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(NASA-CR-151058) RESULTS OF PHASE CHANGE HEAT TRANSFER TEST OH51 USING 0.006-SCALE SPACE SHUTTLE ORBITER MODELS 46-0 AND 90-0 AND PARTIAL WING 0.0175-SCALE MODEL 64-0 IN THE LARC 31-INCH CFHT (Chrysler Corp.) 41 p HC A03/MF A01 G3/16

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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 PHASE CHANGE HEAT TRANSFER TEST OH51 USING 0.006-SCALE SPACE SHUTTLE ORBITER MODELS 46-0 AND 90-0 AND PARTIAL WING 0.0175-SCALE MODEL 64-0 IN THE LaRC 31-INCH CFHT

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Prepared under NASA Contract Number NAS9-13247

by

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Johnson Space Center
National Aeronautics and Space Administration
Houston, Texas

WIND TUNNEL TEST SPECIFICS:

Test Number:	LaRC CFHT 112
NASA Series Number:	OH51
Model Number:	46-0, 64-0, 90-0
Test Dates:	June 17 through July 3, 1974
Occupancy Hours:	40

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RESULTS OF PHASE CHANGE HEAT TRANSFER TEST OH51 USING 0.006-SCALE SPACE SHUTTLE ORBITER MODELS 46-0 AND 90-0 AND PARTIAL WING 0.0175-SCALE MODEL 64-0 IN THE LaRC 31-INCH CFHT

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J. W. Cummings, Rockwell International Space Division

ABSTRACT

Test procedures and results of OH51 are described in this report. Test OH51 was a phase change paint test conducted in the LaRC 31-inch CFHT utilizing models 46-0, 64-0, and 90-0. Model 46-0 represented the Space Shuttle configuration 139 Orbiter. Model 90-0 represented the configuration 140 Orbiter. Model 64-0 represented the forward 45% portion of the Orbiter wing. The partial wing was tested with a shock generator located at various positions relative to the wing. The test was conducted at Mach 10.0, angles of attack from 27.5° through 37.5°, and Reynolds numbers of 0.5 and 1.5 million per foot.

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NOMENCLATURE

Symbol	Definition
M	freestream Mach number
P_o	freestream stagnation pressure, psia
Re/ft	freestream unit Reynolds number, million per foot
T_o	freestream total temperature, °F
T_{pc}	paint phase change temperature, °F
X	longitudinal distance between shock generator leading edge and wing model reference point as defined in figure 2c, in.
X_o	Orbiter longitudinal coordinate, in.
Y	lateral distance between shock generator centerline and wing model reference point as defined in figure 2c, in.
Y_o	Orbiter lateral coordinate, in.
Z	vertical distance between shock generator and wing model reference system as defined in figure 2c, in.
Z_o	Orbiter vertical coordinate, in.
α	angle of attack, deg.
β	angle of sideslip, deg.
T_i	initial model temperature before model is injected into tunnel, °F
b/2	semi-span
C	local chord, inches
IML	inner mold line
OML	outer mold line

CONFIGURATIONS INVESTIGATED

Three different configurations were investigated. Model 64-0 was a partial model of the Orbiter wing. Model 46-0 represented the Orbiter -139 configuration. Model 90-0 represented the Orbiter -140 configuration. The shock generator edge model was cut from an existing 0.0175-scale, Grumman built, Material "G", Orbiter paint model 21-0. Two identical models were fabricated: one for testing at $\alpha = 30°$ and the other for testing at $\alpha = 35°$. The model was cut from the left hand wing to have dimensions from the 35% semi-span to the wing tip and cut along a line three inches from the leading edge and parallel to the 45° sweep angle. The model was sting mounted directly to the tunnel support system. A removable thin metal plate was attached at the 35% semi-span. A third leading edge model was fabricated and painted with strips to be used as a grid reference system. The model was defined by Rockwell drawing SS-H-01304 and is shown in figures 2b and 3c.

The leading edge wing model was sting mounted to the tunnel support system and positioned to be visible in the Schlieren window. The shock generator consisted of a series of sharp nose cones attached to a strut and located forward of the wing leading edge model. Six cones were provided which had half angles of 25°, 27°, 28°, 29°, 30°, and 32°. All cones were made from 17-4 PH stainless steel and all were removable. The shock generator was attached to the injection system floor. Shock strength and location were varied by changing cones and location of the generator. It was defined by Rockwell drawing SS-H-01305. Figures

2c and 3d show the shock generator installation with the partial wing model.

The 0.006 paint model 46-0 was sting mounted to the tunnel support system utilizing the W-118SA bent sting adapter. The model was rolled 90° clockwise from the conventional position and located in the Schlieren window in the same general location as the leading edge wing model. The 0.006 paint model 90-0 was sting mounted to the tunnel support system and rolled 90° utilizing the SS-H-00386-1 bent sting adapter. A reference grid model was available for each configuration. All models were leveled in pitch and roll prior to testing. Figure 2a shows the general Orbiter configuration. Figure 3a shows an Orbiter grid model mounted in the tunnel.

Two 35-mm cameras were aligned and focused on the model in the tunnel, one from the top and one from the side. When taking paint data, both cameras operated together. When Schlieren coverage was required, the side camera was "cranked" down out of the way. When testing the leading edge wing model, the initial location of the shock generator was positioned at pre-determined values. Upon evaluation of the Schlieren photographs, the shock generator was adjusted as required to position shock impingement. Any movement in the shock generator was noted and recorded as given in Table II.

Before each run, the initial temperature of the model was determined by a digital contact thermometer. This thermometer was mounted on the end of a probe, which was placed against the model surface for a reading. Before and after a run, the model was in the injection chamber outside of the test section. Only after flow was established was the model and support system injected. Continuous pictures were taken throughout the test period. At the end of the test period, the model was withdrawn. The test period was determined by the paint-melt temperature and estimated heating rates. After the model was removed from the injection chamber and replaced by a freshly painted model, specific areas of interest on the tested model were photographed at various angles with a Polaroid camera. After all photographs were completed, the model was washed with a solvent to remove the remaining paint. Fresh paint was then sprayed on to prepare the model for another run.

The models were denoted as follows:

Configuration Designation	Model	Component Designation
Wing	64-0	W_{123}
139 ORB	46-0	B_{17} C_7 F_5 M_4 V_7 W_{103} E_{22} R_5
140 ORB	90-0	B_{26} C_9 F_8 M_7 V_8 W_{116} E_{22} R_5

Where individual component designations were as follows:

Nomenclature	Description
B_{17}	Body (46-0)

CONFIGURATIONS INVESTIGATED (Concluded)

Nomenclature	Description
B_{26}	Body (90-0)
C_7	Canopy (46-0)
C_9	Canopy (90-0)
F_5	Body Flap (46-0)
F_8	Body Flap (90-0)
M_4	OMS Pods (46-0)
M_7	OMS Pods (90-0)
V_7	Vertical Tail (46-0)
V_8	Vertical Tail (90-0)
W_{103}	Wing used with body B_{17}, (46-0)
W_{116}	Wing used with body B_{26}, (90-0)
W_{123}	Partial wing fabricated from left wing of model 21-0, (64-0)
E_{22}	elevon
R_5	rudder

TEST FACILITY DESCRIPTION

The Mach 10 nozzle of the Langley Continuous Flow Hypersonic Tunnel is designed to operate at stagnation pressures of 15 to 150 atmospheres at temperatures up to 1960°R. Air is preheated electrically by passing it through a multi-tube heater. The nozzle has a 31-inch square test section which incorporates a movable second minimum. Continuous operation is achieved by passing the air through a series of compressors. Additional information on this facility is given in NASA TM X-1130 entitled, "Characteristics of Major Active Wind Tunnels at the Langley Research Center," by William T. Schaefer, Jr.

