Enclosure
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Vol. I

BOEING

(NASA-CR-150833) LOAD AND DYNAMIC ASSESSMENT OF B-52B-008 CARRIER AIRCRAFT FOR FINNED CONFIGURATION 1 SPACE SHUTTLE SOLID ROCKET BOOSTER DECELERATOR SUBSYSTEM DROP TEST VEHICLE. VOLUME 1: (Boeing Co.)

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ABSTRACT

The George C. Marshall Space Flight Center (MSFC), National Aeronautics and Space Administraction (NASA), has identified B-52B Airplane (Serial No. 008) for use in solid rocket booster (SRB) parachute drop flight testing. This testing will verify the structural integrity of the SRB parachutes and the deployment concept for the drogue parachute. The drop test vehicle (DTV) used to accomplish this testing was designed and fabricated for MSFC by Martin Marietta-Denver. Testing on the program will be accomplished out of the NASA Edwards Hugh Dryden Flight Research Center (DFRC). The parachute drop testing will be done at the National Parachute Test Range (NPTR).

The purpose of this study was to determine by theoretical analysis methods the compatibility and structural capability of B-52B-008/DTV Configuration 1 (with fins) to accomplish the drop test mission. This document, consisting of four volumes, presents the analysis results on the subject program. In addition, airspeed, load factor and airplane gross weight restrictions are defined. Each volume of this report contains the following information:

- Volume I — Summary of airplane flutter and load-strength evaluation analysis results and a comparative study of the pylon loading resulting from DTV inertia and aerodynamic considerations. The pylon loads were developed based on X-15A-2 inertia load factor criteria and DTV aerodynamics per Marshall Space Flight Center (MSFC).
- Volume II — Detailed B-52B-008/DTV Configuration 1 (with fins) flutter and load analysis results.
- Volume III — Pylon loading at the DTV and wing interface attach points using stiffness Method 1.
- Volume IV — Pylon loading at the DTV and wing interface attach points using stiffness Method 2.

The study was conducted for George C. Marshall Space Flight Center (MSFC) under Contract NAS8-31805 Modification Number 3. Technical contacts at MSFC on this program were Mr. R. Mitchell and Mr. D. Kross.

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1.0 INTRODUCTION

The B-52B airplane (Serial No. 008) identified by the NASA for use in solid rocket booster (SRB) parachute drop testing is a jet propelled swept-back shoulder-wing monoplane with conventionally located swept-back tail surfaces. It is powered by eight Pratt and Whitney J57-P-19/P-29 turbojet engines mounted in pairs under the wing in four forward-slung pods. Engine water injection provisions are provided for increased takeoff power. The main landing gear consists of four twin wheel units in quadricycle arrangement which retract into the fuselage. In addition, a single wheel tip protection gear is located at approximately 80 percent of wing semispan and retracts into the wing aft of the rear spar.

Pitch control is provided by a full span elevator hinged at the 90 percent stabilizer chord. Longitudinal trim is accomplished by rotation of the entire horizontal stabilizer. Lateral control and trim are achieved by use of a rudder, independent extension of seven plate-type spoilers on each wing and ailerons. Corresponding spoilers on each wing are simultaneously extended as airbrakes for landing approach and rapid descent.

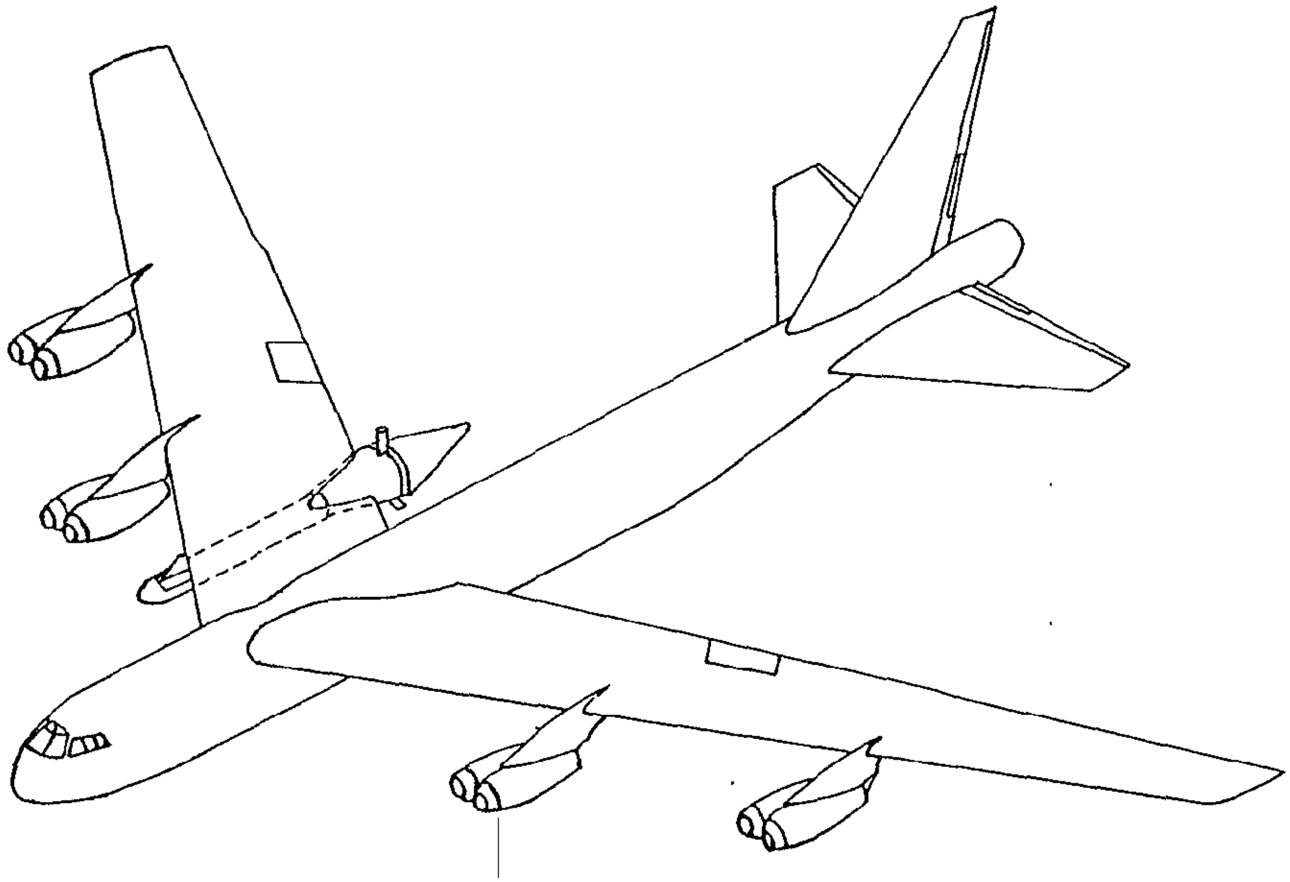
In addition to the general description given in previous paragraphs, B-52B-008 has been modified for X-15 and X-24 Programs as follows:

- Main wing fuel cell number 3 removed.
- Major rework to the right hand wing inspar box inboard of WBL 208. This rework includes the addition of an auxiliary front spar to take the additional shear loading induced by the research vehicles.
- Inboard flaps are permanently fixed in the retracted position. It should be noted that the outboard flaps are not fixed in the retracted position; however, they are never extended during flight, takeoff, landing or taxi operation.
- External wing fuel tanks removed.

- Pylon mounted on the right hand wing at WBL 208.
- Extensive rework to the right hand wing trailing edge structure (including cutout) at WBL 208.

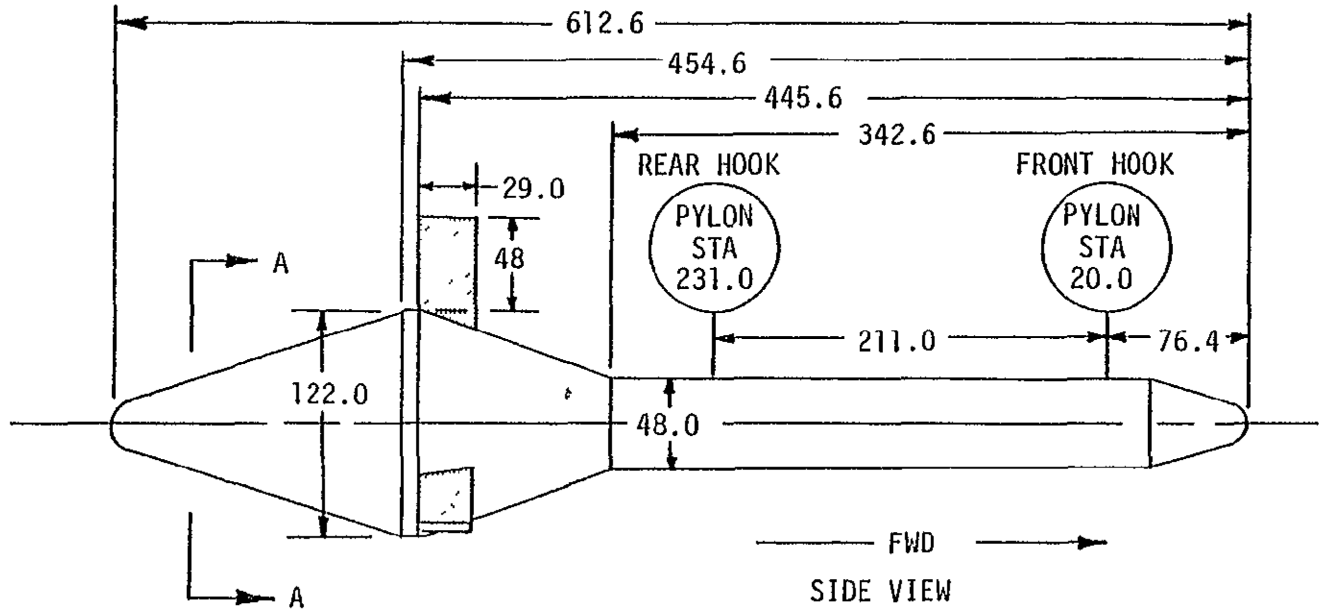
Other structural, pneumatic and electrical changes have been made but are not pertinent to this discussion.

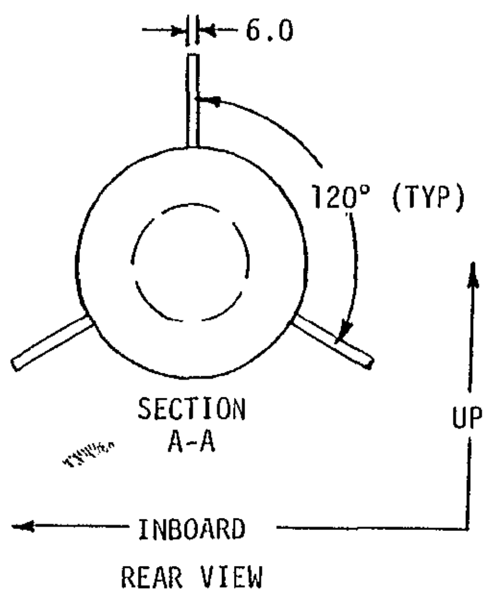
A sketch of B-52B-008 with DTV Configuration 1 (with fins) mounted under the right hand wing is shown in Figure 1. A sketch of DTV Configuration 1 (with fins) is shown in Figure 2.



B-52B-008/DTV CONFIGURATION 1 (WITH FINS) DESCRIPTION

FIGURE 1





DTV CONFIGURATION 1
(WITH FINS) DEFINITION

FIGURE 2

2.0 SUMMARY

This document presents the theoretical B-52B-008/Drop Test Vehicle (DTV) flutter and airplane-pylon load-strength evaluation analysis obtained by the Boeing Wichita Company for the George C. Marshall Space Flight Center (MSFC) under Contract No. NAS8-31805 Modification No. 3. The purpose of the study was to verify B-52B-008/DTV compatibility and B-52B-008/pylon structural capability to accomplish the drop test mission required by the NASA for structural integrity testing of the solid rocket booster (SRB) parachutes and for drogue parachute deployment concept evaluation. See Figure 1 for a sketch of the B-52B/DTV configuration evaluated.

The maximum operational gross weight of the B-52B/DTV was established as 336,344 pounds. This weight allows for a maximum DTV weight of 52,000 pounds and a fuel loading of 100,000 pounds. The fuel sequence as given in Section 3.0 of this volume was developed to minimize airplane lateral unbalance during taxi-takeoff and landing operations while yet allowing an early drop if emergency conditions develop. Normal DTV drop is accomplished with sufficient lateral unbalance at the time of drop to minimize airplane rolling moment excitation, thereby reducing the need for an abrupt aileron-spoiler input to stabilize the airplane. Adjustments to the initial fuel loading and subsequent fuel sequence will be required depending on the actual DTV weight.

The airspeed restriction on the B-52B/DTV Configuration 1 (with fins) is given in Figure 3. This 260 Knot calibrated airspeed or Mach .75 restriction, whichever is less, along with the altitude restriction of 35,000 feet was developed based on coordination with personnel of NASA Edwards Hugh Dryden Flight Research Center (DFRC), MSFC, Martin Marietta-Denver and Boeing.

Flutter analyses of B-52B-008 with DTV Configuration 1 (with fins) were accomplished to determine flutter speeds for two selected gross weight conditions considered to be the most critical based on previous flutter test and analysis experience. Variations in DTV-pylon frequencies were evaluated to account for possible errors in estimation of pylon stiffness. Results of these analyses indicate that the B-52B-008/DTV Configuration 1 (with fins) is flutter free within the flight design envelope of Figure 3, including a 15 percent margin of safety in equivalent airspeed. See Section 4.0 of this volume for a more detailed discussion of flutter analysis results.

Gust and maneuver flight load analyses for the B-52B-008/DTV Configuration 1 (with fins) were accomplished based on the maneuver load factor criteria defined in Figure 4 and the gust load factor criteria of Reference 1, Page 7, (complete gust criteria is given in Section 4.1, Volume II of this document). Taxi-takeoff (3.0g ultimate load factor criteria) and ground turn (1.0g vertical and .27g side limit load factor criteria) analysis results for B-52-008/DTV Configuration 1 (with fins) are unchanged from those documented in Reference 2. Results of these analyses show the airplane structure to have adequate strength to fly the drop test mission. The 1.8g limit maneuver load factor restriction for gross weights above 306,000 pounds was imposed because of right hand wing overload in the area between the pylon and inboard nacelle at a 2.0g limit load factor. The factor of safety applied to all airplane limit load factor analysis results was 1.5. See Section 5.0 of this volume for a more detailed evaluation of load analysis results.

