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SPACE SHUTTLE

AEROTHERMODYNAMIC DATA REPORT

JOHNSON SPACE CENTER

HOUSTON, TEXAS

DATA MANagement services

SPACE DIVISION CHRYSLER CORPORATION

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RESULTS OF FLOW VISUALIZATION TESTS OF 0.010-SCALE SPACE SHUTTLE MODELS 32-OTS AND 52-O IN THE AEDC VKF TUNNEL A (IA61B)

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Prepared under NASA Contract Number NAS9-13247

By

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National Aeronautics and Space Administration
Houston, Texas

WIND TUNNEL TEST SPECIFICS:

Test Number: AEDC VKF A-VA422 - 21AA
NASA Series Number: IA61B
Model Number: 32-OTS, 52-0
Test Date: 25 February 1974
Occupancy Hours: 8

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Chrysler Corporation Space Division assumes no responsibility for the data presented other than display characteristics.

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0.010-SCALE SPACE SHUTTLE MODELS
32-OTS AND 52-0 IN THE
AEDC VKF TUNNEL A (IA61B)

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ABSTRACT

Results of oil flow visualization tests of an 0.010-scale model of the Space Shuttle vehicle configuration 3 are presented in this report. The test was conducted at Mach numbers of 3.75 and 5.03 in the AEDC VKF Tunnel A during February 1974. Angles of attack of -5°, 0°, and 30° and angles of sideslip of 0° and 5° were investigated.

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NOMENCLATURE

General

SYMBOL	SADSAC SYMBOL	DEFINITION
a		speed of sound; m/sec, ft/sec
C_p	CP	pressure coefficient; $(p_l - p_\infty)/q$
M	MACH	Mach number; V/a
p		pressure; N/m^2, psf
q	Q(NSM) Q(PSF)	dynamic pressure; $1/2\rho V^2$, N/m^2, psf
RN/L	RN/L	unit Reynolds number; per m, per ft
V		velocity; m/sec, ft/sec
α	ALPHA	angle of attack, degrees
β	BETA	angle of sideslip, degrees
ψ	PSI	angle of yaw, degrees
ϕ	PHI	angle of roll, degrees
ρ		mass density; kg/m^3, $slugs/ft^3$

Reference & C.G. Definitions

SYMBOL	SADSAC SYMBOL	DEFINITION
A_b		base area; m^2, ft^2
b	BREF	wing span or reference span; m, ft
c.g.		center of gravity
ℓ_{REF} $\bar{c}$	LREF	reference length or wing mean aerodynamic chord; m, ft
S	SREF	wing area or reference area; m^2, ft^2
	MRP	moment reference point
	XMRP	moment reference point on X axis
	YMRP	moment reference point on Y axis
	ZMRP	moment reference point on Z axis

SUBSCRIPTS

b	base
l	local
s	static conditions
t	total conditions
∞	free stream

CONFIGURATIONS INVESTIGATED

The models for this test in the AEDC-VKF Tunnel A were 0.010-scale force models of the Rockwell International Space Shuttle Vehicle Configuration 3, designated Model 32-OTS and model 52-0. A three-view of the vehicle is shown in Figure 2a.

All control surfaces were at their nominal positions for the test; i.e., there were no elevon, aileron, body flap, or rudder deflections.

Configurations tested were:

$O_1 = B_{19}\ C_7\ E_{23}\ F_5\ M_4\ N_8\ N_{24}\ R_5\ V_7\ W_{107}$

$O_2 = B_{19}\ C_7\ E_{23}\ F_5\ M_4\ N_8\ R_5\ V_7\ W_{107}$

$ET = T_{10}\ AT_6\ AT_7\ AT_{11}\ PT_1\ PT_2\ PT_3\ FL_1\ FL_2$

$SRB = S_8$

The model components are defined as follows:

Symbol		
AT_6	Left rear Orbiter to external tank	VL72-000088D & 89
AT_7	Right rear Orbiter to external tank	VL72-000088D & 89
AT_{11}	Front Orbiter to external tank	VL72-000088D & 89
B_{19}	Body	VL70-00139B
C_7	Canopy	VL70-00139B
E_{23}	Elevons	VL70-00139B
F_5	Body flap	VL70-00139B

CONFIGURATIONS INVESTIGATED (Concluded)

FL_1	LO_2 feedlines	VL78-000050
FL_2	LH_2 feedline	VL78-000050
M_4	Orbital Maneuvering System	VL70-00139B
N_8	OMS Nozzles	VL70-000140A
N_{24}	Orbiter SSME nozzles	VL70-000140A
R_5	Rudder	VL70-000140A
S_8	Boosters (Solid Rocket)	VL72-000088 & VL77-000036
T_{10}	External tank	VL78-00041B
V_7	Vertical tail	VL70-000140A
W_{107}	Wing	VL70-000140A

Dimensional data for the components are given in Table II.

TESTING TECHNIQUES

The oil used for these tests was composed of a silicone oil base (trade named Dow Corning Fluid), a Titanium Dioxide pigment, and Oleic acid (to enhance suspension). Different combinations of two viscosities (10 and 100 centistokes) of the oil base were mixed with varying quantities of pigment and a few drops of acid until satisfactory results were obtained.

When oil viscosity is too low, the oil blows off of the model and oil patterns change during retraction of the model from the test section. If the viscosity is too high the oil dries out before the flow pattern can be satisfactorily established.

The model was first painted with blue layout dye, but this was found to be difficult to work with (comes off very easily), and more satisfactorily results were obtained with flat black enamel paint.

Several methods of applying the oil were tried. Oil was sprayed on (this oil was too low in viscosity) and dabbed on in spots. The best results were obtained when the oil was wiped on evenly with cheese cloth.

The test procedure was to paint the model (touch up bad spots in between runs), apply the oil, and inject the model into the tunnel with the model set at the attitude for the run. After the flow pattern had established and photos were taken the model was retracted. Close-up photos of the oil pattern were then taken. On mated vehicle configurations the Orbiter was detached from the ET in order to photograph the lower surface of the Orbiter and the upper surface of the ET.

TESTING TECHNIQUES (Concluded)

Model 32-OTS was used for integrated vehicle runs, and model 52-0 for Orbiter alone.

TEST FACILITY DESCRIPTION

The AEDC von Karmon Facility (VKF) Tunnel A is a continuous, closed-circuit, variable density wind tunnel with an automatically driven flexible-plate-type nozzle and a 40- by 40-in. test section. The tunnel can be operated at Mach numbers from 1.5 to 6 at maximum stagnation pressures from 29 to 200 psia, respectively, and stagnation temperatures up to 750° R ($M = 6$). Minimum operating pressures range from about one-tenth to one-twentieth of the maximum at each Mach number. A description of the tunnel and airflow calibration information may be found in the Test Facilities Handbook*.

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*Test Facilities Handbook (Ninth Edition). "von Karmon Gas Dynamics Facility, Vol. 3," Arnold Engineering Development Center, July 1971.

TABLE I. - TEST SUMMARY

Run Log

Run Number	Configuration	Mach No.	α (deg.	β (deg.)	φ (deg.)	Comments
1	0_1 +ET +SRB	3.75	0	0	0	
2	0_1 +ET +SRB	3.75	0	0	0	
3	0_1 +ET +SRB	3.75	0	0	0	
4	0_1 +ET +SRB	3.75	0	0	0	good oil flow
5	0_2 +ET +SRB	3.75	-5	0	0	good oil flow
6	0_2 +ET +SRB	3.75	0	5	0	good oil flow
45	0_2 +ET +SRB	3.75	0	0	0	shadowgraphs
55	0_2 +ET +SRB	3.75	-5	0	0	shadowgraphs
85	0_2 +ET +SRB	5.03	0	0	0	shadowgraphs
105	0_2 +ET +SRB	5.03	-5	0	0	shadowgraphs
7	0_1	5.03	0	0	0	good oil flow
8	0_2 +ET +SRB	5.03	0	0	0	good oil flow
9	0_1	5.03	30	0	-90	Laser shadowgram

Tunnel Freestream Conditions

Mach No.	Stagnation Pressure (psia)	Stagnation Temperature (°F)	Unit Reynolds No. (Million per foot)
3.75	50	100	5.0
5.03	115	180	5.0

TABLE II. MODEL DIMENSIONAL DATA

MODEL COMPONENT : BODY - B_{19}

GENERAL DESCRIPTION : Fuselage, configuration 3.

NOTE: Identical to B_{17} except forebody.

MODEL SCALE: 0.010

DRAWING NUMBER : VL70-000139B

DIMENSIONS :	FULL SCALE	MODEL SCALE
Length	1290.3	12.903
Max Width	267.6	2.676
Max Depth	244.5	2.445
Fineness Ratio	4.822	4.822
Area - Ft^2		
Max. Cross-Sectional	386.67	0.0387
Planform		
Wetted		
Base		

TABLE II. (CONT'D)

MODEL COMPONENT : CANOPY - C_7

GENERAL DESCRIPTION : Configuratioan 3

MODEL SCALE: 0.010

DRAWING NUMBER : VL70-000139

DIMENSIONS :	FULL SCALE	MODEL SCALE
Length (X_o=433-X_o=578), In.	145.00	1.450
Max Width		
Max Depth		
Fineness Ratio		
Area		
Max. Cross-Sectional		
Planform		
Wetted		
Base		

TABLE II. (CONT'D)

MODEL COMPONENT: ELEVON - E_{23}

GENERAL DESCRIPTION: Configuration 3 per W_{107}

Data for 1 of 2 sides.

MODEL SCALE: 0.010

DRAWING NUMBER: VL70-000139B

DIMENSIONS:	FULL-SCALE	MODEL SCALE
Area - Ft^2	205.52	0.0206
Span (equivalent), In.	353.34	3.533
Inb'd equivalent chord, In.	114.78	1.148
Outb'd equivalent chord, In.	55.00	0.550
Ratio movable surface chord/ total surface chord		
At Inb'd equiv. chord	0.208	0.208
At Outb'd equiv. chord	0.400	0.400
Sweep Back Angles, degrees		
Leading Edge	0.00	0.00
Tailing Edge	- 10.24	- 10.24
Hingeline	0.00	0.00
Area Moment (~~Normal to hinge line~~) (Product of Area & $\overline{c}$), Ft^3	1548.70	0.0015

TABLE II. (CONT'D)

MODEL COMPONENT : BODY FLAP - F_5

GENERAL DESCRIPTION : Configuration 3

MODEL SCALE: 0.010

DRAWING NUMBER : VL70-000139

DIMENSIONS :	FULL SCALE	MODEL SCALE
Length , In.	84.70	0.847
Max Width , In.	267.6	2.676
Max Depth		
Fineness Ratio		
Area - Ft^2		
Max. Cross-Sectional		
Planform	142.5	0.0143
Wetted		
Base	38.0958	0.0038

TABLE II. (CONT'D)

MODEL COMPONENT : ORBITAL MANEUVERING SYSTEM - M_4

GENERAL DESCRIPTION : Configuration 3

NOTE: M_4 identical to M_3 except intersection to fuselage.

MODEL SCALE: 0.010

DRAWING NUMBER : VL70-000139

DIMENSIONS :

	FULL SCALE	MODEL SCALE
Length , In.	346.0	3.460
Max Width , In.	108.0	1.080
Max Depth, In.	113.0	1.130
Fineness Ratio		
Area		
Max. Cross-Sectional		
Planform		
Wetted		
Base		

TABLE II. (CONT'D)

MODEL COMPONENT: NOZZLES - N_8

GENERAL DESCRIPTION: Basic OMS nozzle of configuration 2A. Intersection of nozzle exit plane and nozzle centerline at X_o = 1570.75, Y_o = + 99.25, Z_o = 507.25

MODEL SCALE: 0.010

DRAWING NUMBER: VL70-008306, VL70-000089B, SS-A00092

DIMENSIONS:	FULL SCALE	MODEL SCALE
MACH NO.		
Length - In.		
Gimbal Point to Exit Plane		
Throat to Exit Plane		
Diameter - In.		
Exit	50.00	0.500
Throat	N/A	N/A
Inlet	28.00	0.280
Area - ft^2		
Exit	13.635	0.136
Throat		
Gimbal Point (Station) - In.		
~~Upper Nozzle~~		
X	1518.00	15.180
Y	± 88.0	± 0.880
Z	492.0	4.920
Lower Nozzles		
X		
Y		
Z		
Null Position - Deg.		
~~Upper Nozzle~~		
Pitch	15°49'	15°49'
Yaw	12°17'	12°17'
Lower Nozzle		
Pitch		
Yaw		

TABLE II. (CONT'D)

MODEL COMPONENT: MPS NOZZLES - N_{24}

GENERAL DESCRIPTION: Configuration 140A/B Orbiter MPS nozzles.

MODEL SCALE: 0.010 MODEL DRAWING: SS-A00147, Release 12

DRAWING NUMBER: VL70-005030A, VL70-000140A

DIMENSIONS:		FULL SCALE		MODEL SCALE
MACH NO.				
Length - In.				
Gimbal Point to Exit Plane		157.0		1.570
Throat to Exit Plane		99.2		0.992
Diameter - In.				
Exit		91.000		0.910
Throat				
Inlet				
Area - ft^2				
Exit		45.166		0.0045
Throat				
Gimbal Point (Station) - In.				
Upper Nozzle				
X_O		1445.		14.450
Y_O		0.0		0.0
Z_O		443.0		4.430
Lower Nozzles				
X_O		1468.17		14.682
Y_O	±	53.00	±	0.530
Z_O		342.640		3.426
Null Position - Deg.				
Upper Nozzle				
Pitch		16		16
Yaw		0		0
Lower Nozzle				
Pitch		10		10
Yaw		3.5		3.5

TABLE II. (CONT'D)

MODEL COMPONENT: RUDDER - R_5

GENERAL DESCRIPTION: Configuration 140C orbiter rudder (identical to configuration 140A/B rudder)

MODEL SCALE: 0.010

DRAWING NUMBER: VL70-000146B, VL70-000095

DIMENSIONS:	FULL-SCALE	MODEL SCALE
Area - Ft^2	100.15	0.0100
Span (equivalent), In.	201.0	2.010
Inb'd equivalent chord, In.	91.585	0.916
Outb'd equivalent chord, In.	50.833	0.508
Ratio movable surface chord/ total surface chord		
At Inb'd equiv. chord	0.400	0.400
At Outb'd equiv. chord	0.400	0.400
Sweep Back Angles, degrees		
Leading Edge	34.83	34.83
Tailing Edge	26.25	26.25
Hingeline	34.83	34.83
Area Moment (Product of area & $\bar{c}$) (~~Normal to hinge line~~), Ft^3	610.92	0.00061
Mean aerodynamic chord, In.	73.2	0.732

TABLE II. (CONT'D)

MODEL COMPONENT: VERTICAL - V_7

GENERAL DESCRIPTION: Centerline vertical tail doublewedge airfoil with rounded leading edge

NOTE: Same as V_5 but with manipulator housing removed

MODEL SCALE: 0.010

DRAWING NUMBER: VL70-000139

DIMENSIONS:	FULL SCALE	MODEL SCALE
TOTAL DATA		
Area (Theo) - Ft^2		
Planform	425.92	0.0426
Span (Theo) - In.	315.72	3.157
Aspect Ratio	1.675	1.675
Rate of Taper	0.507	0.507
Taper Ratio	0.404	0.404
Sweep-Back Angles, Degrees.		
Leading Edge	45.000	45.000
Trailing Edge	26.249	26.249
0.25 Element Line	41.130	41.130
Chords:		
Root (Theo) WP	268.50	2.685
Tip (Theo) WP	108.47	1.085
MAC	199.81	1.998
Fus. Sta. of .25 MAC	1463.50	14.635
W.P. of .25 MAC	635.522	6.355
B.L. of .25 MAC	0.00	0.00
Airfoil Section		
Leading Wedge Angle - Deg.	10.00	10.00
Trailing Wedge Angle - Deg.	14.920	14.920
Leading Edge Radius	2.00	0.020
Void Area	13.17	0.0013
Blanketed Area	0.0	0.0

TABLE II. (CONT'D)

MODEL COMPONENT: WING-W_{107}

GENERAL DESCRIPTION: Configuration 3 per Rockwell Lines VL70-000139B

NOTE: Same as W_{105} except cuff, airfoil and incidence angle.

MODEL SCALE: 0.010

TEST NO.