DATA REDUCTION

Recorded data consisted of motion picture film recorded by the cameras outside the tunnel. These data are retained by:

James C. Dunavant
Mail Stop 408
Langley Research Center
Hampton, Va. 23665
Phone: (804) 827-3984

Use of the data should be obtained through contact with the above person.

REFERENCES

1. SD74-SH-0017, "Pretest Information For Tests of an 0.0175-Scale Leading Edge Wing Model (64-0) and a 0.006 Scale Paint Model (46-0 and 90-0) in the Langley Research Center, Variable Density, Mach Wind Tunnel (Test OH51)," By D. G. Walstad, March 6, 1974.

2. Jones, R. A. and Jaeger, Hunt: "Use of Temperature Indicators for Obtaining Quantitative Aerodynamic Heat Transfer Data." NASA-TRR-230 (Feb. 1966).

3. Carslaw, H. S. and Jaeger J. C.: "Conduction of Heat in Solids." Oxford Clarenden Press (1959).

4. SAS/WTO/74-407, Trip Report for Test OH51, Model 64-0, Wing and Shock Generator Including Two (2) 0.006-Scale Full Span Orbiters. By J. W. Cummings, dated July 23, 1974.

TABLE 1.

TEST : OH51 (LaRC CFHT 112)			DATE : Post-test
TEST CONDITIONS			
MACH NUMBER	REYNOLDS NUMBER (per foot)	DYNAMIC PRESSURE (pounds/sq. inch)	STAGNATION TEMPERATURE (degrees Fahrenheit)
10.0	1.5×10^6	7.788	1375
10.0	0.5×10^6	2.424	1350

BALANCE UTILIZED: ____________________

	CAPACITY:	ACCURACY:	COEFFICIENT TOLERANCE:
NF			
SF			
AF			
PM			
RM			
YM			

COMMENTS:

TABLE II. - TEST PROGRAM

Config.	α (deg)	Re/ft (million/ft)	P_o (psia)	T_o (°F)	T_i (°F)	T_{pc} (°F)	Cone half angle (deg)	Position X	Position Y	Position Z	Run No.
140 ORB	30										GRID
139 ORB	30										GRID
140B ORB	35										GRID
139 ORB	35										GRID
Wing	35										GRID
Wing	30										GRID
Wing	32.5										GRID
Wing	27.5										GRID
Wing	37.5										GRID
139 ORB	30	1.5	1200	1360	78	300					1
140 ORB	↓	↓	↓	1370	78	300					2
139 ORB	↓	↓	↓	1360	80	500					3
140 ORB	↓	↓	↓	1395	80	500					4
139 ORB	↓	↓	↓	1370	Oil	Flow					5
140 ORB	↓	↓	↓	1370	Oil	Flow					6
139 ORB	35	↓	↓	1410	82	350					7
140 ORB	↓	↓	↓	1350	82	350					8
139 ORB	↓	↓	↓	1375	82	500					9
140 ORB	↓	↓	↓	1375	82	500					10
139 ORB	↓	↓	↓	1390	Oil	Flow					11
140 ORB	↓	↓	↓	1400	Oil	Flow					12
139 ORB	30	↓	↓	1375	Oil	Flow					13
140 ORB	↓	↓	↓	1395	Oil	Flow					14
Wing	↓	0.5	375	1375	77	350					15
Wing	32.5	0.5	375	1360	77	350					16
↓	32.5	↓	↓	1375	77	250					17
↓	30	↓	↓	1350	77	250					18
↓	32.5	↓	↓	1355	77	Oil					19
↓	30	↓	↓	1375	78	Oil					20
↓	37.5	↓	↓	1400	78	350					21
↓	30	↓	↓	1400	78	Oil					22
↓	37.5	↓	↓	1360	78	250					23

TABLE II. - Continued.

Config.	α (deg)	Re/ft (million/ft)	P_o (psia)	T_o (°F)	T_i (°F)	T_{pc} (°F)	Cone half angle (deg)	Position X	Position Y	Position Z	Run No.
Wing	30	0.5	375	1350	78	350					24
	37.5			1350	78	Oil					25
	30			1350	78	250					26
	30			1355	79	Oil					27
	35			1360	79	350					28
	27.5			1370	80	350					29
	35			1370	80	250					30
	27.5			1370	80	250					31
	35			1375	80	Oil					32
	27.5			1380	80	Oil					33
	32.5			1385	80	Oil					34
		SHOCK GENERATOR INSTALLED									
	30			1350	75	350	25	5.0	2.37	1.28	35
				1405	75	250					36
				1340	75	Oil					37
	35			1330	75	350	28	5.0	2.79	1.32	38
	30			1335	77	350					39
	35	0.5	375	1360	77	250	28	5.0	2.79	1.32	40
	30			1360	77	250					41
	35			1375	78	Oil					42
	30			1375	78	Oil					43
	30			1380	78	350	29	5.0	2.93	1.34	44
	30			1385	80	250					45
	30			1335	80	Oil					46
	35			1320	80	350	30	5.0	3.07	1.36	47
	30			1300	80	350					48
	35			1330	80	250					49
	30			1350	80	250					50
	35			1345	75	Oil					51
	30			1360	75	Oil					52

TABLE II. - Concluded.

Config.	α (deg)	Re/ft (million/ft)	P_o (psia)	T_o (°F)	T_i (°F)	T_{pc} (°F)	Cone half angle (deg)	Position X	Position Y	Position Z	Run No.
Wing	30	0.5	375	1360	78	350	27	6.08	3.19	1.29	53
	30			1360	78	250					54
	30			1370	78	Oil					55
	35			1375	78	350	28	5.6	3.07	1.18	56
	35			1320	80	250					57
	35			1320	80	250					58
	35			1375	80	Oil					59
	30			1385	80	350					60
	30			1335	80	250					61
	30			1320	80	Oil					62
	30			1320	80	350	29	5.08	2.98	1.06	63
	30			1320	80	250					64
	30	0.5	375	1320	80	Oil	29	5.08	2.98	1.06	65
	35			1315		350	30	5.10	3.10	1.08	66
	35			1370		250					67
	35			1335		Oil					68
	30			1340		350	30	5.08	3.14	1.08	69
	30			1335		250					70
	30			1365		Oil					71
	30			1345	82	350	32	5.08	3.45	1.12	72
	30			1350	82	250					73
	30			1335	82	Oil					74
	30			1335	82	500					75
	30			1325	82	350	27	5.0	2.64	131	76
	30			1340	82	250					77
	30			1365	82	Oil					78

TABLE III. - MODEL DIMENSIONAL DATA

MODEL COMPONENT: Body (B_{17})

GENERAL DESCRIPTION: Basic fuselage for models 46-1, -2, -3, -4.

Model Scale = 0.00593

DRAWING NUMBER VL70-000139

DIMENSION:	FULL SCALE	MODEL SCALE
Length ~ in.	1290.3	7.65148
Max Width ~ in.	267.6	1.58687
Max Depth ~ in.	244.5	1.44988
Fineness Ratio	4.82175	4.82175
Area ~ ft^2		
Max Cross-Sectional	386.67	0.01360
Planform		
Wetted		
Base		

TABLE III. - Continued.

MODEL COMPONENT: BODY - B_{26}

GENERAL DESCRIPTION: Orbiter Fuselage Configuration 140 A/B

NOTE: B_{26} identical to B_{24} except underside of fuselage refaired to accept W_{116}.

