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Proposal for Static Test of B-36B and B-36C Fuselages

(None)

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Consolidated Vultee Aircraft Corp., Fort Worth, Texas

R-FZS-36-173

USAF Contract W33-038-ac-7

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May '48 Unclass. U.S. English 16 tables, diagrs

A report is given on the feasibility of conducting static tests on a portion of the fuselage of the B-36B and C bomber to prove the structural integrity of the aircraft for large bombs and the VDT engine installation. The truss tubes, the side shear panels, and the lower longerons have been considered individually in order to determine the portion of the bomb bay region that would be most representative and thereby prove the structural integrity of the entire region. A general plan for the testing and test set up has been developed and is discussed. Data from the B-36A bomber static test program will be used wherever possible as substantiation of the B-36B and C structures.

Structures (7)
Testing (4)
Structural members - Testing (90859.45); Fuselages - Structural tests (42759); Structural elements - Strength (90853.8); B-36 (14884.6)

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TITLE

PROPOSAL FOR STATIC TEST

OF

B-36B AND B-36C FUSELAGES

CONSOLIDATED VULTEE AIRCRAFT CORPORATION

FORT WORTH DIVISION • FORT WORTH 1, TEXAS

MODEL B-36B
B-36C

REPORT FZS-36-173
DATE 4 May 1948

TITLE

PROPOSAL FOR STATIC TEST
OF
B-36B AND B-36C FUSELAGES

SUBMITTED UNDER

Contract W33-038-ac-7

PREPARED BY: M. M. Alexander
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GROUP: STRUCTURES

REFERENCE:

CHECKED BY: A. R. Kirkel

APPROVED BY: N. B. Robinson

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INTRODUCTION

The purpose of this report is to study the feasibility of conducting tests at this facility on a portion of the fuselage of the B-36B and C Airplane to prove the structural integrity of the aircraft for large bombs and the VDT engine installation.

A survey of the structural differences between the fuselages of the B-36A Airplanes and the B-36B or C Airplanes reveals that they are identical except for the bomb bay region (Sta. 4.0 to Sta. 10). It therefore follows that the fuselage forward of Sta. 4.0 and aft of Sta. 10 will have been tested adequately in the B-36A test program since the loadings in these regions are essentially the same for all three airplanes.

The greatest departure in the bomb bay region consists of the lower longeron which for the B-36B and C Airplanes is elastically supported at Stas. 6 and 8 when the swinging door track is open in flight prior to dropping bombs. The only satisfactory means of testing this longeron as a beam column with elastic supports is to test an entire section of fuselage. However, it is believed that this need only be done on the forward or aft portion of the bomb bay region. The feasibility of this idea is determined in Part I of this report and the results are shown on Pages 11 & 12. The general plan of testing and test set up are shown and discussed in Part II. Parts I and II will be worked out for the B-36B Airplane and the general effects of the B-36C loads as they effect the test are discussed on Page 13.

PART 1

DETERMINATION OF MOST REPRESENTATIVE PORTION OF BOMB BAY FOR TEST

Assuming that it is highly desirable to test only one-half of the bomb bay region, (either forward or aft of wing) the following investigation is made to determine which half would be most representative and thereby prove the structural integrity of the entire region. To make this investigation three items are to be considered. They are the truss tubes, the side shear panels, and the lower longerons themselves.

Truss Tubes

The truss tube sizes (based on 24ST81) are shown for left and right hand sides, forward and aft in Fig. 1 . Column (1) of Table 1 lists all of the different sizes of tubes shown in this figure and Columns 3 and 4 identifies all of the members either forward or aft where each size is used. The next two columns (5 & 6) list the most critical Grand Slam loading for each size both forward and aft. An inspection of this data makes it possible to list in Column 7 in which portion (forward or aft) the most critical loading occurs. This makes it possible to see immediately if one or the other portion is tested what tube sizes will not be covered. However, the results of this table are influenced by which tubes will have been substantiated in the B-36A test program. Therefore, Table 2 is shown to introduce this factor and is believed to be self explanatory. Column 5 of this table summarizes which tubes of the untested end will remain without substantiation depending upon which end is tested. It may be seen that a test of either portion alone leaves some tubes without static test coverage. However, further comments on these untested tubes are shown in Table 3 . From these comments, and all of the data presented so far, it definitely appears that the most satisfactory test will be obtained on the truss tubes if the forward portion is tested.

