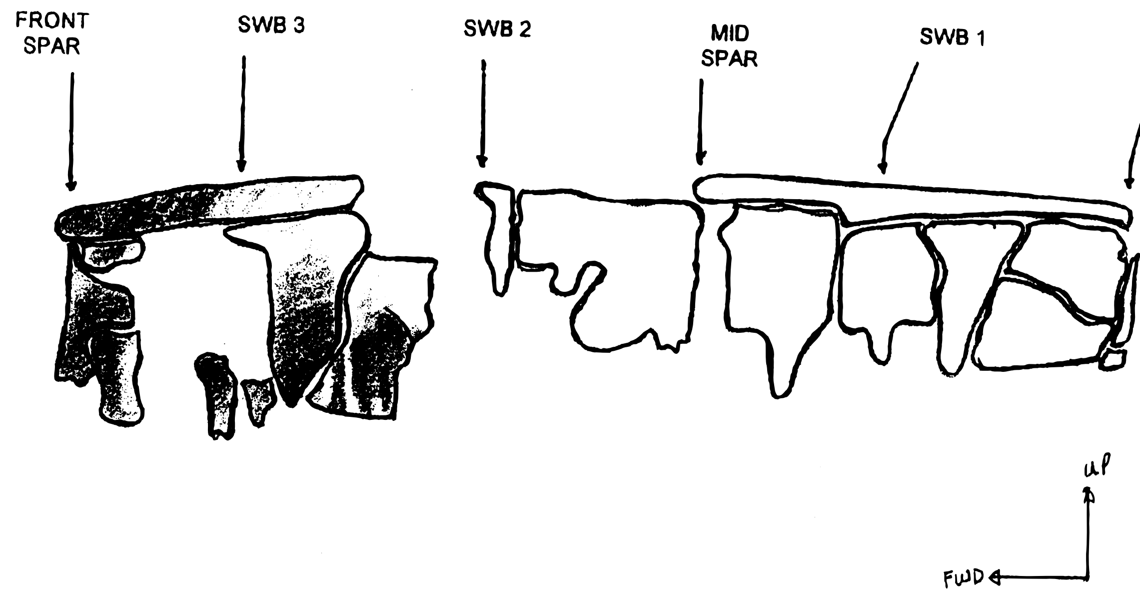
CENTER WING TANK SOOTING PATTERN DIAGRAM

RIGHTHAND SIDE OF BODY RIB - OUTBOARD SURFACE



CENTER WING TANK SOOTING PATTERN DIAGRAM

RIGHTHAND SIDE OF BODY RIB - INBOARD SURFACE



FRACTURES:

CLEAN

SOOTED

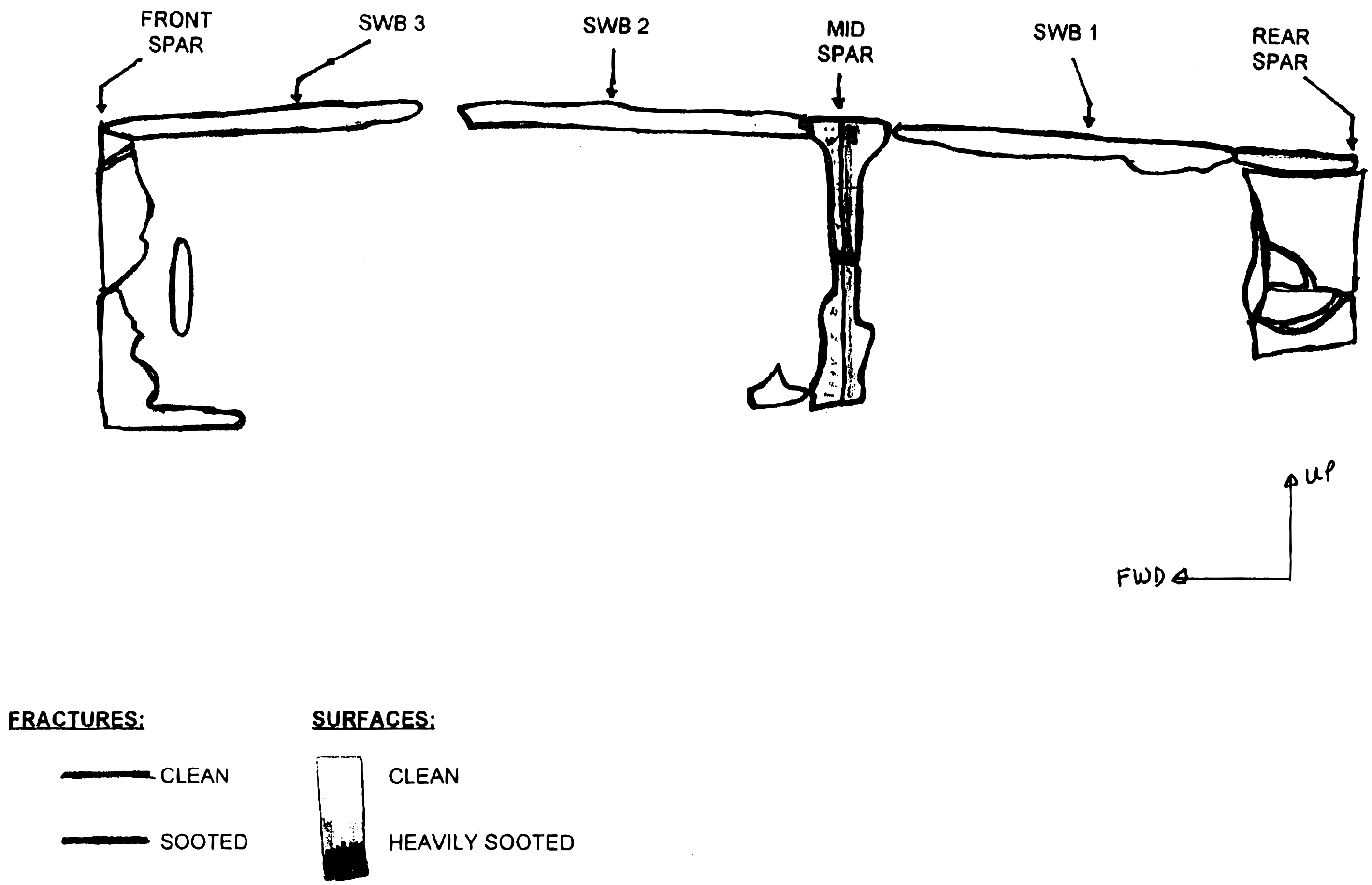
SURFACES:

CLEAN

HEAVILY SOOTED

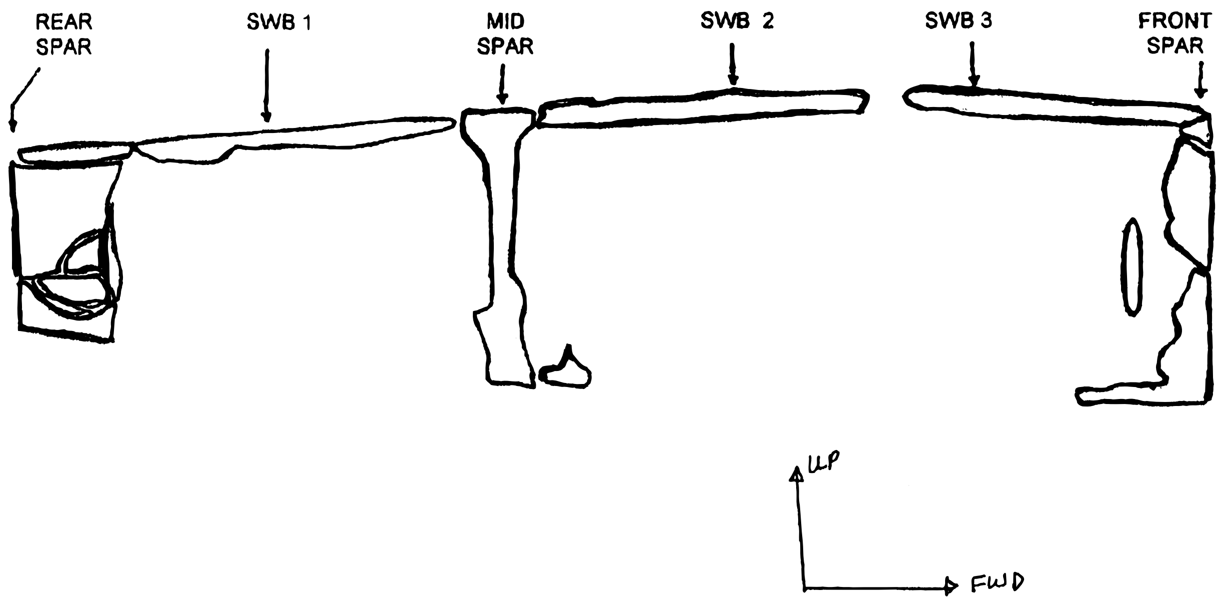
CENTER WING TANK SOOTING PATTERN DIAGRAM

LEFTHAND SIDE OF BODY RIB - OUTBOARD SURFACE



CENTER WING TANK SOOTING PATTERN DIAGRAM

LEFTHAND SIDE OF BODY RIB - INBOARD SURFACE



FRACTURES:

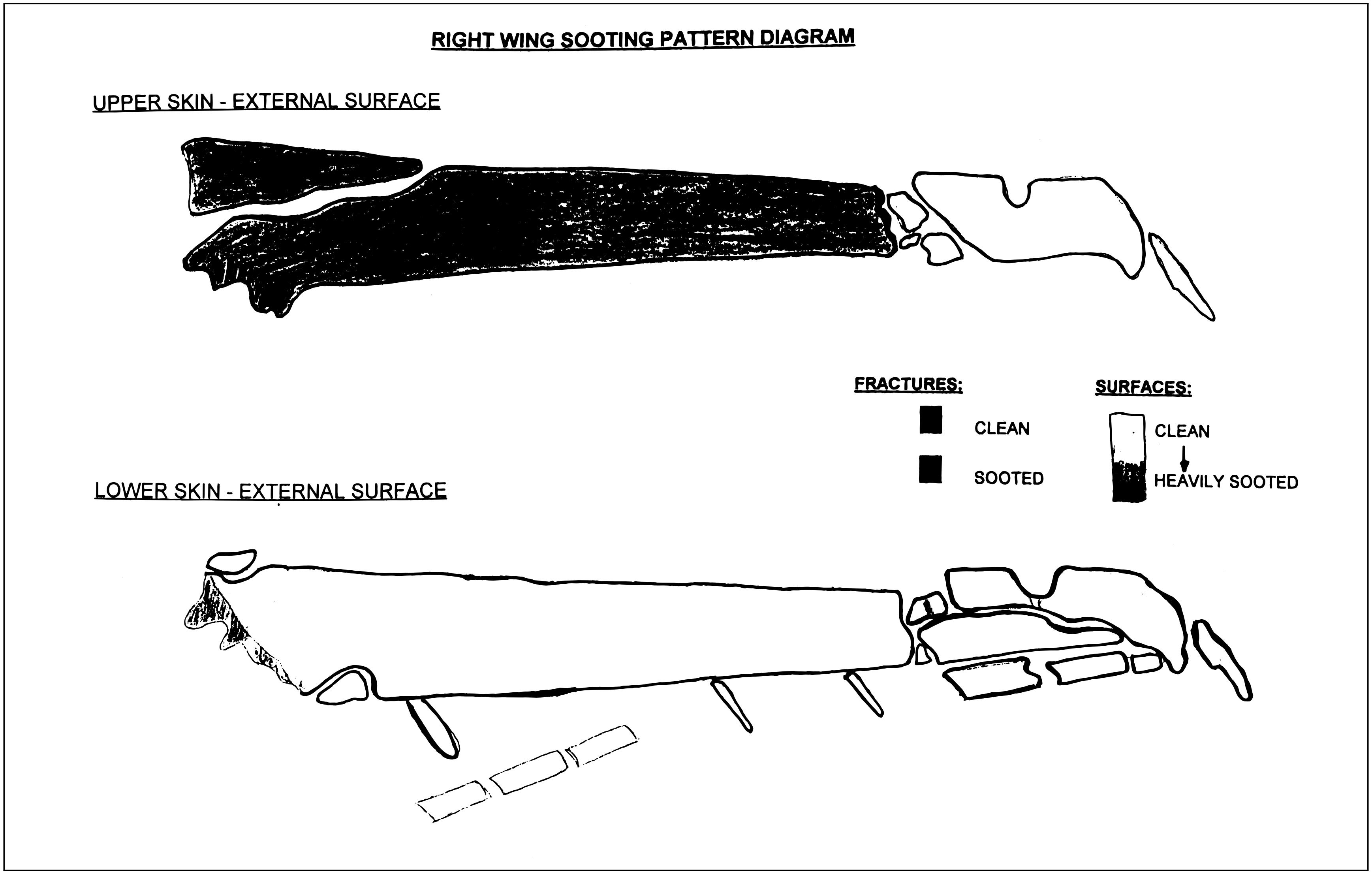
CLEAN

SOOTED

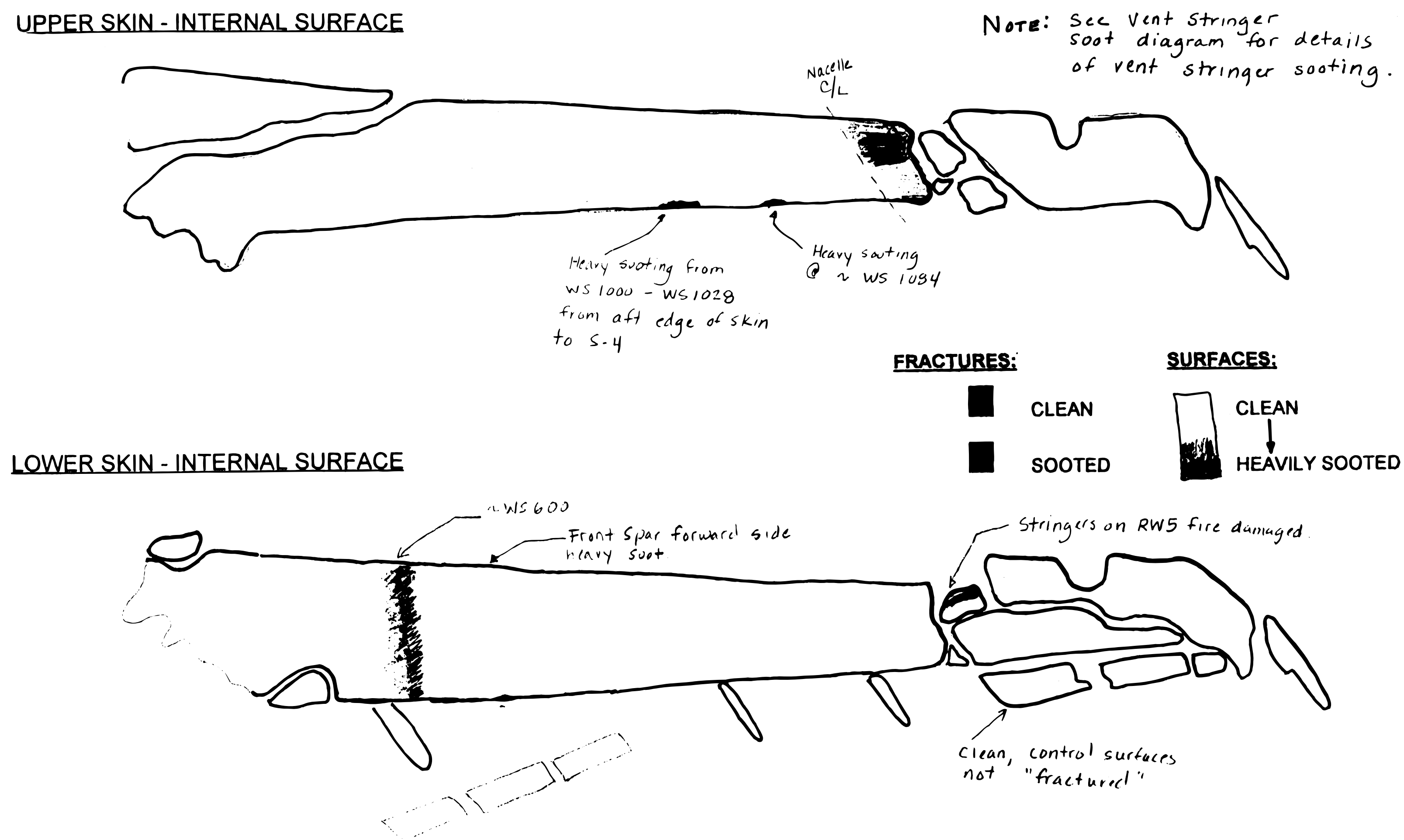
SURFACES:

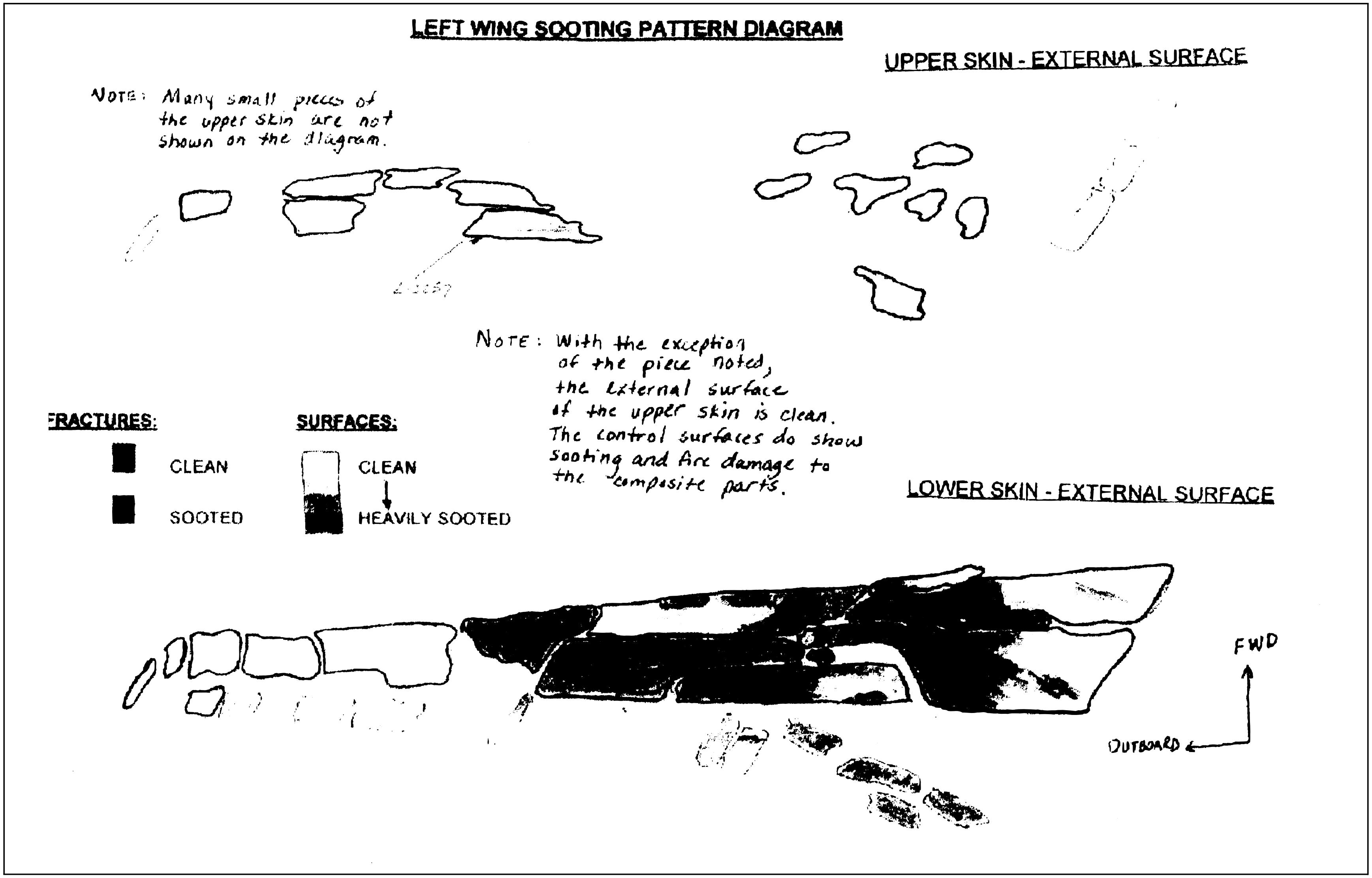
CLEAN

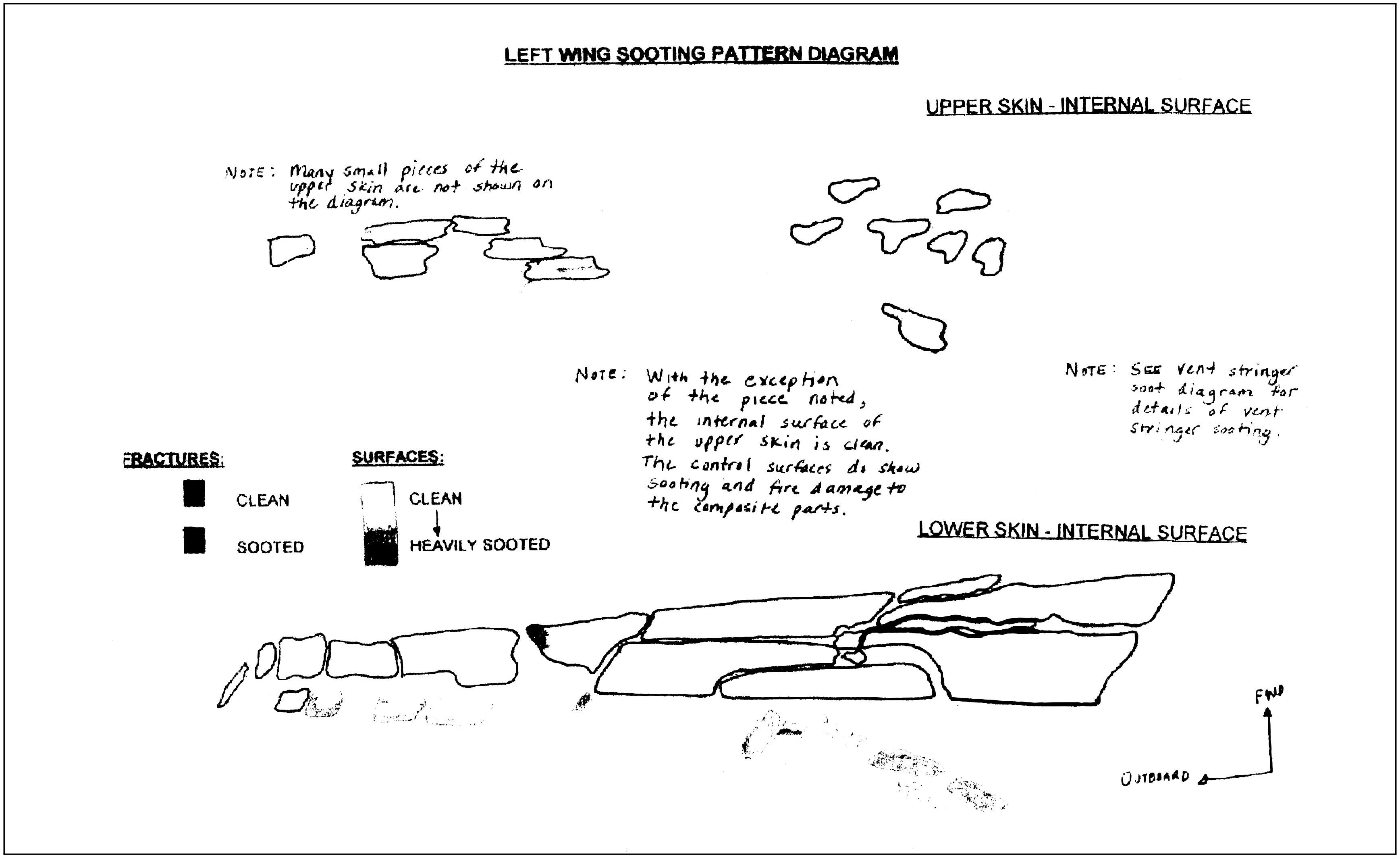
HEAVILY SOOTED

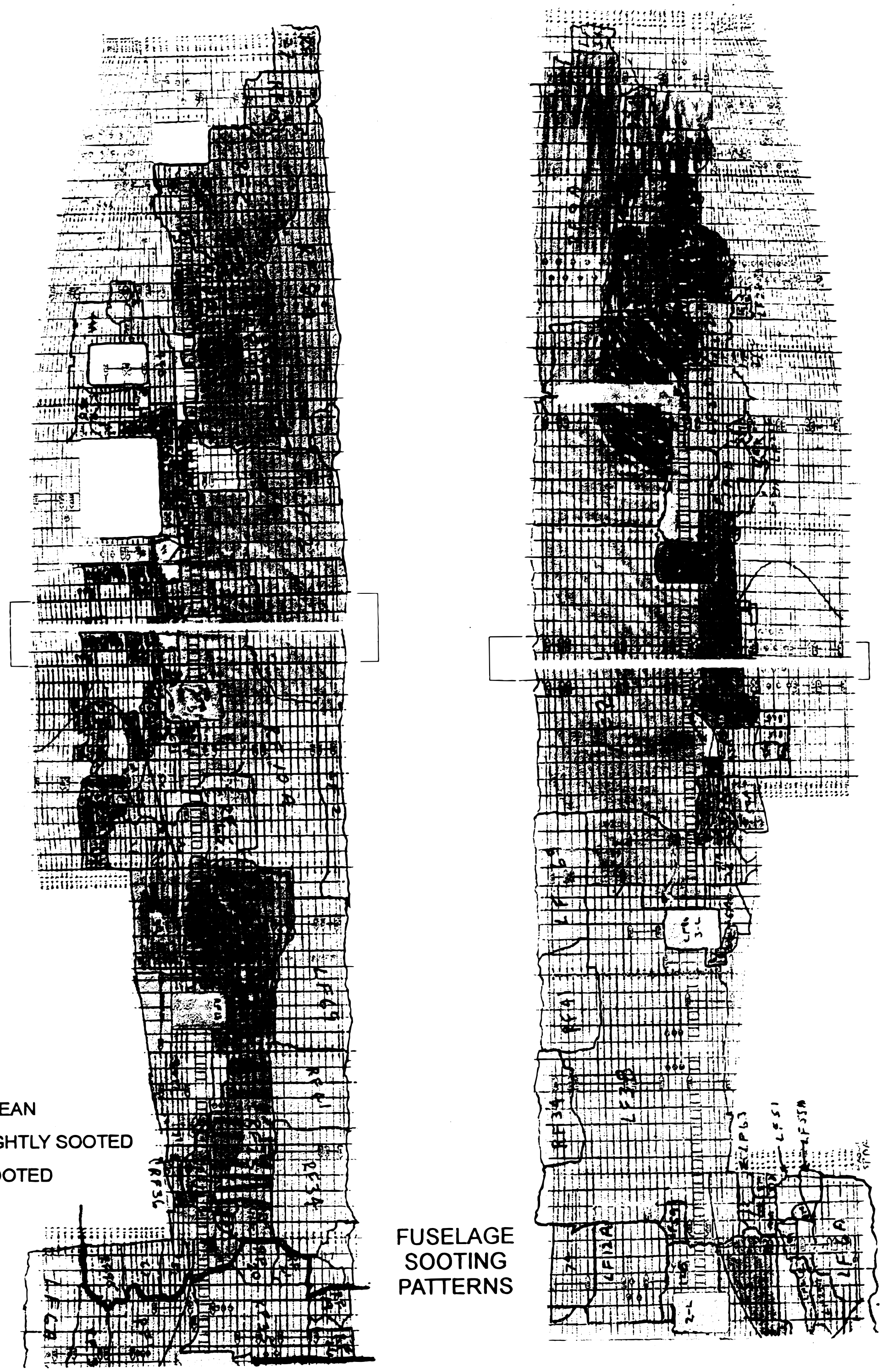

RIGHT WING SOOTING PATTERN DIAGRAM
UPPER SKIN - EXTERNAL SURFACE
FRACTURES:
CLEAN
SOOTED
SURFACES:
CLEAN
HEAVILY SOOTED
LOWER SKIN - EXTERNAL SURFACE

RIGHT WING SOOTING PATTERN DIAGRAM



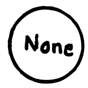

LEFT WING SOOTING PATTERN DIAGRAM
UPPER SKIN - EXTERNAL SURFACE
NOTE: Many small pieces of the upper skin are not shown on the diagram.
NOTE: With the exception of the piece noted, the external surface of the upper skin is clean. The control surfaces do show sooting and fire damage to the composite parts.
FRACTURES:
CLEAN
SOOTED
SURFACES:
CLEAN
HEAVILY SOOTED
LOWER SKIN - EXTERNAL SURFACE
FWD
OUTBOARD


LEFT WING SOOTING PATTERN DIAGRAM
UPPER SKIN - INTERNAL SURFACE
NOTE: Many small pieces of the upper skin are not shown on the diagram.
NOTE: With the exception of the piece noted, the internal surface of the upper skin is clean. The control surfaces do show sooting and fire damage to the composite parts.
NOTE: See vent stringer soot diagram for details of vent stringer sooting.
FRACTURES:
CLEAN
SOOTED
SURFACES:
CLEAN
HEAVILY SOOTED
LOWER SKIN - INTERNAL SURFACE
FWD
OUTBOARD