Model Scale = 0.006

DRAWING NUMBER: VL70-000193
VL70-000140A

DIMENSIONS:

	FULL-SCALE	MODEL SCALE
Length (Body Fwd Sta X_o = 235) - in.	1293.3	7.759
Max. Width (at X_o = 1520) - in.	262.0	1.572
Max. Depth (at X_o = 1464) - in.	250.0	1.500
Fineness Ratio	0.26357	0.26357
Area - ft^2		
Max. Cross-Sectional	340.88462	.01227
Planform		
Wetted		
Base		

TABLE III. - Continued.

MODEL COMPONENT: Canopy (C_7)

GENERAL DESCRIPTION: 3 configurations per lines VL70-000139. Insufficient information to complete dimensional data at this time.

Model Scale = 0.006

DRAWING NUMBER VL70-000139

DIMENSION:	FULL SCALE	MODEL SCALE
Length (Sta. Fwd. Bulkhead)	432.70	3.0309
Max Width (T.E. Bulkhead)	571.40	3.997
Max Depth (WPZ_o = ____ to Z_o = 501)		
Fineness Ratio		
Area		
Max Cross-Sectional		
Planform		
Wetted		
Base		

MODEL DIMENSIONAL DATA - Continued.

MODEL COMPONENT : Canopy (C9)

GENERAL DESCRIPTION : Configuration 140B

Model Scale = 0.006

DRAWING NUMBER : VL70-000140B
VL70-000143A

DIMENSIONS :	FULL SCALE	MODEL SCALE
Length (X_o=434.643 to 670.0)	235.357	1.412
Max Width (@ X_o = 513.127)	152.412	.914
Max Depth (@ X_o = 485.0)	25.00	.150
Fineness Ratio		
Area		
Max. Cross-Sectional		
Planform		
Wetted		
Base		

TABLE III. - Continued.

MODEL COMPONENT: ELEVON E_{22}

GENERAL DESCRIPTION: Design configuration 3, right wing only

Model Scale: 0.006

DRAWING NUMBER: VL70-000139

DIMENSIONS:	FULL-SCALE	MODEL SCALE
Area- Ft^2	205.52	0.00739
Span (equivalent) - In.	353.34	2.120
Inb'd equivalent chord - In.	114.78	0.689
Outb'd equivalent chord - In.	55.00	0.330
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)		

TABLE III. - Continued.

MODEL COMPONENT: Body Flap (F_5)

GENERAL DESCRIPTION: Body flap located on the lower aft end of the orbiter fuselage.

Model Scale = 0.00593

DRAWING NUMBER VL70-000139

DIMENSION:	FULL SCALE	MODEL SCALE
Length ~ in.	84.70	0.50227
Max Width ~ in.	267.6	1.58687
Max Depth		
Fineness Ratio		
Area ~ ft^2		
Max Cross-Sectional		
Planform	142.5195	0.00501
Wetted		
Base	38.0958	0.00134

TABLE III. - Continued.

MODEL COMPONENT: Body Flap - F_8

GENERAL DESCRIPTION: Configuration 4

Model Scale - 0.006

DRAWING NUMBER VL70-000140B, VL70-000200

DIMENSION:	FULL SCALE	MODEL SCALE
Length in.	84.7	.508
Max Width in.	262.308	1.574
Max Depth in.	23.000	.138
Fineness Ratio		
Area - ft^2		
Max Cross-Sectional		
Planform	158.85350	.0057
Wetted		
Base	41.89642	.00151

TABLE III. - Continued.

MODEL COMPONENT: OMS Pod - M_4

GENERAL DESCRIPTION: OMS Pods located on the aft Orbiter fuselage

Model Scale = 0.00593

DRAWING NUMBER VL70-000139

DIMENSION:	FULL SCALE	MODEL SCALE
Length - IN	346.0	2.05178
Max Width - IN	108.0	0.64044
Max Depth - IN	113.0	113.0
Fineness Ratio		
Area - FT^2		
Max Cross-Sectional		
Planform		
Wetted		
Base		

℄ of OMS Pod

WP = 463.9 in. F.S.: WP 400 + 63.9 = 463.9

BP = 80.0 in. F.S.

Length 1214.0 to 1560.0 = 346.0 in. F.S.

NOTE: M_4 identical to M_3 of 2A configuration except intersection to body.

TABLE III. - Continued.

MODEL COMPONENT: OMS POD - M_7

GENERAL DESCRIPTION: Configuration 140B Orbiter OMS Pod

MODEL SCALE: 0.006

DRAWING NUMBER: VL70-000140A
VL70-000145

DIMENSIONS:	FULL SCALE	MODEL SCALE
Length (OMS Fwd Sta X_o = 1233.0) - IN.	327.000	1.962
Max Width (@ X_o = 1450.0) - IN.	94.5	.567
Max. Depth (@ X_o = 1493.0) - IN.	109.000	.654
Area		
Max Max Cross-Sectional		
Planform		
Wetted		
Base		

TABLE III. - Continued.

MODEL COMPONENT: RUDDER R_5

GENERAL DESCRIPTION: Design configurations 2A, 3 and 3A

MODEL SCALE: 0.006

DRAWING NUMBER: VL70-000146A -000095 -000139

DIMENSIONS:	FULL-SCALE	MODEL SCALE
Area - Ft^2	100.15	0.036
Span (equivalent)-In.	201.00	1.206
Inb'd equivalent chord - In.	91.585	0.5495
Outb'd equivalent chord - In.	50.833	0.305
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	3[illegible].83	34.83
Tailing Edge	26.25	26.25
Hingeline	34.83	34.83
Area Moment (Normal to hinge line)		
Mean aerodynamic chord - In.	73.2	0.4392

TABLE III. - Continued.

MODEL COMPONENT: Vertical (V_7)—Lightweight orbiter configuration.

GENERAL DESCRIPTION: Centerline vertical tail, double-wedge airfoil with rounded leading edge.

Model Scale = 0.00593

DRAWING NUMBER: VL70-0000139
VL70-000095

DIMENSIONS:	FULL-SCALE	MODEL SCALE
TOTAL DATA		
Area, (Theo.) ft^2 Planform	425.92	0.01498
Span, (Theo.) in.	315.72	1.87222
Aspect Ratio	1.675	1.675
Rate of Taper	0.507	0.507
Taper Ratio	0.404	0.404
Sweepback 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	1.59220
Tip, (Theo.) WP	108.47	0.64323
MAC	199.81	1.18487
Fus. Sta. of 0.25 MAC	1463.50	8.67856
W.P. of 0.25 MAC	635.522	3.76864
B.L. of 0.25 MAC	0.00	0.00
Airfoil Section		
Leading Wedge Angle, degrees	10.000	10.000
Trailing Wedge Angle, degrees	14.920	14.920
Leading Edge Radius ~ in.	2.00	0.01186
Void Area	13.17	0.00046
Blanketed Area		

MODEL COMPONENT: VERTICAL - V8

GENERAL DESCRIPTION: Configuration 140B Orbiter Vertical Tail

NOTE: Similar to V5 with radius of T.E. upper corner and L.E. corner where vertical meets fuselage.

MODEL SCALE = 0.006

DRAWING NUMBER: VL70-000140B

DIMENSIONS:	FULL-SCALE	MODEL SCALE
TOTAL DATA		
Area (Theo) Ft^2	413.253	.0148
Planform		
Span (Theo) In	315.72	1.894
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	45.00	45.00
Trailing Edge	25.947	25.947
0.25 Element Line	41.130	41.130
Chords:		
Root (Theo) WP	268.500	1.611
Tip (Theo) WP	108.470	0.651
MAC	199.807	1.198
Fus. Sta. of .25 MAC	1463.50	8.781
W. P. of .25 MAC	635.52	3.813
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	14.92
Leading Edge Radius	2.00	2.00
Void Area	13.17	13.17
Blanketed Area	0.0	0.00

TABLE III. - Continued.