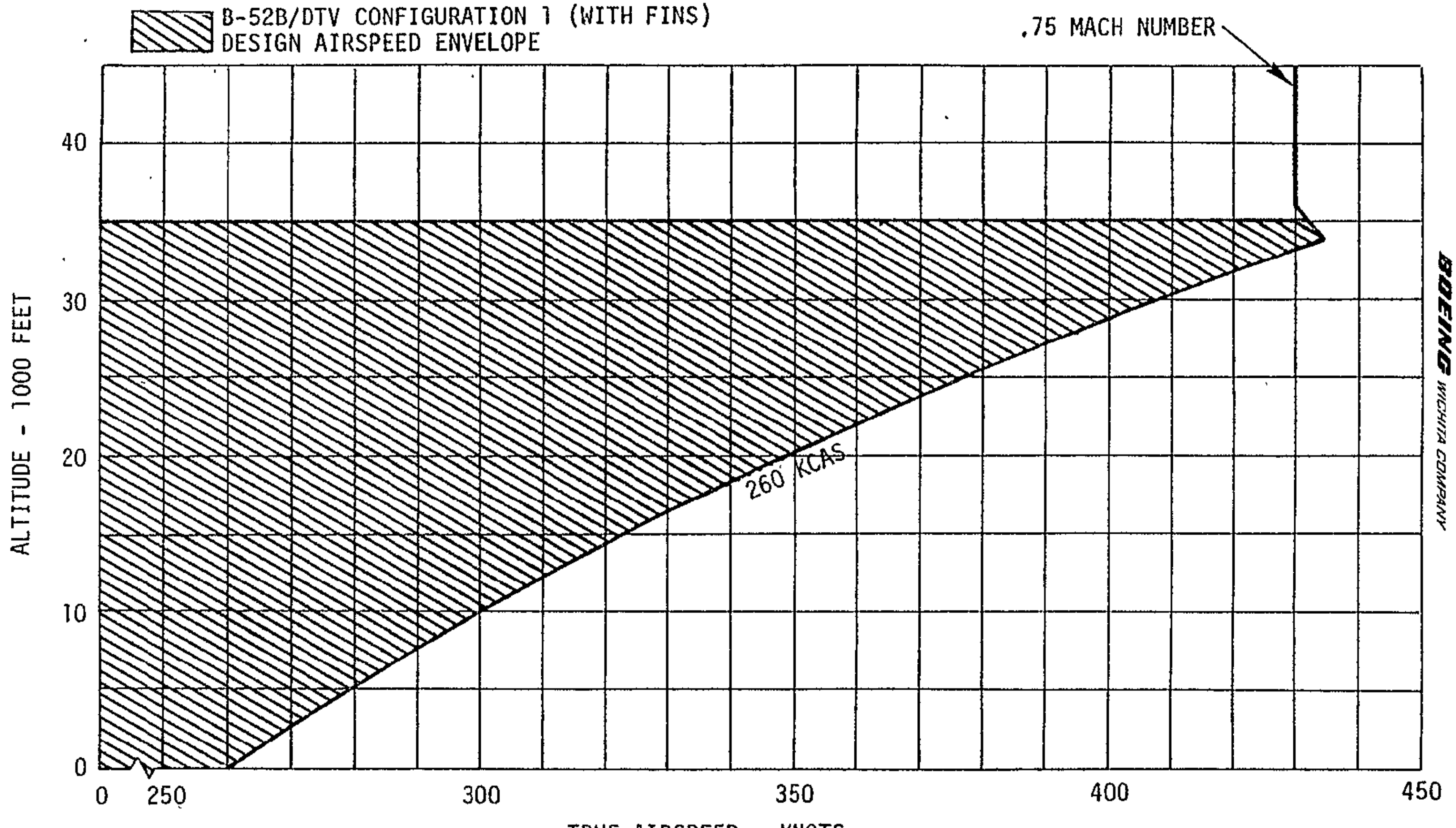
Pylon structural evaluation was accomplished using X-15A-2 load factor criteria along with finned DTV Configuration 1 aerodynamics per MSFC. The results of these analyses show the pylon to be acceptable for carriage of DTV Configuration 1 (with fins). See Section 6.0 of this volume for a complete evaluation of the pylon loads analysis.

Ground clearance analysis results remain unchanged from those documented in Section 7.0, Volume I of Reference 2 for DTV Configuration 1. Section 7.0 of this volume reiterates the ground clearance capability.

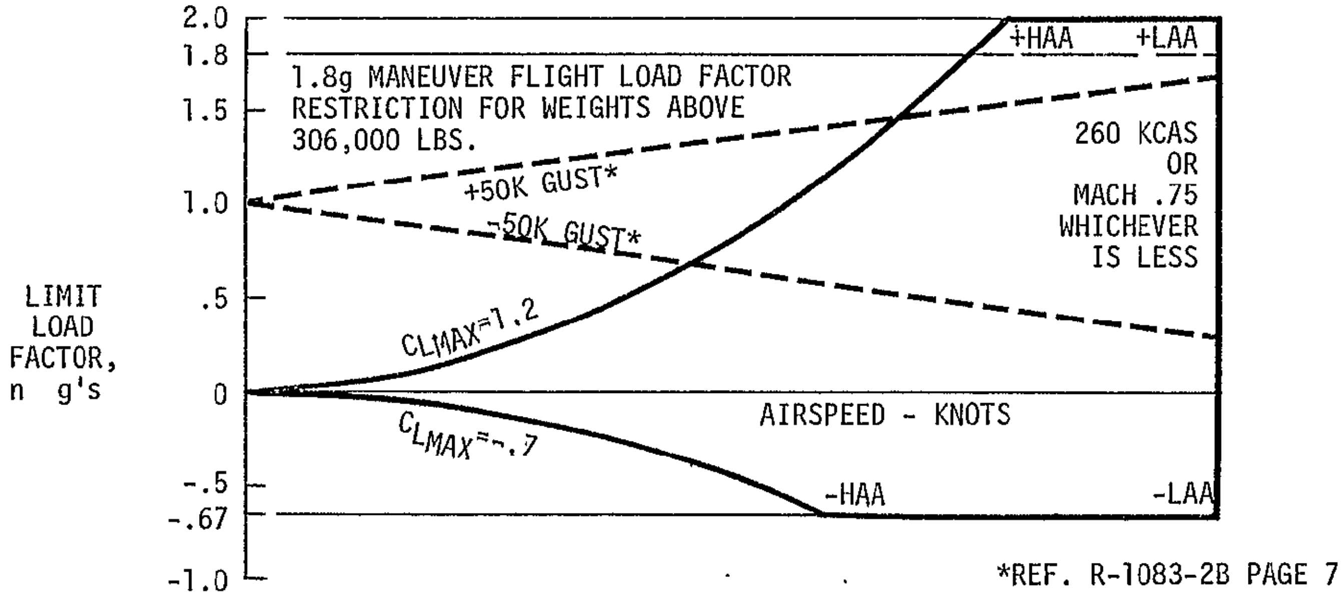
2.1 Conclusions and Recommendations

Based on the results of the flutter and load-strength evaluation analyses, it is concluded that B-52B-008/DTV Configuration 1 (with fins) is safe for flight. However, it is recommended by Boeing that the following flight test procedures be followed to minimize dynamic excitation of the DTV:

- Fly only when the forecast of turbulence level in the test area is calm or light.
- Avoid abrupt elevator, aileron and rudder inputs.
- Minimize landing impact speed (sink rate) when landing with the DTV still attached to the pylon.



B-52B/DTV CONFIGURATION 1 (WITH FINS)
DESIGN AIRSPEED ENVELOPE
FIGURE 3



V-n DIAGRAM

FIGURE 4

3.0 FUEL SEQUENCE

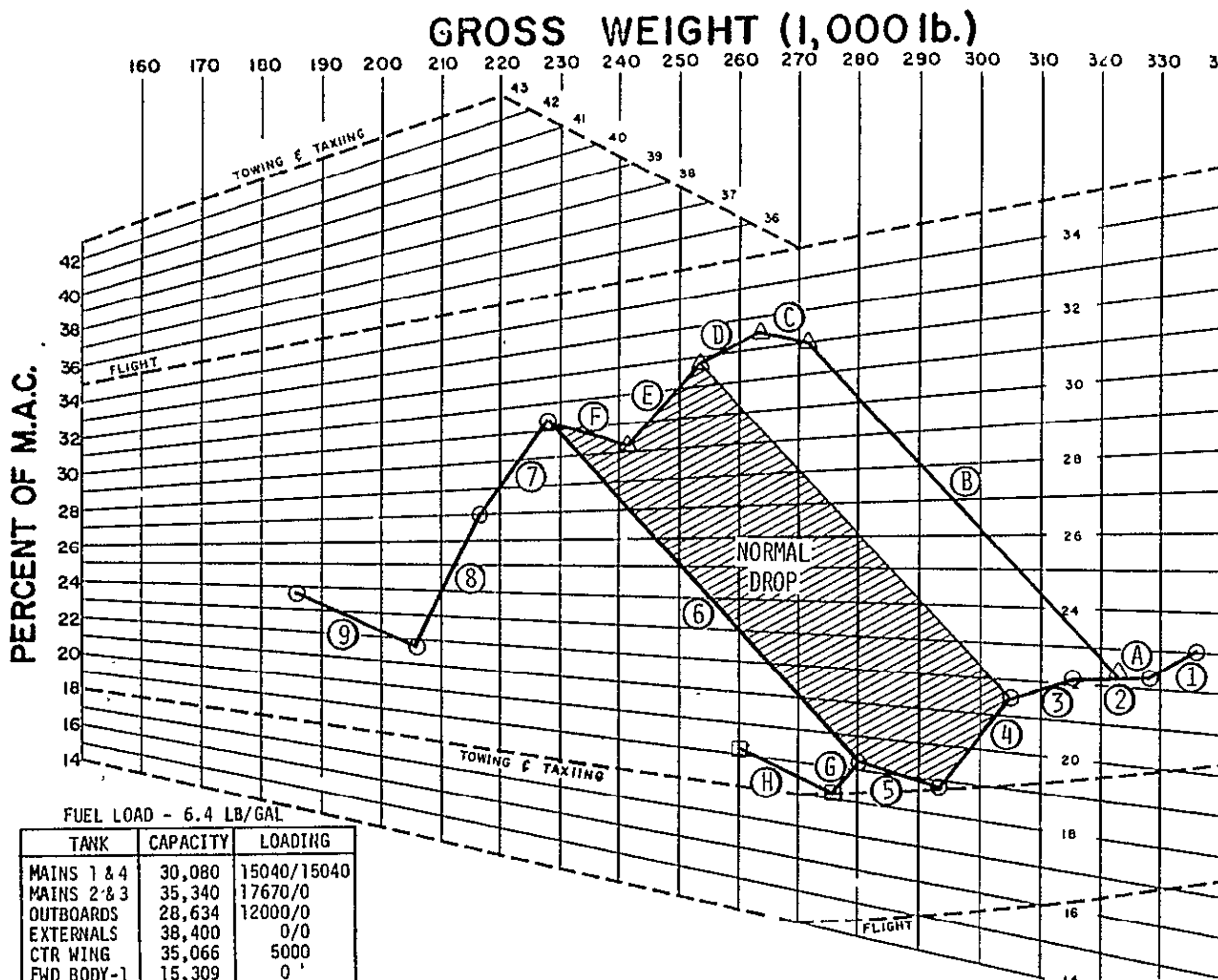
Based on the NASA mission requirement that the B-52B have a maximum fuel capability of 100,000 pounds, a fuel sequence was developed which minimized aircraft structural loading and flutter degradation. The fuel sequence was developed using the following criteria:

- Airplane rolling moment balanced by left hand wing fuel for takeoff.
- Gradual airplane rolling moment unbalance obtained by fuel burn and transfer from the left hand wing. At the time of DTV drop, the airplane will be approximately one-half of the unbalance caused by the DTV.
- After DTV drop, the airplane will be approximately rebalanced by fuel burn and fuel transfer for landing.

Based on these criteria and the NASA requirement, the maximum B-52B/DTV weight was established as 336,344 pounds. The weight was allocated as follows:

- B-52B-008 (including LOX Tank) + Pylon + Crew = 181,344 pounds
- Maximum DTV weight = 52,000 pounds
- Water Injection - H_2O = 3,000 pounds
- Maximum Fuel Weight = 100,000 pounds
- LOX = 0 pounds

Early DTV drop (emergency drop), normal DTV drop and mission abort fuel sequencing procedures are defined in Figures 5 and 6. The fuel sequence as developed maintains good longitudinal and lateral CG control during all phases of operation. The fuel sequence as presented is based on 6.4 pound per gallon density fuel.



FUEL LOAD - 6.4 LB/GAL

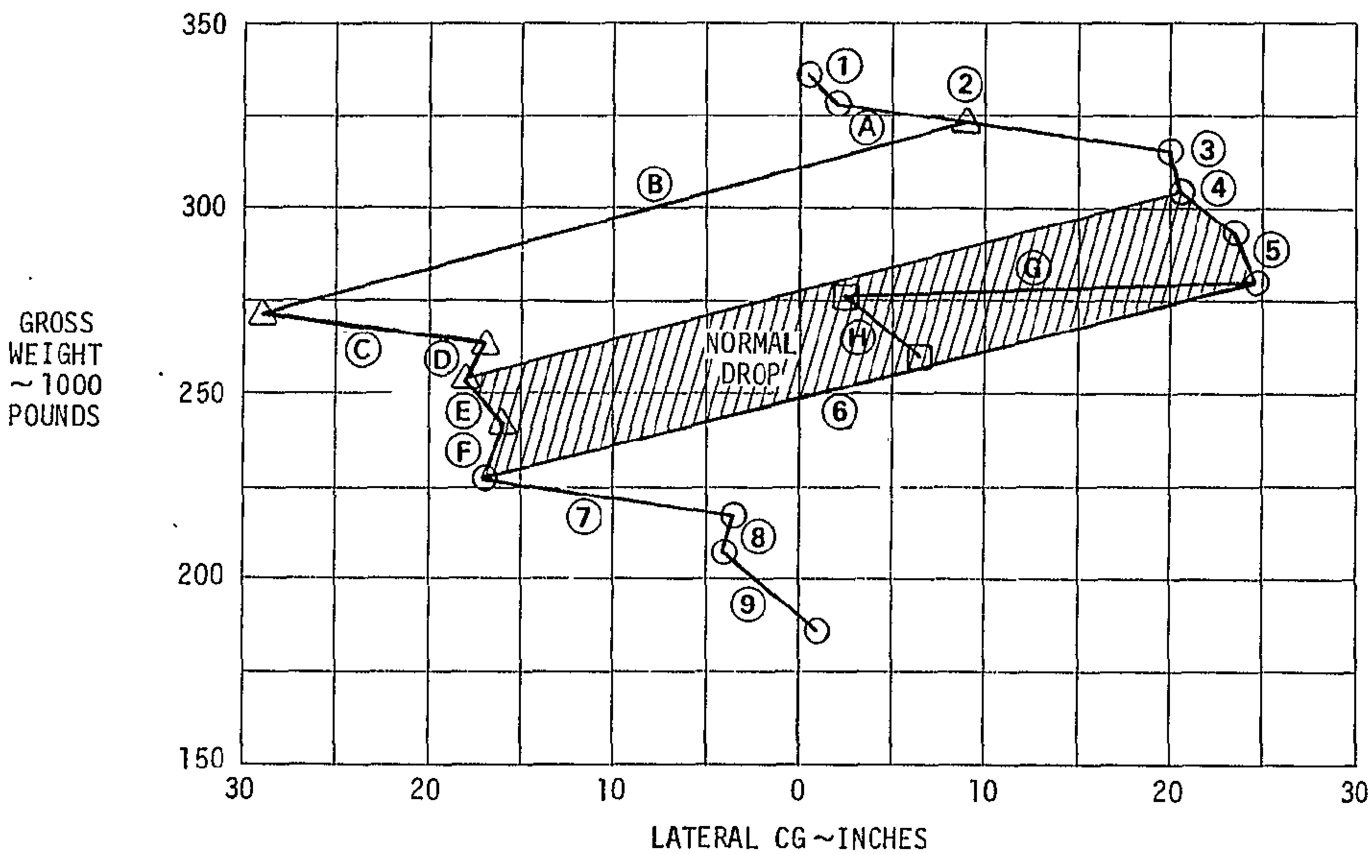
TANK	CAPACITY	LOADING
MAINS 1 & 4	30,080	15040/15040
MAINS 2 & 3	35,340	17670/0
OUTBOARDS	28,634	12000/0
EXTERNALS	38,400	0/0
CTR WING	35,066	5000
FWD BODY-1	15,309	0
FWD BODY-2	12,672	0
MID BODY	32,602	0
AFT BODY	37,837	35250
TOTAL FUEL	265,940	100000

LEGEND

	SYM	TANK	FUEL IN POUNDS USED	FUEL IN POUNDS REMAINING
NORMAL LAUNCH	1	MAIN 1 MAIN 2 MAIN 4 WATER	1203 2406 1203 3000	13837 15264 13837 0
	2	L. OUTBD MAIN 2	6500 6500	5500 8764
	3	AFT BODY CTR WING	5000 5000	30250 0
	4	AFT BODY MAIN 2	9000 3000	21250 5764
	5	MAIN 1 MAIN 4	6837 6837	7000 7000
	6	LAUNCH	52000	0
	7	L. OUTBD AFT BODY	5500 5500	0 15750
	8	AFT BODY	10750	5000
	9	MAIN 1 MAIN 2 MAIN 4	7000 5764 7000	0 0 0
EARLY LAUNCH	A	L. OUTBD MAIN 2	2500 2500	9500 12764
	B	LAUNCH	52000	0
	C	L. OUTBD MAIN 2	4000 4000	5500 8764
	D	AFT BODY CTR WING	5000 5000	30250 0
	E	AFT BODY MAIN 2	9000 3000	21250 5764
	F	MAIN 1 MAIN 4	6837 6837	7000 7000
ABORT	G	MAIN 1 MAIN 4 AFT BODY L. OUTBD	2000 2000 -8817 +8817	5000 5000 12433 14317
	H	MAIN 1 MAIN 2 MAIN 4	5000 5764 5000	0 0 0

FUEL SEQUENCE GRID (LONGITUDINAL CG)

FIGURE 5



FUEL SEQUENCE GRID (LATERAL CG)
FIGURE 6

4.0 FLUTTER

Flutter analyses were accomplished to verify that B-52B-008 is flutter free (including a 15 percent margin of safety in equivalent airspeed) when carrying DTV Configuration 1 (with fins) at airspeeds within the design envelope defined in Figure 3.