DWG. NO. VL70-000139B

DIMENSIONS:	FULL-SCALE	MODEL SCALE
TOTAL DATA		
Area (Theo.) Ft^2		
Planform	2690.00	0.2690
Span (Theo In.	936.68	9.367
Aspect Ratio	2.265	2.265
Rate of Taper	1.177	1.177
Taper Ratio	0.200	0.200
Dihedral Angle, degrees	3.500	3.500
Incidence Angle, degrees	0.500	0.500
Aerodynamic Twist, degrees	3.000	3.000
Sweep Back Angles, degrees		
Leading Edge	45.000	45.000
Trailing Edge	- 10.056	- 10.056
0.25 Element Line	35.209	35.209
Chords:		
Root (Theo) B.P.0.0.	689.24	6.892
Tip, (Theo) B.P.	137.85	1.379
MAC	474.81	4.748
Fus. Sta. of .25 MAC	1136.89	11.369
W.P. of .25 MAC	299.20	2.992
B.L. of .25 MAC	182.13	1.821
EXPOSED DATA		
Area (Theo) Ft^2	1752.29	17.523
Span, (Theo) In. BP108	720.68	7.207
Aspect Ratio	2.058	2.058
Taper Ratio	0.2451	0.245
Chords		
Root BP108	562.40	5.624
Tip 1.00 $\frac{b}{2}$	137.85	1.379
MAC	393.03	3.930
Fus. Sta. of .25 MAC	1185.31	11.853
W.P. of .25 MAC	300.20	3.002
B.L. of .25 MAC	251.76	2.518
Airfoil Section (Rockwell Mod NASA) XXXX-64		
Root $\frac{b}{2}$ =	0.100	0.100
Tip $\frac{b}{2}$ =	0.120	0.120
Data for (1) of (2) Sides		
Leading Edge Cuff		
Planform Area Ft^2	118.333	0.0118
Leading Edge Intersects Fus M. L. @ Sta	500.00	5.00
Leading Edge Intersects Wing @ Sta	1083.4	10.834

TABLE II. (CONT'D)

MODEL COMPONENT: ORBITER UMBILICAL FAIRING - FR_5

GENERAL DESCRIPTION: Fairing around orbiter umbilical assembly on orbiter lower surface fuselage trailing edge.

MODEL SCALE: 0.01

DRAWING NO.: VL78-000050

DIMENSIONS:

	FULL SCALE	MODEL SCALE
Height (from orbiter surface, In.)		
Leading edge	5.0	0.050
Trailing edge	23.0	0.230
Maximum	26.0	0.260
Length, In.	154.00	1.540
Max. width, In.	235.0	2.350

TABLE II. (CONT'D)

MODEL COMPONENT : EXTERNAL TANK - T_{10}

GENERAL DESCRIPTION : External oxygen-hydrogen tank, 3 configuration.

MODEL SCALE: 0.010

DRAWING NUMBER : VL72-000088, VL78-000041

DIMENSIONS :	FULL SCALE	MODEL SCALE
Length , In. (Nose @ X = 309),	1865.00	18.650
Max Width (Dia.), In.	324.00	3.240
Max Depth		
Fineness Ratio	5.756	5.756
Area - Ft^2		
Max. Cross-Sectional	572.555	0.0573
Planform		
Wetted		
Base		
W.P. of tank centerline (X_T), In.	400.0	4.000

TABLE II. (Cont'd.)

MODEL COMPONENT: ATTACH STRUCTURE - AT_6

GENERAL DESCRIPTION: Right rear, Orbiter to External Tank

NOTE: This is a cross-brace strut.

MODEL SCALE: 0.010

DRAWING NO.: VL72-000088B (Location), VL72-000089 (Detail of struts)

DIMENSIONS	FULL SCALE	MODEL SCALE
First Strut		
Diameter, In. (Approx.)	1	0.01
Fwd Location, In. (Attach to Orbiter)		
X_o	1307.00	13.070
X_s	2058.00	20.580
App. Aft Location (Attach to Orbiter)		
X_o	1107.00	11.070
X_s	1858.00	18.580
Second Strut		
Diameter (In.,Approx.)	1	0.010
Location, In.		
X_o	1307.00	13.070
X_s	2058.00	20.580

TABLE II - (CONT'D)

MODEL COMPONENT: ATTACH STRUCTURE - AT_7

GENERAL DESCRIPTION: Left rear, Orbiter to External Tank

MODEL SCALE: 0.010

DRAWING NO.: VL72-000088B (Location), VL72-000089 (Detail of Struts)

DIMENSIONS:	FULL SCALE	MODEL SCAOE
Forward attach points:		
Orbiter to Tank		
No. of Struts	1	1
Diameter. In. (Approx.)	1	0.010
Location, In.		
X_O	1307.00	13.070
X_T	2058.00	20.580
Aft Attach points:		
Orbiter to Tank		
No. of Struts	1	1
Diameter, In. (Approx.)	1.00	0.010
Location, In.		
X_O	1107.00	11.070
X_T	1858.00	18.580

TABLE II. (CONT'D)

MODEL COMPONENT: ATTACH STRUCTURE - AT_{11}

GENERAL DESCRIPTION: Right rear orbiter/ET attach structure (3 member structure

MODEL SCALE: 0.010 MODEL DRAWING: ________

DRAWING NO.: VL78-000050

DIMENSIONS:

MEMBER		FULL SCALE	MODEL SCALE
#1	X_O	1313.00	13.130
	Y_O	96.00	0.960
	Z_O	258.00	2.580
	X_T	1859.00	18.590
	Y_T	115.00	1.150
	Z_T	510.00	5.100
#2	X_O	1317.00	13.170
	Y_O	96.00	0.960
	Z_O	258.00	2.580
	X_T	2058.00	20.580
	Y_T	115.00	1.150
	Z_T	510.00	5.100
#3	X_O	1317.00	13.170
	Y_O	96.00	0.960
	Z_O	258.00	2.580
	X_T	2058.00	20.580
	Y_T	0.0	0.0
	Z_T	566.00	5.660

Diameter of members, In.:

MEMBER	FULL SCALE	MODEL SCALE
#1	12.00	0.120
#2		
#3	8.0	0.080

TABLE II. (CONT'D)

MODEL COMPONENT: FEEDLINE - FL_1

GENERAL DESCRIPTION: LOX feedline between ET and Orbiter.

MODEL SCALE: 0.010

DRAWING NO.: VL78-000050

DIMENSIONS:

		FULL SCALE	MODEL SCALE
Centerline at	X_T	2063.5	20.635
	Y_T	70.0	0.700
	X_O	1440.6	14.406
	Y_O	70.0	0.700
Diameter		18.5	0.185

TABLE II. (CONT'D)

MODEL COMPONENT: FEEDLINE - FL_2

GENERAL DESCRIPTION: LH_2 feedline between ET and Orbiter.

MODEL SCALE: 0.010

DRAWING NO.: VL78-000050

DIMENSIONS:

		FULL SCALE	MODEL SCALE
Centerline at	X_T	2063.5	20.635
	Y_T	- 70.0	- 0.700
	X_O	1330.5	13.305
	Y_O	- 70.0	- 0.700
Diameter		18.5	0.185

TABLE II. (CONT'D)

MODEL COMPONENT : BOOSTER SOLID ROCKET MOTOR - S_8

GENERAL DESCRIPTION : Booster solid rocket, 3 configuration, body of revolution, data for 1 of 2 sides.

MODEL SCALE: 0.010

DRAWING NUMBER : VL72-000088, VL77-000036

DIMENSIONS :	FULL SCALE	MODEL SCALE
Length (Includes nozzle), In.	1741.0	17.410
Max Width(Tank dia.), In.	142.0	1.420
Max Depth (Aft shroud), In.	205.0	2.050
Fineness Ratio	8.493	8.493
Area - Ft^2		
Max. Cross-Sectional	229.21	0.0229
Planform		
Wetted		
Base		
WP of BSRM Centerline (Z_T), In.	400.0	4.00
FS of BSRM Nose (X_T), In.	200.0	2.000

TABLE II. (CONT'D)

MODEL COMPONENT: SRB FORWARD SEPARATION MOTOR FAIRING - PS_5

GENERAL DESCRIPTION: Fairing over forward separation motors on SRB. Fairing covers two separation motors.

MODEL SCALE: 0.010.

DRAWING NUMBER SS-A01184.

DIMENSION:	FULL SCALE	MODEL SCALE
Length	150.00	1.500
Max Width	56.3	0.563
Max Depth	18.0	0.180
Fineness Ratio		
Area		
Max Cross-Sectional		
Planform		
Wetted		
Base		
Leading edge of fairing at X_s	45.0	0.450

TABLE II. (CONT'D)

MODEL COMPONENT: SRB AFT SEPARATION MOTOR FAIRING - PS_6

GENERAL DESCRIPTION: Fairing over aft separation motors on SRB skirt. Fairing covers to separation motors.

MODEL SCALE: 0.010.

DRAWING NUMBER SS-A01184

DIMENSION:	FULL SCALE	MODEL SCALE
Length	120.128	1.201
Max Width	56.3	0.563
Max Depth	18.0	0.180
Fineness Ratio		
Area		
Max Cross-Sectional		
Planform		
Wetted		
Base		
Leading edge of fairing at X_s	1850.00	18.500

NOTE: Dimensions measured relative to skirt surface.

TABLE II. (CONT'D)

MODEL COMPONENT: SRB FORWARD SEPARATION NOZZLE BLOCK - N_{66}

GENERAL DESCRIPTION: Separation nozzles for configuration 3 solid rocket booster.

MODEL SCALE: 0.010

DRAWING NUMBER: SS-A01184

DIMENSIONS:	FULL SCALE	MODEL SCALE
MACH NO. (Design Exit Mach No.)	2.15	2.15
Length - In.		
Gimbal Point to Exit Plane		
Throat to Exit Plane		
Diameter - In.		
Exit	9.45	0.095
Throat	6.81	0.068
Inlet	6.81	0.068
Area - ft^2		
Exit	0.4871	0.0487
Throat	0.2529	0.0253
Gimbal Point (Station) - In.		
Upper Nozzle		
X		
Y		
Z		
Lower Nozzles		
X		
Y		
Z		
Null Position - Deg.		
Upper Nozzle		
Pitch		
Yaw		
Lower Nozzle		
Pitch		
Yaw		
No. of Nozzles	(In 2 blocks) 4	4
Center of rotation of thrust centerline	450	4.50

Nozzles control 20 deg. forward, away from O/ET

TABLE II. (CONT'D)

MODEL COMPONENT: SRB AFT SEPARATION NOZZLE BLOCK - N_{68}

GENERAL DESCRIPTION: Aft separation nozzles for configuration 3 solid rocket booster.

MODEL SCALE: 0.010

DRAWING NUMBER: SS-A01184

DIMENSIONS:	FULL SCALE	MODEL SCALE
MACH NO. (Design Exit)	2.15	2.15
Length - In.		
Gimbal Point to Exit Plane		
Throat to Exit Plane		
Diameter - In.		
Exit	9.45	0.094
Throat	6.81	0.068
Inlet	6.81	0.068
Area - ft^2		
Exit	0.4871	0.00049
Throat	0.2529	0.00025
Gimbal Point (Station) - In.		
Upper Nozzle		
X		
Y		
Z		
Lower Nozzles		
X		
Y		
Z		
Null Position - Deg.		
Upper Nozzle		
Pitch		
Yaw		
Lower Nozzle		
Pitch		
Yaw		
No. of nozzles:	4	4
Center of rotation of thrust centerline, X_s	1850	18.50

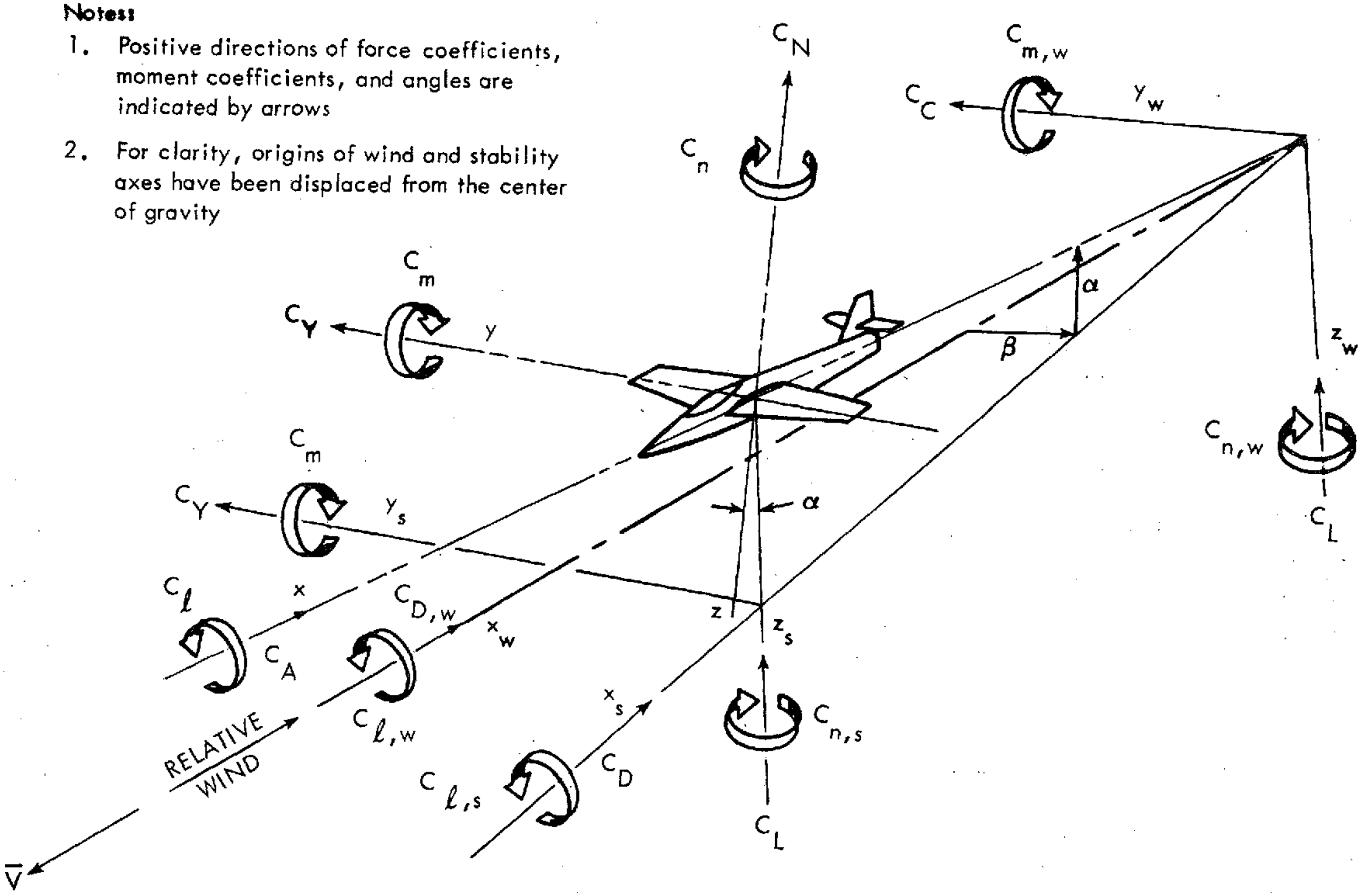
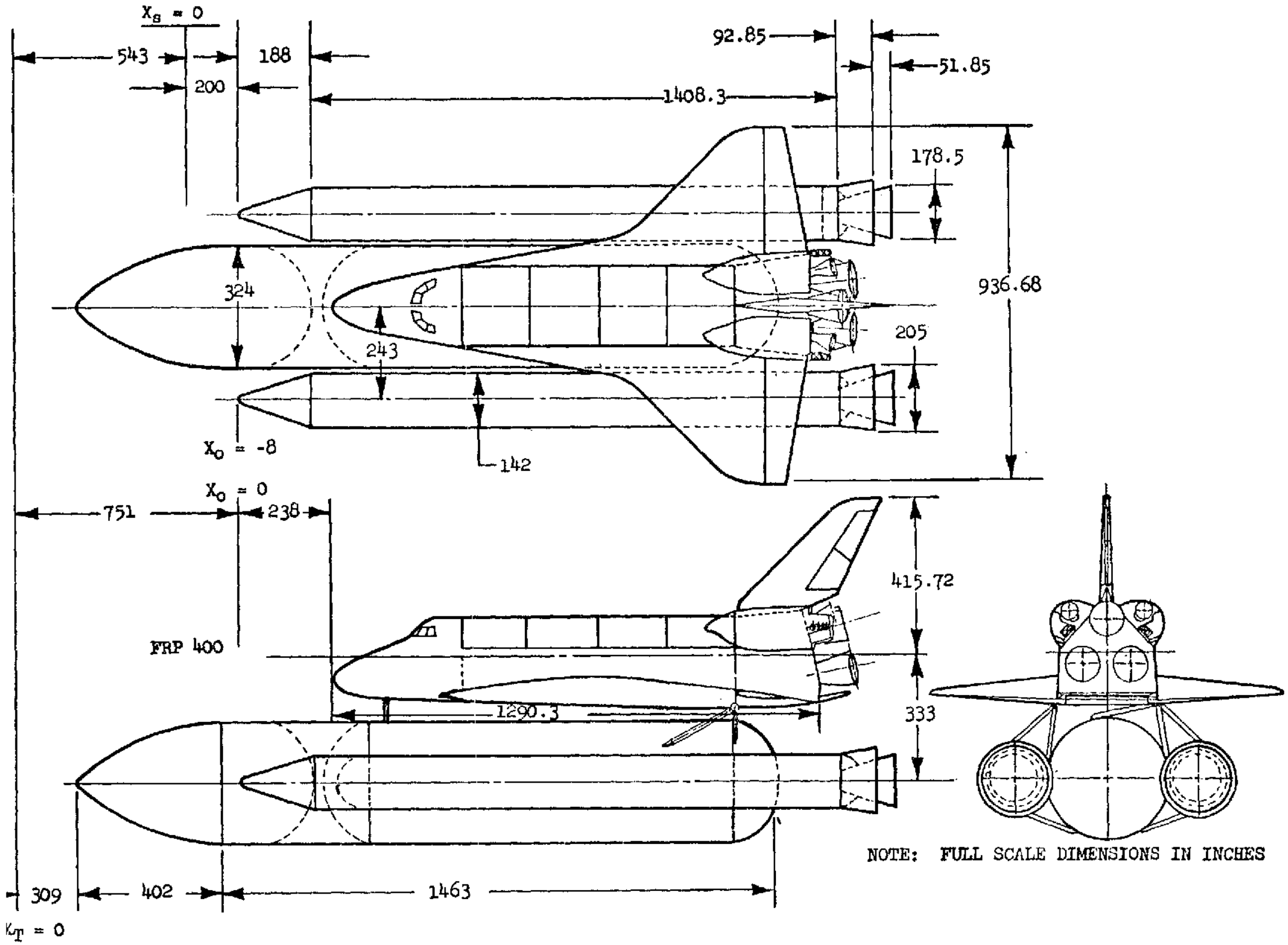
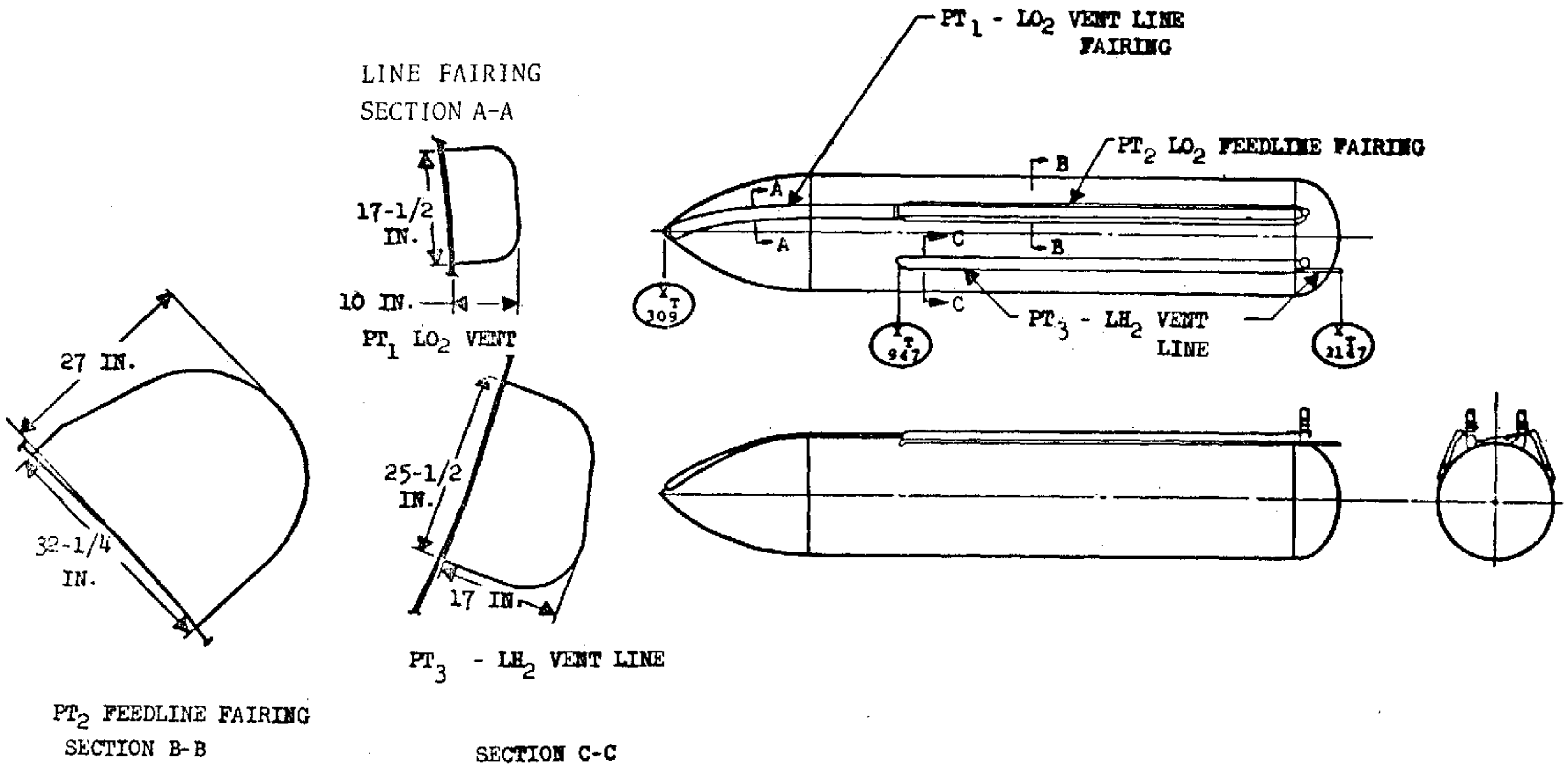