MODEL COMPONENT: Wing W_{103} New Lightweight Orbiter

GENERAL DESCRIPTION: Configuration 3 Orbiter per lines VL70-000139

NOTE: Same planform as W_{87}, except dihedral at TE

Scale Model = 0.006

DRAWING NUMBER: VL70-000139

DIMENSIONS:	FULL-SCALE	MODEL SCALE
TOTAL DATA		
Area (Theo.) - Ft^2		
Planform	2690.00	0.09684
Wetted		
Span (Theo In.)	936.68	5.62
Aspect Ratio	2.265	2.265
Rate of Taper	1.177	1.177
Taper Ratio	0.200	0.200
Dihedral Angle, degrees (@ TE of Elevon)	3.500	3.500
Incidence Angle, degrees	3.000	3.000
Aerodynamic Twist, degrees	+3.000	+3.000
Toe-In Angle		
Cant Angle		
Sweep Back Angles, degrees		
Leading Edge	45.000	45.000
Trailing Edge	-10.24	-10.24
0.25 Element Line	35.209	35.209
Chords:		
Root (Theo) B.P.0.0.	689.24	4.135
Tip, (Theo) B.P.	137.85	0.8271
MAC	474.81	2.849
Fus. Sta. of .25 MAC	1136.89	6.8213
W.P. of .25 MAC	299.20	1.7952
B.L. of .25 MAC	182.13	1.09278
Airfoil Section		
Root		
Tip		
EXPOSED DATA		
Area (Theo) Ft^2	1752.29	0.06211
Span, (Theo) In. BP108	720.68	4.32408
Aspect Ratio	2.058	
Taper Ratio	0.2451	
Chords		
Root BP108	562.40	3.3744
Tip 1.00 $\frac{b}{2}$	137.85	.8271
MAC	393.03	2.35818
Fus. Sta. of .25 MAC	1185.31	7.11186
W.P. of .25 MAC	300.20	1.8012
B.L. of .25 MAC	251.76	1.51056

MODEL COMPONENT: WING-W116

GENERAL DESCRIPTION: Configuration 4

NOTE: Identical to W114 except airfoil thickness. Dihedral angle is along trailing edge of wing.

Model Scale = 0.006

TEST NO. DWG. NO. VL70-000140B VL70-000200

DIMENSIONS:	FULL-SCALE	MODEL SCALE
TOTAL DATA		
Area (Theo.) Ft^2		
Planform	2690.00	.09684
Span (Theo In.	936.6816	5.620
Aspect Ratio	2.265	2.265
Rate of Taper	1.177	1.177
Taper Ratio	0.200	0.200
Dihedral Angle, degrees(at X_o=1506.623, Y_o=	3.500	3.500
Incidence Angle, degrees 105, Z_o= 282.75)	0.500	0.500
Aerodynamic Twist, degrees	+3.000	+3.000
Sweep Back Angles, degrees		
Leading Edge	45.00	45.00
Trailing Edge	-10.056	-10.056
0.25 Element Line	35.209	35.209
Chords:		
Root (Theo) B.P.0.0.	689.2429	4.135
Tip, (Theo) B.P.	137.8486	.827
MAC	474.8117	2.849
Fus. Sta. of .25 MAC	1126.721	6.760
W.P. of .25 MAC	291.00	1.746
B.L. of .25 MAC	187.33491	1.124
EXPOSED DATA		
Area (Theo) Ft^2	1812.2205	.0652
Span, (Theo) In. BP108	736.6816	4.420
Aspect Ratio	2.058	2.058
Taper Ratio	0.2451	0.2451
Chords		
Root BP108	570.6230	3.424
Tip 1.00 $\frac{b}{2}$	137.8512	.827
MAC	354.2376	2.1254
Fus. Sta. of .25 MAC	1164.237	6.985
W.P. of .25 MAC	292.00	1.752
B.L. of .25 MAC	239.67786	1.438
Airfoil Section (Rockwell Mod NASA) XXXX-64		
Root $\frac{b}{2}$ = 0.425	0.113	0.113
Tip $\frac{b}{2}$ = 1.00	0.12	0.12
Data for (1) of (2) Sides		
Leading Edge Cuff Planform Area Ft^2	118.33	.00426
Leading Edge Intersects Fus M. L. @ Sta	505.0	3.030
Leading Edge Intersects Wing @ Sta	1003.5	6.021

TABLE III. - Concluded.

MODEL COMPONENT: WING-W 123 - New Light Weight Orbiter

GENERAL DESCRIPTION: Same as W103 but cut at the 35% semi-span and 3" from L.E. and parallel to the 45% element line.

NOTE: Dihedral angle is defined at the lower surface of the wing at the 75.33% element line projected into a plane ⊥ to the FRL.

TEST NO. Model Scale = 0.0175 DWG. NO. VL70-000139

DIMENSIONS:

	Full-Scale	Model Scale
TOTAL DATA		
Area (Theo.) Ft^2		
Planform	2690.00	0.82381
Span (Theo In.	936.68	16.39190
Aspect Ratio	2.265	2.265
Rate of Taper	1.177	1.177
Taper Ratio	0.200	.200
Dihedral Angle, degrees	3.500	3.500
Incidence Angle, degrees	3.000	3.000
Aerodynamic Twist, degrees	+3.000	+3.000
Sweep Back Angles, degrees		
Leading Edge	45.00	45.000
Trailing Edge	-10.24	-10.24
0.25 Element Line	35.209	35.209
Chords:		
Root (Theo) B.P.0.0.	689.24	12.0617
Tip, (Theo) B.P.	137.85	2.41238
MAC	474.81	8.30918
Fus. Sta. of .25 MAC	1136.89	19.89558
W.P. of .25 MAC	299.20	5.2360
B.L. of .25 MAC	182.13	3.18728
EXPOSED DATA		
Area (Theo) Ft^2	1752.29	0.53644
Span, (Theo) In. BP108	720.68	12.6119
Aspect Ratio	2.058	2.058
Taper Ratio	0.2451	0.2451
Chords		
Root BP108	562.40	9.842
Tip 1.00 $\frac{b}{2}$	137.85	2.41238
MAC	393.03	6.87802
Fus. Sta. of .25 MAC	1185.31	20.74292
W.P. of .25 MAC	300.20	5.2535
B.L. of .25 MAC	143.76	2.5158
Airfoil Section (Rockwell Mod NASA) XXXX-64		
Root $\frac{b}{2}$ =	.10	.10
Tip $\frac{b}{2}$ =	.12	.12
Data for (1) of (2) Sides		
Leading Edge Cuff		
Planform Area Ft^2	120.33	0.03685
Leading Edge Intersects Fus M. L. @ Sta	560.0	9.8
Leading Edge Intersects Wing @ Sta	1035.0	18.1125