4.1 Method of Analysis

Unsymmetric flutter analyses were conducted to allow for different left and right hand wing fuel loadings and for carriage of the DTV at the right hand pylon location. Coupled airplane vibration analyses were based on an elastic axis lumped parameter representation of the airplane as shown in Figure 7. Vibration modes for the DTV/pylon configuration were determined based on X-15 ground vibration test results. Cantilever vibration frequencies, along with variations thereof, which were analyzed to evaluate the sensitivity of flutter speeds to possible errors in the estimation of the nominal DTV/pylon frequencies are shown in Table I.

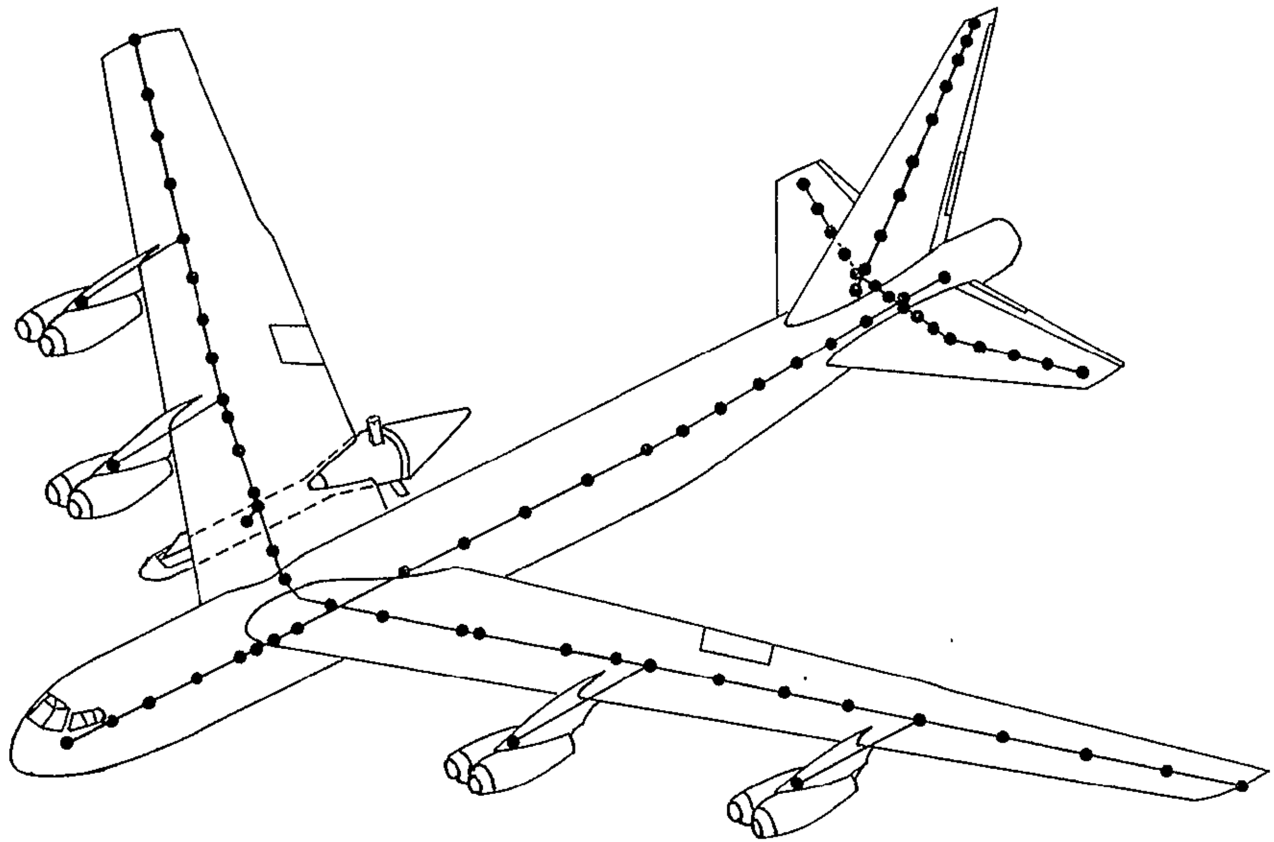
Unsteady aerodynamic forces for the airplane were generated based on lifting surface theory which used the patch paneling as shown in Figure 8. Quasi-steady aerodynamic loading was included for the DTV based on data provided by Marshall Space Flight Center.

Flutter analyses were accomplished at an altitude of 27,450 feet to be consistent with analysis results documented in the Reference 2 evaluation of the original DTV Configuration 1 and 2 designs. Two gross weight conditions (315,435 pounds and 272,441 pounds) on the fuel sequence defined in Figures 5 and 6 were selected based on flutter criticality as experienced during past flutter analysis and testing on other B-52 programs. The 315,435 pound condition (mains 1 and 4 at 92 percent, main 2 at 59 percent and left outboard at 50 percent) is on the normal launch sequence whereas the 272,441 pound condition (mains 1, 2 and 4 at 33 percent and left outboard full) is for an aborted mission. Flutter analyses of the two selected fuel loadings with only the pylon installed are documented in Reference 2.

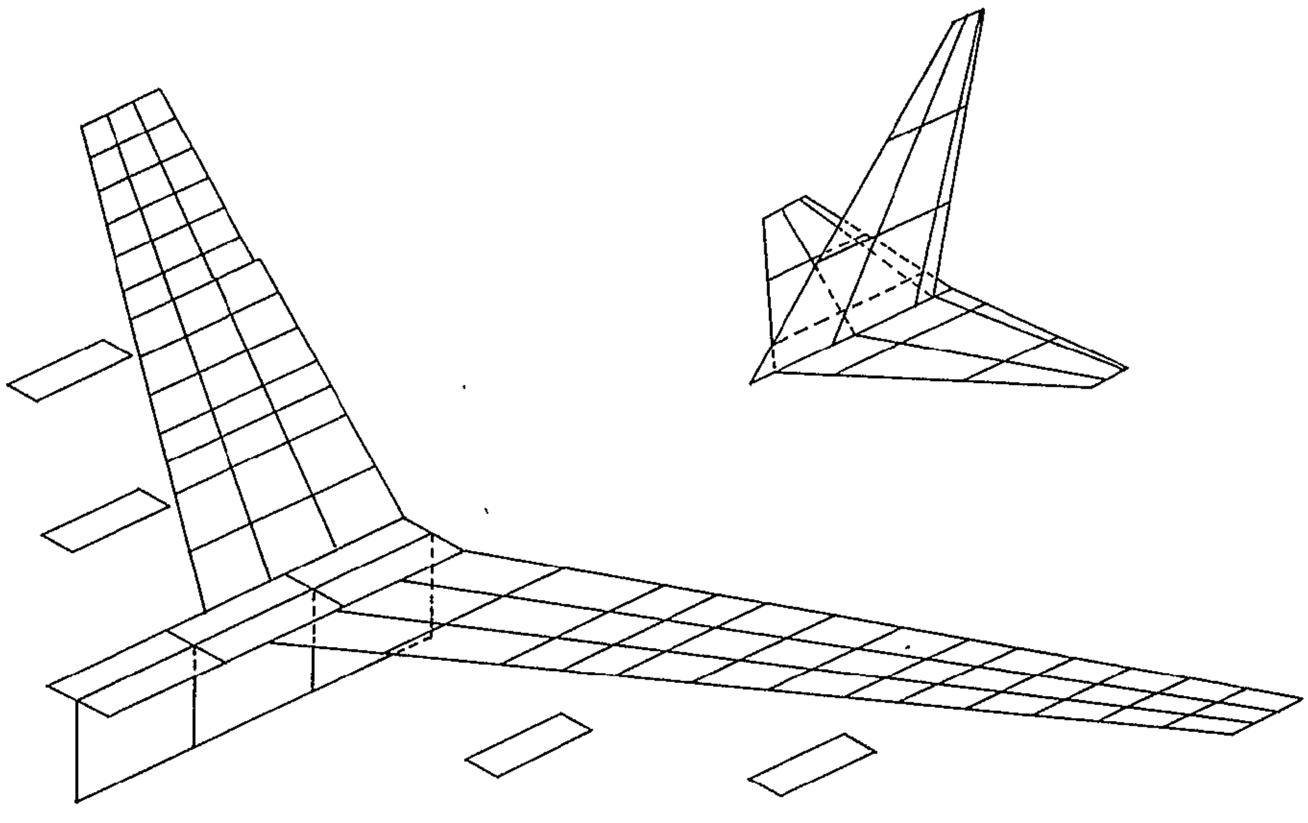
4.2 Analysis Results

Summary results are presented in this section for the 315,435 pound gross weight condition only since the 272,441 pound airplane is less flutter sensitive for the range of DTV frequencies evaluated. Detailed analysis results for all conditions analyzed are included in Section 3.0 of Volume II.

Damping trends for finned DTV Configuration 1 are shown in Figure 9. Only the two sensitive airplane modes (2.40 Hertz and 2.85 to 3.00 Hertz) and three modes which consist primarily of DTV motion are shown. The 1.75 Hertz mode is primarily DTV pitch while the 1.85 and 2.70 Hertz modes are primarily DTV torsion and side bending. In addition, the effect of DTV pitch frequency variations on the 2.40 Hertz and the 2.85 to 3.00 Hertz airplane modes is shown in Figures 10 and 11. The damping characteristics for finned DTV Configuration 1 are very similar to those noted in Reference 2 for DTV Configuration 1. In all cases, a flutter velocity above 1.15 V_D (based on the 300 KCAS airspeed limitation of Reference 2) is shown.



ELASTIC AXIS REPRESENTATION
B-52B/DTV CONFIGURATION 1 (WITH FINS)
FIGURE 7



AERODYNAMIC PATCH PANELING
B-52B/DTV

FIGURE 8

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B-52B DROP TEST VEHICLE FLUTTER ANALYSIS

DAMPING TRENDS FOR SELECTED AIRPLANE/DTV MODES

CONFIGURATION 1 (WITH FINS)

GROSS WEIGHT = 315,435 LBS.

ALTITUDE = 27,450 FEET

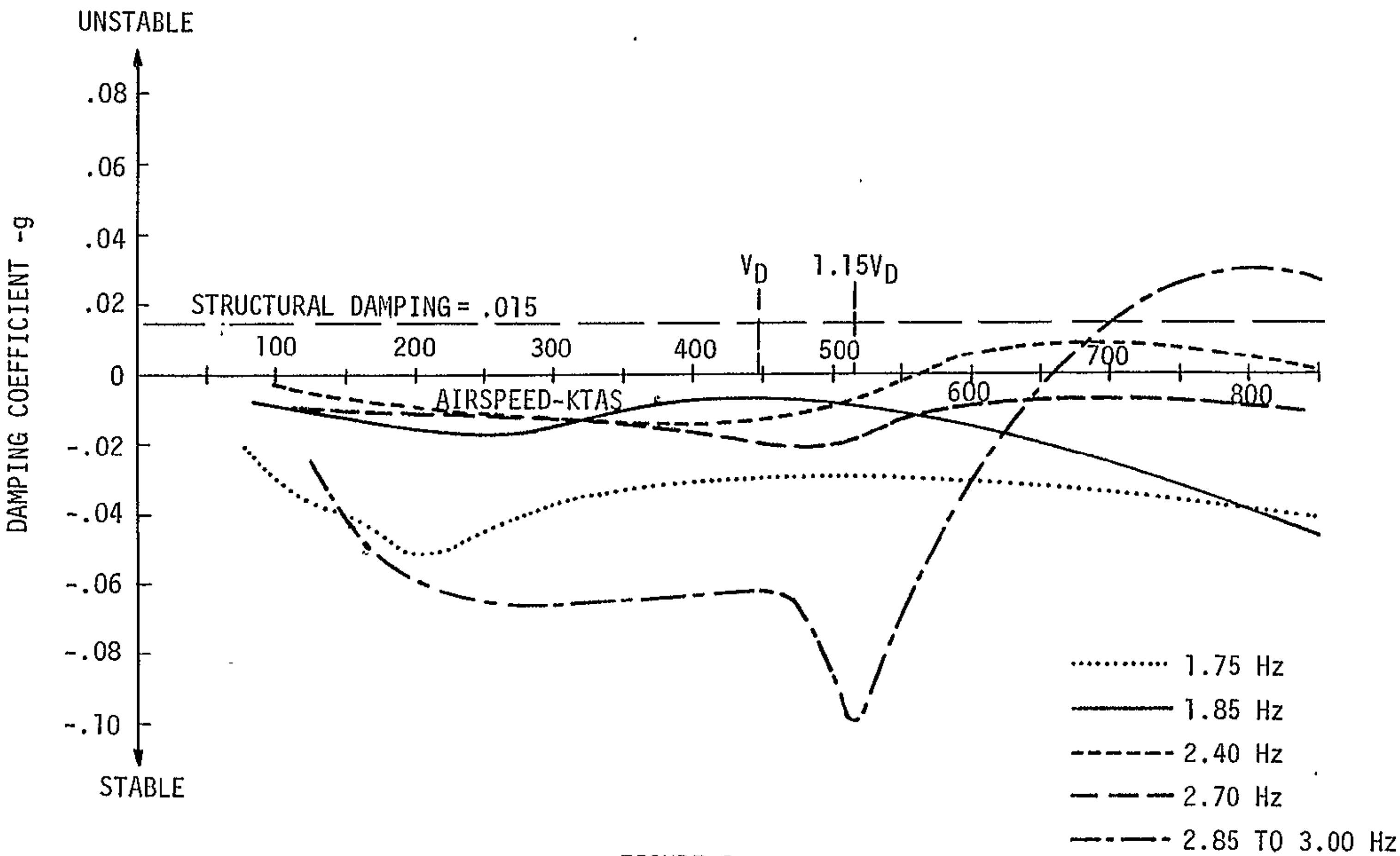

FIGURE 9

B-52B DROP TEST VEHICLE FLUTTER ANALYSIS

EFFECT OF DTV PITCH FREQUENCY (F_3) ON 2.40 Hz AIRPLANE MODE
CONFIGURATION 1 (WITH FINS)

GROSS WEIGHT = 315,435 LBS.

ALTITUDE = 27,450 LBS.

