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NWC TP 5727

F-4B/J Aircraft Conformal Carriage Preliminary Design Study Report

by

Edwin J. Zapel
The Boeing Aerospace Company
for the
Aircraft Systems Department

JANUARY 1975

Naval Weapons Center
CHINA LAKE, CALIFORNIA 93555

Naval Weapons Center

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R. G. Freeman, III, RAdm., USN .... Commander

G. L. Hollingsworth .... Technical Director

FOREWORD

This document is the final report covering the F-4B/J aircraft conformal carriage preliminary design study. This study was conducted by Boeing Aerospace Company, Seattle, Washington, for the Naval Weapons Center (NWC) under Contract Number N00123-74-C-2011. The work was carried out during the period of April through September 1974.

This report is a fascimile of the contract report. It has been reviewed for technical accuracy by R. E. Smith and is released at the working level for information only.

Released by
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(U) An F-4B/J aircraft conformal carriage preliminary design is described which provides a store mounting capability for up to twelve stores simultaneously. Aircraft modifications and required servicing procedure changes are identified.

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INTRODUCTION

The conformal carriage program is the natural product of years of experience in configuration studies, wind tunnel investigations, weapon development, and weapon handling studies, culminating in the design and flight test of an F-4B conformal carriage feasibility, prototype. The flight test results obtained during tests of the feasibility prototype verified the performance gains indicated by theoretical and wind tunnel studies. Maintenance considerations were not preeminent in the design since the aircraft was to be retired after the flight test program and neither time nor funds permitted designing for optimal maintenance access. Figure 1 depicts the historical background of the conformal carriage program leading to the preliminary design study recently completed and described in this document.

The objective of the preliminary design study was to define an F-4B/J conformal carriage which could be used effectively in an operational environment with a minimal impact upon aircraft maintenance and service. An additional objective was to develop any ejector requirements special to conformal carriage installations.

All results to date indicate the feasibility of a fleet modification program and an enhanced tactical capability such a program would provide. The development plan leading to combat readiness status of the F-4B/J conformal carriage on July 1, 1977 is shown in Figure 2. Should international conditions require advancing the IOC, the R.D.T.&E. flight test program could overlap the production program as much as eight months. Thus the earliest IOC for the system could be 12/1/76.

SUMMARY

The study results indicate the F-4B/J conformal carriage aircraft can be operated and maintained aboard CVA class carriers with only minor changes required in F-4B/J maintenance and servicing procedures.

The package loading system conceived permits unit loading of three preloaded weapon bays or of three rows of weapons prearranged on bomb skids. The builtin hoisting mechanism devised for each weapon bay can be operated with any external power source.

A weapon list compatible with the F-4B/J conformal carriage has been developed and is included as Tables 1 and 2. Configurations developed for these weapons are included as Figures 3 through 36. The ejector matrix and structural arrangement requisite to carriage of these weapon configurations are included as Figures 41, 42, and 43.

Functional characteristics desirable for ejectors in conformal carriage installations have been defined.

Two conformal carriage configurations have been developed. One configuration includes two permanently installed GAU-9A 30 mm guns with associated ammunition storage. An alternate configuration contains modular ECM and Pave Spike equipment in the fwd fairing and provision is made for installation of the GAU-9 30 mm gun pod. This latter configuration is recommended for an R.D.T.&E. program.

The removable aft fairing of the conformal carriage is recommended for use as chaff and flare dispensers and also for storage and release of other passive defensive devices.

The detailed engineering plan for a Research, Development, Test, and Evaluation program is included as part of Figure 2.

AIRCRAFT IDENTIFICATION

The candidate aircraft chosen for this investigation were the F-4J and the F-4B after modification to the F-4N configuration. Configuration differences between the F-4J and F-4N are not considered critical in conformal carriage design or installation.

WEAPON LOADS

At the start of this study NWC provided a desired weapon list which was used in developing an initial configuration. To the NWC weapon list were added weapons found compatible with conformal carriage installations during performance of a parallel USAF contract. Thus the weapon list given in Table 1 contains not only those weapons initially identified by NWC but also several additional weapons. Included in Table 1 are the quantities of each weapon requested by NWC and shown feasible during the preliminary design study. Only physical fitment was considered.