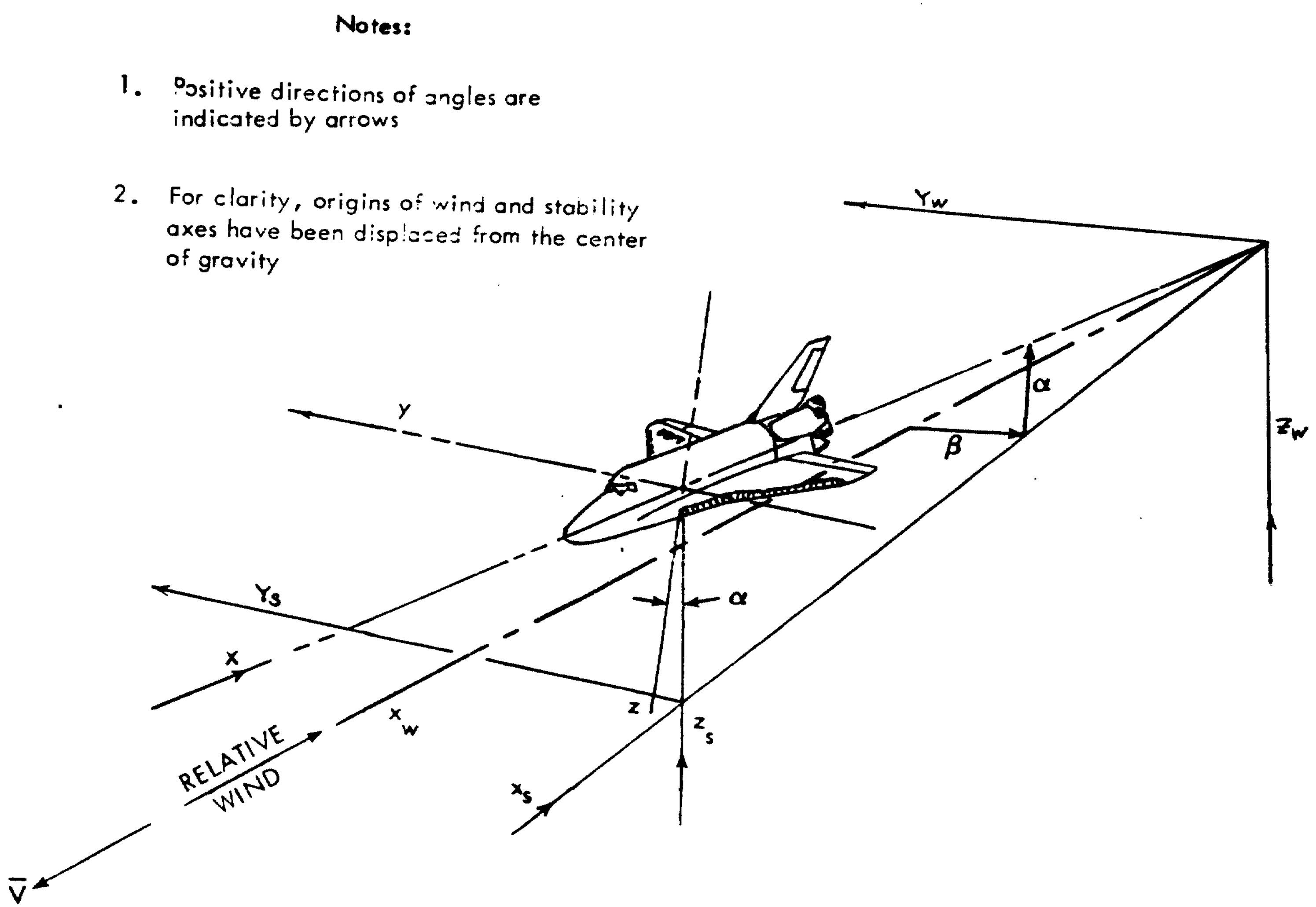
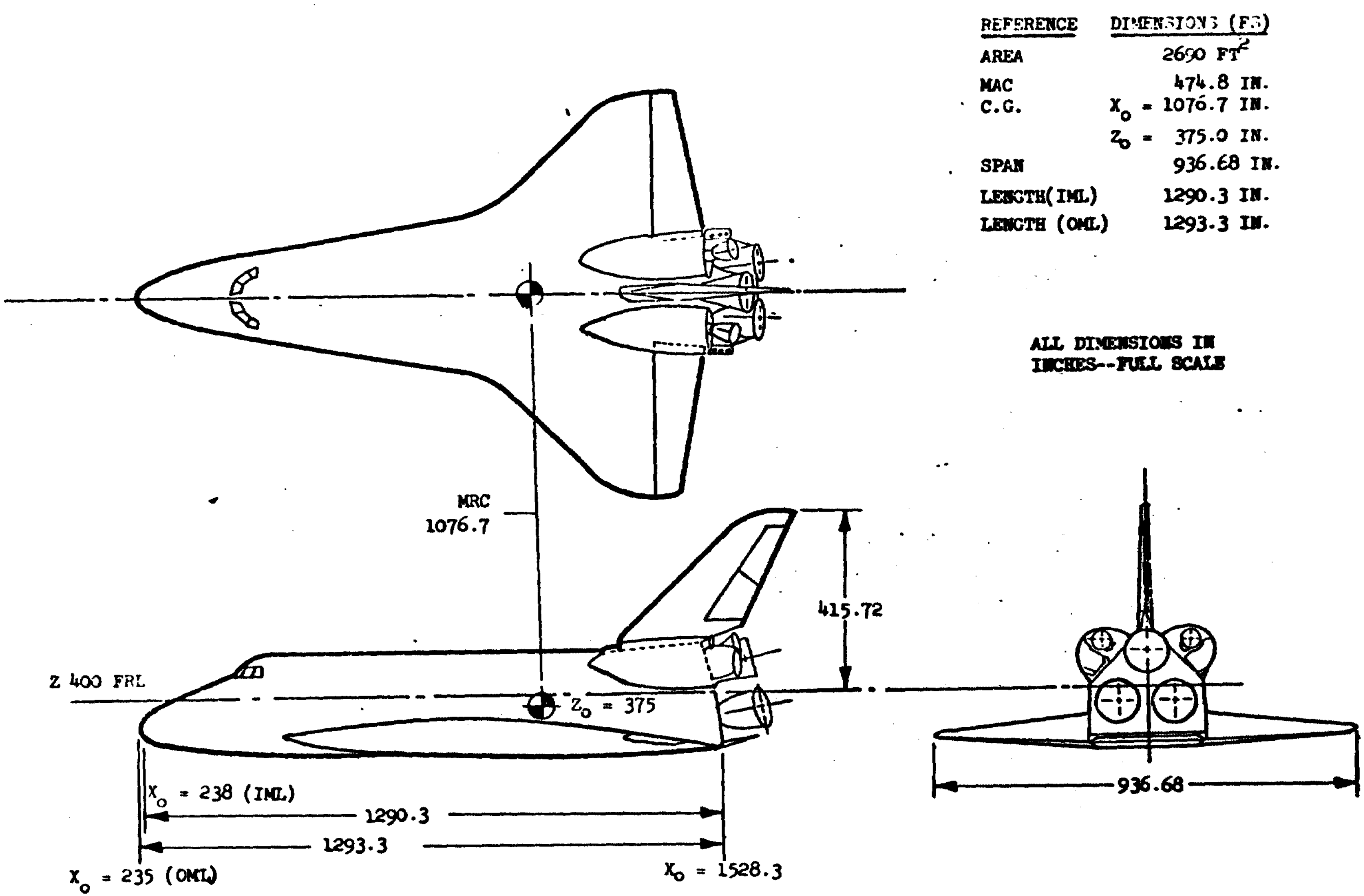
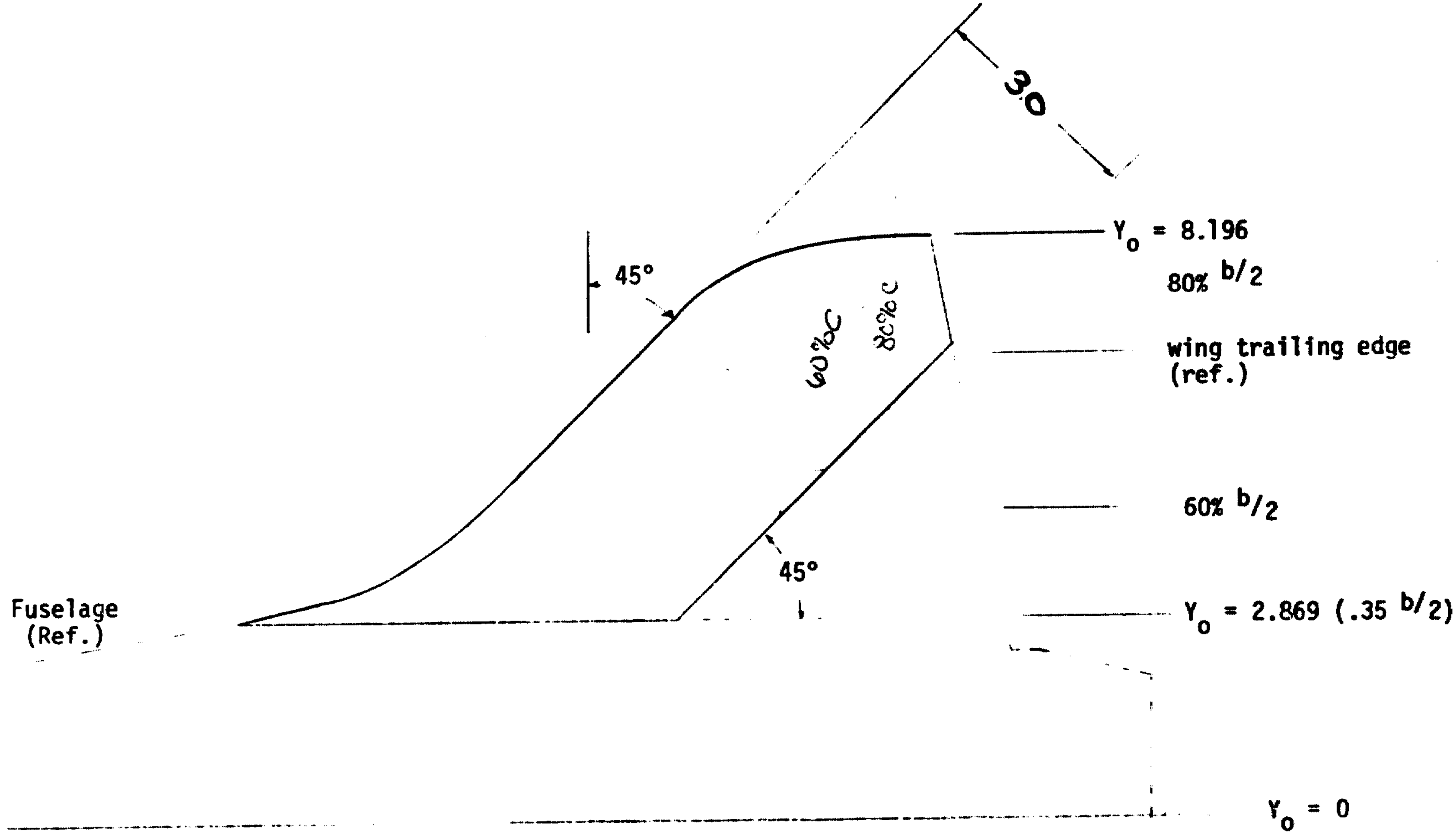