ANALYSIS [illegible] STATIC TEST
PREPARED BY
CHECKED BY Kuhn
REVISED BY

Consolidated Vultee Aircraft Corporation
FORT WORTH DIVISION
FORT WORTH, TEXAS

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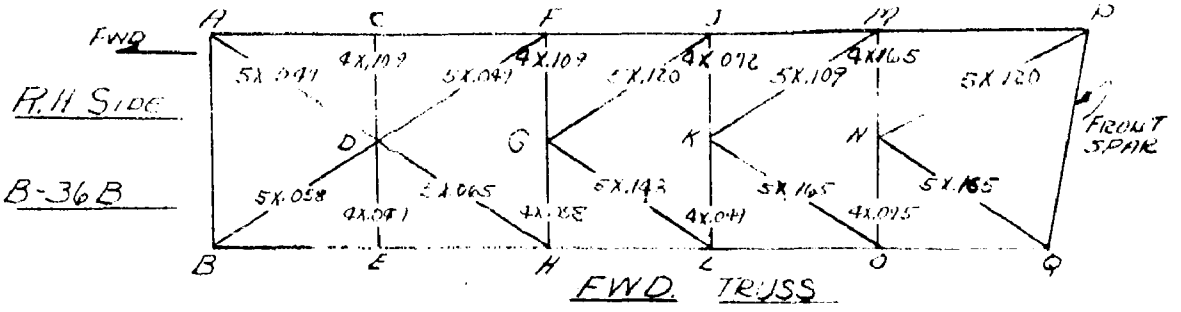
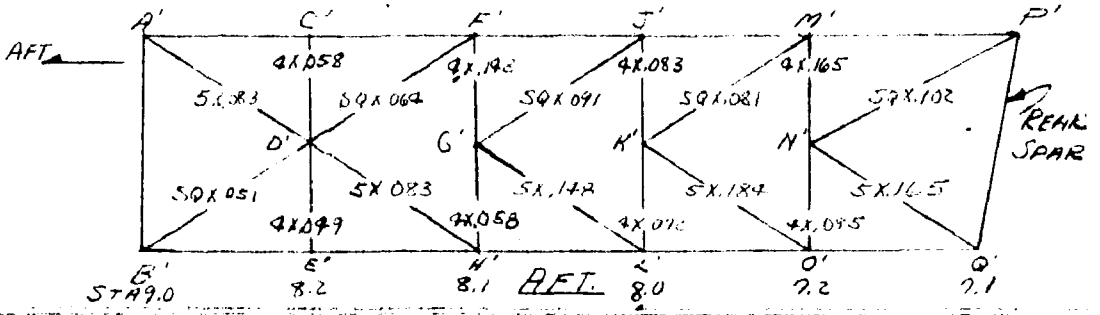
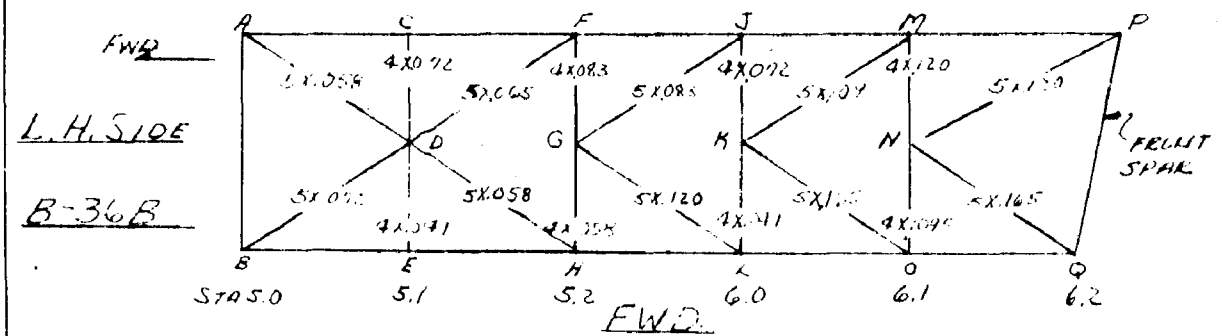
MODEL B-36B
DATE 2-4-46