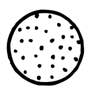


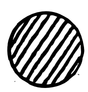
FUSELAGE SOOTING PATTERNS

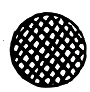
Fuselage sooting diagrams



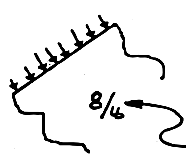
No sooting evident


Light sooting

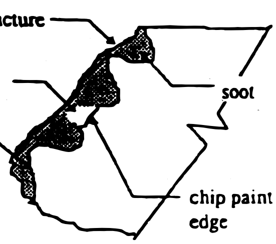

Moderate sooting


Heavy sooting

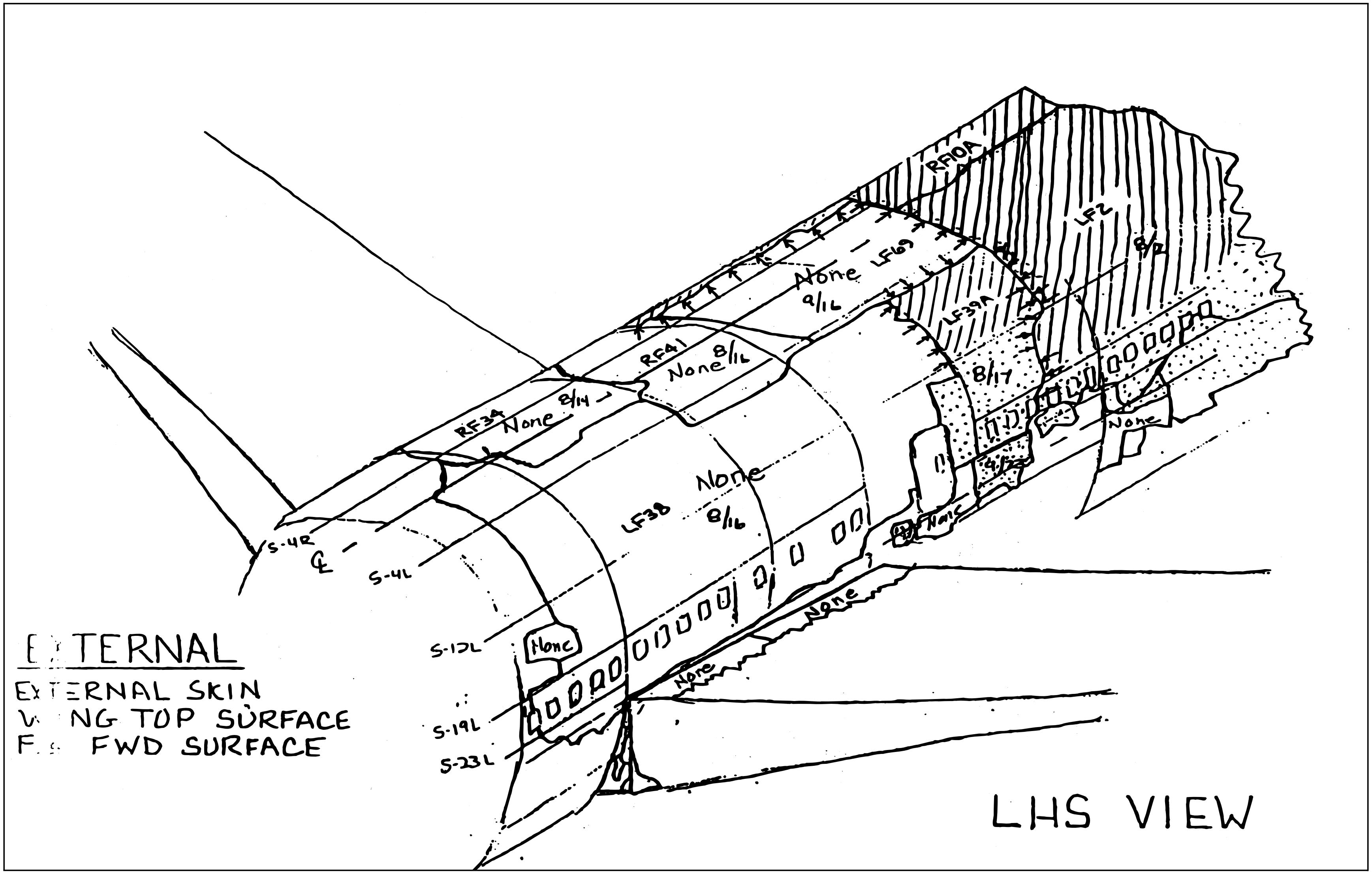
Surveyed panels are all recovered from the Green debris field and are located from approximately STA 910 to STA 1600.
Aft of STA 1600, no sooting is evident internally. On the exterior, there is light to moderate sooting extending aft along the entire length of the fuselage from approximately the main deck window belt on the RHS to approximately S-8 on the LHS