Figures 3 through 21 illustrate uniform load weapon configurations which can be carried on a conformal carriage containing internal GAU-9A guns, Figures 22 through 27 depict six mixed loads compatible with the conformal carriage gun installation.

The installation of GAU-9A guns and associated ammunition storage containers requires a deeper conformal carriage configuration which changes the relationship of external stores and the catapult bridle. In some cases stores which would be hit by the catapult bridle if the conformal carriage were deep enough to contain the GAU-9A guns would not be affected by the bridle were the conformal carriage only deep enough for the weapon ejectors. The external stores so affected are listed in Table 2.

The conformal carriage installation can be more versatile if the GAU-9A 30-mm gun is carried as an external pod instead of internally.

The GAU-9 gun pod resembles the existing MK-4 gun pod and could be carried at the centerline 30-inch weapon ejector position. Maintenance of gun boresight pointing could be assured by pod sway brace supports at the forward and aft end of the pod.

Gun cavity purging in the pod mounted installation is much less complicated than that required by internal GAU-9A installations, and accidental explosion of gun gases in the pod would not be a hazard to aircraft structural integrity.

The difference in conformal carriage depth between a conformal carriage containing GAU-9A guns and one not containing these guns is such that some weapons can not be carried on the outboard fwd stations of the deeper conformal carriage because of catapult bridle interference.

The reduced complexity and increased weapon load capability coupled with increased system versatility provided by the shallower conformal carriage are considered sufficient justification for recommending an R.D.T.&E. program with the 30-mm gun mounted as a removable external pod.

Weapon configurations illustrating the increased weapon load capability provided by the shallower conformal carriage are shown in Figures 28 through 36.