FIG. 1 B-36B TRUSS TYPE SYMBOLS
20.5% FLIGHT LOADS - MOST CRITICAL CONDITIONS







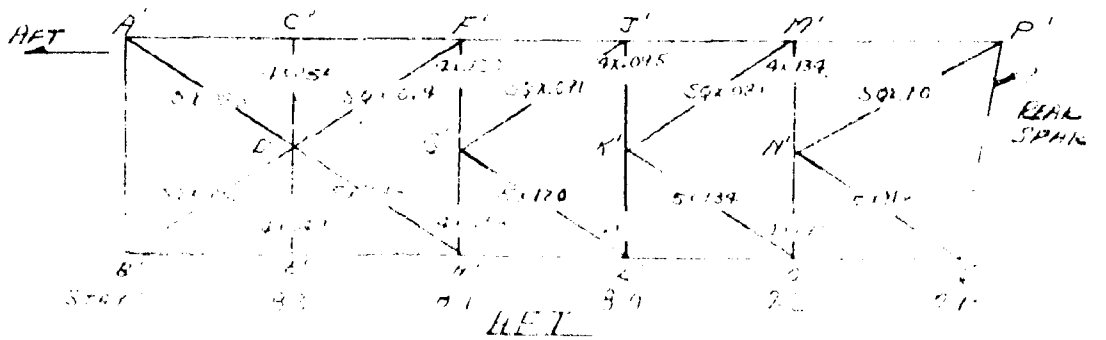


TABLE I

(1)	(2)	(3)	(4)	(5)	(6)	(7)
5X.049	FWD.		AIL INC	BD = -1,830 (SW/K); L = -16520 (SW/K)		FWD.
5X.059	FWD.	ND, E9	BD	[illegible]		FWD.
5X.065	FWD.	DF	DF	[illegible]		FWD.
5X.072	FWD.	BD		[illegible]		FWD.
5X.083	FWD. & AFT	GL, A'D', D'F'	A'D', D'H'	[illegible]		AFT
5X.104	FWD.	EN	EN	[illegible]		FWD.
5X.160	FWD. & AFT	GL, NP G'E'		GL = -4,970 (LBS/IN.) [illegible]		FWD.
5X.184	AFT	K'D'	K'D'	[illegible]		AFT
5X.148	FWD. & AFT	N'Q'	GL, G'E'	GL = 4,110 (LBS/IN.)		AFT
5X.165	FWD. & AFT	KO, NQ	KO, NQ	[illegible]		AFT
5X.087	FWD. & AFT	GL, E'F'	DE, G'E'	[illegible]		AFT
5X.088	FWD. & AFT	GH, J'K', G'E'	GH, B'D', G'E'	[illegible]		FWD.
5X.116	FWD.	GD		[illegible]		FWD.
5X.163	FWD.	FG		[illegible]		FWD.
5X.095	FWD. & AFT	GL, N'O'	GL, N'O'	GL [illegible]		AFT
5X.101	FWD.	FWD.		[illegible]		FWD.
5X.120	FWD. & AFT	AN, F'G'		[illegible]		FWD.
5X.124	AFT	M'N'		[illegible]		AFT
5X.128	AFT			[illegible]		AFT
5X.096	FWD. & AFT			[illegible]		AFT