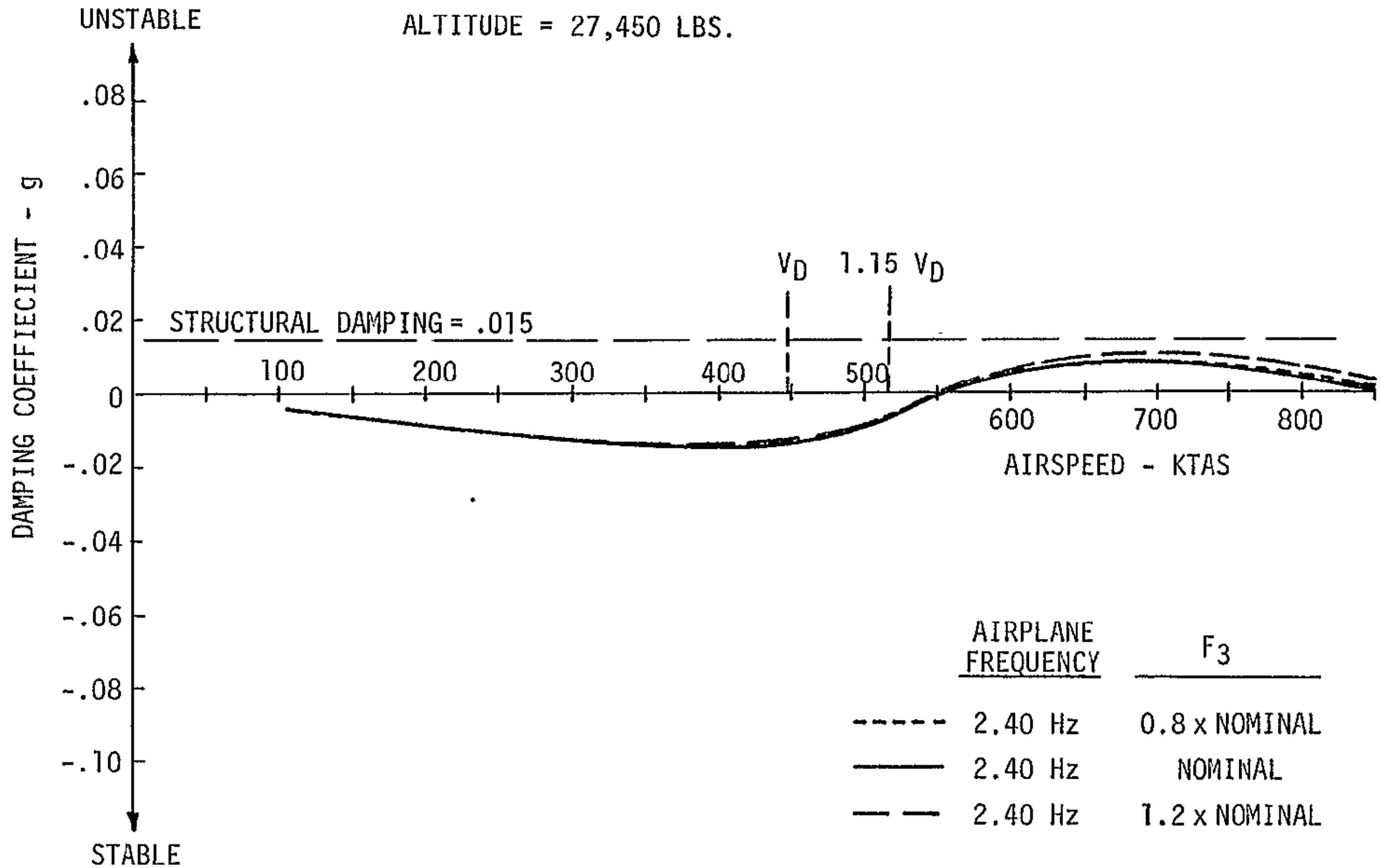

FIGURE 10

B-52B DROP TEST VEHICLE FLUTTER ANALYSIS

EFFECT OF DTV PITCH FRÉQUENCY (F_3) ON 2.85 TO 3.00 Hz AIRPLANE MODE

CONFIGURATION 1 (WITH FINS)

GROSS WEIGHT = 315,435 LBS.

ALTITUDE = 27,450 LBS.

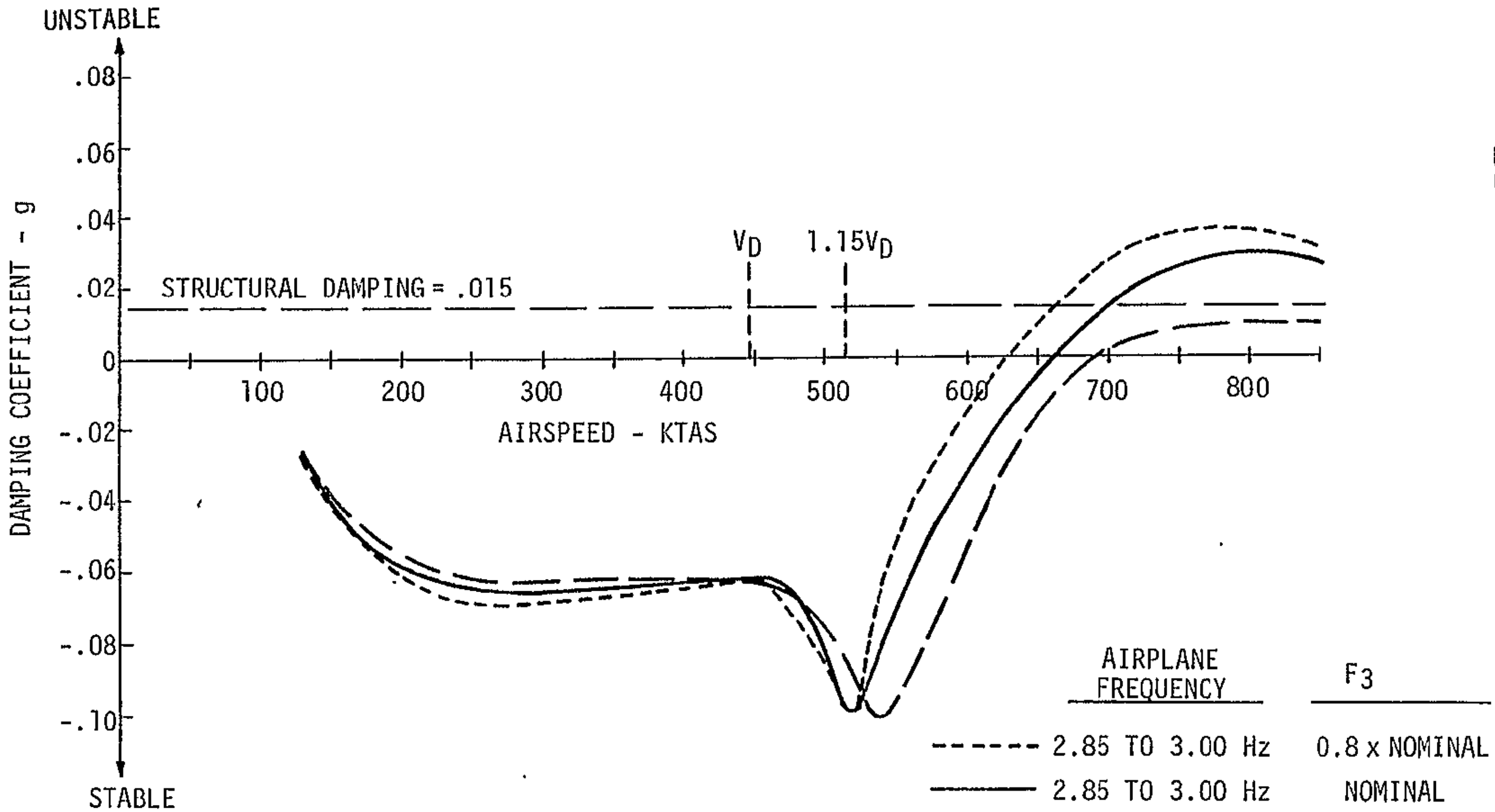

FIGURE 11

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5.0 AIRPLANE LOAD AND STRENGTH EVALUATION

Load and strength evaluation analyses of B-52B-008 with and without DTV Configuration 1 (with fins) suspended from the right hand wing pylon were accomplished to validate the structural capability and structural integrity of the airframe. The analyses were conducted using the fuel sequence as defined in Section 3.0 of this volume and the following design criteria:

- Maximum B-52B/DTV gross weight of 336,344 pounds.
- Airspeed limitation of 260 KCAS or Mach .75, whichever is less.
- Maximum flight altitude of 35000 feet.
- Maneuver flight load factor restrictions.
    - Positive limit load factor of 1.8 g's for weights in excess of 306,000 pounds and 2.0 g's for weights at or below 306,000 pounds.
    - Negative limit load factor of -.67 g's for all gross weight configurations.
- Ground handling load factor restrictions.
    - Positive ultimate load factor of 3.0 g's for taxi-takeoff conditions.
    - Positive vertical limit load factor of 1.0 g and side limit load factor of .27 g's for the ground turn conditions.
- Gust load factors per Reference 1, page 7. See Volume II, Paragraph 2.2 of this document for detail gust load factor mathematic description.
- Ultimate loads are 1.5 times limit loads.

5.1 Method of Analysis

Maneuver and gust flight load analyses were conducted using aeroelastic analysis techniques similar to those defined in Reference 3. This method incorporates airframe flexibility, distributed mass and modified lifting line quasi-static aerodynamics. Modifications were made to allow for the inclusion of DTV Configuration 1 (with fins) aerodynamics provided by MSFC.

Analyses were accomplished at the four corners of the airspeed-load factor (V-n) diagram shown in Figure 4. (See Paragraph 4.1, Volume II of this document for detailed V-n diagrams). Fifteen airplane gross weight configurations were evaluated. The four corners of the V-n diagram are defined as follows:

- Upper left hand corner - positive high angle of attack (+ HAA).
- Upper right hand corner - positive low angle of attack (+ LAA).
- Lower left hand corner - negative high angle of attack (- HAA).
- Lower right hand corner - negative low angle of attack (- LAA).

Ground load taxi-takeoff and ground turn analyses used static-elastic analysis techniques which included the nonlinear characteristics of the gear oleo. See Paragraph 2.4, Volume II of Reference 2 for a complete mathematical description of the analysis method. All ground load analysis results were made for the 336,344 pound gross weight configuration.

5.2 Analysis Results

Results of the load and strength evaluation substantiate the B-52B-008 structure for operation with finned DTV Configuration 1. The following subparagraphs show the structural substantiation for the wing, wing center section and landing gear. The loading on the empennage is well below the existing design allowable. In addition, little empennage buffet due to the DTV wake is anticipated. Therefore, the empennage loading in conjunction with the light fuselage loading result in no fuselage or empennage structural problems.

5.2.1 Wing Evaluation

Comparisons of left and right hand wing ultimate positive and negative vertical bending moments to the wing bending allowables defined in Reference 4 are shown in Figures 12 through 15. These data show that both wings have sufficient bending strength to withstand the loading imposed during the DTV Configuration 1 (with fins) drop test mission. The ultimate shear flows (front and rear spar) for the DTV Configuration 1 (with fins) are no greater than the shear flows documented in Reference 2.

Based on this structural evaluation, the wing structure has adequate strength. For detail shear, moment and torsion design load envelopes, see Paragraph 4.2, Volume II of this document.

5.2.2 Wing Center Section Evaluation

A comparison of critical wing center section loads to the critical X-15A-2 loads given in Reference 5 is shown in Table II. The taxi-takeoff loading for the B-52B/DTV Configuration 1 (with fins) is less than the loading shown for the X-15A-2 taxi condition given in Reference 5. The maximum delta shear experienced by the center wing structure is 109,466 pounds for the B-52B/DTV Configuraton 1 (with fins) as compared to 123,428 pounds for the X-15A-2. The bending and torsional moments at the side of body are not critical. Therefore, the center wing structure has sufficient structural capability.

5.2.3 Landing Gear Evaluation

Comparisons of B-52B/DTV Configuration 1 (with fins) gear loads to the design allowable loading are shown in Tables III and IV. The front main truck, rear main truck and tip protection gear loading for B-52B/DTV Configuration 1 (with fins) are less than the design allowables given in Reference 6. Therefore, no gear difficulties other than normal routine maintenance are anticipated.

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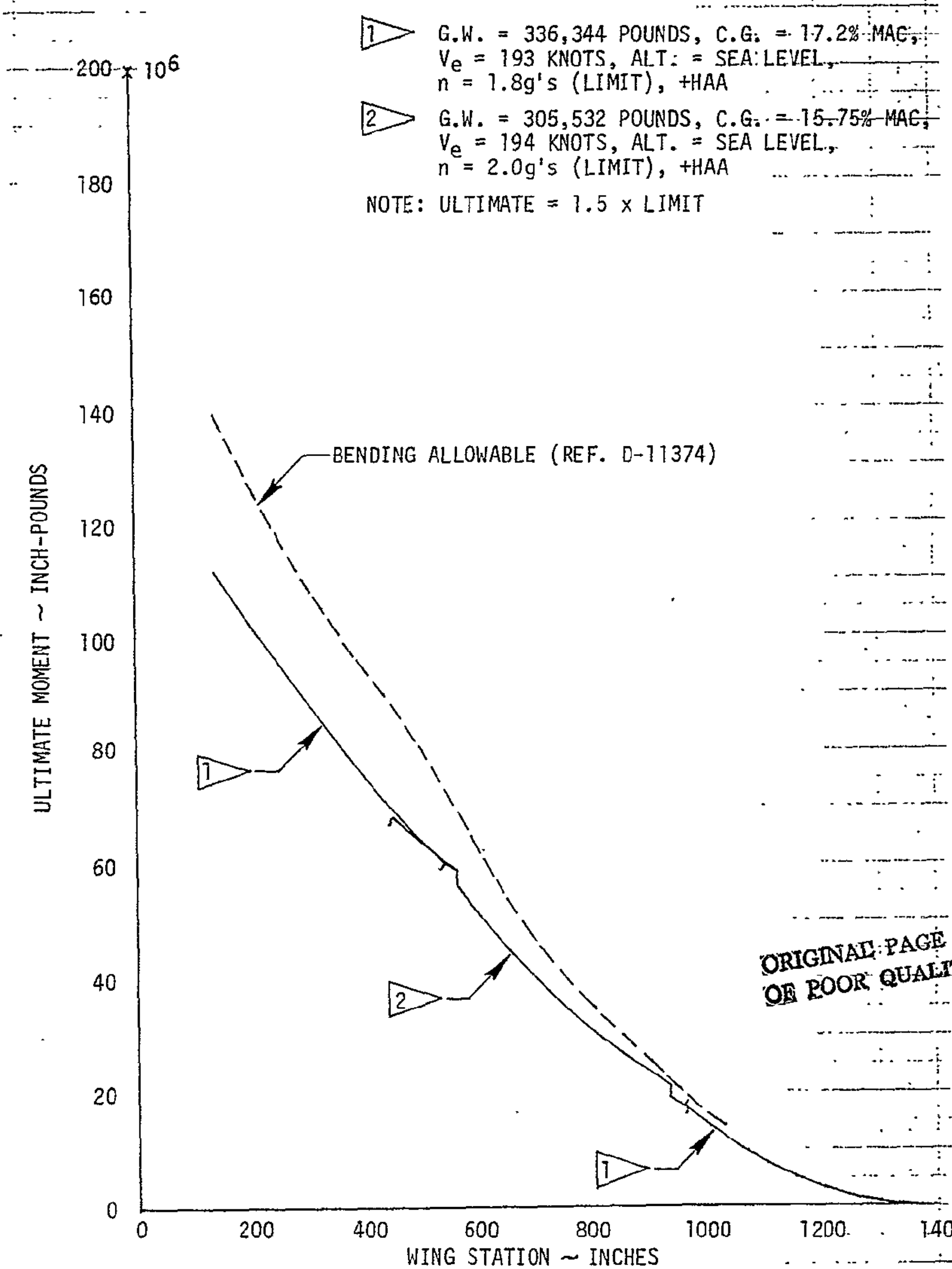

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WING ULTIMATE POSITIVE VERTICAL BENDING MOMENT - LEFT HAND WING
B-52B/DTV CONFIGURATION 1
(WITH FINS) FIGURE 12