Figure 1. - Axis systems.



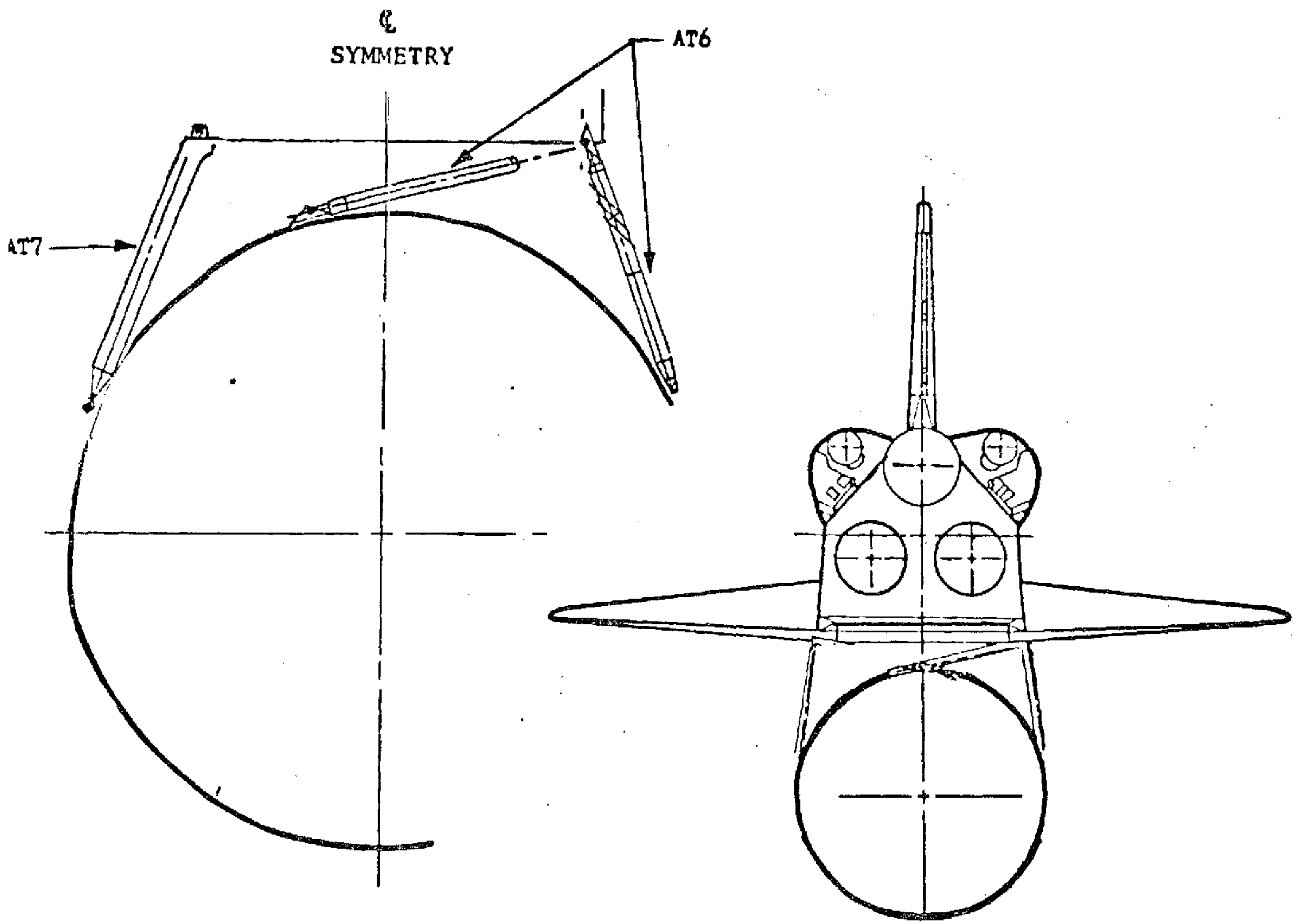
a. Integrated Vehicle Configuration 3

Figure 2. - Model sketches.



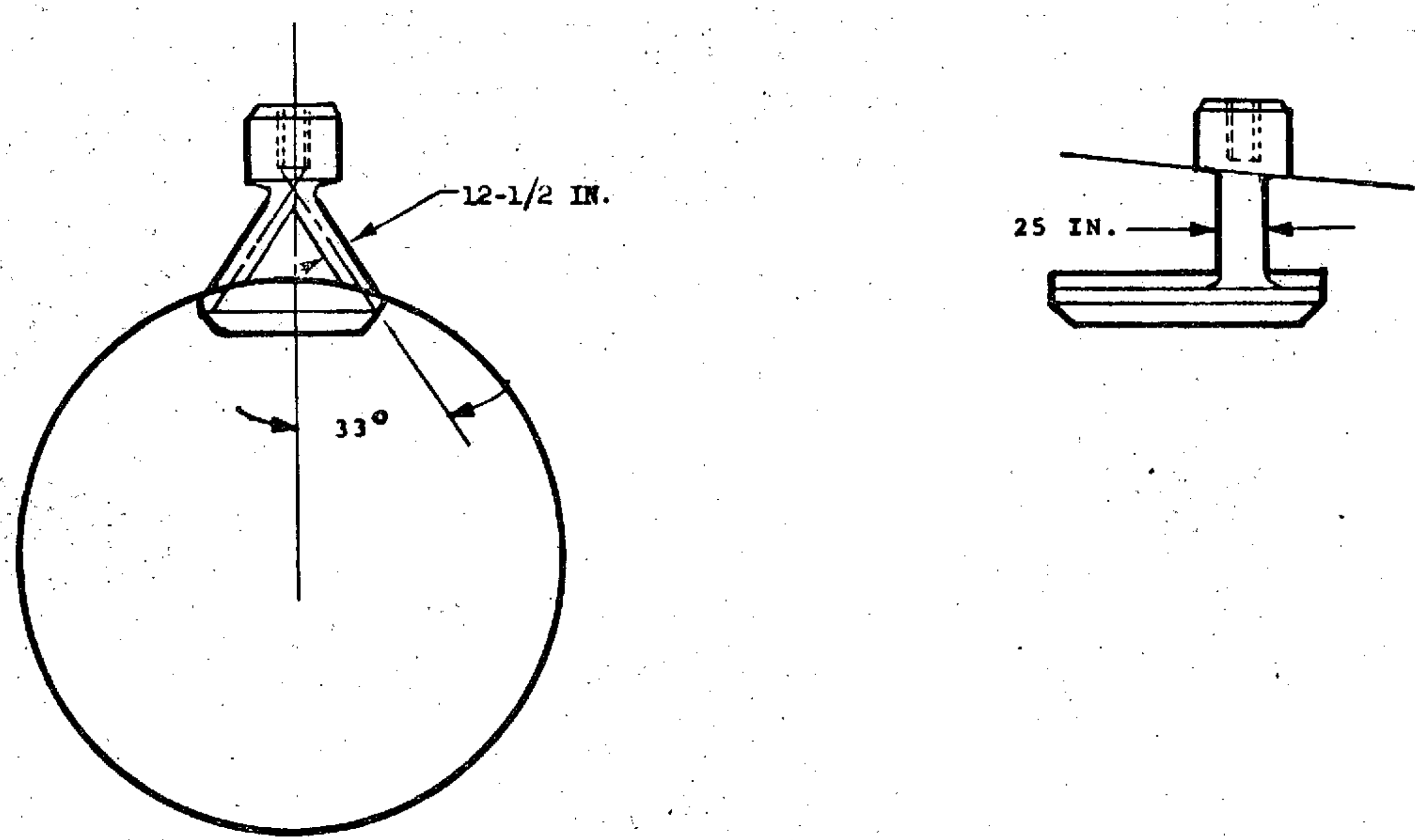
b. External Tank Protuberances (PT_1, PT_2, PT_3)

Figure 2. - Continued.



c. Aft Attachment of External Tank to Orbiter

Figure 2. - Continued.



d. Forward Attachment of External Tank to Orbiter (AT_{11})

Figure 2. - Concluded.