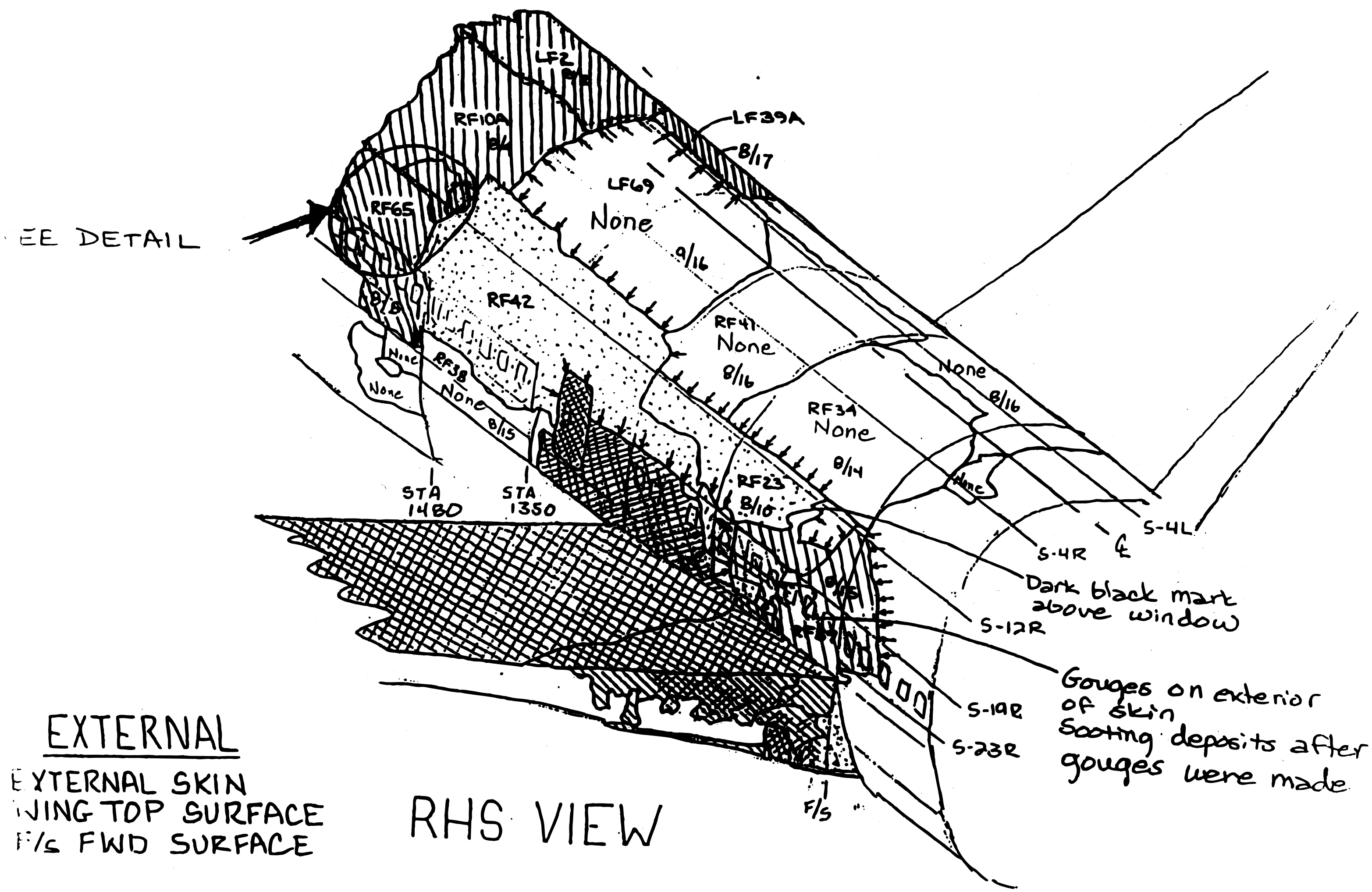


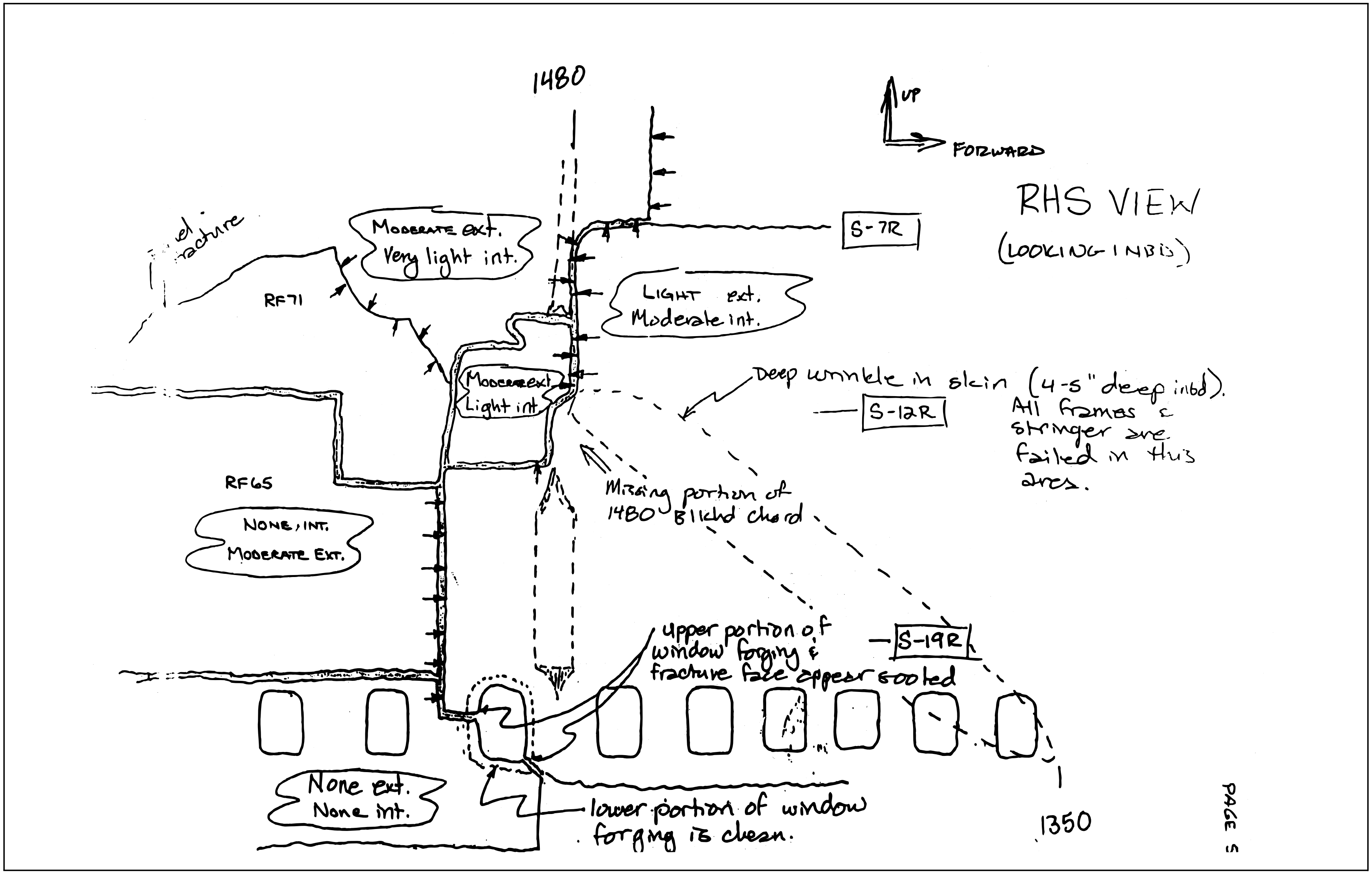
Sooting deposits evident on edges with arrows.
Panel recovery date