BY: C. Alexander
CHK. BY: Kirk

CONSOLIDATED VULTEE AIRCRAFT CORPORATION

TABLE 2

TAB / SIDE / DATE	TRANSDUCER MATCH CENTERLINE (1)	(2)	MAX. LOADING FOR P.S.B. SHEAR CONDITION (3)	MAX. LOADING FOR A-26A TUNNEL ← COMPARE BT → P-64 STATIC TEST PROBLEM (4)	TRANSDUCER CONNECTED AT THIS STATION FOR TEST (5)
ASSUMING:			(-1.25)	(1.33 LESS 10%)	
(1) FORWARD FUSELAGE IS TESTED FOR TWO CONDITIONS: (1) REDUCED GROSS WT., LAW, HIGH SPEED @ 500', AND (2) 3 WHEEL LANDING-INCLINED REACTIONS					
5X.003	AFT	-33,140	-33,140		
5X.134	AFT	-75,210	(MAX. ON B-26A)		X
5X.148	AFT	-76,660	-77,360		
5X.165	AFT	-76,660	-77,360		
4X.049	AFT	-1414	-19,500		
4X.015	AFT	+50,100	-41,600, +17,500		X
4X.134	AFT	-98,150	0, 400		
4X.148	AFT	-146,50	-64,100		
4X.165	AFT	-98,150	-63,600		
SQUARE TUBES					
.001	AFT	+134,500	+142,500		
.064	↓	+27,060	+56,400		
.081		+74,400	(MAX. ON B-26A)		X
.091		+29,[illegible]	+69,600		
.102	AFT	+79,590	+79,100		
(2) AFT FUSELAGE IS TESTED FOR TWO CONDITIONS: (1) REDUCED GROSS WT., LAW, HIGH SPEED @ 500', AND (2) 2 WHEEL LANDING-INCLINED REACTIONS					
5X.003	AFT	+[illegible]	+[illegible]		
5X.134	AFT	+[illegible]	+[illegible]		X
5X.148	AFT	+[illegible]	+[illegible]		X
5X.165	AFT	+[illegible]	[illegible]		X
5X.[illegible]	AFT	+[illegible]	" " " "		X
5X.[illegible]	AFT	+[illegible]	+[illegible]		
5X.[illegible]	AFT	+[illegible]	+[illegible]		X
4X.[illegible]	AFT	+[illegible]	+[illegible]		
4X.[illegible]	AFT	+[illegible]	+[illegible]		
4X.[illegible]	AFT	+[illegible]	+[illegible]		
4X.[illegible]	AFT	+[illegible]	+[illegible]		
SQUARE TUBES					
.[illegible]	AFT	+[illegible]	+[illegible]		
.[illegible]	AFT	+[illegible]	+[illegible]		
.[illegible]	AFT	+[illegible]	+[illegible]		
.[illegible]	AFT	+[illegible]	+[illegible]		
.[illegible]	AFT	+[illegible]	+[illegible]		

ANALYSIS [illegible]	Consolidated Vultee Aircraft Corporation	PAGE [illegible]
PREPARED BY [illegible]	FORT WORTH DIVISION	REPORT NO. [illegible]
CHECKED BY Kirk	FORT WORTH, TEXAS	MODEL [illegible]
REVISED BY		DATE [illegible]

TABLE 5. REMARKS PERTAINING TO RESULTS OF INVESTIGATION OF TRUSSES FOR PROPOSED STATIC TEST OF THE B-36 B AIRPLANE

(1) ASSUMING FORWARD FUSELAGE IS TESTED FOR TWO CONDITIONS: (a) 3 WHEEL LANDING, AND (b) L.A.A. @ 5000'.

TUBES NOT [illegible] BY [illegible] TESTS	DESIGN LOADS LBS.	REMARKS
ROUND 5 X .134	−75,[illegible]10	TUBES USED IN AFT END ONLY, NONE ON B-36A
ROUND 4 X .095	+50100	LOAD IN AFT TRUSS +50,100 WHILE LOAD IN FWD. TRUSS IS +45350 WITH M.S. = 23%. ON B-36A MEMBER IS PRIMARILY A COMPRESSION TUBE WITH −41,600# & +17,800#
SQUARE .081	+74,300	TUBE USED IN AFT FUSELAGE ONLY. NONE OF THIS GAGE ON B-36A.

(2) ASSUMING AFT FUSELAGE IS TESTED FOR TWO CONDITIONS: (a) 2 WHEEL LANDING, AND (b) LAA @ 5000'.

TUBES NOT COVERED BY B-36 B OR B-36A TESTS	DESIGN LOADS LBS.	REMARKS
ROUND 5 X .058	+41,450	NONE AFT ON B-36B. B-36A LOADS FOR DESIGN ARE: +283[illegible]# & −31500#
ROUND 5 X .065	−33,710	NONE AFT ON B-36B. B-36A LOADS ARE −32700# & +48000#
ROUND 5 X .072	−42100	NONE AFT ON B 36B AND NOT USED AT ALL ON B-36A.
ROUND 5 X .164	+78200	NONE AFT ON B-36B AND NOT USED AT ALL ON B-36A
ROUND 4 X [illegible]	−[illegible]10	[illegible] AFT = +80200, [illegible] − 75[illegible] ([illegible]) & +136400 [illegible]
ROUND [illegible]	+22180 ([illegible])	NONE AFT ON B-36B. ON B-36A [illegible] A COMP. MEMBER [illegible] − [illegible]# AND +[illegible] ([illegible] 21200) [illegible] − [illegible]#

Side Shear Panels

The side shear panel gages and maximum shears for each panel both forward and aft are shown in Table 4 . It should be noted that the LAA condition should be run with the arch open and also with the arch closed, since this effects the side shear panel shear distribution. The B-36A shear flows are also shown on this table, since they will have been substantiated by the B-36A static test program.