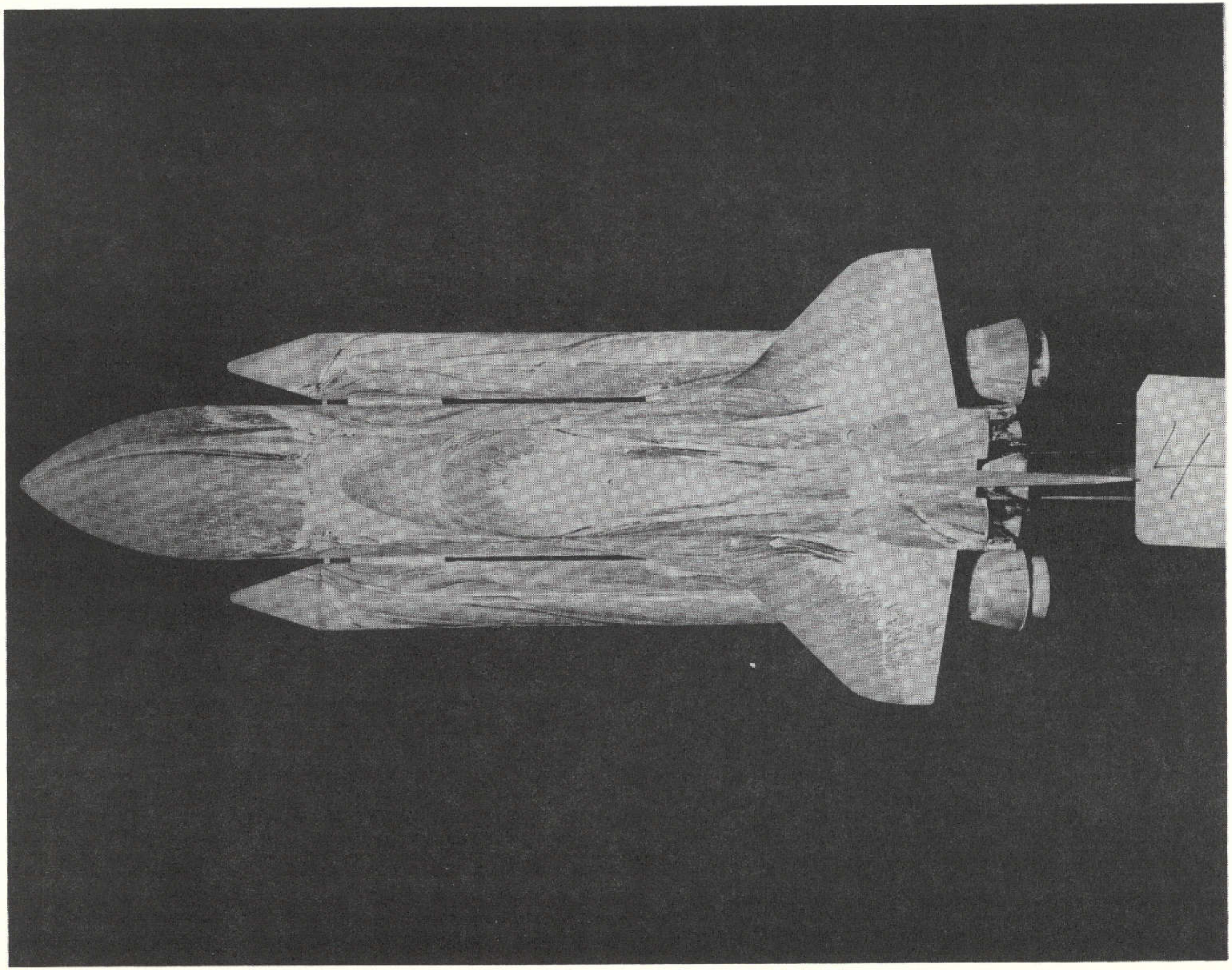


Figure 3. Run Number 4, View of Top

Mach = 3.75, $\alpha = 0°$ $\beta = 0°$

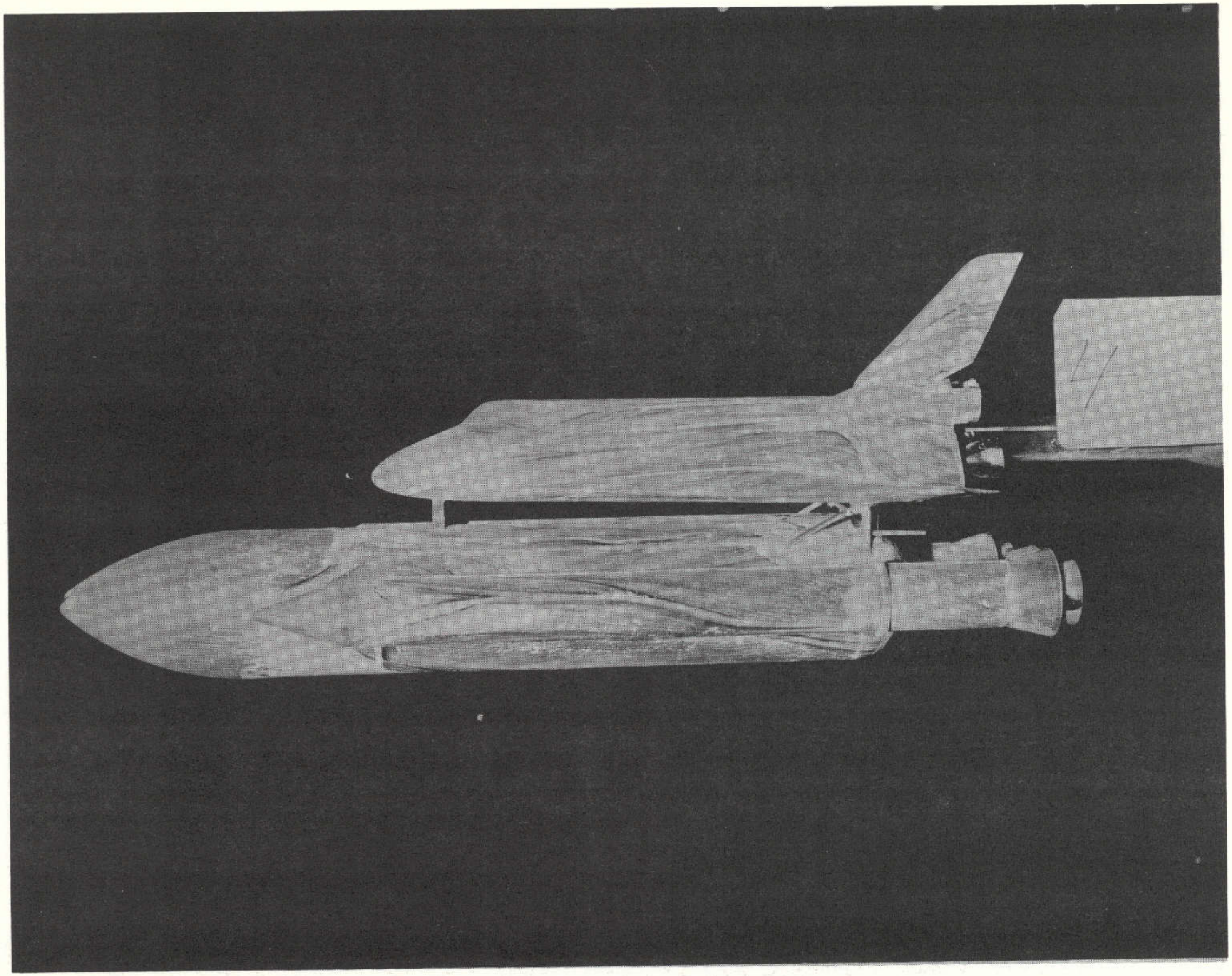


Figure 4. Run Number 4, View of Left Side

Mach = 3.75, α = 0° β = 0°

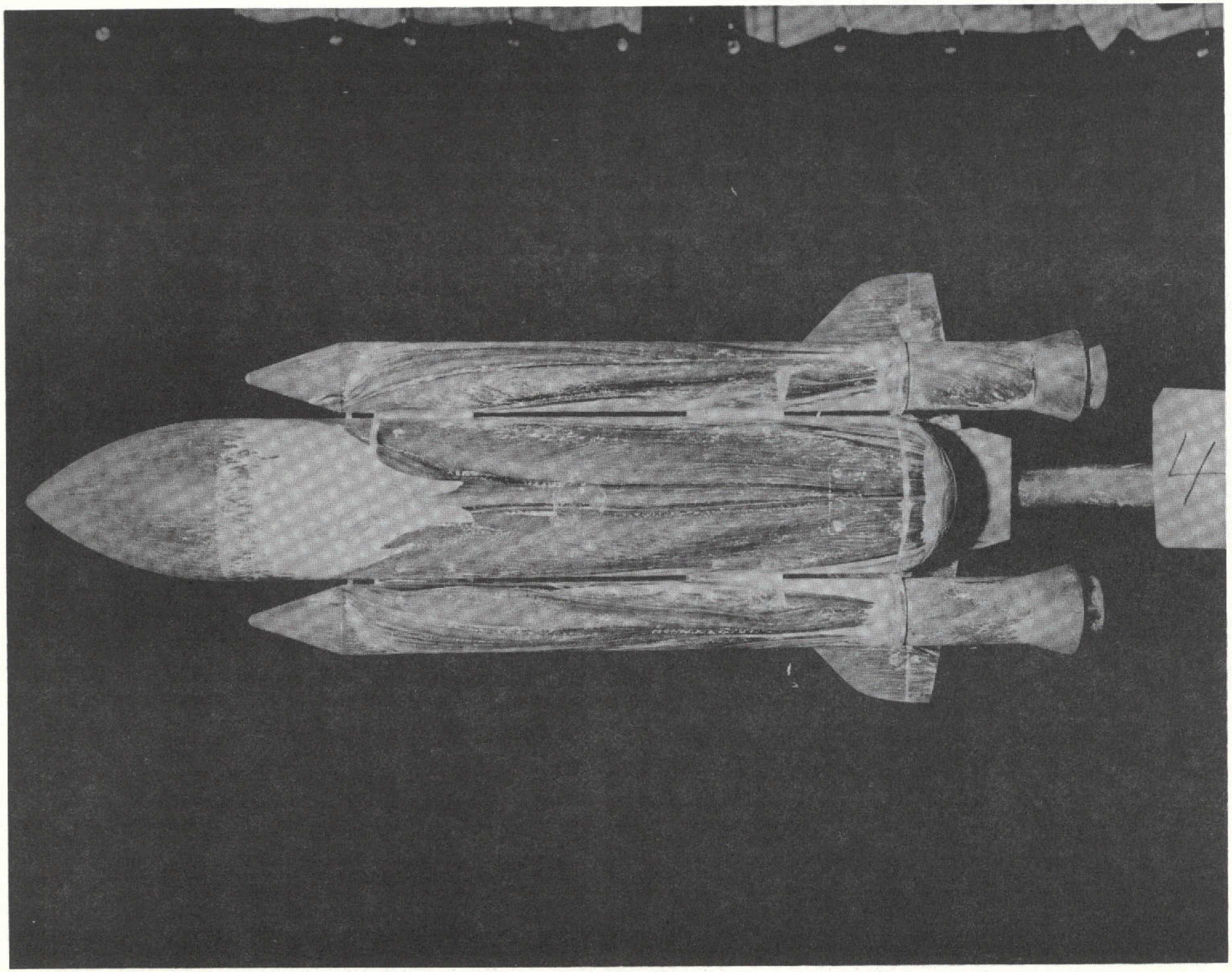


Figure 5. Run Number 4, View of Bottom

Mach = 3.75, α = 0° β = 0°

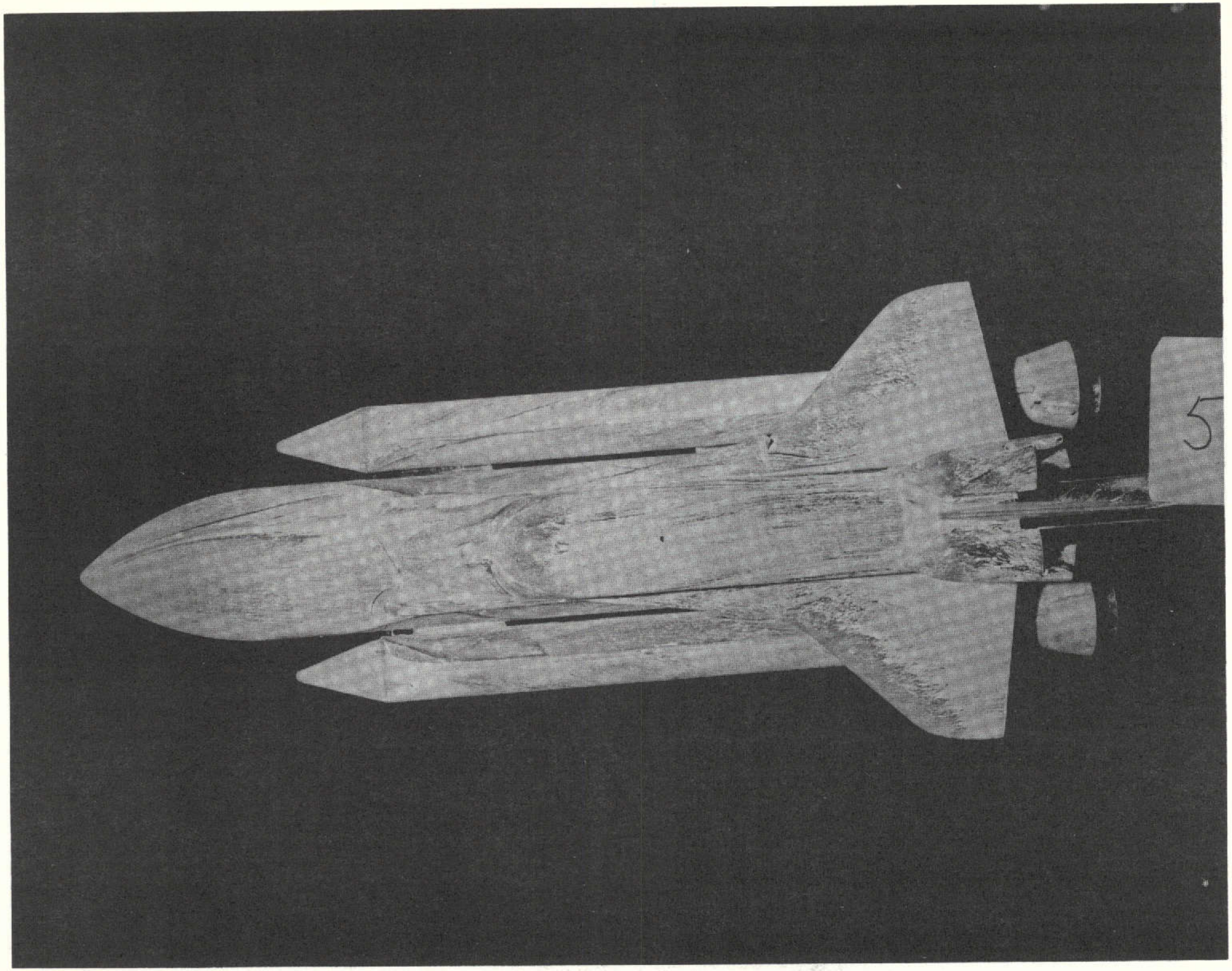


Figure 6. Run Number 5, View of Top

Mach = 3.75, α = -5° β = 0°

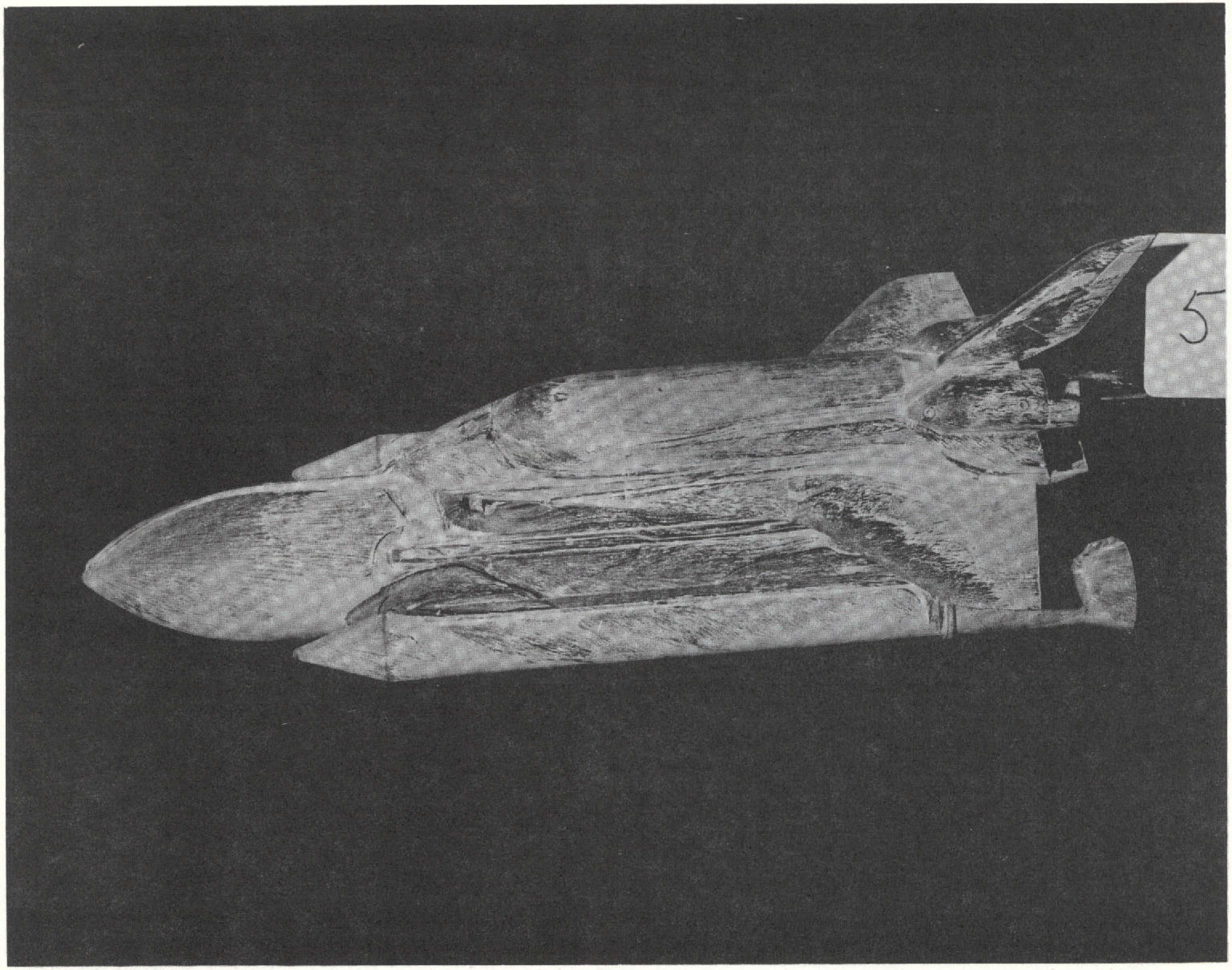


Figure 7. Run Number 5, View of Left Side Upper