Figure 1. Axis Systems.



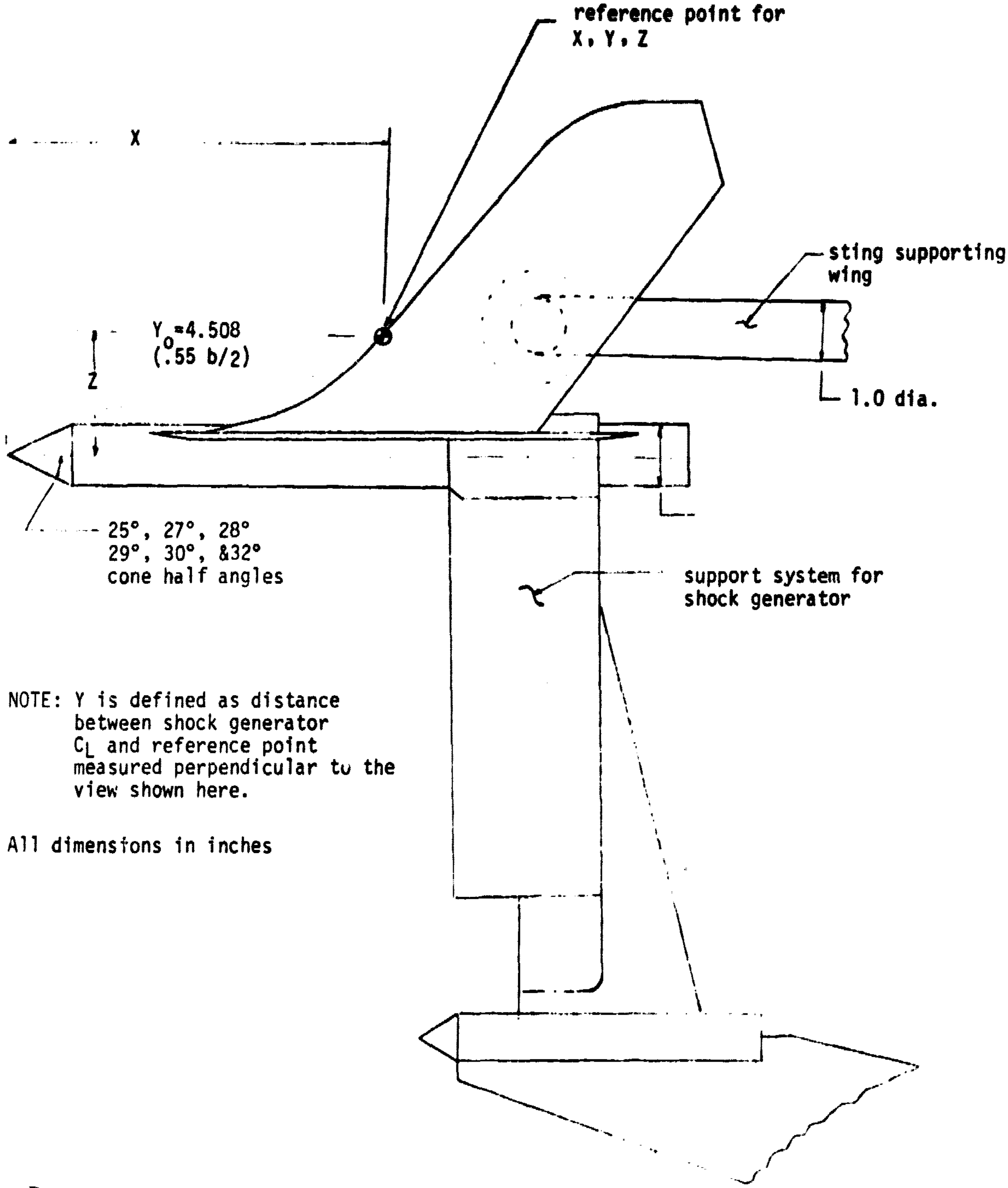
a. Orbiter Configuration

Figure 2. - Model Sketches.



b. Model 64-0 Partial Wing

Figure 2. - Continued.



NOTE: Y is defined as distance between shock generator C_L and reference point measured perpendicular to the view shown here.