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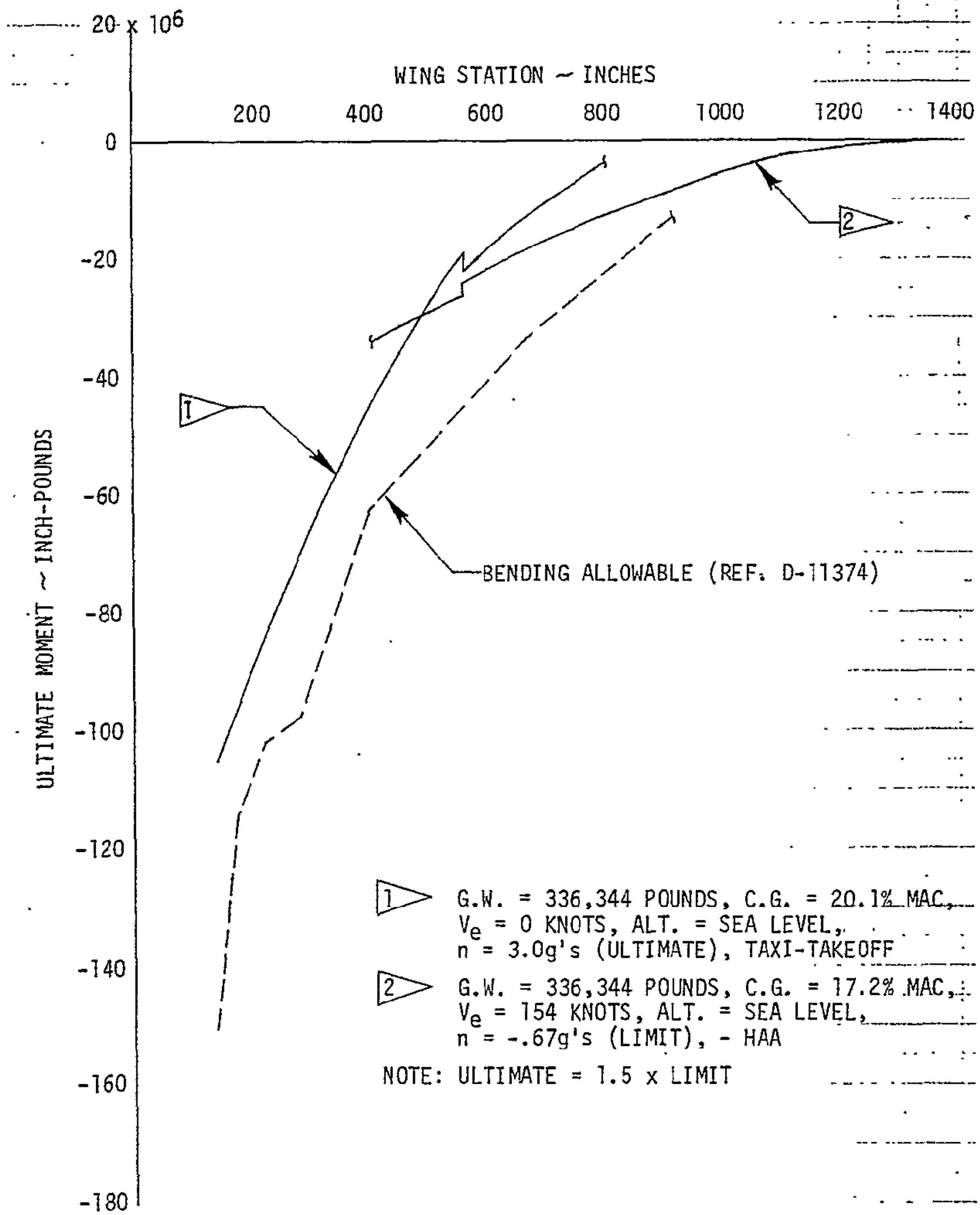

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WING ULTIMATE NEGATIVE VERTICAL BENDING MOMENT - LEFT HAND WING
B-52B/DTV CONFIGURATION 1
(WITH FINS) FIGURE 13

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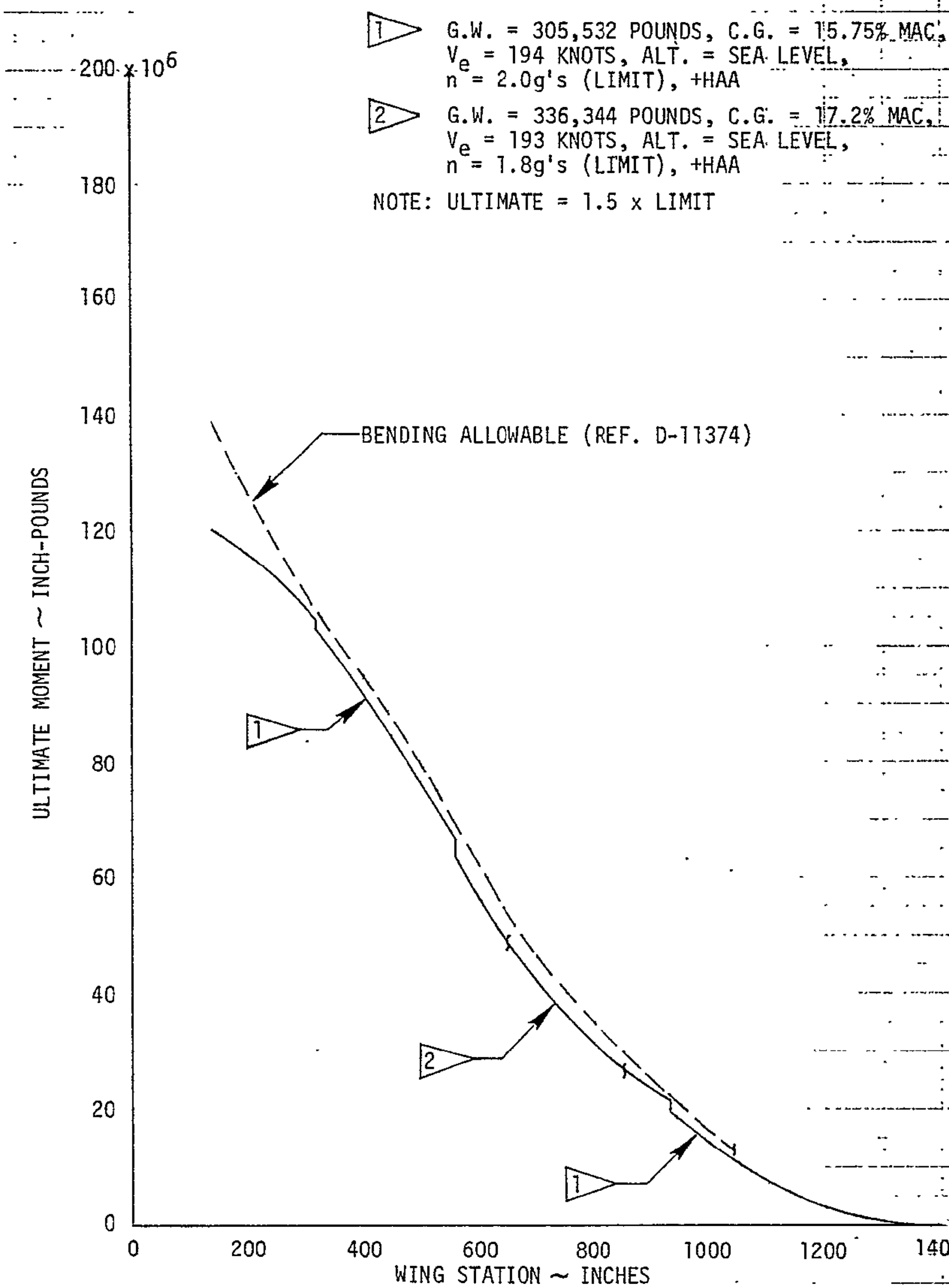

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WING ULTIMATE POSITIVE VERTICAL BENDING MOMENT - RIGHT HAND WING B-52B/DTV CONFIGURATION 1 (WITH FINS) FIGURE 14

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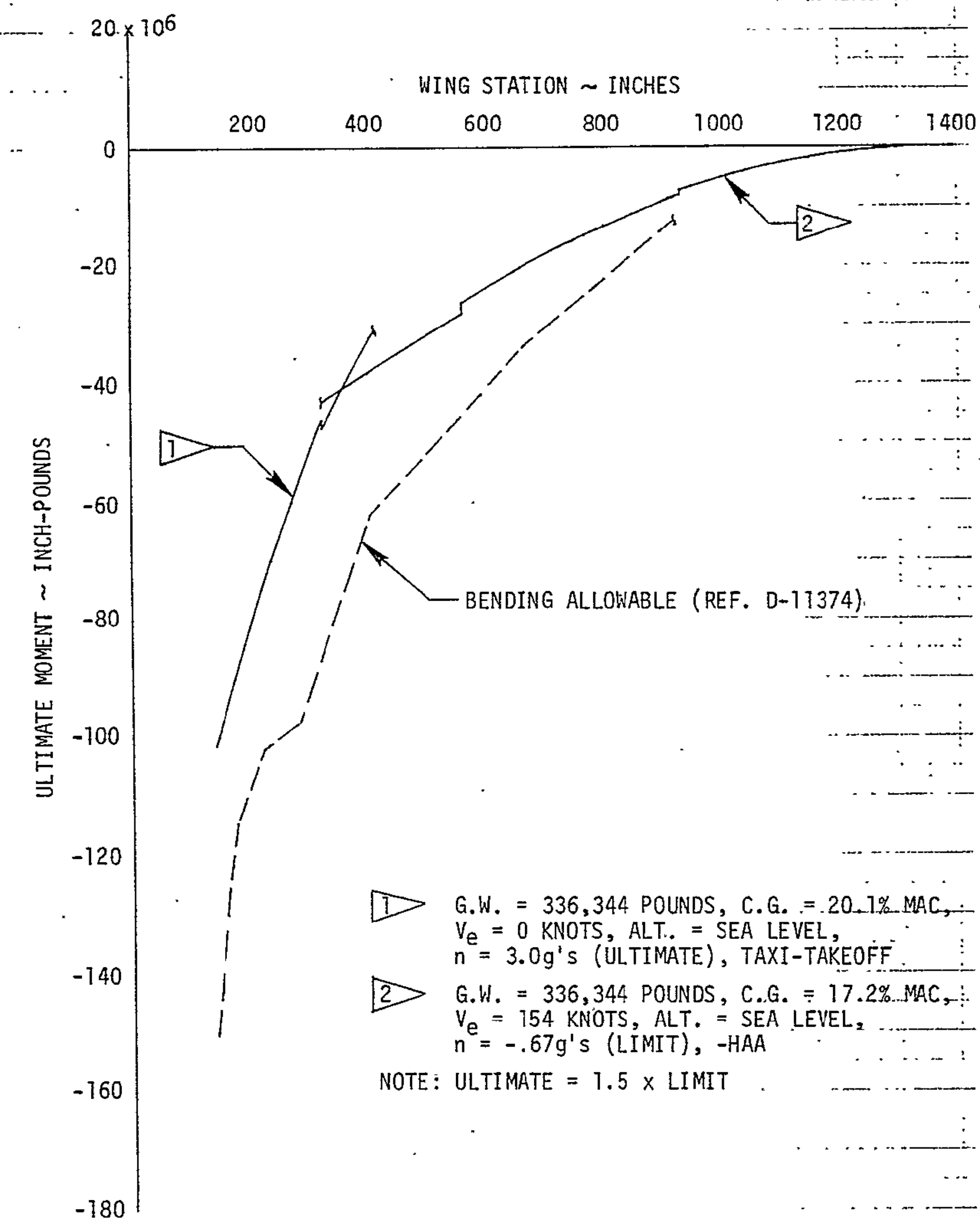

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WING ULTIMATE NEGATIVE VERTICAL BENDING MOMENT - RIGHT HAND WING B-52B/DTV CONFIGURATION 1 (WITH FINS) FIGURE 15

E-4176

TABLE II

ULTIMATE WING CENTER SECTION LOADS

(WING BUTTOCK LINE 55 - SIDE OF BODY)

CONDITION	V_{Z_L} * 10^{-3} (POUNDS)	M_{X_L} * 10^{-6} (INCH-LBS.)	T_L * 10^{-6} (INCH-LBS.)	V_{Z_R} * 10^{-3} (POUNDS)	M_{X_R} * 10^{-6} (INCH-LBS.)	T_R * 10^{-6} (INCH-LBS.)
B-52B/X-15A-2 (REFERENCE TFD 66-513 PAGE 3-7-2)						
TAXI-TAKEOFF [1]	-235.776	-100.794	48.534	-359.214	-100.518	51.243
B-52B/DTV CONFIGURATION 1 (WITH FINS)						
TAXI-TAKEOFF [2]	-262.712	-93.557	48.452	-335.835	-91.206	45.077
+HAA [3]	193.016	95.471	-55.434	118.229	100.065	-66.282
GUST [4]	187.589	69.450	-45.364	78.123	70.555	-50.226

[1] G.W. = 336,000 POUNDS, C.G. = 24.8% MAC, V_e = 0 KNOTS, ALT. = SEA LEVEL, POWER OFF, n = 3.0 g's (ULTIMATE)

[2] G.W. = 336,344 POUNDS, C.G. = 20.1% MAC, V_e = 0 KNOTS, ALT. = SEA LEVEL, POWER OFF, n = 3.0 g's (ULTIMATE)

[3] G.W. = 305,532 POUNDS, C.G. = 15.75% MAC, V_e = 194 KNOTS, ALT. = SEA LEVEL, POWER OFF, n = 2.0 g's (LIMIT)

[4] G.W. = 260,094 POUNDS, C.G. = 14% MAC, V_e = 247 KNOTS, ALT. = 33,900 FEET, POWER OFF, n = 2.03 g's (LIMIT)

TABLE III
ULTIMATE GEAR LOADS
(3.0g TAXI-TAKEOFF)

		B-52B (REF. D-10754)		B-52B/DTV CONFIGURATION 1 (WITH FINS)		
		POUNDS	POUNDS	POUNDS	POUNDS	POUNDS
AIRPLANE GROSS WEIGHT		405,000	405,000	336,344	336,344	336,344
CG IN PERCENT MAC		22	32	20.1	23	35
FRONT GEAR LOADS	F_L	299,600	271,700	232,818	226,597	201,738
	F_R	299,600	271,700	272,179	264,910	233,956
	D_L	0	0	0	0	0
	D_R	0	0	0	0	0
	S_L	0	0	0	0	0
	S_R	0	0	0	0	0
REAR GEAR LOADS	F_L	283,900	311,800	219,226	225,398	251,997
	F_R	283,900	311,800	256,289	263,507	292,241
	D_L	0	0	0	0	0
	D_R	0	0	0	0	0
	S_L	0	0	0	0	0
	S_R	0	0	0	0	0
TIP PROTECTION GEAR LOADS	F_L	39,800	40,400	16,100	16,150	16,280
	F_R	39,800	40,400	12,420	12,470	12,820
	D_L	0	0	0	0	0
	D_R	0	0	0	0	0
	S_L	0	0	0	0	0
	S_R	0	0	0	0	0

F - Vertical force
D - Drag Force
S - Side Force

Sub L - Left
Sub R - Right

TABLE IV
ULTIMATE GEAR LOADS
(GROUND TURN, n_z = 1.0g (LIMIT), n_y = .27g (LIMIT))

		B-52B (REF. D-10754)		B-52B/DTV CONFIGURATION 1 (WITH FINS)					
		(n_y = .40)	(n_y = .40)	GROUND TURN TO RIGHT			GROUND TURN TO LEFT		
		POUNDS	POUNDS	POUNDS	POUNDS	POUNDS	POUNDS	POUNDS	POUNDS
AIRPLANE GROSS WEIGHT		405,000	405,000	336,344	336,344	336,344	336,344	336,344	336,344
C.G. IN PERCENT MAC		22	32	20.1	23	35	20.1	23	35
FRONT GEAR LOADS	F_L	204,000	183,300	173,250	168,000	146,250	74,037	72,089	66,658
	F_R	97,100	89,700	79,593	78,092	85,656	178,800	174,000	151,500
	D_L	0	0	0	0	0	0	0	0
	D_R	0	0	0	0	0	0	0	0
	S_L	80,400	72,000	46,361	44,945	39,077	-19,812	-19,285	-17,811
	S_R	38,200	35,300	21,298	20,892	19,216	-47,847	-46,551	-40,482
REAR GEAR LOADS	F_L	179,200	200,200	158,250	162,750	183,750	71,090	73,165	78,980
	F_R	92,300	99,300	76,589	78,840	71,918	163,800	168,450	190,500
	D_L	0	0	0	0	0	0	0	0
	D_R	0	0	0	0	0	0	0	0
	S_L	82,100	90,700	46,200	47,415	53,150	-20,750	-21,314	-22,839
	S_R	42,300	45,000	22,361	22,968	24,777	-47,811	-49,070	-55,088
TIP PROTECTION GEAR LOADS	F_L	35,000	35,000	16,834	16,834	16,942	0	0	0
	F_R	0	0	0	0	0	16,789	16,812	16,878
	D_L	0	0	0	0	0	0	0	0
	D_R	0	0	0	0	0	0	0	0
	S_L	7,000*	7,000*	3,367*	3,367*	3,388*	0	0	0
	S_R	0	0	0	0	0	-3,358*	-3,362*	-3,376*

*S_{TPG} = .2 F_{TPG} (REF. D-10754)

F - Vertical Force
D - Drag Force
S - Side Force

Sub L - Left
Sub R - Right

6.0 PYLON LOADING

The ultimate pylon loading at the drop test vehicle (DTV)-pylon and pylon-wing interface attach points as obtained using Stiffness Methods 1 and 2 is given for DTV Configuration 1 (with fins). Pylon geometry used in these analyses is defined in Figure 16. The analysis design conditions defined in Table V were developed using the inertia load factor criteria defined in Reference 7, B-52B angle of attack data per Reference 8, B-52B lateral gust criteria (55 foot per second limit gust velocity) and DTV aerodynamics per George C. Marshall Space Flight Center (MSFC). These DTV aerodynamics were determined by MSFC after extensive evaluation of wind tunnel test results. An explanation of the condition numbering system is given in Figure 17.