Mach = 3.75, α = -5° β = 0°

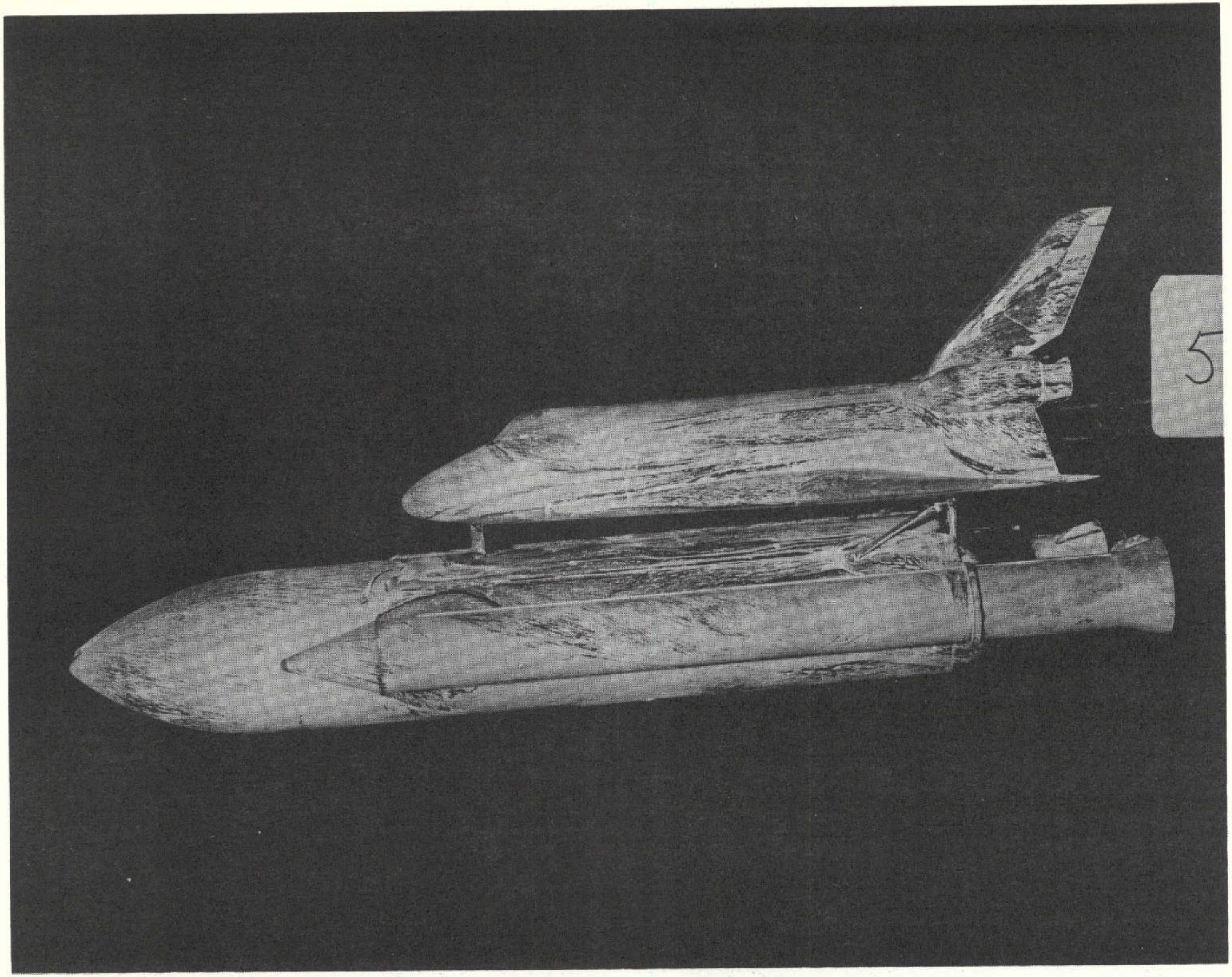


Figure 8. Run Number 5, View of Left Side

Mach = 3.75, α = -5° β = 0°

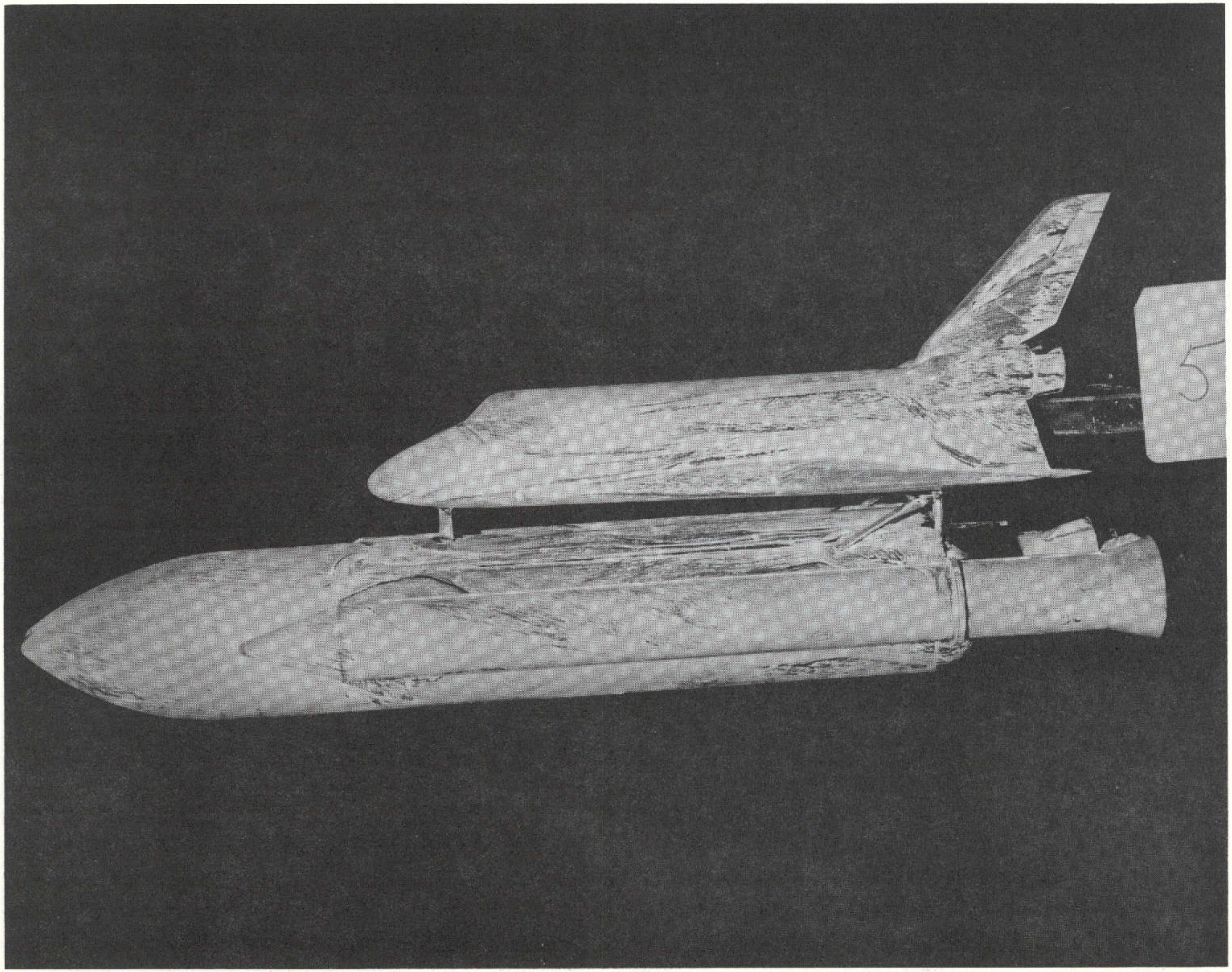


Figure 9. Run Number 5, View of Left Side

Mach = 3.75, α = -5° β = 0°

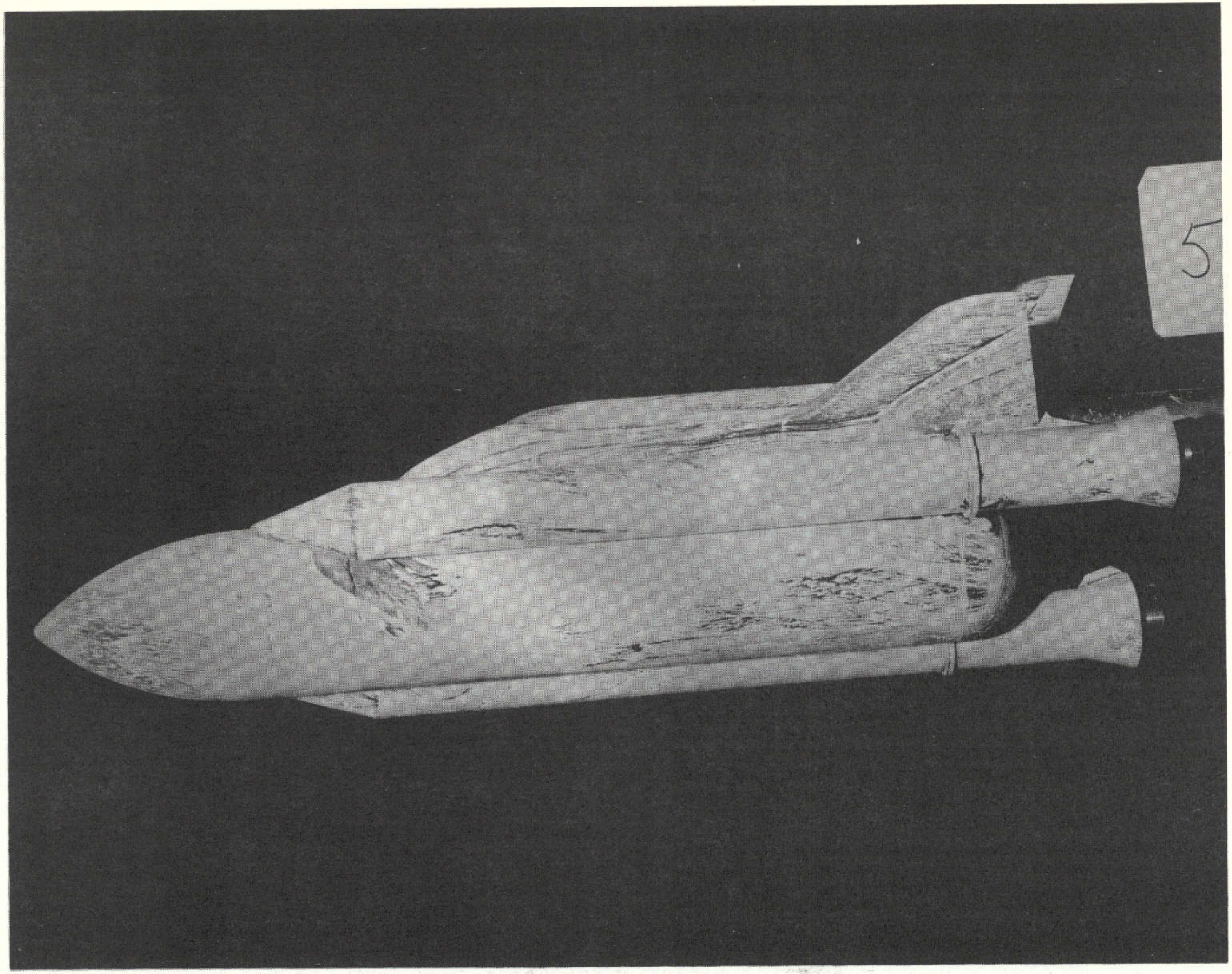


Figure 10. Run Number 5, View of Left Side Lower

Mach = 3.75, α = -5°, β = 0°

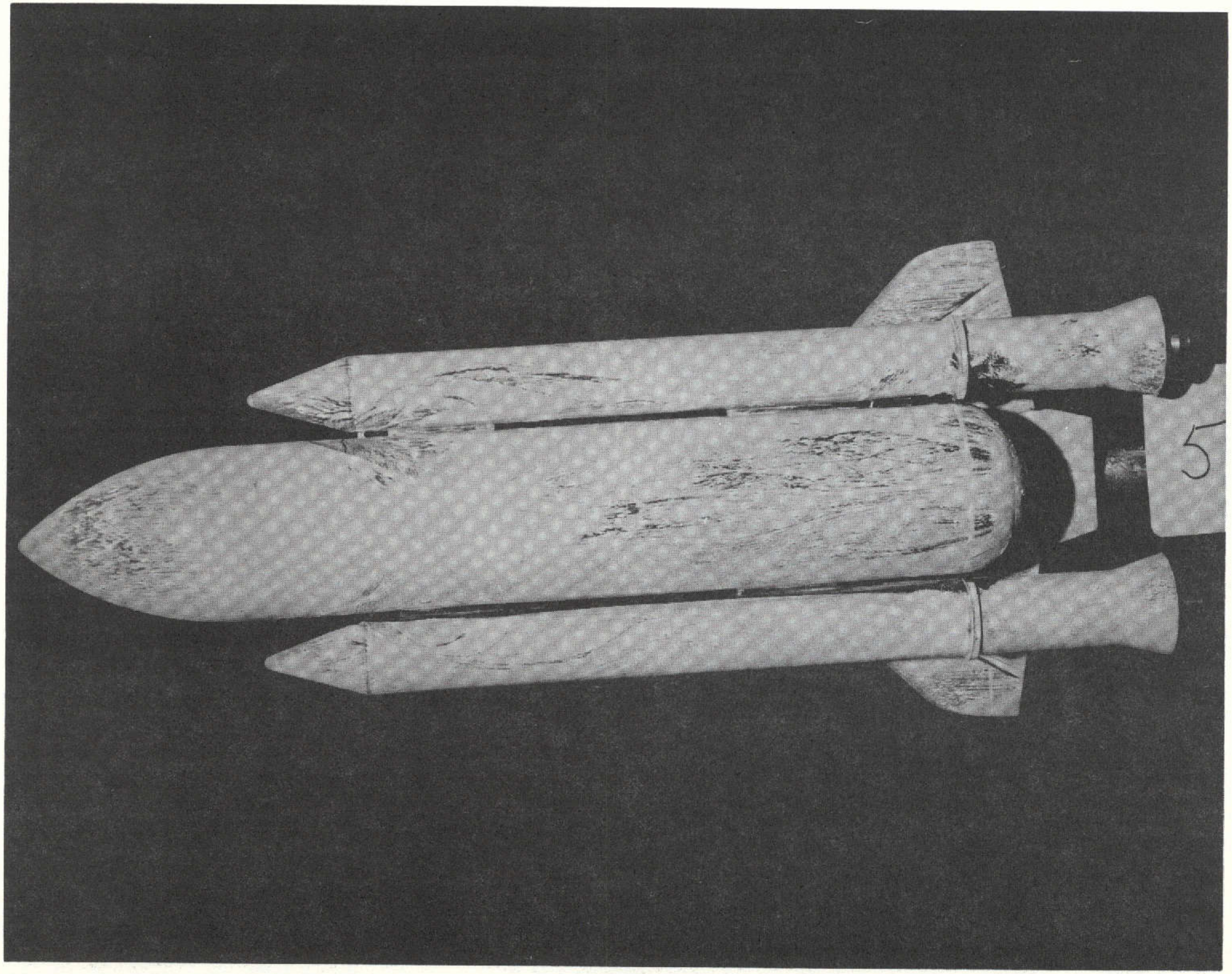


Figure 11. Run Number 5, View of Bottom

Mach = 3.75, α = -5° β = 0°

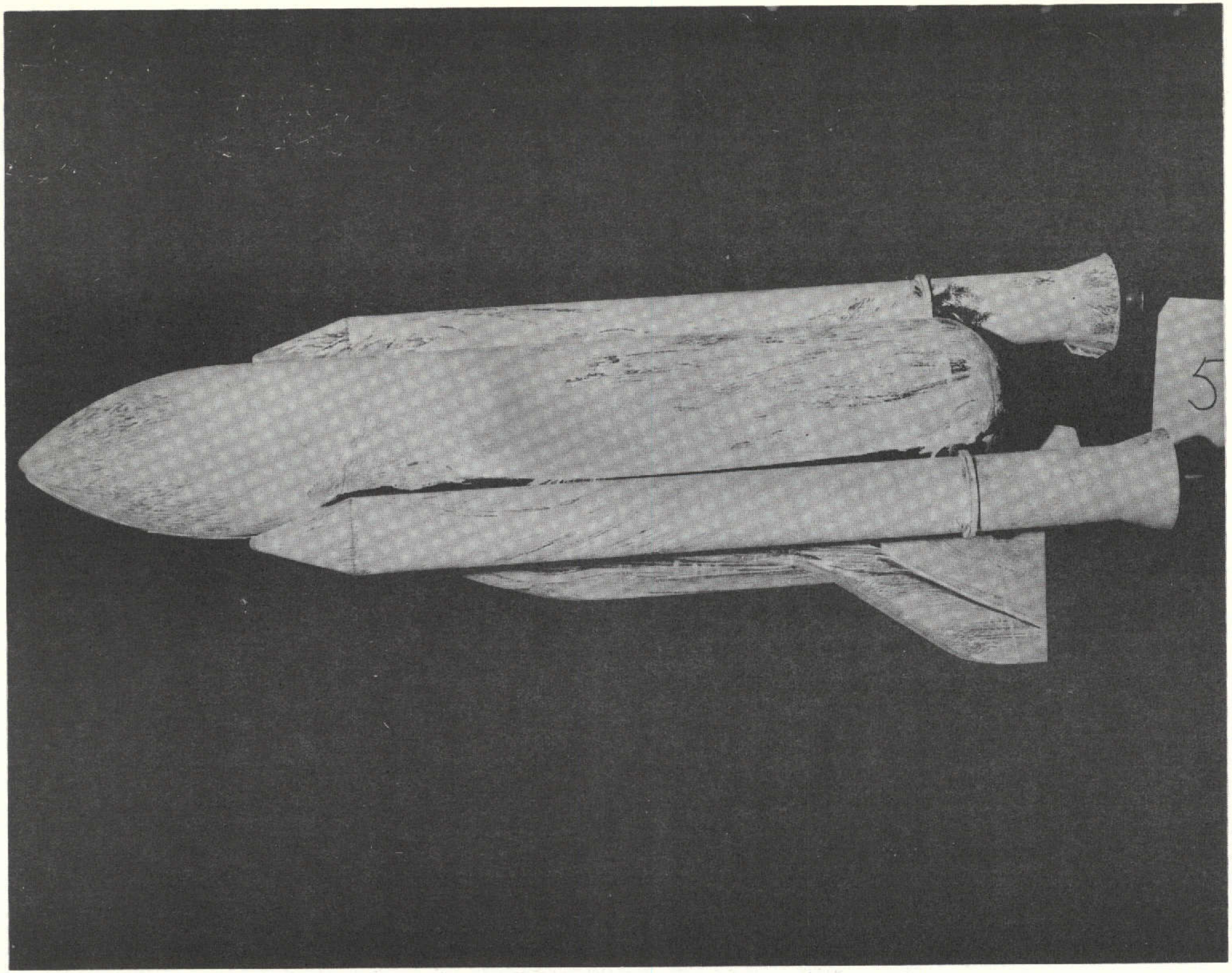