All dimensions in inches

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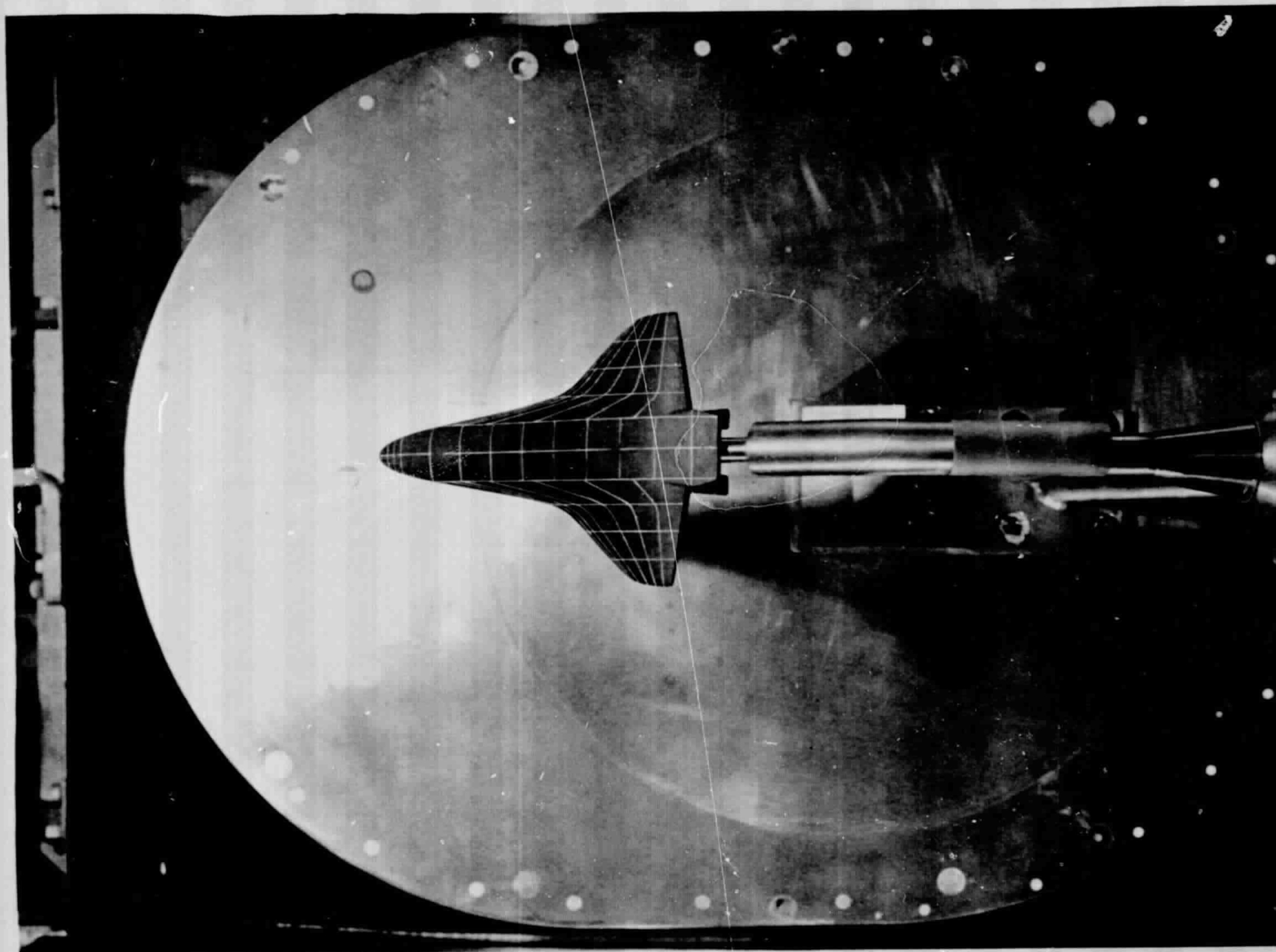
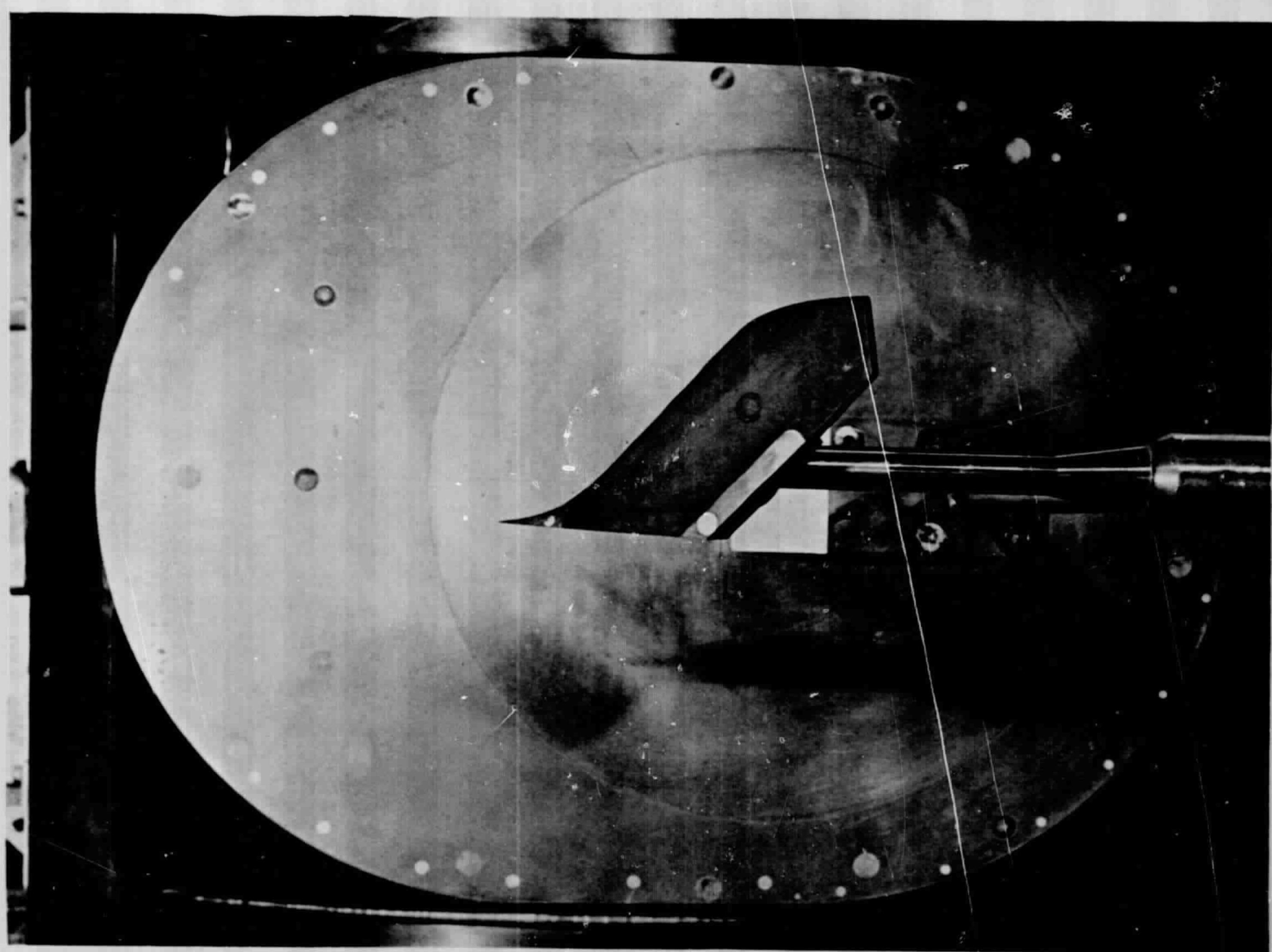
c. Partial Wing Installation With Shock Generator

Figure 2. - Concluded.