6.1 Analysis Method Description

Mathematical equations for defining DTV-pylon and pylon-wing interface attachment loading are given in Section 2.0, Volumes III and IV of Reference 2. Aerodynamic loading equations for DTV Configuration 1 (with fins) are shown in Section 2, Volumes III and IV of this document. The analysis procedure closely parallels the method defined in Reference 9 except that relative stiffness of the drag pins and forward hook guide was assumed. In Stiffness Method 1, the side stiffness of the forward hook guide was assumed to be one-fourth the fore and aft stiffness of each drag pin. Therefore, the resultant stiffness of the drag pins is 8 times greater than the side stiffness of the front hook guide. The net effect of this assumption is that the drag pins react approximately 15 percent of the DTV yawing moment as a drag couple while the forward hook guide reacts the remaining 85 percent of the DTV yawing moment as a side force. In Stiffness Method 2, the side stiffness of the forward hook guide was assumed equal to the fore and aft stiffness of each drag pin. Therefore, the resultant stiffness of the drag pins is twice the side stiffness of the front hook guide. The net effect of this assumption is that the drag pins react approximately 4 percent of the DTV yawing moment as a drag couple while the forward hook guide reacts the remaining 96 percent of the DTV yawing moment as a side force.

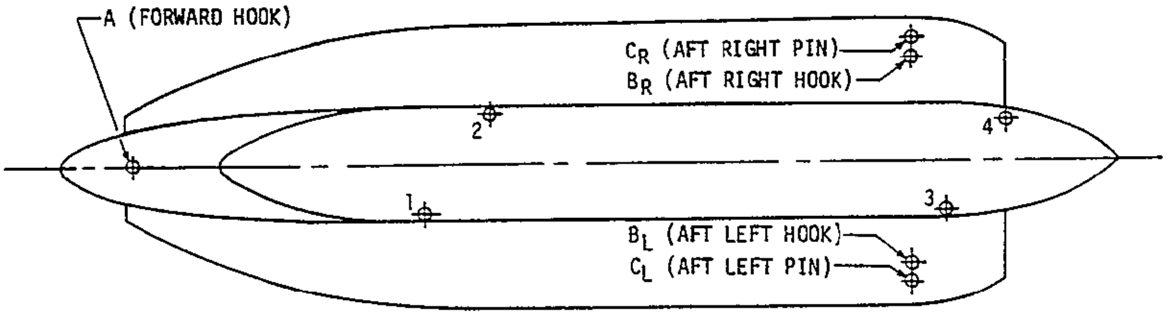
6.2 Loads Evaluation

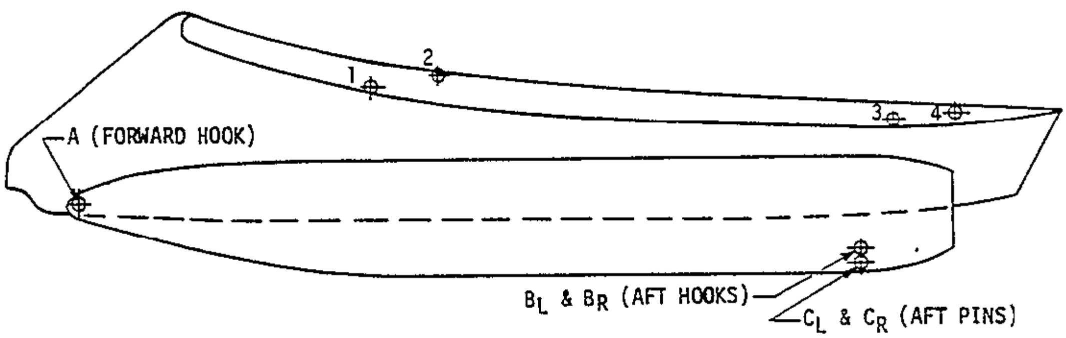
Critical pylon loadings for DTV Configuration 1 (with fins) obtained using Stiffness Methods 1 and 2 are given in Tables

VI and VII. Comparisons of DTV Configuration 1 (with fins) hook-pin loadings to those documented in References 7 and 9 for the X-15A-2 are given in Tables VIII through XVI. DTV-pylon and pylon-wing DTV Configuration 1 (with fins) ultimate loadings along with X-15A-2 ultimate loadings are given in Tables XVII and XVIII. For design condition loadings not presented in this section, see Volumes III and IV of this document.

The loading imposed by finned DTV Configuration 1 on the pylon is very similar to that given in References 7 and 9 for the X-15A-2. In most cases, the loadings are less than present evaluation allows; however, increases were noted in forward hook vertical load (V_A), aft pin vertical load (V_{CR}), aft pin drag load (D_{CR}) and vertical load at the B-52B front spar attachment (V_2). The small increase in vertical load at V_A results in a reduction of the hook margin of safety from +.01 to +.00. (See pages 2-1-1 and 2-1-2 of Reference 7 for the strength evaluation method). The increase in aft pin vertical load (V_{CR}) along with the corresponding drag force (D_{CR}) results in a shear margin of safety for the NAS 627 bolt (Reference Drawing 2581-630710, Pylon R.H. Drag Shaft Support) of +.033. Likewise, the increased aft pin drag load (D_{CR}) along with the corresponding vertical force (V_{CR}) results in a shear margin of safety for the NAS 627 bolt of +.027. The NAS 627 bolt is defined as bolt 1 in the sketch given on page 3-4-18 of Reference 7. The margin of safety of the critical bolt in the right hand forward pylon-wing attachment, due to the increased vertical loading at V_2, is reduced from +.09 to +.05. (See pages 5-10-11 and 5-10-12 of Reference 10 for the strength evaluation.)

Therefore, based on these load comparison and minimal strength evaluation analyses, it is concluded that the pylon strength is sufficient to withstand finned DTV Configuration 1 loading when operated within the speed and load factor constraints noted previously in this document.





PYLON LOCATION	PYLON STATION	PYLON BUTTOCK LINE	PYLON WATER LINE
A	20.000	0.000	-1.1875
B_L	231.000	-26.437	-15.1870
B_R	231.000	26.437	-15.1870
C_L	231.000	-31.312	-17.5000
C_R	231.000	31.312	-17.5000
1	98.500	-13.500	28.7930
2	115.625	13.500	29.5210
3	236.342	-13.093	18.9440
4	251.813	11.750	19.2910

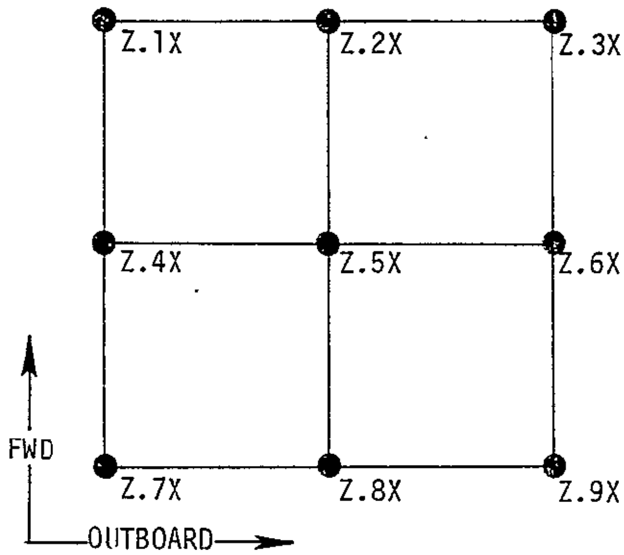
PYLON GEOMETRY
FIGURE 16

TABLE V

DESIGN CONDITIONS - PYLON LOADS

CONDITION NUMBER	n_x +FORWARD	n_y +LEFT	n_z +DOWN	VELOCITY (KEAS)	ALTITUDE (FEET)	FUS. (DEGREES)	BETA [1] (DEGREES)	BETA [1] (DEGREES)	BETA [1] (DEGREES)
1 OR 101	1.50	0	3.32	203.328	0	14.0	-9.18	0	9.18
2 OR 102	1.50	0	3.32	260.000	0	4.6	-7.18	0	7.18
3 OR 103	1.50	0	3.32	247.260	33900.	4.7	-7.55	0	7.55
4 OR 104	-1.50	0	3.32	203.328	0	14.0	-9.18	0	9.18
5 OR 105	-1.50	0	3.32	260.000	0	4.6	-7.18	0	7.18
6 OR 106	-1.50	0	3.32	247.260	33900.	4.7	-7.55	0	7.55
7 OR 107	0	.56	1.50	143.775	0	14.0	-12.98	0	12.98
8 OR 108	0	.56	1.50	260.000	0	-.5	-7.18	0	7.18
9 OR 109	0	.56	1.50	247.260	33900.	-.9	-7.55	0	7.55
10 OR 110	0	-.56	1.50	143.775	0	14.0	-12.98	0	12.98
11 OR 111	0	-.56	1.50	260.000	0	-.5	-7.18	0	7.18
12 OR 112	0	-.56	1.50	247.260	33900.	-.9	-7.55	0	7.55
13 OR 113	1.50	0	-1.53	154.085	0	-15.1	-12.11	0	12.11
14 OR 114	1.50	0	-1.53	260.000	0	-8.7	-7.18	0	7.18
15 OR 115	1.50	0	-1.53	247.260	33900.	-10.4	-7.55	0	7.55
16 OR 116	-1.50	0	-1.53	154.085	0	-15.1	-12.11	0	12.11
17 OR 117	-1.50	0	-1.53	260.000	0	-8.7	-7.18	0	7.18
18 OR 118	-1.50	0	-1.53	247.260	33900.	-10.4	-7.55	0	7.55
19 OR 119	.75	0	3.32	---	---	---	---	---	---
20 OR 120	-.75	0	3.32	---	---	---	---	---	---
21 OR 121	0	.42	3.32	---	---	---	---	---	---
22 OR 122	0	-.42	3.32	---	---	---	---	---	---

[1] $BETA = (55/(6080.20 / 3600))(57.3)/V_{KEAS} = (32.565/V_{KEAS}) * 57.3$



PLAN VIEW

CONDITION NO.	PYLON STATION	PYLON B.L.	PYLON W.L.
Z.1X	167.56	-0.65	-27.35
Z.2X	167.56	0.00	-27.35
Z.3X	167.56	0.65	-27.35
Z.4X	170.21	-0.65	-27.35
Z.5X	170.21	0.00	-27.35
Z.6X	170.21	0.65	-27.35
Z.7X	172.86	-0.65	-27.35
Z.8X	172.86	0.00	-27.35
Z.9X	172.86	0.65	-27.35

If Z = 1 thru 22, Approximately 85% of Yawing Moment taken by S_A and 15% taken by D_{CL} and D_{CR} as drag couple - Method 1

If Z = 101 thru 122, Approximately 96% of Yawing Moment taken by S_A and 4% taken by D_{CL} and D_{CR} as drag couple - Method 2

If X = 0, Beta = 0 Degrees - Taxi Condition

If X = 1, Beta angle is negative

If X = 2, Beta = 0 Degrees

If X = 3, Beta angle is positive

FIGURE 17
CONDITION NUMBER DEFINITION

TABLE VI

PYLON LOADS SUMMARY (ULTIMATE)
METHOD 1   CONFIGURATION 1 (WITH FINS)

PYLON HOOK LOADS - ULTIMATE

PLUS LOADS - UP, AFT, LEFT (REVERSE SIGN FOR LOADS ON DTV)

CONFIGURATION 1.0 WITH FINS

COND. NO.	VA POUNDS	VBL POUNDS	VBR POUNDS	VCL POUNDS	VCR POUNDS	DCL POUNDS	DCR POUNDS	SA POUNDS	SCL POUNDS
4.33	-57122.6	-47556.0	-52180.0	0.0	0.0	39190.0	41703.4	-2117.1	8121.4
5.11	-55345.6	-54210.4	-49271.6	0.0	0.0	44192.5	41396.6	2355.1	-9795.4
5.33	-55345.6	-49332.0	-54150.0	0.0	0.0	41197.6	44391.5	-2690.4	10398.4
5.93	-51259.4	-51375.1	-56193.2	0.0	0.0	41197.6	44391.5	-2690.4	10398.4
8.93	-20644.0	-17571.7	-34506.2	0.0	0.0	8377.7	3711.4	3930.6	31217.5
11.13	-22490.3	-32826.8	-17404.9	0.0	0.0	398.2	11691.0	-9512.3	-10219.7
16.73	19714.2	0.0	0.0	27287.7	25150.3	38132.9	39613.0	-1246.7	5780.5
16.91	19714.2	0.0	0.0	25132.3	27305.7	39543.1	38202.8	1129.0	-5568.7
17.71	21033.1	0.0	0.0	25267.6	24504.2	44192.5	41396.6	2355.1	-9795.4
17.93	21033.1	0.0	0.0	24453.2	25318.7	41197.6	44391.5	-2690.4	10398.4
21.90	-44825.6	-51605.9	-66248.4	0.0	0.0	2861.9	-2861.9	4821.3	15758.7
22.70	-44825.6	-66248.3	-51605.9	0.0	0.0	-2861.9	2861.9	-4821.3	-15758.7

TABLE VI (CONTINUED)

PYLON LOADS SUMMARY (ULTIMATE)
METHOD 1   CONFIGURATION 1 (WITH FINS)

PYLON LOADS - ULTIMATE

PLUS LOADS - UP, AFT, LEFT (REVERSE SIGN FOR LOADS ON B-52B)

CONFIGURATION 1.0 WITH FINS

COND. NO.	CASE 1 V1 POUNDS	CASE 1 V2 POUNDS	CASE 1 V3 POUNDS	CASE 1 V4 POUNDS	CASE 2 V1 POUNDS	CASE 2 V2 POUNDS	CASE 2 V3 POUNDS	CASE 2 V4 POUNDS
4.33	60099.7	68780.3	6108.3	25754.6	61353.8	67523.4	4745.1	27120.6
5.11	67417.7	56758.9	28938.9	9596.5	65941.6	58238.3	30543.3	7988.7
5.33	58725.1	69180.6	5733.9	29072.3	60242.5	67659.8	4084.5	30725.2
5.93	55588.3	66043.9	8701.1	32378.7	57105.7	64523.0	7051.7	34031.6
8.93	791.5	50582.2	-33758.6	56861.9	6504.3	44856.5	-39968.3	63084.5
11.13	37338.5	3376.1	44797.3	-11034.8	34008.6	6713.5	48416.9	-14661.9
16.73	-11365.9	-5373.8	-33099.0	-24103.7	-10514.9	-6226.7	-34024.1	-23176.7
16.91	-6315.7	-12557.2	-19911.0	-35158.5	-7152.1	-11718.8	-19001.8	-36069.6
17.71	-5958.6	-12803.3	-18893.9	-34939.2	-6958.5	-11801.3	-17807.1	-36028.3
17.93	-11541.4	-4900.0	-33142.1	-23011.7	-10500.2	-5943.6	-34273.9	-21877.6
21.90	29896.0	62881.6	5535.4	68251.4	33502.5	59266.9	1615.1	72179.8
22.70	57520.9	24535.4	69333.3	15174.7	53914.4	28150.1	73253.5	11246.3

TABLE VI (CONTINUED)

PYLON LOADS SUMMARY (ULTIMATE)
METHOD 1 CONFIGURATION 1 (WITH FINS)

PYLON LOADS - ULTIMATE

PLUS LOADS - UP, AFT, LEFT (REVERSE SIGN FOR LOADS ON B-52B)