Figure 12. Run Number 5, View of Right Side Lower

Mach = 3.75, α = -5° β = 0°

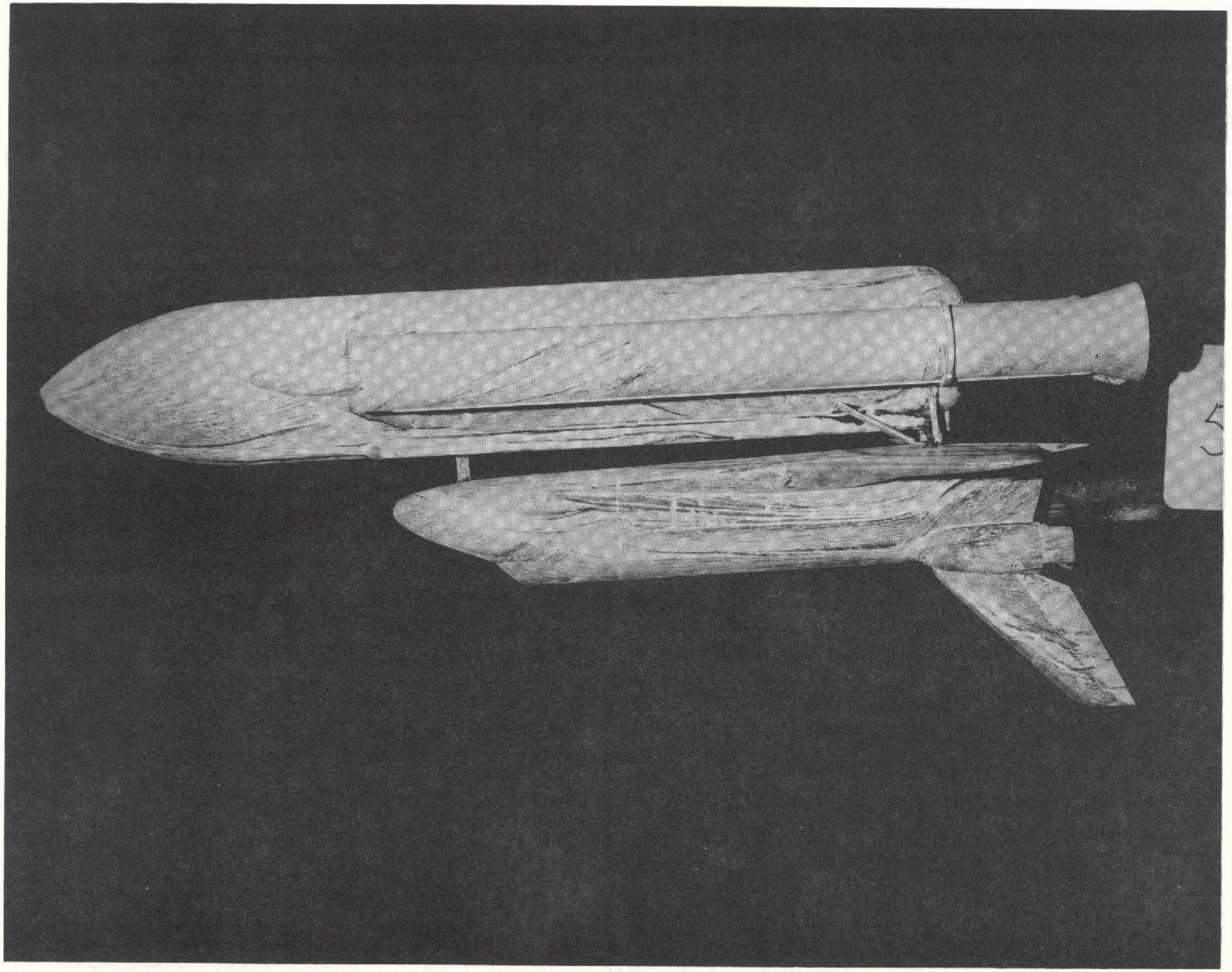


Figure 13. Run Number 5, View of Right Side

Mach = 3.75, α = -5° β = 0°

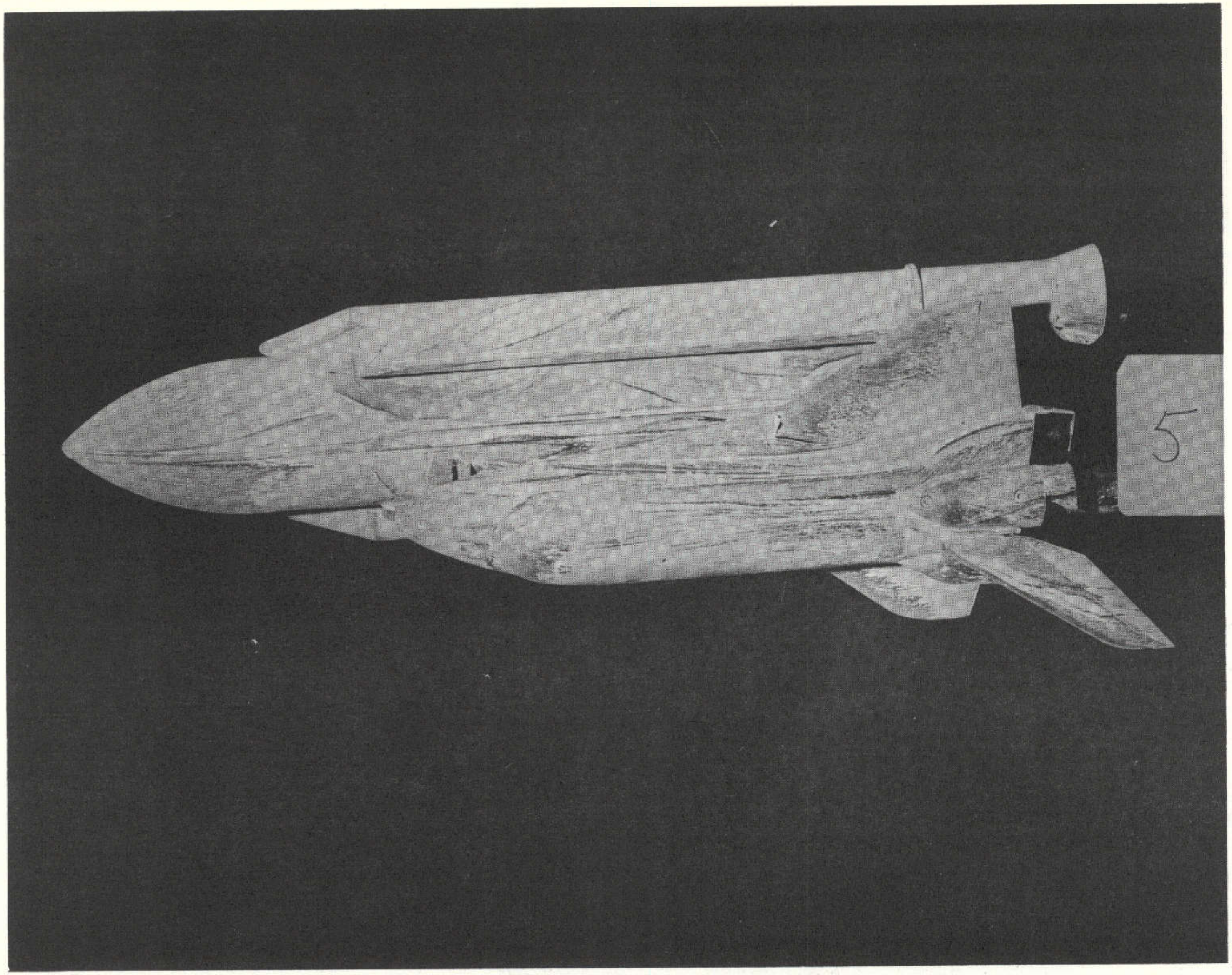


Figure 14. Run Number 5, View of Right Side Upper

Mach = 3.75, α = -5° β = 0°

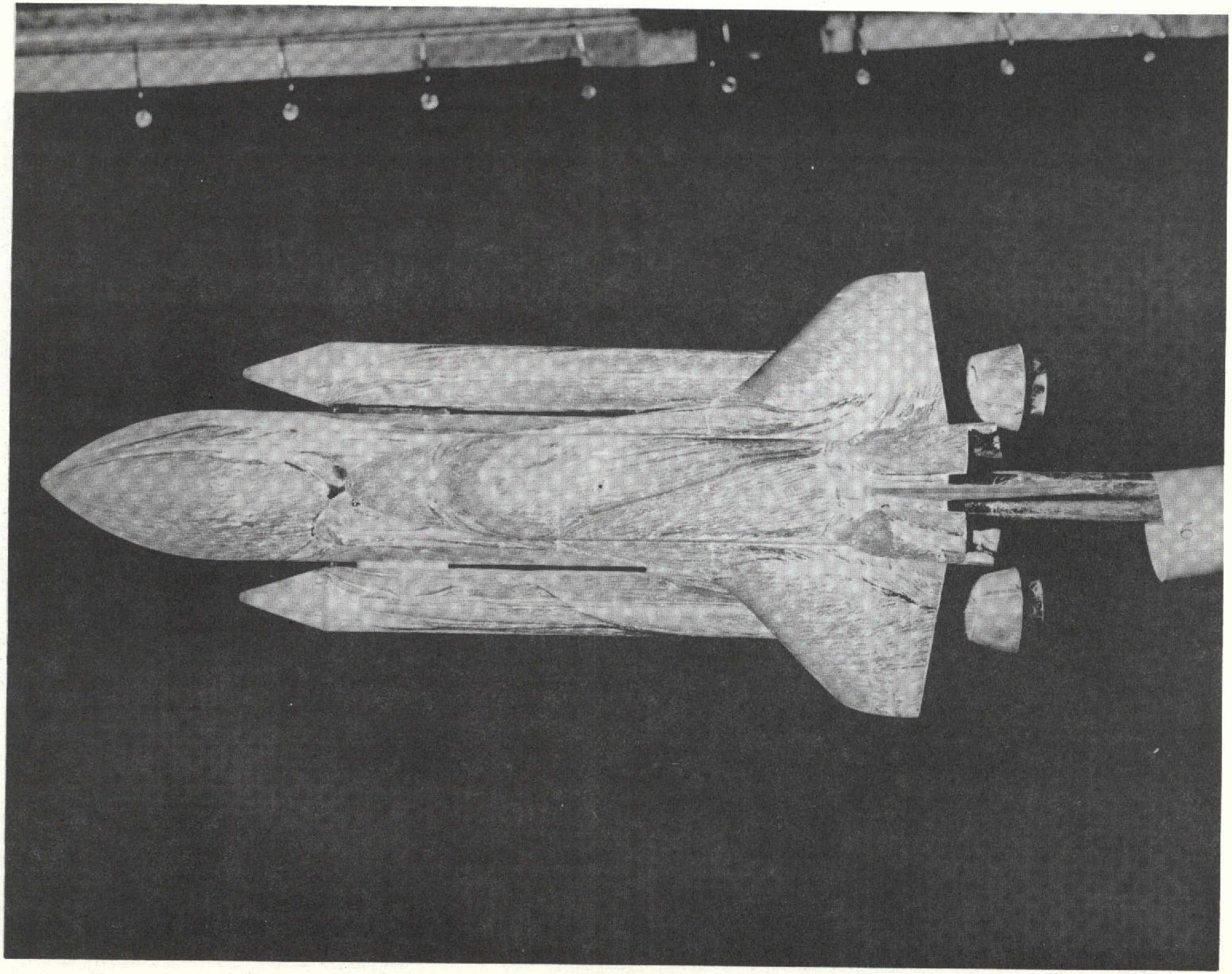


Figure 15. Run Number 6, View of Top

Mach = 3.75, $\alpha = 0^\circ$ $\beta = 5^\circ$

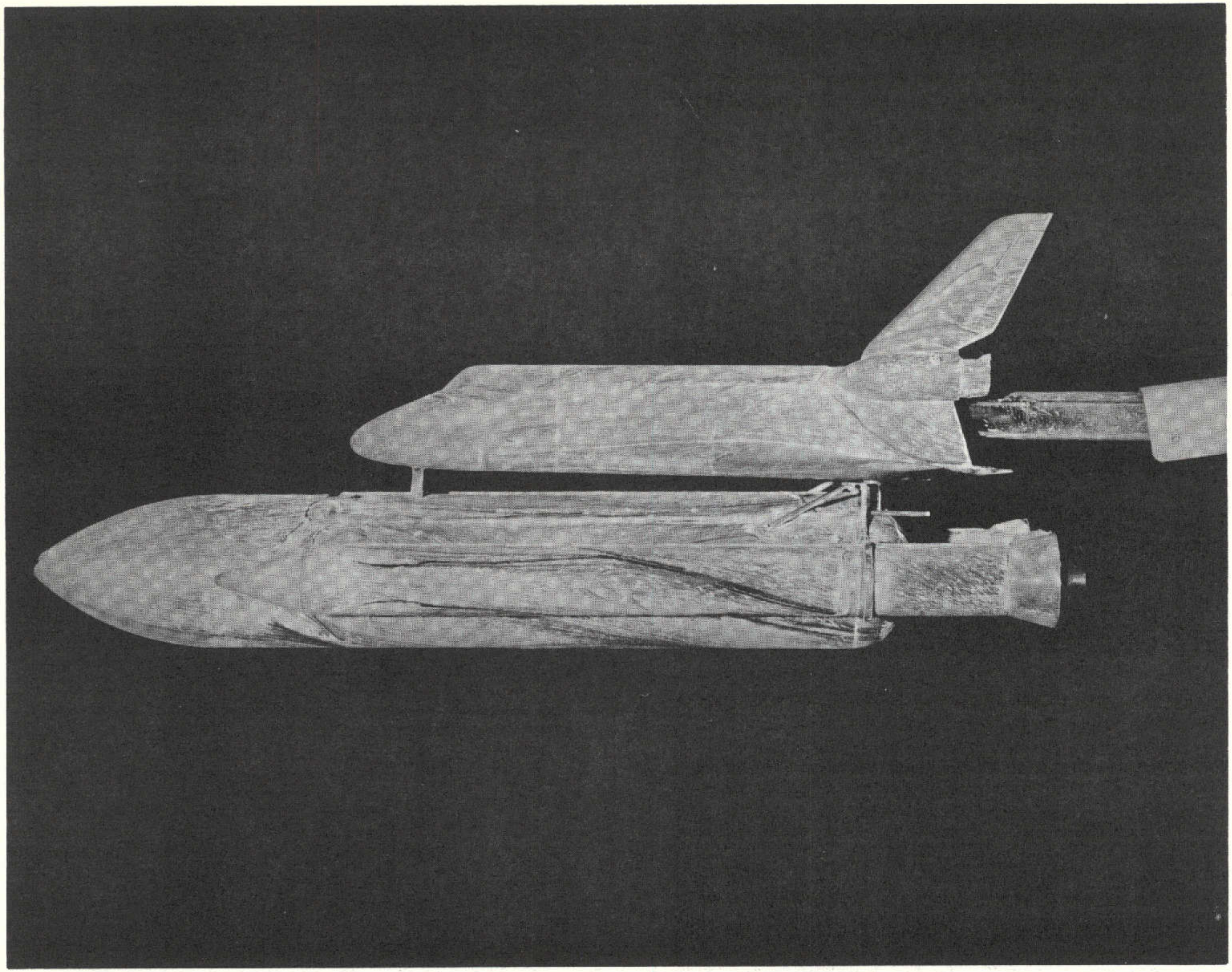


Figure 16. Run Number 6, View of Left Side

Mach = 3.75, $\alpha = 0°$ $\beta = 5°$