Investigation of the data shows that if the forward portion is tested to LAA and 2.5LLR, the maximum shear flow for the .051 sheet of the aft portion will not be attained. However, if the aft portion is tested, the maximum shear flow for the .040 sheet of the forward portion will not be attained. In addition to this, if the aft portion is tested, no test will be made of the forward vertical shear panel in the turret bay. On this basis it appears desirable to test the forward portion and to introduce local shears in the region of the .051 sheet which will substantiate the shear flow which exists in the aft .051 skin. Such a local shear could not be introduced in the aft end turret bay panel to substantiate the forward turret bay, because the sheet gage of the forward turret bay panel is .016 whereas the aft turret bay panel is .020. All of the foregoing data indicates that a test of the forward portion would substantiate the aft portion provided a supplementary shear is introduced into the .051 sheet.

TABLE 4(a)
SIDE SHEAR PANEL SHEARS - BOMB [illegible]
[illegible]

	BAY STA-STA.	GAGE OF SKIN	MAX. SHEARS - B-36B GRAND SLAM LOADING CONDITIONS: ARCH OPEN	ARCH CLOSED	MAX. B-36A SHEARS SUBSTANTIATED BY B-36A STATIC TEST PROGRAM
			LBS./IN.	LBS./IN.	LBS./IN.
FORWARD FUS.	4.0-4.1	.040	— *1	301	341
	4.1-5.0	.040	—	301	342
	5.0-5.1	.040	—	376	402
	5.1-5.2	.040	—	376	372
	5.2-6.0	.040	—	376	375
	6.0-6.1	.051	484	532	507
	6.1-6.2	.040	465	513	392
AFT FUSELAGE	7.1-7.2	.051	— *2	609	540
	7.2-8.0	.051	—	609	566
	8.0-8.1	.051	330	— *3	330
	8.1-8.2	.040	352	—	313
	8.2-9.0	.040	326	—	449
	9.0-9.1	.040	266	—	319
	9.1-10.0	.040	260	—	319

*1 FROM STA. 4.0 TO STA. 6.0 GROUND TURNING CONDITION YIELDS MAX. SHEARS FOR "GRAND SLAM" LOADINGS.

*2 FROM STATION 7.1-8.0 MAX. SHEARS OCCUR IN 2 WHEEL LANDING - INCLINED REACTIONS CONDITION - ARCH IS CLOSED.

*3 FROM STA. 8.0 TO STA. 10.0, SHEARS ARE GREATEST [illegible] L.A.H. CONDITION WITH ARCH CLOSED.

TABLE 4(b) VERTICAL SHEAR PANEL LOADS [illegible]
[illegible]

	BAY	WEB GAGE AL.	MAX SHEARS-B36B GRAND SLAM LOADING CONDITIONS	MAX. SHEARS-B36A COVERED BY B36A TEST PROGRAM
FWD	[illegible]-4.1	[illegible]	[illegible] LBS./IN.	352 LBS./IN.
	[illegible]	[illegible]	[illegible]	357 "
	[illegible]	[illegible]	380	[illegible]
	[illegible]	[illegible]	[illegible]	[illegible]

Longerons

A. Lower

A comparison of the B-36B forward and aft longeron compressive stresses, deflections and margins of safety are shown in Fig. 2 for the Grand Slam loading conditions. It will be noted that for the aft longeron the stresses for the 2 Wheel Landing With Inclined Reactions Condition are shown rather than the stresses for LAA condition, which is shown to be more critical in C.V.A.C. Report FZS-36-144B. New rational tail loads using overall airplane pitching moment coefficients are such that the lower longeron compressive stresses in the L.A.A. condition are approximately 50% as great as those shown in the above mentioned report. Therefore, the LAA condition was not considered in this comparison. Also shown on Fig. 2 are the maximum aft longeron compressive stresses for the B-36A Airplane, which will be substantiated in the B-36A static test program.

In view of the data presented it was determined that a static test of the forward lower longeron in compression will be the more representative test for the following reasons: (1) The maximum stresses on the aft longeron occur when the arch at Sta. 8.0 is closed (landing); (2) the B-36A static test program will substantiate the aft longeron with the arch closed; (3) margins of safety on the forward lower longeron for Grand Slam loadings are smaller in the regions where the stresses are most critical.