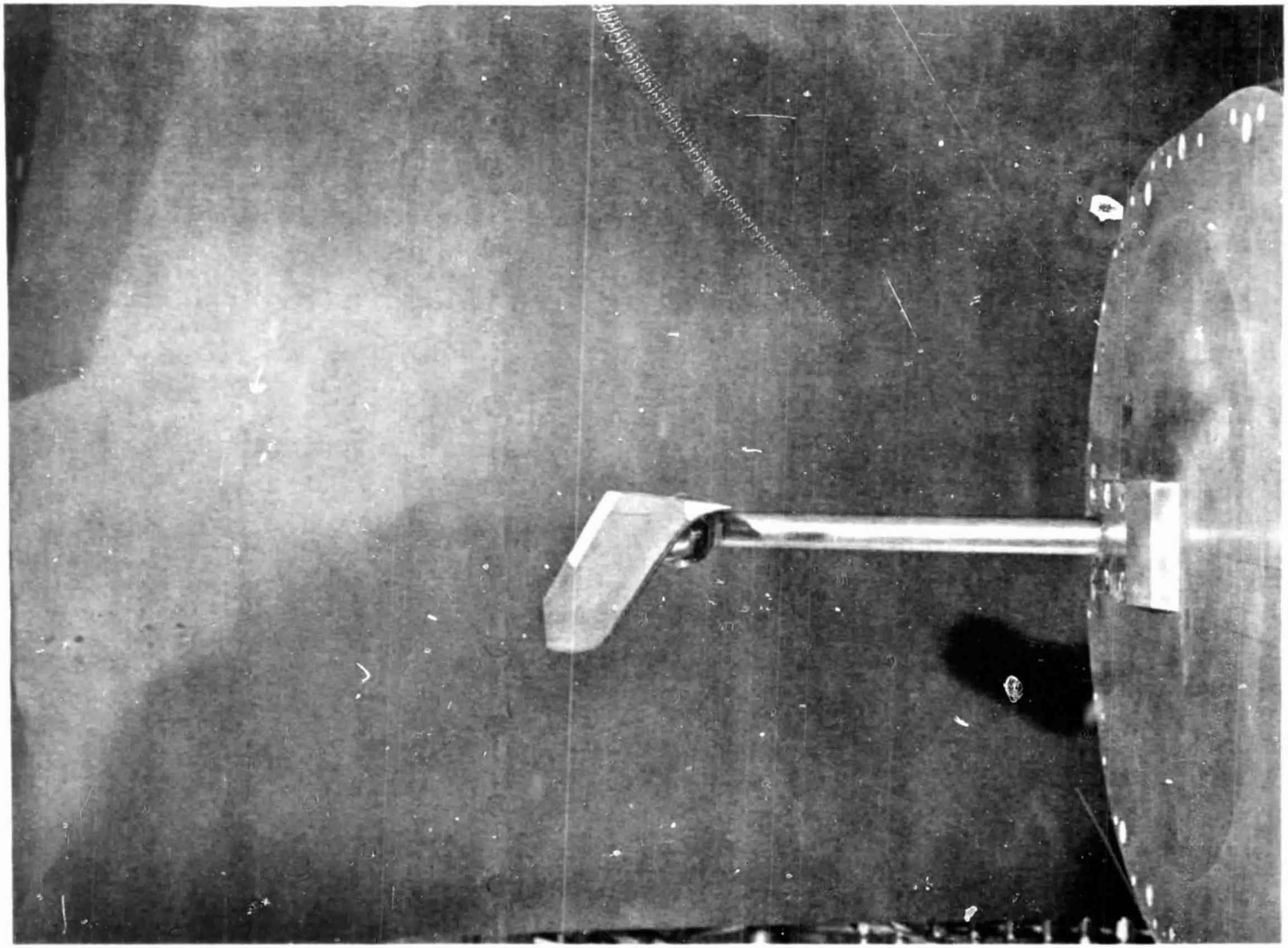
a. Orbiter Grid Model Installed in Tunnel

Figure 3. - Model Photographs.



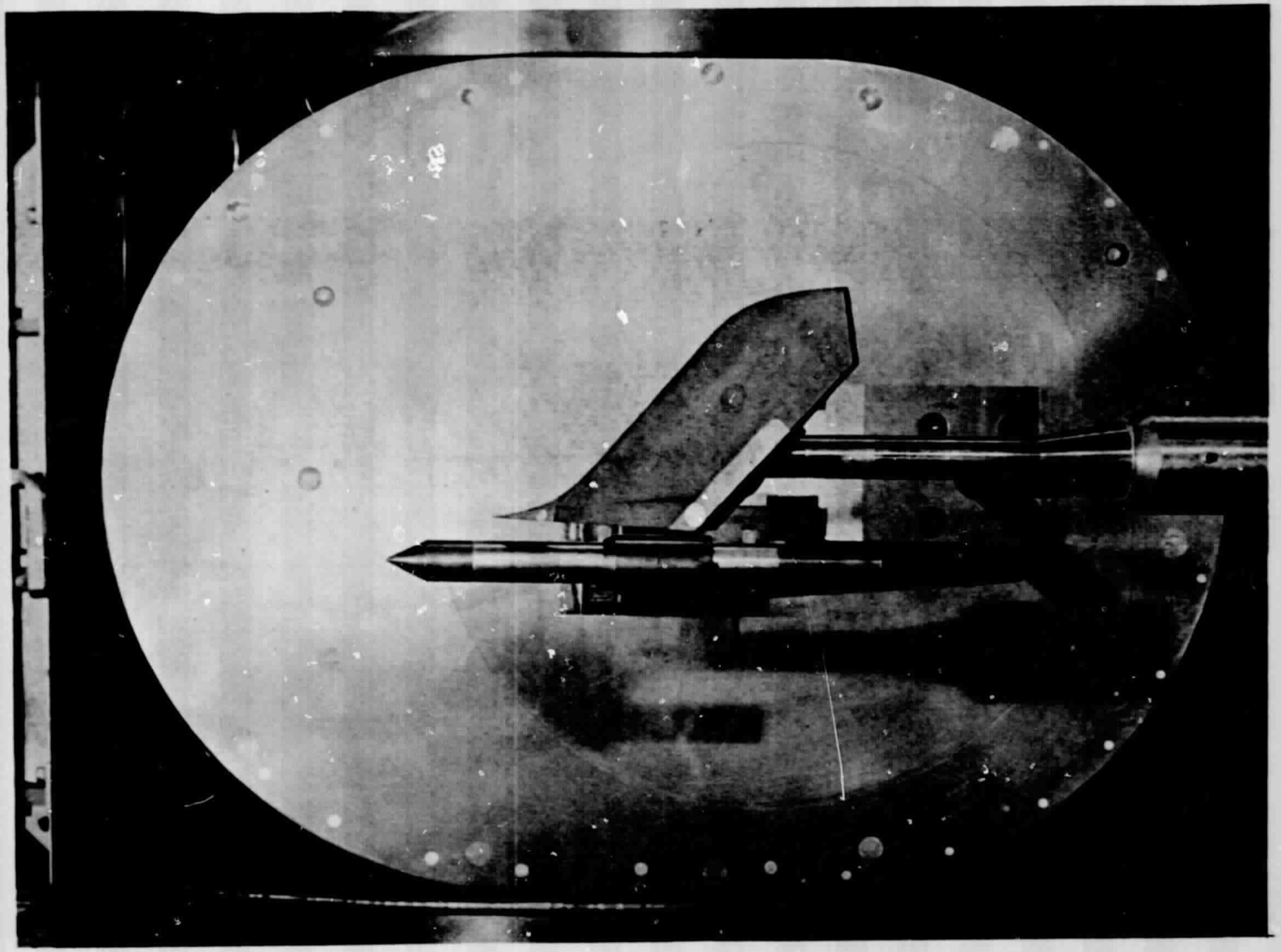
b. Partial Wing Model Installed in Tunnel

Figure 3. - Continued.



c. Partial Wing Model Mounting Assembly

Figure 3. - Continued.



d. Partial Wing Model With Shock Generator

Figure 3. - Concluded.