CONFIGURATION 1.0 WITH FINS

COND. NO.	S1 POUNDS	S2 POUNDS	CASE 1 AND 2 S3 POUNDS	S4 POUNDS	D3 POUNDS	D4 POUNDS
4.33	1833.3	1833.3	-4835.5	-4835.5	-41324.2	-41324.2
5.11	-1563.8	-1563.8	5283.9	5283.9	-43672.1	-43672.1
5.33	2282.7	2282.7	-6136.7	-6136.7	-43672.1	-43672.1
5.93	2282.7	2282.7	-6136.7	-6136.7	-43672.1	-43672.1
8.93	-5428.2	-5428.2	-12473.4	-12473.4	-6044.6	-6044.6
11.13	9806.8	9806.8	386.8	386.8	-6044.6	-6044.6
16.73	1107.5	1107.5	-3374.4	-3374.4	-39750.4	-39750.4
16.91	-615.8	-615.8	2835.6	2835.6	-39750.4	-39750.4
17.71	-1563.8	-1563.8	5283.9	5283.9	-43672.1	-43672.1
17.93	2282.7	2282.7	-6136.7	-6136.7	-43672.1	-43672.1
21.90	-5514.1	-5514.1	-5021.6	-5021.6	0.0	0.0
22.70	5514.1	5514.1	5021.6	5021.6	0.0	0.0

BOEING WICHITA COMPANY

TABLE VI (CONTINUED)

PYLON LOADS SUMMARY (ULTIMATE)
METHOD 1 CONFIGURATION 1 (WITH FINS)

INERTIA AND AIRLOADS - ULTIMATE

INERTIA LOADS - PLUS FWD, LEFT AND DOWN
AIRLOAD FORCES - PLUS AFT, RIGHT AND UP
AIRLOAD MOMENTS - PLUS NOSE UP AND NOSE RIGHT

CONFIGURATION 1.0 WITH FINS

COND. NO.	PNX FWD. POUNDS	PNY LEFT POUNDS	PNZ DOWN POUNDS	PX AFT POUNDS	PY RIGHT POUNDS	PZ UP POUNDS	MY NOSE UP INCH-LBS.	MZ NOSE RIGHT INCH-LBS.
4.33	-73500.0	0.0	162679.9	7393.4	-6004.3	5821.3	-1.299506E 06	8.426320E 05
5.11	-73500.0	0.0	162679.9	12089.2	7440.3	3852.2	-7.649614E 05	-9.889950E 05
5.33	-73500.0	0.0	162679.9	12089.2	-7708.0	3852.2	-7.649614E 05	1.088472E 06
5.93	-73500.0	0.0	162679.9	12089.2	-7708.0	3852.2	-7.649614E 05	1.088472E 06
8.93	0.0	27440.0	73500.0	12089.2	-7708.0	778.0	-2.714220E 04	1.088472E 06
11.13	0.0	-27440.0	73500.0	12089.2	-7708.0	778.0	-2.714220E 04	1.088472E 06
16.73	-73500.0	0.0	-74969.9	4245.9	-4533.7	-2817.7	7.323012E 05	6.327848E 05
16.91	-73500.0	0.0	-74969.9	4245.9	4439.7	-2817.7	7.323012E 05	-5.978466E 05
17.71	-73500.0	0.0	-74969.9	12089.2	7440.3	-4164.9	1.159155E 06	-9.889950E 05
17.93	-73500.0	0.0	-74969.9	12089.2	-7708.0	-4164.9	1.159155E 06	1.088472E 06
21.90	0.0	20580.0	162679.9	0.0	0.0	0.0	0.000000E-01	0.000000E-01
22.70	0.0	-20580.0	162679.9	0.0	0.0	0.0	0.000000E-01	0.000000E-01

BOEING WICHITA COMPANY

TABLE VI (CONTINUED)

PYLON LOADS SUMMARY (ULTIMATE)
METHOD 1   CONFIGURATION 1 (WITH FINS)

PYLON HOOK LOADS - AERODYNAMIC CONSIDERATIONS

CONFIGURATION 1.0 WITH FINS

COND. NO.	RHO SLUGS/FT**3	VELOCITY KEAS	XCP INCHES	YCP INCHES	ZCP INCHES	ALPHA DEGREES	BETA DEGREES
4.33	0.0023769	203.328	170.210	0.000	-26.000	14.000	9.180
5.11	0.0023769	260.000	170.210	0.000	-26.000	4.600	-7.180
5.33	0.0023769	260.000	170.210	0.000	-26.000	4.600	7.180
5.93	0.0023769	260.000	170.210	0.000	-26.000	4.600	7.180
8.93	0.0023769	260.000	170.210	0.000	-26.000	-0.500	7.180
11.13	0.0023769	260.000	170.210	0.000	-26.000	-0.500	7.180
16.73	0.0023769	154.085	170.210	0.000	-26.000	-15.100	12.110
16.91	0.0023769	154.085	170.210	0.000	-26.000	-15.100	-12.110
17.71	0.0023769	260.000	170.210	0.000	-26.000	-8.700	-7.180
17.93	0.0023769	260.000	170.210	0.000	-26.000	-8.700	7.180
21.90	0.0023769	0.000	170.210	0.000	-26.000	0.000	0.000
22.70	0.0023769	0.000	170.210	0.000	-26.000	0.000	0.000

TABLE VI (CONTINUED)

PYLON LOADS SUMMARY (ULTIMATE)
METHOD 1   CONFIGURATION 1 (WITH FINS)

PYLON HOOK LOADS - INERTIA CONSIDERATIONS

CONFIGURATION 1.0 WITH FINS

COND. NO.	DTV WT. POUNDS	ULTIMATE LOAD FACTOR NX	NY	NZ	XCG INCHES	YCG INCHES	ZCG INCHES
4.33	49000.0	-1.50	0.00	3.32	167.560	0.650	-27.350
5.11	49000.0	-1.50	0.00	3.32	167.560	-0.650	-27.350
5.33	49000.0	-1.50	0.00	3.32	167.560	0.650	-27.350
5.93	49000.0	-1.50	0.00	3.32	172.860	0.650	-27.350
8.93	49000.0	0.00	0.56	1.50	172.860	0.650	-27.350
11.13	49000.0	0.00	-0.56	1.50	167.560	-0.650	-27.350
16.73	49000.0	-1.50	0.00	-1.53	172.860	-0.650	-27.350
16.91	49000.0	-1.50	0.00	-1.53	172.860	0.650	-27.350
17.71	49000.0	-1.50	0.00	-1.53	172.860	-0.650	-27.350
17.93	49000.0	-1.50	0.00	-1.53	172.860	0.650	-27.350
21.90	49000.0	0.00	0.42	3.32	172.860	0.650	-27.350
22.70	49000.0	0.00	-0.42	3.32	172.860	-0.650	-27.350

TABLE VII

PYLON LOADS SUMMARY (ULTIMATE)
METHOD 2. CONFIGURATION 1 (WITH FINS)

PYLON HOOK LOADS - ULTIMATE

PLUS LOADS - UP, AFT, LEFT (REVERSE SIGN FOR LOADS ON DTV)

CONFIGURATION 1.0 WITH FINS

COND. NO.	VA POUNDS	VBL POUNDS	VBR POUNDS	VCL POUNDS	VCR POUNDS	DCL POUNDS	DCR POUNDS	SA POUNDS	SCL POUNDS
104.33	-57122.6	-47638.7	-52097.3	0.0	0.0	40092.8	40800.6	-2385.0	8389.3
105.11	-55345.6	-54118.4	-49363.6	0.0	0.0	43188.3	42400.8	2653.2	-10093.5
105.33	-55345.6	-49437.0	-54045.0	0.0	0.0	42344.8	43244.3	-3030.8	10738.9
105.93	-51259.4	-51480.1	-56088.2	0.0	0.0	42344.8	43244.3	-3030.8	10738.9
108.93	-20644.0	-17418.3	-34659.7	0.0	0.0	6701.7	5387.5	4428.0	30720.0
111.13	-22490.3	-33198.2	-17033.5	0.0	0.0	4454.3	7634.8	-10716.1	-9015.8
116.73	19714.2	0.0	0.0	27246.6	25191.4	38664.5	39081.4	-1404.5	5938.2
116.91	19714.2	0.0	0.0	25169.5	27268.5	39061.7	38684.2	1271.9	-5711.6
117.71	21033.1	0.0	0.0	25345.3	24426.6	43188.3	42400.8	2653.2	-10093.5
117.93	21033.1	0.0	0.0	24364.5	25407.4	42344.8	43244.3	-3030.8	10738.9
121.90	-44825.6	-51417.6	-66436.6	0.0	0.0	806.0	-806.0	5431.5	15148.5
122.70	-44825.6	-66436.6	-51417.7	0.0	0.0	-806.0	806.0	-5431.5	-15148.5

TABLE VII (CONTINUED)

PYLON LOADS SUMMARY (ULTIMATE)
METHOD 2   CONFIGURATION 1 (WITH FINS)

PYLON LOADS - ULTIMATE

PLUS LOADS - UP, AFT, LEFT (REVERSE SIGN FOR LOADS ON B-52B)

CONFIGURATION 1.0 WITH FINS

COND. NO.	CASE 1 V1 POUNDS	CASE 1 V2 POUNDS	CASE 1 V3 POUNDS	CASE 1 V4 POUNDS	CASE 2 V1 POUNDS	CASE 2 V2 POUNDS	CASE 2 V3 POUNDS	CASE 2 V4 POUNDS
104.33	60099.7	68780.3	6108.3	25754.7	61353.8	67523.3	4745.1	27120.7
105.11	67417.7	56758.9	28938.9	9596.5	65941.7	58238.3	30543.3	7988.7
105.33	58725.1	69180.6	5733.9	29072.3	60242.5	67659.8	4084.5	30725.2
105.93	55588.3	66043.9	8701.1	32378.7	57105.7	64523.0	7051.7	34031.6
108.93	791.5	50582.2	-33758.6	56861.9	6504.3	44856.5	-39968.3	63084.5
111.13	37338.5	3376.1	44797.3	-11034.8	34008.6	6713.5	48416.9	-14661.9
116.73	-11365.9	-5373.8	-33099.1	-24103.6	-10514.9	-6226.7	-34024.1	-23176.7
116.91	-6315.7	-12557.2	-19911.0	-35158.4	-7152.1	-11718.8	-19001.8	-36069.6
117.71	-5958.6	-12803.3	-18893.9	-34939.2	-6958.5	-11801.3	-17807.1	-36028.3
117.93	-11541.4	-4900.0	-33142.1	-23011.7	-10500.2	-5943.6	-34273.9	-21877.6
121.90	29896.0	62881.6	5535.4	68251.4	33502.5	59266.9	1615.1	72179.8
122.70	57520.9	24535.4	69333.3	15174.7	53914.4	28150.1	73253.5	11246.3

TABLE VII (CONTINUED)

PYLON LOADS SUMMARY (ULTIMATE)
METHOD 2   CONFIGURATION 1 (WITH FINS)

PYLON LOADS - ULTIMATE

PLUS LOADS - UP, AFT, LEFT (REVERSE SIGN FOR LOADS ON B-52B)

CONFIGURATION 1.0 WITH FINS

COND. NO.			CASE 1 AND 2			
	S1 POUNDS	S2 POUNDS	S3 POUNDS	S4 POUNDS	D3 POUNDS	D4 POUNDS
104.33	1833.3	1833.3	-4835.5	-4835.5	-41324.2	-41324.2
105.11	-1563.8	-1563.8	5283.9	5283.9	-43672.1	-43672.1
105.33	2282.7	2282.7	-6136.7	-6136.7	-43672.1	-43672.1
105.93	2282.7	2282.7	-6136.7	-6136.7	-43672.1	-43672.1
108.93	-5428.2	-5428.2	-12473.4	-12473.4	-6044.6	-6044.6
111.13	9806.8	9806.8	386.8	386.8	-6044.6	-6044.6
116.73	1107.5	1107.5	-3374.4	-3374.4	-39750.4	-39750.4
116.91	-615.8	-615.8	2835.6	2835.6	-39750.4	-39750.4
117.71	-1563.8	-1563.8	5283.9	5283.9	-43672.1	-43672.1
117.93	2282.7	2282.7	-6136.7	-6136.7	-43672.1	-43672.1
121.90	-5514.1	-5514.1	-5021.6	-5021.6	0.0	0.0
122.70	5514.1	5514.1	5021.6	5021.6	0.0	0.0

TABLE VII (CONTINUED)

PYLON LOADS SUMMARY (ULTIMATE)
METHOD 2 CONFIGURATION 1 (WITH FINS)

INERTIA AND AIRLOADS - ULTIMATE

INERTIA LOADS - PLUS FWD, LEFT AND DOWN
AIRLOAD FORCES - PLUS AFT, RIGHT AND UP
AIRLOAD MOMENTS - PLUS NOSE UP AND NOSE RIGHT

CONFIGURATION 1.0 WITH FINS

COND. NO.	PNX FWD. POUNDS	PNY LEFT POUNDS	PNZ DOWN POUNDS	PX AFT POUNDS	PY RIGHT POUNDS	PZ UP POUNDS	MY NOSE UP INCH-LBS.	MZ NOSE RIGHT INCH-LBS.
104.33	-73500.0	0.0	162679.9	7393.4	-6004.3	5821.3	-1.299506E 06	8.426320E 05
105.11	-73500.0	0.0	162679.9	12089.2	7440.3	3852.2	-7.649614E 05	-9.889950E 05
105.33	-73500.0	0.0	162679.9	12089.2	-7708.0	3852.2	-7.649614E 05	1.088472E 06
105.93	-73500.0	0.0	162679.9	12089.2	-7708.0	3852.2	-7.649614E 05	1.088472E 06
108.93	0.0	27440.0	73500.0	12089.2	-7708.0	778.0	-2.714220E 04	1.088472E 06
111.13	0.0	-27440.0	73500.0	12089.2	-7708.0	778.0	-2.714220E 04	1.088472E 06
116.73	-73500.0	0.0	-74969.9	4245.9	-4533.7	-2817.7	7.323012E 05	6.327848E 05
116.91	-73500.0	0.0	-74969.9	4245.9	4439.7	-2817.7	7.323012E 05	-5.978466E 05
117.71	-73500.0	0.0	-74969.9	12089.2	7440.3	-4164.9	1.159155E 06	-9.889950E 05
117.93	-73500.0	0.0	-74969.9	12089.2	-7708.0	-4164.9	1.159155E 06	1.088472E 06
121.90	0.0	20580.0	162679.9	0.0	0.0	0.0	0.000000E-01	0.000000E-01
122.70	0.0	-20580.0	162679.9	0.0	0.0	0.0	0.000000E-01	0.000000E-01

TABLE VII (CONTINUED)

PYLON LOADS SUMMARY (ULTIMATE)
METHOD 2   CONFIGURATION 1 (WITH FINS)

PYLON HOOK LOADS - AERODYNAMIC CONSIDERATIONS

CONFIGURATION 1.0 WITH FINS

COND. NO.	RHO SLUGS/FT**3	VELOCITY KEAS	XCP INCHES	YCP INCHES	ZCP INCHES	ALPHA DEGREES	BETA DEGREES
104.33	0.0023769	203.328	170.210	0.000	-26.000	14.000	9.180
105.11	0.0023769	260.000	170.210	0.000	-26.000	4.600	-7.180
105.33	0.0023769	260.000	170.210	0.000	-26.000	4.600	7.180
105.93	0.0023769	260.000	170.210	0.000	-26.000	4.600	7.180
108.93	0.0023769	260.000	170.210	0.000	-26.000	-0.500	7.180
111.13	0.0023769	260.000	170.210	0.000	-26.000	-0.500	7.180
116.73	0.0023769	154.085	170.210	0.000	-26.000	-15.100	12.110
116.91	0.0023769	154.085	170.210	0.000	-26.000	-15.100	-12.110
117.71	0.0023769	260.000	170.210	0.000	-26.000	-8.700	-7.180
117.93	0.0023769	260.000	170.210	0.000	-26.000	-8.700	7.180
121.90	0.0023769	0.000	170.210	0.000	-26.000	0.000	0.000
122.70	0.0023769	0.000	170.210	0.000	-26.000	0.000	0.000

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TABLE VII (CONTINUED)

PYLON LOADS SUMMARY (ULTIMATE)
METHOD 2   CONFIGURATION 1 (WITH FINS)