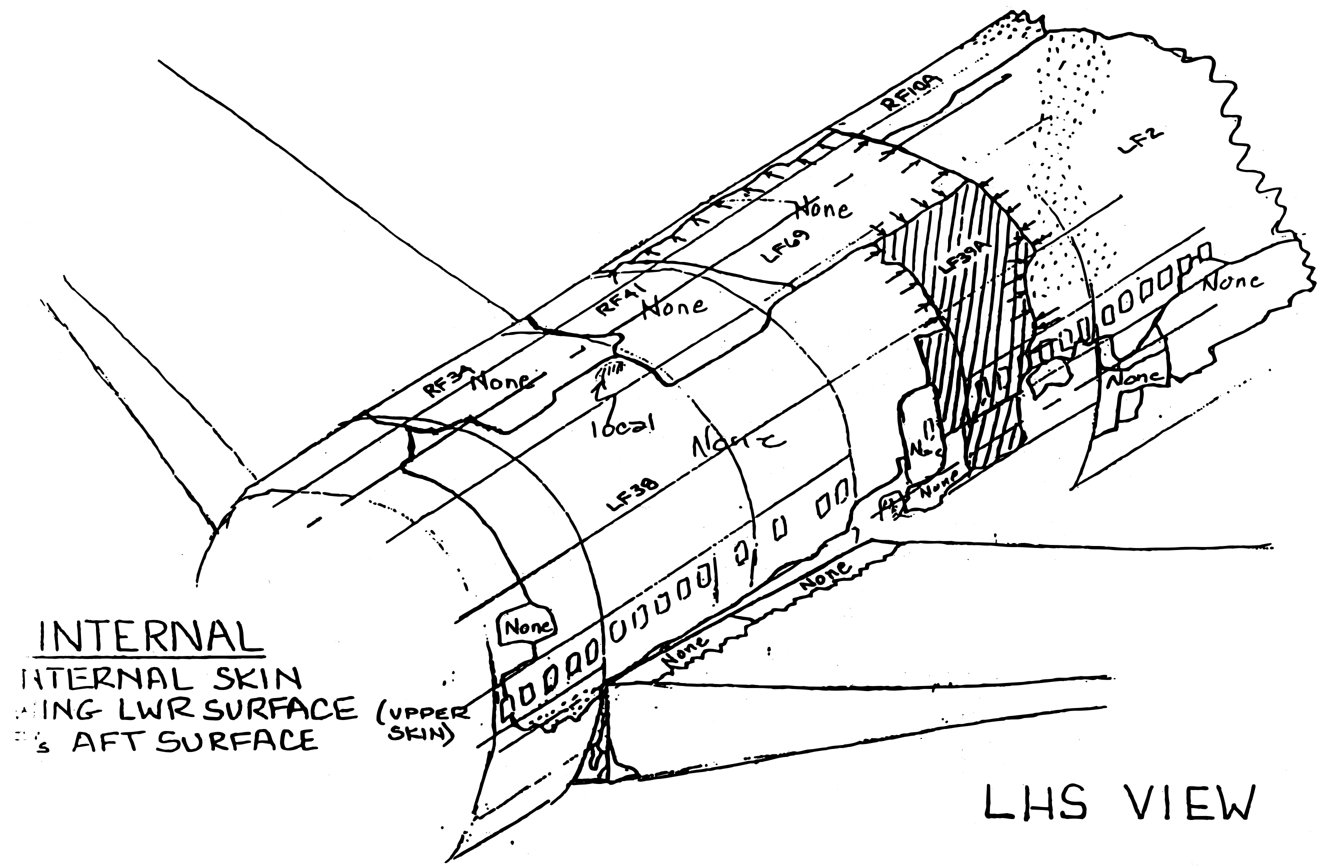


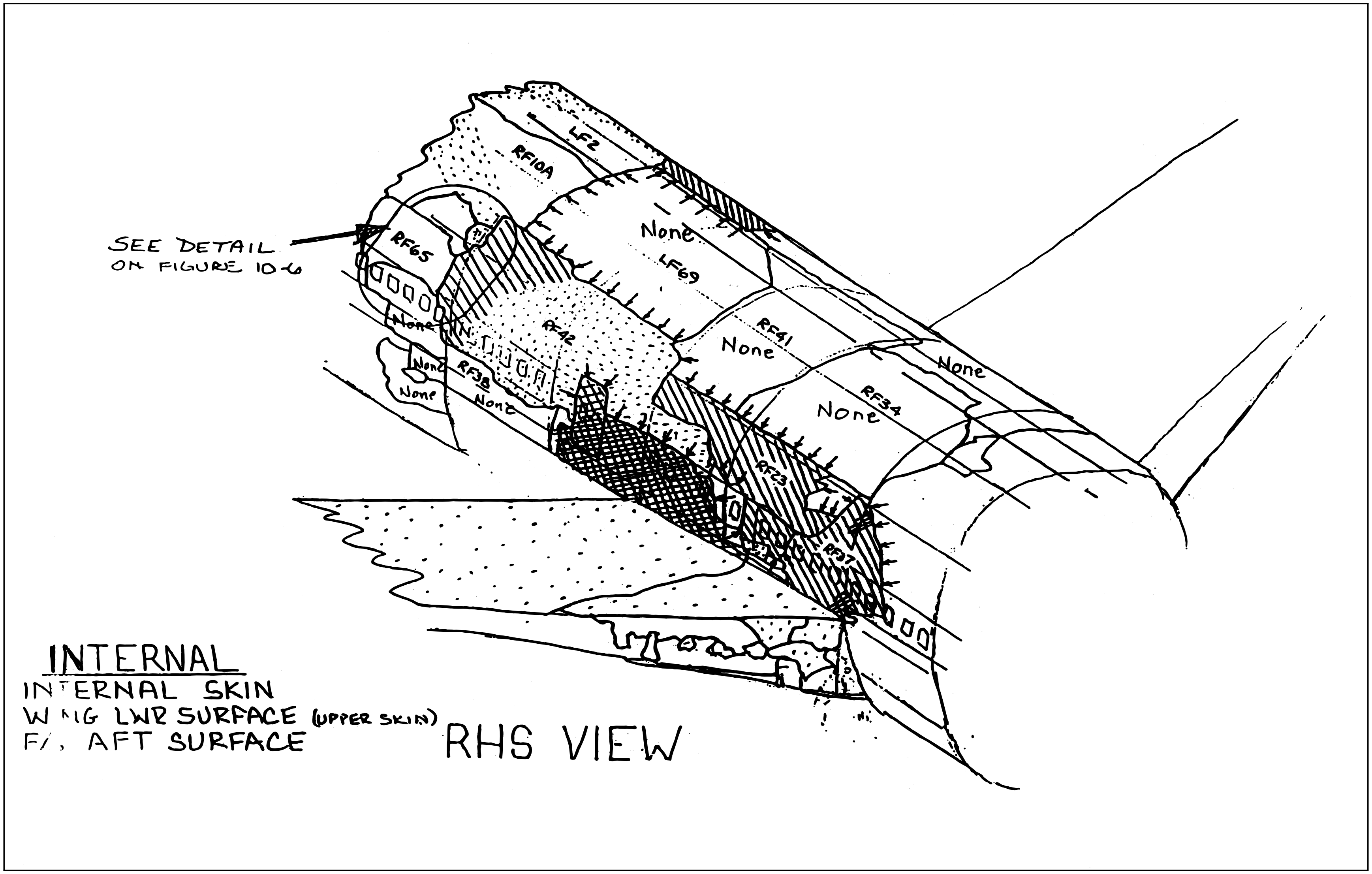
Determination primarily made by examining external paint failures near the fracture edge. Soot deposits remain on underlying paint when the top layer peels near fracture.

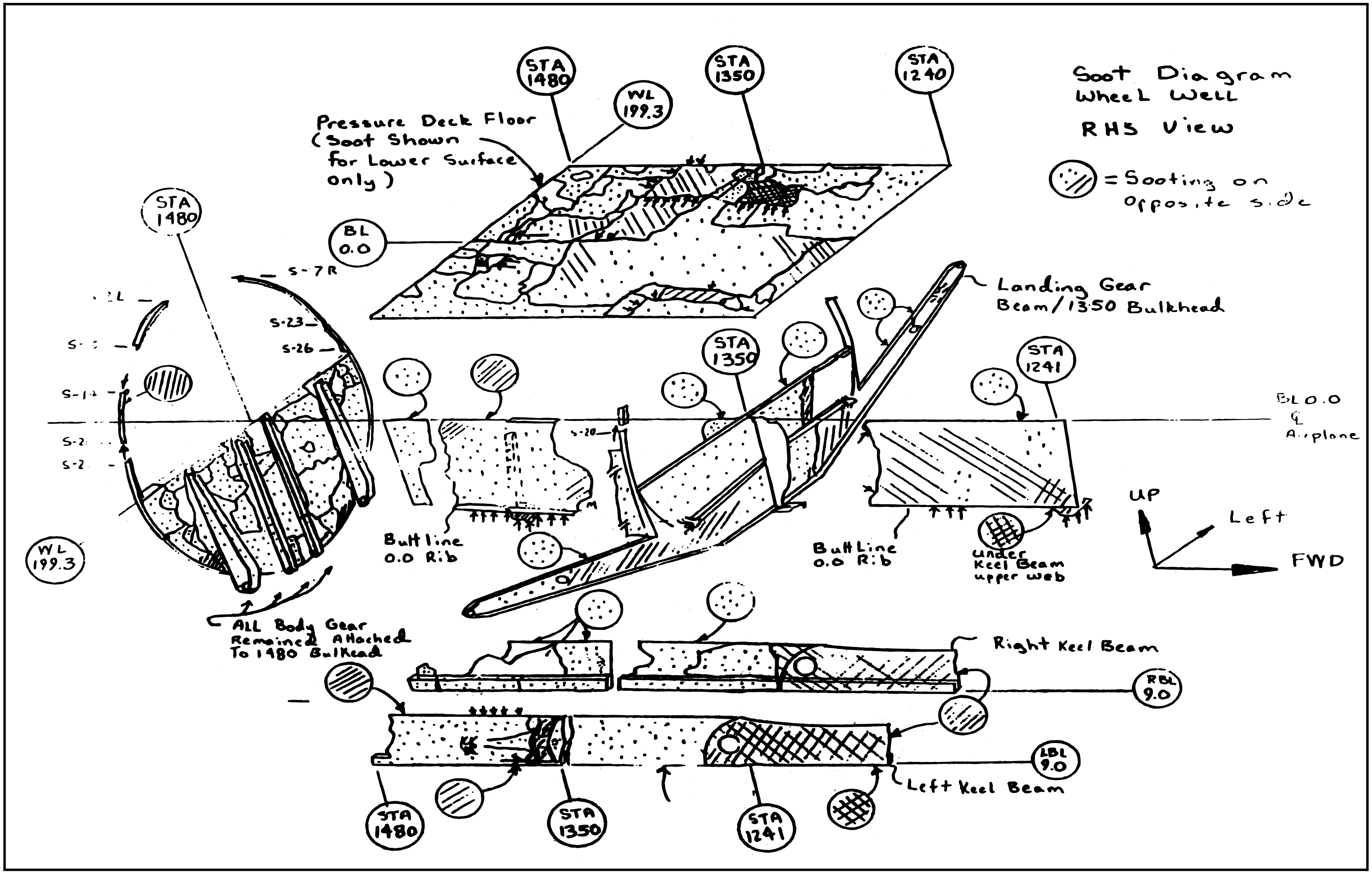

EXTERNAL
EXTERNAL SKIN
WING TOP SURFACE
FWD SURFACE
LHS VIEW
RF10A
LF2
8/12
None
LF69
9/16
LF39A
8/17
RF41
None
8/16
RF39
None
8/14
LF38
None
8/16
S-4R
℄
S-4L
S-12L
S-19L
S-23L
None
None
None
None