B. Upper

For the Grand Slam loadings, the upper longerons do not receive the local bending loads to which they are subjected on the B-36A Airplane. A comparison of margins of safety between the B-36A and B-36B Airplanes show that with very few exceptions, the margins on the B-36B are greater than those for the B-36A. Since there is no difference in their construction, support or general design procedure, it is felt that the B-36B upper longeron design will have been substantiated by the B-36A test program. It is therefore proposed that no particular attempt be made in this test to test the upper longerons to ultimate loads, this will greatly facilitate testing inasmuch as it will not be necessary to [illegible]

FIG. 2 LOWER LONGERON STRESSES, DEFLECTIONS AND MARGINS OF SAFETY

B-36B - LOWER LONGERON - COMPARISON OF FORWARD AND AFT.
(REF: P.144, FES-36-144B)

[illegible side label]

STA.	5.0	5.1	5.2	6.0	6.1	6.2	7.0
LATERAL DEFL.-IN.	0	0.317	0.788	1.16	0.773	0.221	0
P/A STRESS	24900	27200	32700	21400	44100	48900	3?600
f_b BEND. STRESS	0	1600	400	5700	1200	2300	4200
M.S.-COMP.	+1.77	+1.41	+1.00	+1.07	+0.47	+0.34	+1.00

[illegible side label] REACTIONS - AGN. (2) - 43000# BOMBS

STA.	9.0	8.2	8.1	8.0	7.2	7.1	7.0
LATERAL* DEFL.-IN.	0	0	0	0	0	0	0
P/A STRESS	34100	39000	37700	34300	43200	46300	46800
f_b BEND* STRESS	0	0	0	0	0	0	0
M.S.-COMP.*	+0.93	+0.68	+0.83	+0.99	+0.56	+0.45	+0.46

B-36A - AFT LOWER LONGERON COMPRESSIVE STRESSES TO BE SUBSTANTIATED BY B36A STATIC TEST PROGRAM. (REF: P.606, FES-36-144)

[illegible side label] 72000# BOMBS [illegible]

STA.	9.0	8.2	8.1	8.0	7.2	7.1	7.0
LATERAL DEFL.-IN.*	0	0.249	0.176	0	0.194	0.206	0
P/A STRESS*	43600	48200	47300	44700	53000	54100	54900
f_b BEND. STRESS*	4600	4700	800	5500	1960	3100	7000
M.S. COMP.*	+.37	+.26	+.44	+.30	+.24	+.19	+.13

[illegible side label]

LATERAL DEFL.-IN.*	0	0.230	0.202	0	0.087	0.028	0
P/A STRESS*	40800	46300	46700	44000	53200	57200	57800
f_b BEND. STRESS*	4000	4500	900	5300	2700	2300	100
M.S. COMP.*	+.48	+.31	+.45	+.35	+.21	+.14	+.15

* [illegible]

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Summary of Results

A survey of the foregoing data indicates that a satisfactory proof of the structural integrity will be obtained if the following tests and procedures are followed:

(1) The forward bomb bay region (Sta. 4.0 to Sta. 7.1) should be subjected to the full design shears for:

(a) Reduced Gross Weight, High Speed, IAS, 5000 ft. Condition (2-43,000# bombs)

(b) Alternate Gross Weight 3#LIR Condition (2-43,000# bombs)

(2) The lower longeron should be subjected to its full axial compression load simultaneously with the shears for the conditions mentioned in (1) above.

(3) The upper longerons in the conditions of (1) above will receive an axial load which amounts to the delta moment between Sta. 4.0 and Sta. 6.1 in these conditions.

(4) The forward bomb rack installation will be used to introduce the loads into the structure and will therefore be tested automatically for the conditions of (1) above.

(5) The aft bomb racks will be set up and tested for design loads on a separate jig.

(6) Supplementary shear tests will be run on the shear panel skins to substantiate any aft panel shears which are greater.

(7) The three tubes of the aft portion which are not covered by the forward test (Ref. Table 3) will be handled as follows:

(a) Strain gages will be placed on forward bay tubes that have a corresponding location.

(b) Loads in these tubes will be obtained from the strain gage data and will be used to verify the stress analysis distribution and loading.

(c) If loads are substantiated, the members can be shown to be satisfactory by comparison to similar members on existing ships, i.e.,

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(f) Data from the B-36A Static Test Program will be used wherever possible as substantiation of B-36B structure.