PYLON HOOK LOADS - INERTIA CONSIDERATIONS

CONFIGURATION 1.0 WITH FINS

COND. NO.	DTV WT. POUNDS	ULTIMATE LOAD FACTOR NX	NY	NZ	XCG INCHES	YCG INCHES	ZCG INCHES
104.33	49000.0	-1.50	0.00	3.32	167.560	0.650	-27.350
105.11	49000.0	-1.50	0.00	3.32	167.560	-0.650	-27.350
105.33	49000.0	-1.50	0.00	3.32	167.560	0.650	-27.350
105.93	49000.0	-1.50	0.00	3.32	172.860	0.650	-27.350
108.93	49000.0	0.00	0.56	1.50	172.860	0.650	-27.350
111.13	49000.0	0.00	-0.56	1.50	167.560	-0.650	-27.350
116.73	49000.0	-1.50	0.00	-1.53	172.860	-0.650	-27.350
116.91	49000.0	-1.50	0.00	-1.53	172.860	0.650	-27.350
117.71	49000.0	-1.50	0.00	-1.53	172.860	-0.650	-27.350
117.93	49000.0	-1.50	0.00	-1.53	172.860	0.650	-27.350
121.90	49000.0	0.00	0.42	3.32	172.860	0.650	-27.350
122.70	49000.0	0.00	-0.42	3.32	172.860	-0.650	-27.350

TABLE VIII

CONFIGURATION 1 - HOOK LOAD EVALUATION, V_A

▷ CONDITION	V_A POUNDS	S_A POUNDS	V_{BL} POUNDS	V_{BR} POUNDS	V_{CL} POUNDS	V_{CR} POUNDS	D_{CL} POUNDS	D_{CR} POUNDS	S_{CL} POUNDS
66A-2	-56624	-878	-64815	-56929	- -	- -	46702	43705	-11811
66B-2	-38621	688	-27626	-31384	- -	- -	28531	28531	-6506
63 -2	-53540	-766	-46179	-56067	- -	- -	41982	38225	-11924
METHOD 1	-57123	-2117	-47556	-52180	- -	- -	39190	41703	8121
METHOD 2	-57123	-2385	-47639	-52097	- -	- -	40093	40801	8389

▷ 66A DENOTES DATA FROM TFD 66-431, PAGE 1-2-1, X-15 WT. = 57250 POUNDS

66B DENOTES DATA FROM TFD 66-431, PAGE 4-1-3, X-15 WT. = 36445 POUNDS

63 DENOTES DATA FROM TFD 63-876, PAGES 1-3-1 AND 1-3-2, X-15 WT. = 50449 POUNDS

METHODS 1 AND 2, DTV CONFIGURATION 1 WT. = 49000 POUNDS

TABLE IX

CONFIGURATION 1 - HOOK LOAD EVALUATION, S_A

CONDITION	V_A	S_A	V_{BL}	V_{BR}	V_{CL}	V_{CR}	D_{CL}	D_{CR}	S_{CL}
	POUNDS	POUNDS	POUNDS	POUNDS	POUNDS	POUNDS	POUNDS	POUNDS	POUNDS
66A-4	-30415	-8458	-38513	-11795	- -	- -	4145	4145	-32754
66B-4	-35952	13002	-17746	-43934	- -	- -	1196	1196	19447
63 -3	-29409	-10743	-33105	-8005	- -	- -	4145	4145	-36751
METHOD 1	-22490	-9512	-32827	-17405	- -	- -	398	11691	-10220
METHOD 2	-22409	-10716	-33198	-17034	- -	- -	4454	7635	-9016

66A DENOTES DATA FROM TFD 66-431, PAGE 1-2-1, X-15 WT. = 57250 POUNDS

66B DENOTES DATA FROM TFD 66-431, PAGE 4-3-1, X-15 WT. = 36445 POUNDS

63 DENOTES DATA FROM TFD 63-876, PAGE 1-3-1 AND 1-3-2, X-15 WT. = 50449 POUNDS

METHODS 1 AND 2, DTV CONFIGURATION 1 WT. = 49000 POUNDS

TABLE X

CONFIGURATION 1 - HOOK LOAD EVALUATION, V_{BL}

▷ CONDITION	V_A	S_A	V_{BL}	V_{BR}	V_{CL}	V_{CR}	D_{CL}	D_{CR}	S_{CL}
	POUNDS	POUNDS	POUNDS	POUNDS	POUNDS	POUNDS	POUNDS	POUNDS	POUNDS
66A-18	-46374	-5866	-86456	-57240	- -	- -	- -	- -	-18178
66B-9	5088	1137	-41696	-45962	- -	- -	2250	2250	-6687
63 -17	-44151	-5585	-66379	-56961	- -	- -	- -	- -	-15603
METHOD 1	-44826	-4821	-66248	-51606	- -	- -	-2862	2862	-15759
METHOD 2	-44826	-5432	-66437	-51418	- -	- -	-806	806	-15149

▷ 66A DENOTES DATA FROM TFD 66-431, PAGE 1-2-1, X-15 WT. = 57250 POUNDS

66B DENOTES DATA FROM TFD 66-431, PAGE 4-3-1, X-15 WT. = 36445 POUNDS

63 DENOTES DATA FROM TFD 63-876, PAGE 1-3-1 AND 1-3-2, X-15 WT. = 50449 POUNDS

METHODS 1 AND 2, DTV CONFIGURATION 2 WT = 49000 POUNDS

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TABLE XI
CONFIGURATION 1 - HOOK LOAD EVALUATION, V_{BR}

▷ CONDITION	V_A	S_A	V_{BL}	V_{BR}	V_{CL}	V_{CR}	D_{CL}	D_{CR}	S_{CL}
	POUNDS	POUNDS	POUNDS	POUNDS	POUNDS	POUNDS	POUNDS	POUNDS	POUNDS
66A-17	-46374	5866	-65097	-78599	- -	- -	- -	- -	18178
66B-9	5088	1137	-41696	-45962	- -	- -	2250	2250	-6687
63-18	-44151	5585	-47114	-76226	- -	- -	- -	- -	15603
METHOD 1	-44826	4821	-51606	-66248	- -	- -	2862	-2862	15759
METHOD 2	-44826	5432	-51418	-66437	- -	- -	806	-806	15149

▷ 66A DENOTES DATA FROM TFD66-431, PAGE 1-2-1, X-15 WT. = 57250 POUNDS

66B DENOTES DATA FROM TFD 66-631, PAGE 4-3-1, X-15 WT. = 36445 POUNDS

63 DENOTES DATA FROM TFD 63-876, PAGE 1-3-1 AND 1-3-2, X-15 WT. = 50449 POUNDS

METHODS 1 AND 2, DTV CONFIGURATION 2 WT. = 49000 POUNDS

TABLE XII

CONFIGURATION 1 - HOOK LOAD EVALUATION, V_{CL}

CONDITION	V_A POUNDS	S_A POUNDS	V_{BL} POUNDS	V_{BR} POUNDS	V_{CL} POUNDS	V_{CR} POUNDS	D_{CL} POUNDS	D_{CR} POUNDS	S_{CL} POUNDS
66A-6	8896	465	- -	- -	45701	25823	46327	43330	2793
66B-6	5165	1451	- -	- -	20561	3547	19020	19020	463
63 -6	8732	578	- -	- -	38369	22915	41606	37849	2680
METHOD 1	19714	-1247	- -	- -	27288	25150	38133	39613	5781
METHOD 2	19714	-1405	- -	- -	27247	25191	38665	39081	5938

66A DENOTES DATA FROM TFD 66-431, Page 1-2-1, X-15 WT. = 57250 POUNDS

66B DENOTES DATA FROM TFD 66-431, PAGE 4-3-1, X-15 WT. = 36445 POUNDS

63 DENOTES DATA FROM TFD 63-876, PAGE 1-3-1 AND 1-3-2, X-15 WT. = 50449 POUNDS

METHODS 1 AND 2, DTV CONFIGURATION 2 WT. = 49000 POUNDS

TABLE XIII
CONFIGURATION 1 - HOOK LOAD EVALUATION, V_{CR}

▷ CONDITION	V_A	S_A	V_{BL}	V_{BR}	V_{CL}	V_{CR}	D_{CL}	D_{CR}	S_{CL}
	POUNDS	POUNDS	POUNDS	POUNDS	POUNDS	POUNDS	POUNDS	POUNDS	POUNDS
66A-6	8896	465	- -	- -	45701	25823	46327	43330	2793
66B-6	5165	1451	- -	- -	20561	3547	19020	19020	463
63 -6	8732	578	- -	- -	38369	22915	41606	37849	2680
METHOD 1	19714	1129	- -	- -	25132	27306	39543	38203	-5569
METHOD 2	19714	1272	- -	- -	25170	27269	39062	38684	-5712

▷ 66A DENOTES DATA FROM TFD 66-431, PAGE 1-2-1, X-15 WT. = 57250 POUNDS

66B DENOTES DATA FROM TFD 66-431, PAGE 4-3-1, X-15 WT. = 36445 POUNDS

63 DENOTES DATA FROM TFD 63-876, PAGE 1-3-1 AND 1-3-2, X-15 WT. = 50449 POUNDS

METHODS 1 AND 2, DTV CONFIGURATION 1 WT. = 49000 POUNDS

TABLE XIV

CONFIGURATION 1 - HOOK LOAD EVALUATION, D_{CL}

CONDITION	V_A POUNDS	S_A POUNDS	V_{BL} POUNDS	V_{BR} POUNDS	V_{CL} POUNDS	V_{CR} POUNDS	D_{CL} POUNDS	D_{CR} POUNDS	S_{CL} POUNDS
66A-2	-56624	-878	-64815	-56929	- -	- -	46702	43705	-11811
66B-2	-38621	688	-27626	-31384	- -	- -	28531	28531	-6506
63 -2	-53540	-766	-46179	-56067	- -	- -	41982	38225	-11924
METHOD 1	21033	2355	- -	- -	25268	24504	44193	41397	-9795
METHOD 2	21033	2653	- -	- -	25345	24427	43188	42401	-10094

66A DENOTES DATA FROM TFD 66-431, PAGE 1-2-1, X-15 WT. = 57250 POUNDS

66B DENOTES DATA FROM TFD 66-431, PAGE 4-3-1, X-15 WT. = 36445 POUNDS

63 DENOTES DATA FROM TFD 63-876, PAGE 1-3-1 AND 1-3-2, X-15 WT. = 50449 POUNDS

METHODS 1 AND 2, DTV CONFIGURATION 1 WT. = 49000 POUNDS

TABLE XV
CONFIGURATION 1 - HOOK LOAD EVALUATION, D_{CR}

CONDITION	V_A	S_A	V_{BL}	V_{BR}	V_{CL}	V_{CR}	D_{CL}	D_{CR}	S_{CL}
	POUNDS	POUNDS	POUNDS	POUNDS	POUNDS	POUNDS	POUNDS	POUNDS	POUNDS
66A-2	-56624	-878	-64815	-56929	- -	- -	46702	43705	-11811
66B-2	-38621	688	-27626	-31384	- -	- -	28531	28531	-6506
63 -2	-53540	-766	-46179	-56067	- -	- -	41982	38225	-11924
METHOD 1	21033	-2690	- -	- -	24453	25319	41198	44392	10398
METHOD 2	21033	-3031	- -	- -	24365	25407	42345	43244	10739

66A DENOTES DATA FROM TFD 66-431, PAGE 1-2-1, X-15 WT. = 57250 POUNDS

66B DENOTES DATA FROM TFD 66-431, PAGE 4-3-1, X-15 WT. = 36445 POUNDS

63 DENOTES DATA FROM TFD 63-876, PAGE 1-3-1 AND 1-3-2, X-15 WT. = 50449 POUNDS

METHODS 1 AND 2, DTV CONFIGURATION 1 WT. = 49000 POUNDS

TABLE XVI

CONFIGURATION 1 - HOOK LOAD EVALUATION, S_{CL}

▷ CONDITION	V_A POUNDS	S_A POUNDS	V_{BL} POUNDS	V_{BR} POUNDS	V_{CL} POUNDS	V_{CR} POUNDS	D_{CL} POUNDS	D_{CR} POUNDS	S_{CL} POUNDS
66A-4	-30415	-8458	-38513	-11795	- -	- -	4145	4145	-32754
66B-3	-35752	-11626	-40175	-21505	- -	- -	1196	1196	-32459
63 -3	-29409	-10743	-33105	-8005	- -	- -	4145	4145	-36751
METHOD 1	-20644	3931	-17572	-34506	- -	- -	8378	3711	31218
METHOD 2	-20644	4428	-17418	-34659	- -	- -	6702	5388	30720

▷ 66A DENOTES DATA FROM TFD 66-431, PAGE 1-2-1, X-15 WT. = 57250 POUNDS

66B DENOTES DATA FROM TFD 66-431, PAGE 4-3-1, X-15 WT. = 36445 POUNDS

63 DENOTES DATA FROM TFD 63-876, PAGE 1-3-1 AND 1-3-2, X-15 WT. = 50449 POUNDS

METHODS 1 AND 2, DTV CONFIGURATION 1 WT. = 49000 POUNDS

TABLE XVII

B-52B/DTV CONFIGURATION 1 (WITH FINS) LOAD CRITICALITY SUMMARY

LOAD COMPONENT	X-15 ANALYSIS		DTV CONF. 1
	MAX. LOAD (LBS.)	MARGIN	MAX. LOAD (LBS.)
V_A	-56624	.01*	-57123
S_A	13002	.27**	-10716
V_{BL}	-86456	.06*	-66437
V_{BR}	-78599	.17*	-66437
V_{CL}	45701	----	27288
V_{CR}	25823	----	27306
D_{CL}	46702	.12*	44193
D_{CR}	43705	.29*	44392
S_{CL}	-36751	.51**	31218

*REFERENCE TFD 66-431

**REFERENCE TFD 63-876

TABLE XVIII

B-52B/DTV CONFIGURATION 1 (WITH FINS)
PYLON TO WING LOAD CRITICALITY SUMMARY

LOAD COMPONENT	X-15 ANALYSIS	DTV CONFIGURATION 1
	MAXIMUM LOAD (LBS.)	MAXIMUM LOAD (LBS.)
V_1	72361*	67418
V_2	66367**	69181
V_3	98512*	73253
V_4	85967*	72180
S_1	10557**	9807
S_2	10557**	9807
S_3	13191**	-12473
S_4	13191**	-12473
D_3	45204*	-43672
D_4	45204*	-43672

* REFERENCE TFD 66-431

** REFERENCE TFD 63-876

7.0 GROUND CLEARANCE

The ground clearance defined in Reference 2 for DTV Configuration 1 is applicable to DTV Configuration 1 (with fins). The minimum ground clearance for DTV Configuration 1 (with fins) is 7.90 inches.

8.0 REFERENCES

1. No. R-1803-2B, "Basic Flight Criteria", Amendment No. 2, dated 17 June 1949.

2. Boeing Document D3-11220-1, "Load and Dynamic Assessment of B-52B-008 Carrier Aircraft for Configuration 1 and 2 Space Shuttle Solid Rocket Booster Decelerator Subsystem Drop Test Vehicles", dated 24 October 1977.

3. NACA TN 3030, "A Method of Calculating the Subsonic Steady-State Load on an Airplane with a Wing of Arbitrary Plan Form and Stiffness", W.L. Gray and K.M. Schenk, dated December 1953.

4. Boeing Document D-11374, "Wing Stress Analysis-Volume I", Model B-52, dated 5 April 1957.

5. Rockwell International Document TFD 66-513, "Wing Analysis of the B-52A-003 and B-52B-008 Carrier Aircrafts for the Increased Gross Weight X-15A-2", dated 1 July 1966.

6. Boeing Document D-10754, "External Loads Criteria, Volume III", Model B-52, dated 14 February 1951.

7. Rockwell International Document TFD 66-431, "Structural Analysis for the B-52 Pylon as Modified for the Increased Gross Weight X-15A-2 Airplane", dated 31 August 1966.

8. Boeing Document D-13084, "Technical Data for RB-52B Flight Simulator", dated 1 October 1952.

9. Rockwell International Document TFD 63-876, "Structural Analysis for the Modified B-52A Pylon for Advanced X-15A-2 Airplane Suspension", dated 15 November 1965.

10. Rockwell International Document TFD 63-901, "Modification Analysis for B-52 Wing for X-15A-2", dated 2 December 1963.