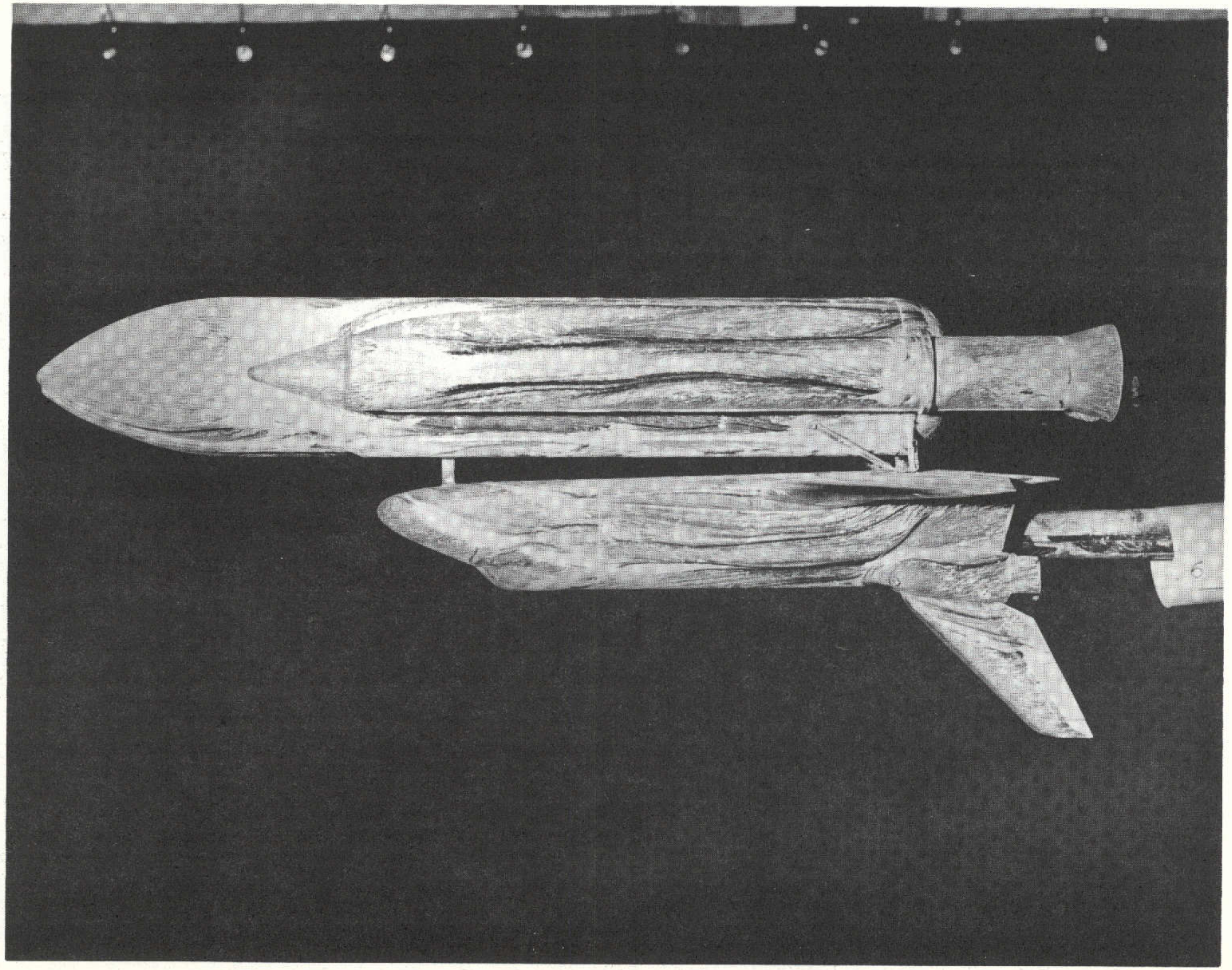


Figure 17. Run Number 6, View of Right Side

Mach = 3.75, α = 0° β = 5°

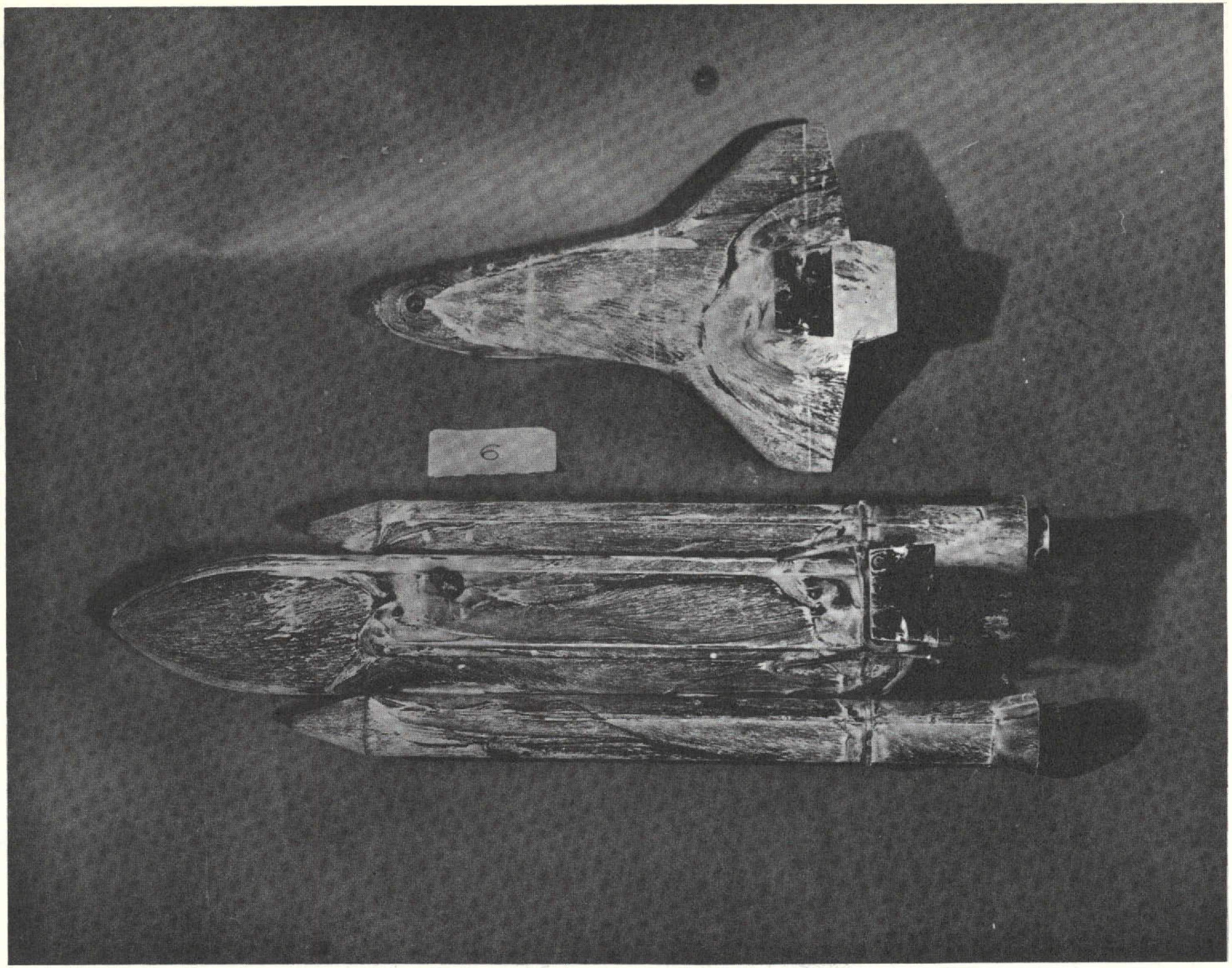


Figure 18. Run Number 6, View of Interference Region

Mach = 3.75, α = 0° β = 5°

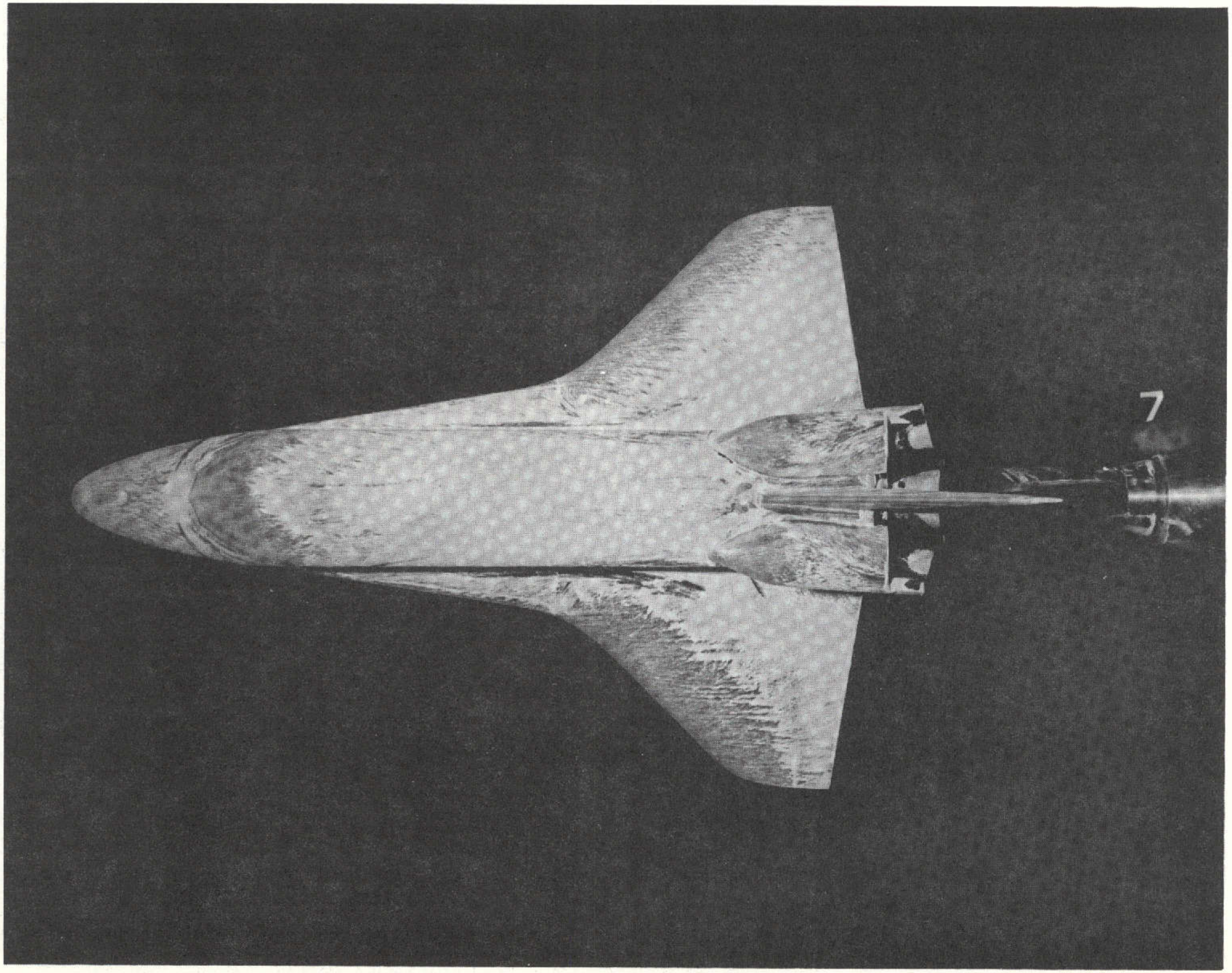


Figure 19. Run Number 7, View of Top

Mach = 5.03, $\alpha = 0°$ $\beta = 0°$

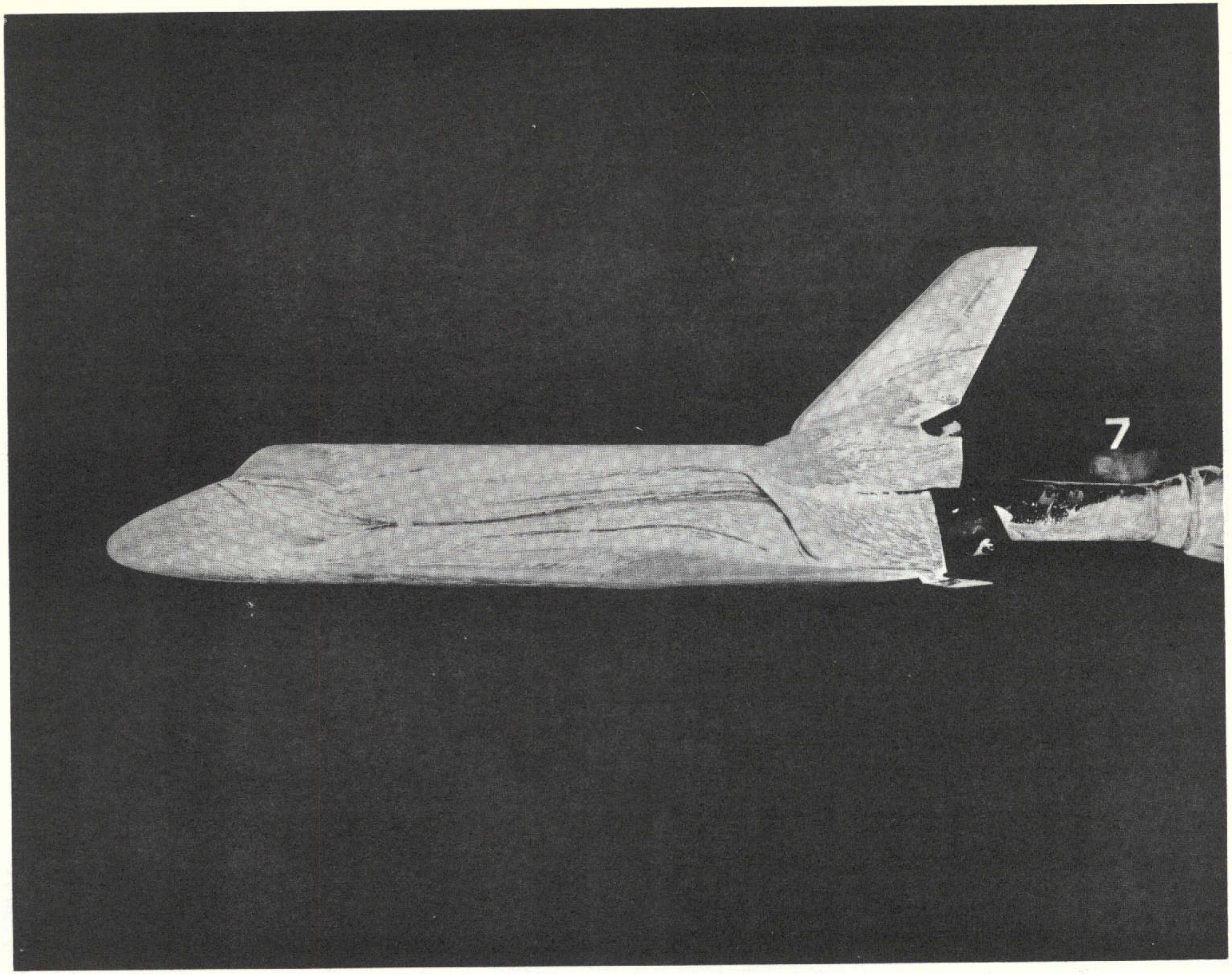


Figure 20. Run Number 7, View of Left Side

Mach = 5.03, $\alpha = 0°$ $\beta = 0°$

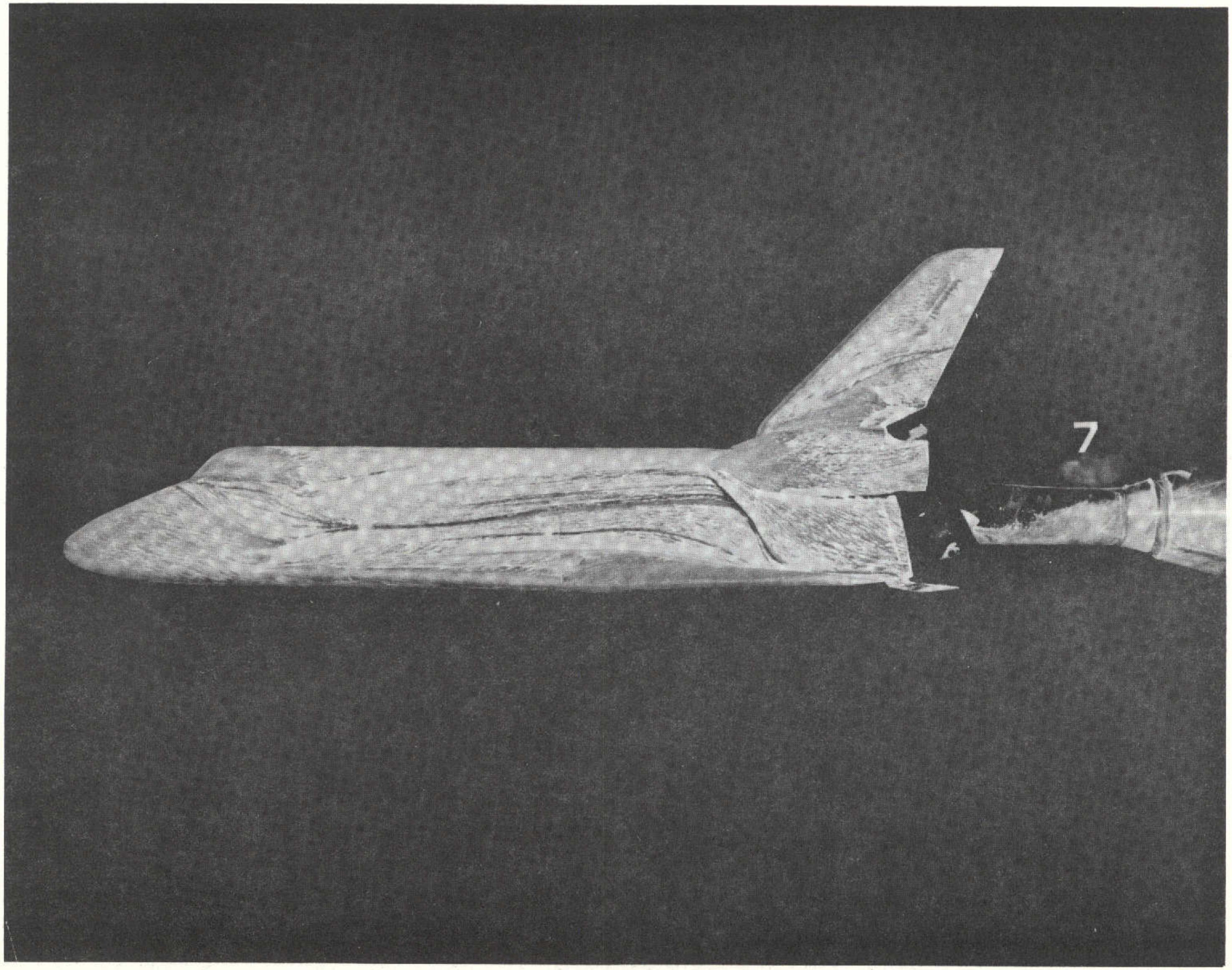