DISCUSSION OF B-36C LOADS

No final stress analysis is yet available on the B-36C Airplane. However, the Contractor has investigated the critical conditions for this airplane and found that the only effect is to get slightly higher shears in two of the shear panels. It is felt that this increase in shear could be substantiated by making supplementary tests on the portion proposed for test.

PART II

TEST SET-UP AND PROCEDURE

Forward Bomb Bay

The general test set up is as shown in Fig. 3 . It is proposed to apply to a dummy bulkhead at Sta. 4.0, a shear load equal to that of all items forward of Sta. 4.0. The shears for all items from Sta. 4.0 to Sta. 6.2 will be applied as indicated in the Fig. 3 . A compression load, equal to the calculated longeron load will be applied to the lower longeron at Sta. 4.0. The applied loads will be reacted by a steel fixture simulating the fuselage and wing box structure between fuselage station 6.2 and a point approximately ten inches aft of station 7. As shown by the figure, all shears will be reacted at station 6.2. Furthermore, the lower longers at Sta. 6.2 will be adjusted laterally the amount indicated in the final stress analysis for the condition concerned to simulate the effect of wing deflection.

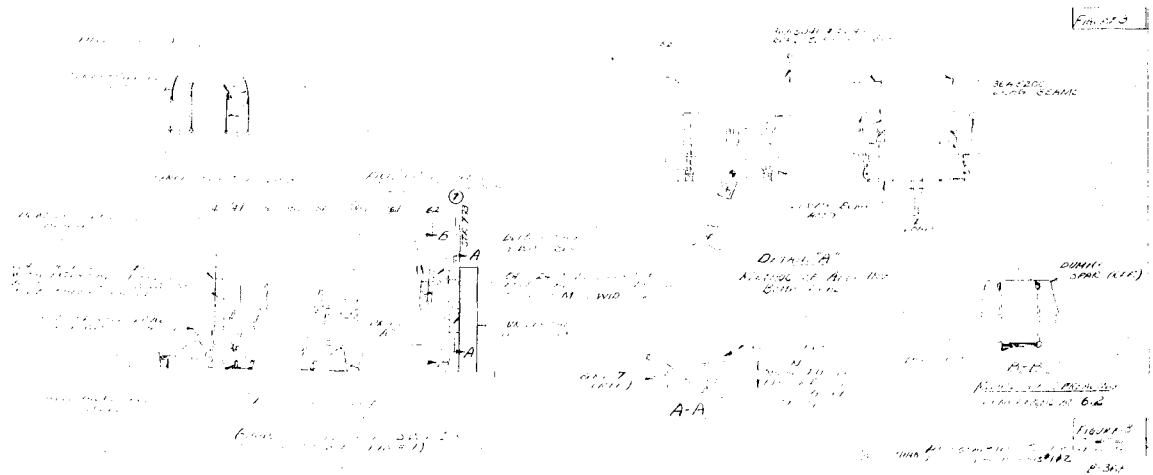
Every effort will be made to design the test fixtures so that a minimum amount of changing will be necessary to complete both test conditions.

Aft Bomb Racks

The aft bomb bay racks and beams for the 43,000# and 22,000# bombs will be tested on separate test fixtures simulating airplane attaching structure.

Supplementary Tests

Supplementary tests of the side shear panels will be made by simply introducing greater shears over the prescribed panel and then reacting this increase by other test equipment.


A-A
DUMMY SPAR (KEEL)

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ABSTRACT:

A report is given on the feasibility of conducting static tests on a portion of the fuselage of the B-36B and C bomber to prove the structural integrity of the aircraft for large bombs and the VDT engine installation. The truss tubes, the side shear panels, and the lower longerons have been considered individually in order to determine the portion of the bomb bay region that would be most representative and thereby prove the structural integrity of the entire region. A general plan for the testing and test set up has been developed and is discussed. Data from the B-36A bomber static test program will be used wherever possible as substantiation of the B-36B and C structures.

DISTRIBUTION: Copies of this report obtainable from Central Air Documents Office; Attn: MCIDXD

DIVISION: Structures (7)
SECTION: Testing (4)

SUBJECT HEADINGS: Structural members - Testing (90859.45); Fuselages - Structural tests (42759); Structural elements - Strength (90853.8); B-36 (14884.6)

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Air Documents Division, Intelligence Department
Air Materiel Command

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