LF2
RF10A
LF39A
8/17
LF69
None
9/16
RF65
EE DETAIL
RF42
RF41
None
8/16
None
8/16
RF34
None
8/14
RF38
None
8/15
None
None
RF23
8/10
STA
1480
STA
1350
S-4R
S-4L
℄
Dark black mark above window
S-12R
S-19R
S-23R
Gouges on exterior of skin
Sooting deposits after gouges were made
F/S
EXTERNAL
EXTERNAL SKIN
WING TOP SURFACE
F/S FWD SURFACE
RHS VIEW


1480
UP
FORWARD
RHS VIEW
(LOOKING INBD)
Moderate ext.
Very light int.
RF71
S-7R
LIGHT ext.
Moderate int.
Moderate ext.
Light int.
Deep wrinkle in skin (4-5" deep inbd).
S-12R
All frames & stringer are failed in this area.
RF65
Missing portion of 1480 Blkhd chord
NONE, INT.
MODERATE EXT.
upper portion of window forging & fracture face appear sooted
S-19R
None ext.
None int.
lower portion of window forging is clean.
1350
PAGE 5


RF10A
LF2
None
LF69
LF39A
RF41
None
None
RF3A
None
local
None
LF38
None
None
None
None
None
None
INTERNAL
NTERNAL SKIN
ING LWR SURFACE (UPPER SKIN)
's AFT SURFACE
LHS VIEW


SEE DETAIL
ON FIGURE 10-6
LF2
RF10A
RF65
None
LF69
RF42
RF41
None
None
RF38
None
None
None
None
RF34
None
RF23
RF37
INTERNAL
INTERNAL SKIN
WING LWR SURFACE (UPPER SKIN)
F/, AFT SURFACE
RHS VIEW


Soot Diagram
Wheel Well
RHS View
= Sooting on Opposite side
Pressure Deck Floor (Soot Shown for Lower Surface only)
STA 1480
WL 199.3
STA 1350
STA 1240
BL 0.0
S-7R
S-23
S-26
Landing Gear Beam/1350 Bulkhead
STA 1350
STA 1241
BL 0.0
℄ Airplane
UP
Left
FWD
Buttline 0.0 Rib
Buttline 0.0 Rib
Under Keel Beam upper web
WL 199.3
All Body Gear Remained Attached To 1480 Bulkhead
Right Keel Beam
RBL 9.0
LBL 9.0
Left Keel Beam
STA 1480
STA 1350
STA 1241

Appendix G
Fuel Tank Explosions/Fires—Civilian and Military Aircraft

FUEL TANK EXPLOSIONS/FIRES -- CIVILIAN AIRCRAFT

Model	Operator/ Location	Year	Fatal	Hull loss	Fuel type	Benefit	Phase of operation	Description/Cause
B707	OSO	1959	4	Yes	UNK	Yes	Flight	
B707	Elkton	1963	81	Yes	JP-4	Yes	Flight	Lightning, In flight explosion.
B707	San Francisco	1965	0	Yes	Jet A	Possible	Flight	#4 Engine fire heated wing upper surface above 900°F-- Partially full fuel tank exploded resulting in loss of 21 ft of wing. Landed safely.
B727	Southern Air Tr.	1964	1	No	Jet A	No	Ground maintenance	While purging center tank for entry, static discharge from CO2 Firex Nozzle to center tank access door caused wing tank explosion.
B727	Minneapolis	1968	0	No	Jet A	Yes	Ground refueling	Electrostatic Charge--Ground refueling system found as source of charging-- minor damage to wing structure group. Equipment and airplane refueling system design standards have eliminated recurrence.
B727	Minneapolis	1971	0	No	Jet A	Yes	Ground refueling	See Above.
DC-8	Toronto Canada	1970	106	Yes	JP-4	Yes	Flight	Spoiler deployed. Possible fuel tank explosion during go-around following ground impact during attempted landing.
DC-8	Travis AFB	1974	1	Yes	JP-4	No	Ground	World Airways DC-8 inboard main tank, exploded and burned at Travis AFB during maintenance. Open fuel cell, mechanic forced circuit breaker in.
DC-9	Air Canada	1982	0	Yes	Jet A-1	Possible	Ground maintenance	During maintenance center wing fuel tank exploded. Dry running of pumps suspected cause.

Be 400	Jackson, MS	1989	0	No	JP-4/Jet A	Yes	Ground Refueling	During refueling of auxiliary tank ignition occurred. Tank remained intact but fuel leakage occurred. Electrostatic charge discharge from polyurethane foam source of ignition.
B727	Avionca	1989	107	Yes	Jet A	Possible	Climb	Bomb located over center wing fuel tank. Inerting benefit unknown.
B737	Philippine Airlines	1990	8	Yes	Jet A	Yes	Taxi	Not determined -- empty center wing fuel tank explosion.
B747	TWA 800	1996	230	Yes	Jet A	Yes	Climb	Unknown -- empty center wing fuel tank explosion.

FUEL TANK EXPLOSIONS/FIRES -- MILITARY AIRCRAFT (NON-COMBAT)

Model	Operator/ location	Year	Fatal	loss	Hull type	Fuel Benefit	Phase of operation	Cause
B-52	Loring AFB Maine	1970 July	0	Yes	JP-4	Yes	Maintenance	Most likely ignition source traced to arcing or overheat of fuel pump shaft or fuel quantity probe.
B707	Spain	1971 June	Yes	Yes	JP-4	Yes	Decent, 17K	In-flight explosion of #1 main tank. USAF determined chafing of boost pump wires located in conduits as possible ignition source
B-52H	Minot AFB, ND	1975 Nov	0	Yes	JP-4	Yes	Maintenance	Prior to body tank refueling, exploded after midnight while on ramp. No specific evidence but suspected fuel pump locket rotor ignition source
B747	Iranian Fuel Tanker	1976	7	Yes	JP-4	Yes	Decent 8K	Lightning--wing tank.
KC-135Q	Plattsburg AFB, NY	1980 Feb		Yes	JP-4	Yes	Refueling	Aft body tank, faulty fuel probe found as problem.
B-52G	Robins AFB, GA	1980 Aug	Yes	Yes	JP-4	Yes	Maintenance	While transferring fuel from body tanks to wing tanks the empty mid body tank exploded. Investigation showed electrical arcing occurred in the mid body boost pump due to mis-positioned phase lead wire inside the pump.
KC-135A	Near Chicago	1982 March	Yes	Yes	JP-4	Yes	Descent, 12K	Forward body tank exploded, initial cause listed as VHF antenna.
B-52G	Grand Forks AFB ND	1983 Jan		Yes	JP-4	Yes	Maintenance	While troubleshooting a fuel transfer malfunction, center wing tank exploded due to an electrical fault associated with the EMI filter on a valve.
KC-135A	Altus AFB, OK	1987 Feb	Yes	Yes	JP-4	Yes	Landing roll out	During landing roll out an explosion and fire occurred following copilot transmission on UHF radio. The

								UHF wire run near the right aft wing root in the fuselage was melted due to an electrical fault. Fuel vapors in the area of the aft body tank were ignited
B-52H	Swayer AFB, MI	1988 Dec	Yes	Yes	JP-4	Yes	Touch and go	At 20 feet AGL while landing, the empty aft body tank exploded. Pump operating in the aft body tank was cause. Evidence of arcing a overheat was found.
KC-135A	Loring AFB Maine	1989 Sept	Yes	Yes	JP-4	Yes	Parked	During system flight shut down, explosion in the aft fuselage tank occurred. Source of ignition was believed to be a hydraulically driven fuel pump mounted inside the aft body fuel tank.
KC-135A	Loring AFB Maine	1989 Oct	Yes	Yes	JP-4	Yes	In flight	Explosion in the pattern aft body fuel tank caused hull loss. Aft body hydraulically driven fuel pump implicated as source of ignition.
KC-135R	Mitchell Field	1993 Dec	Yes	Yes	JP-4	Yes	Maintenance	During maintenance center wing tank exploded. Center wing fuel tank fuel pump implicated as source of ignition.

Mitchell Field, Milwaukee, WI