Figure 21. Run Number 7, View of Left Side

Mach = 5.03, α = 0° β = 0°

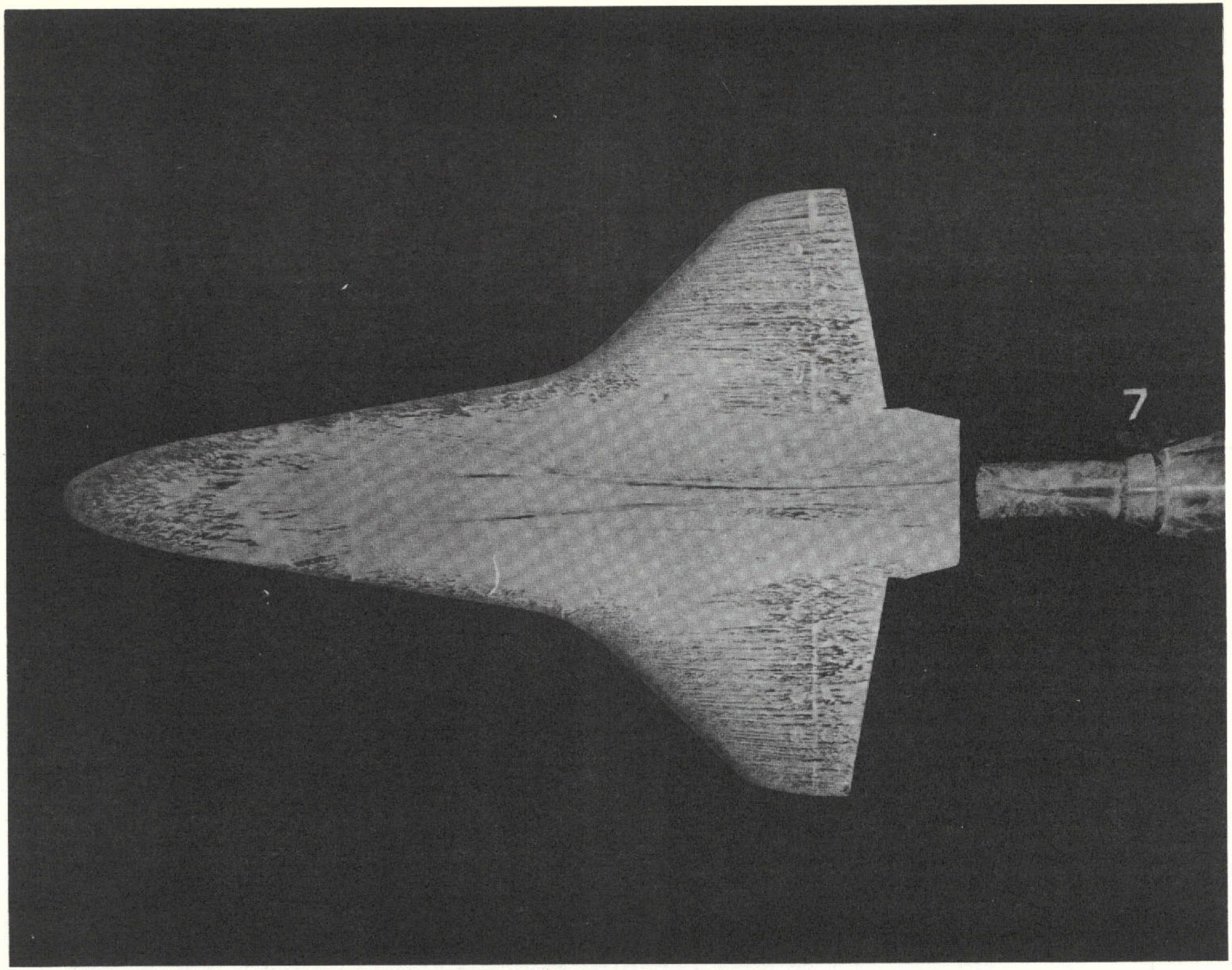


Figure 22. Run Number 7, View of Bottom

Mach = 5.03, α = 0° β = 0°

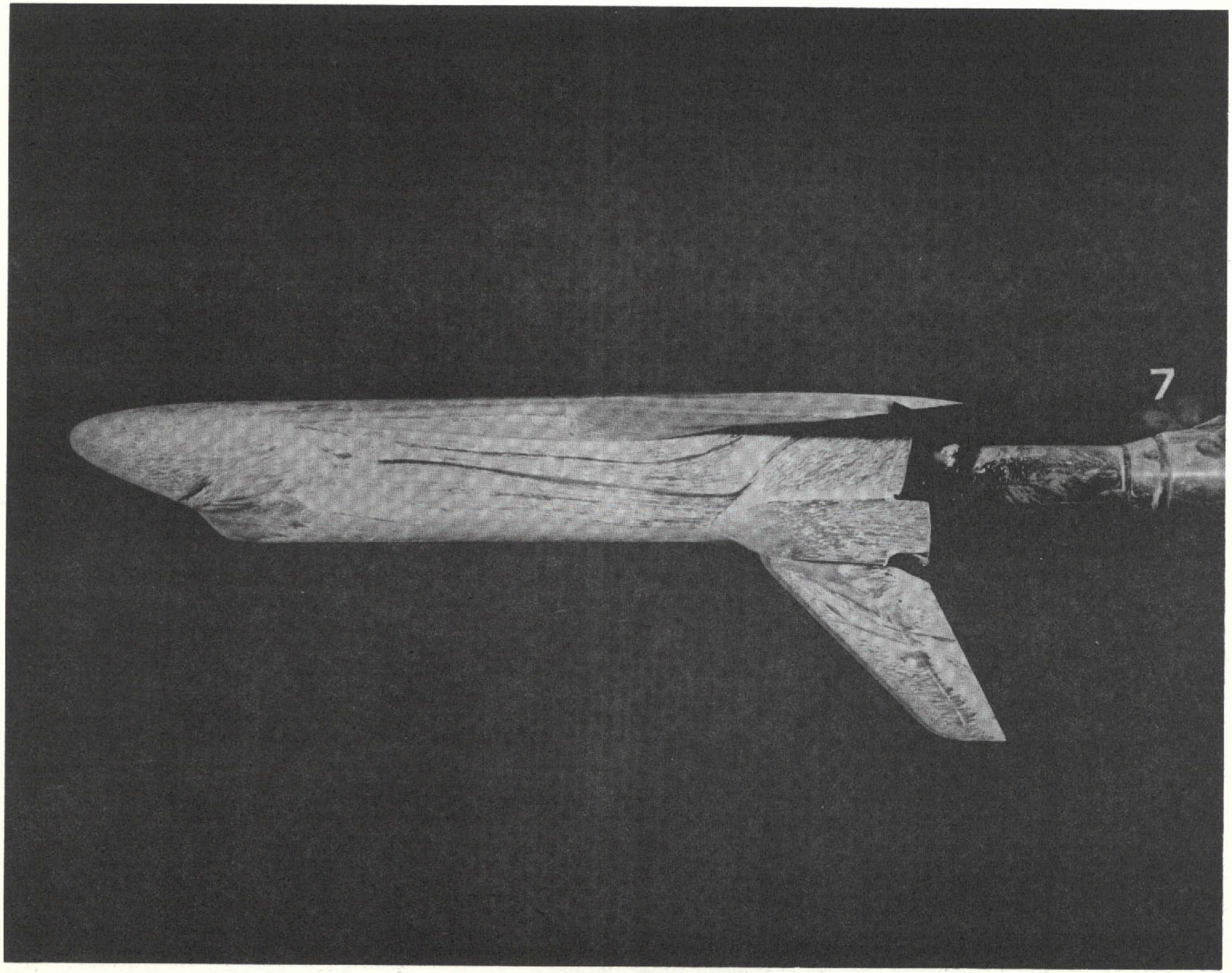


Figure 23. Run Number 7, View of Right Side

Mach = 5.03, $\alpha = 0°$ $\beta = 0°$

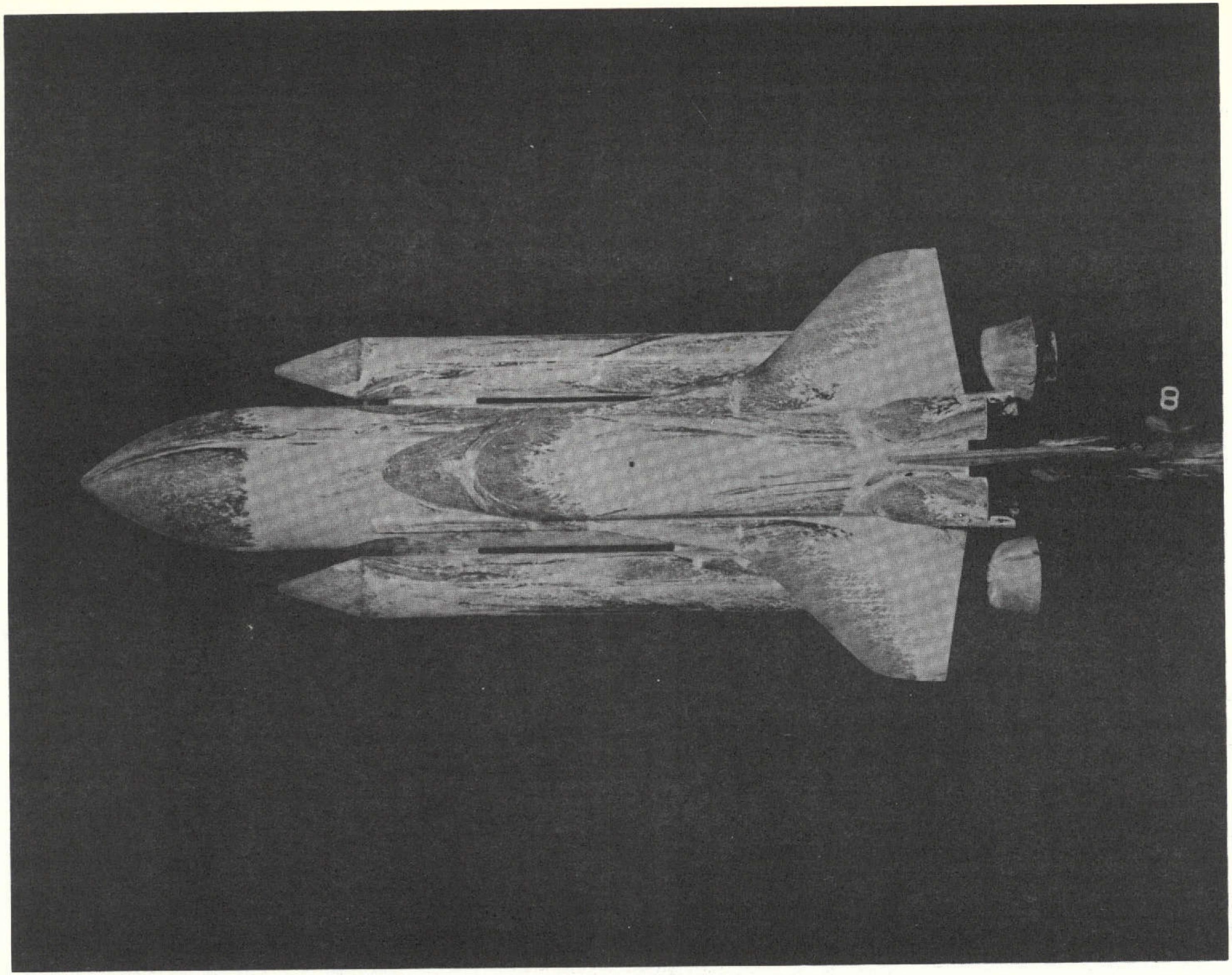


Figure 24. Run Number 8, View of Top

Mach = 5.03 α = 0° β = 0°

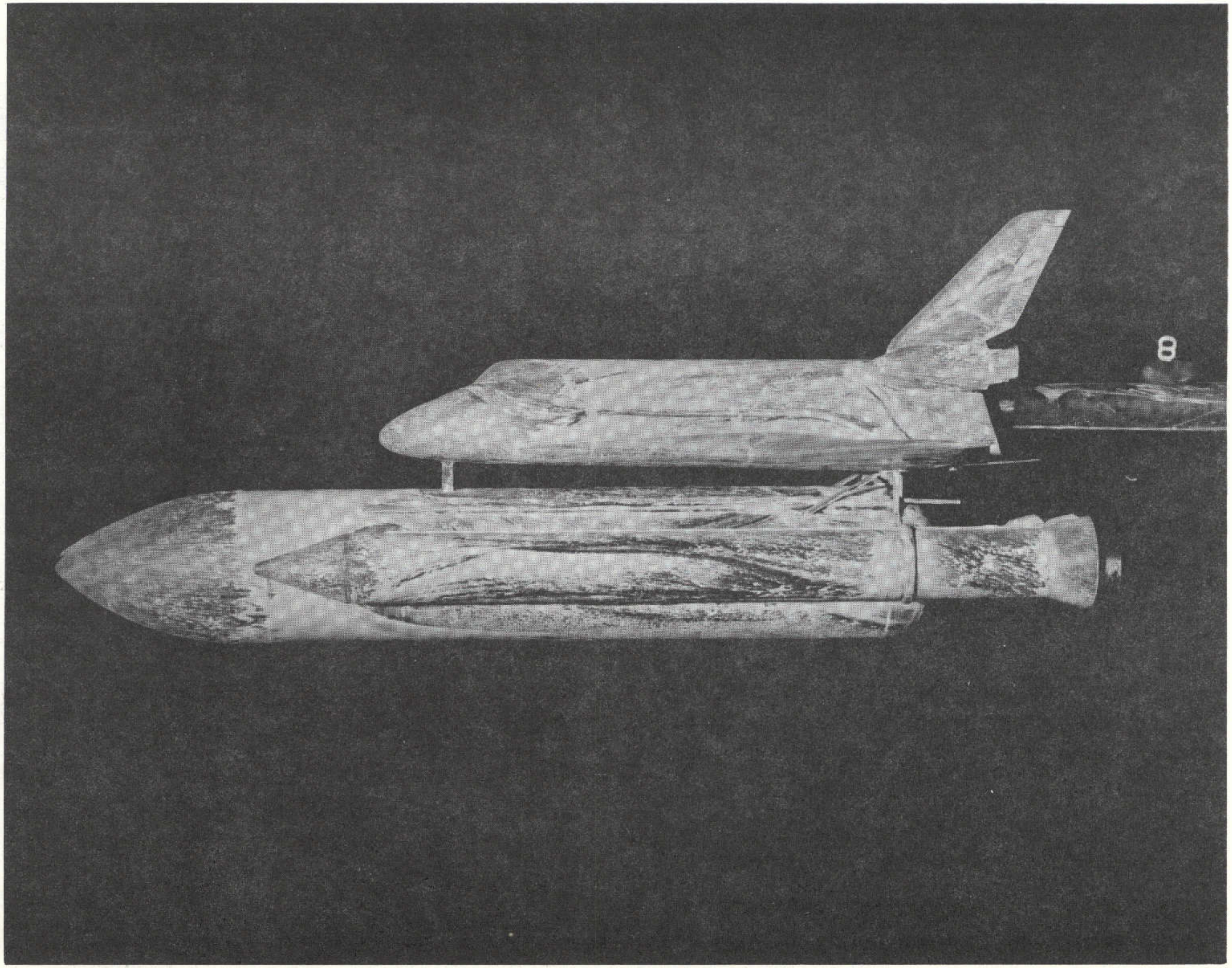


Figure 25. Run Number 8, View of Left Side

Mach = 5.03, $\alpha = 0°$ $\beta = 0°$