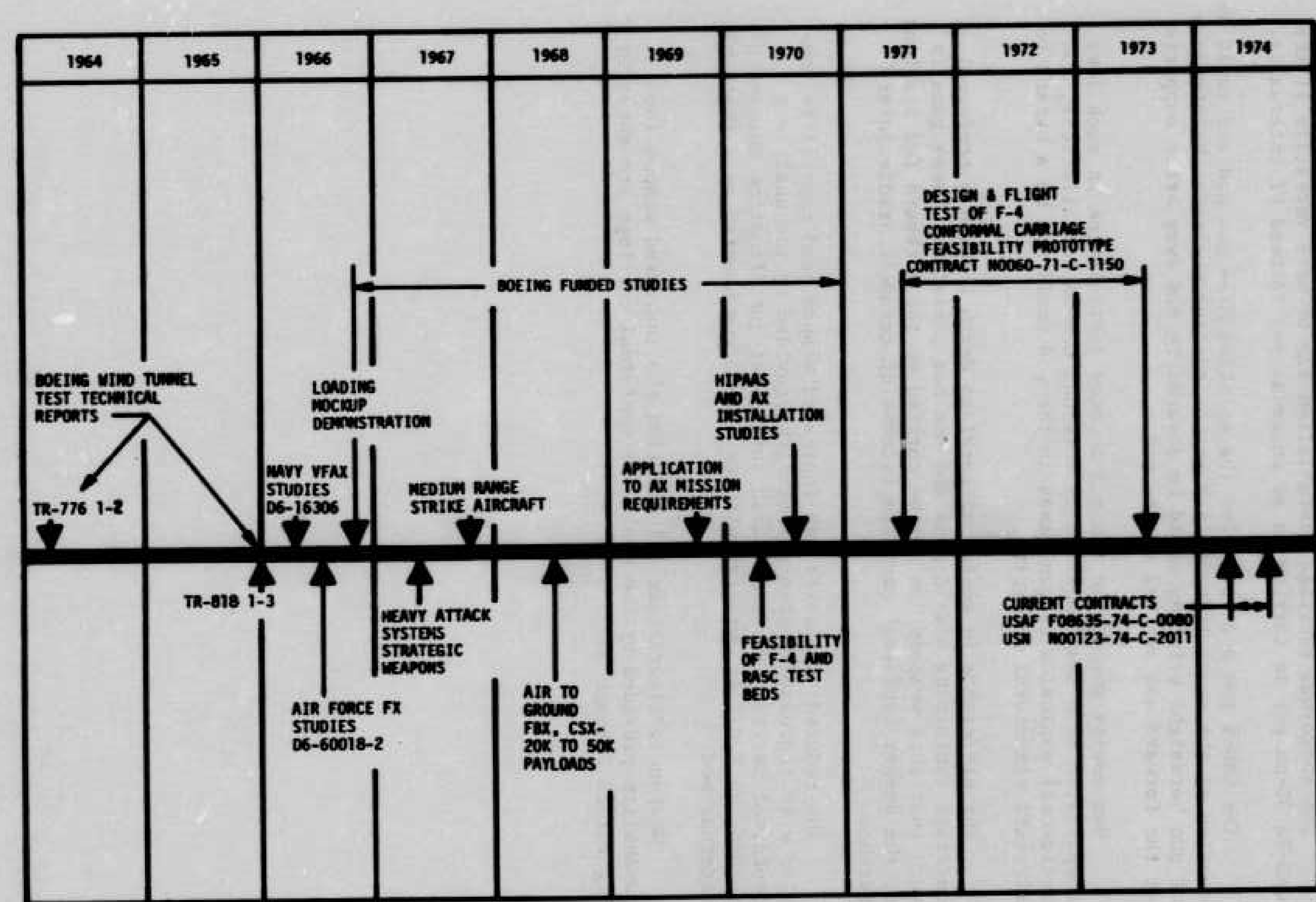


Figure 1: Conformal Carriage Development Program History

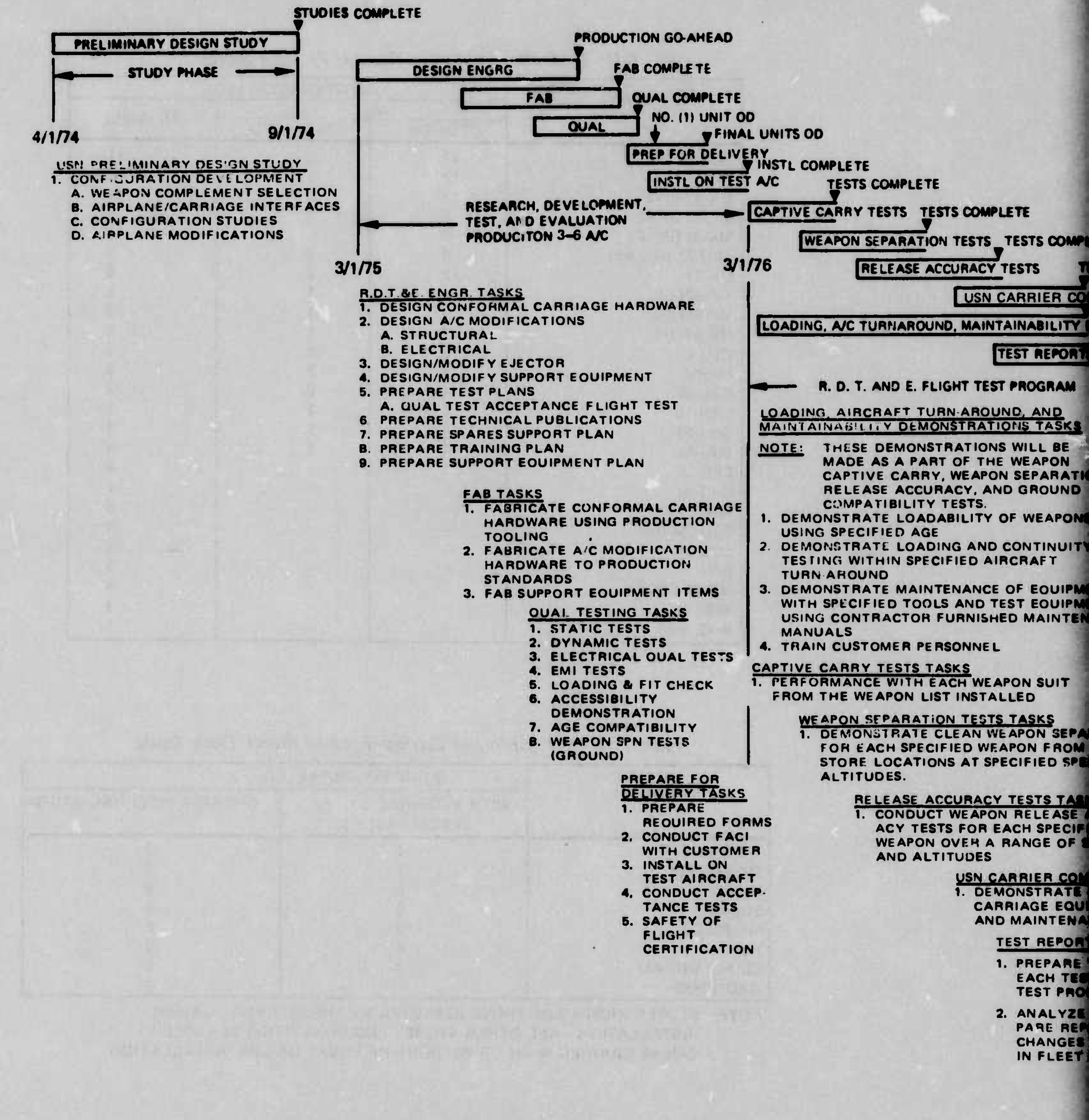
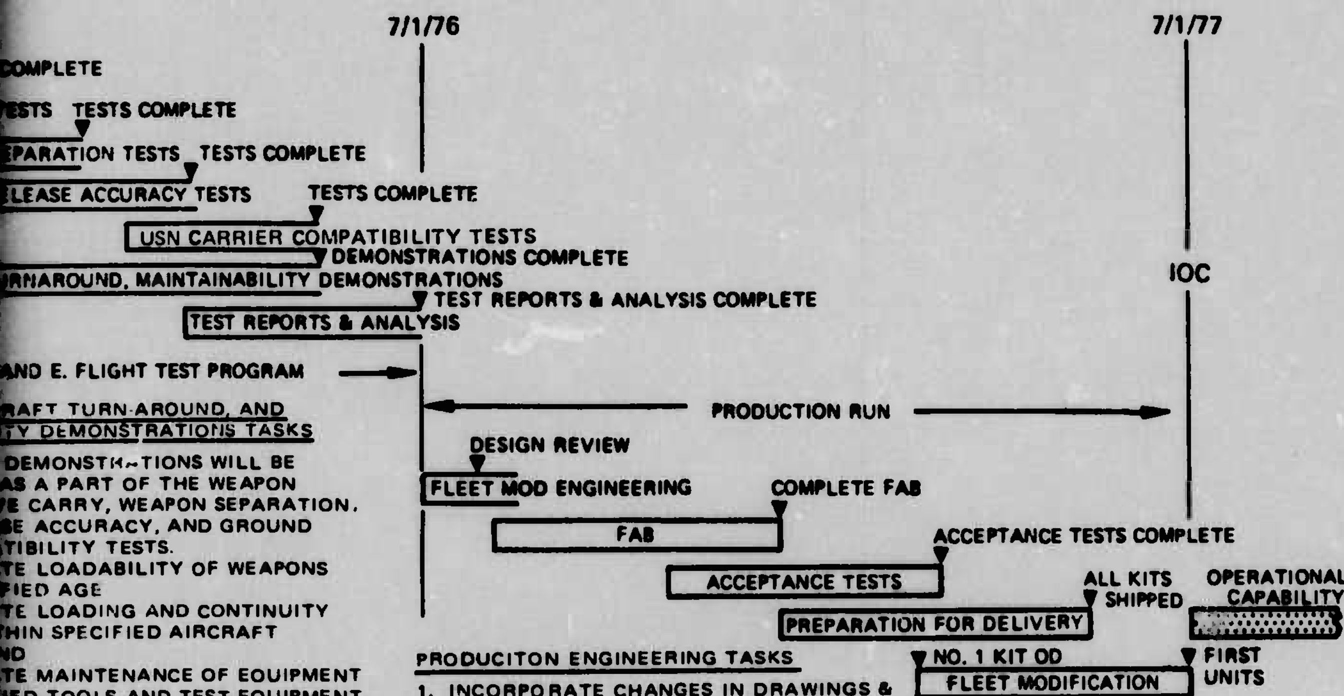


FIGURE 2. F-4 B/J Conformal Carriage Program



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FIED AGE
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THIN SPECIFIED AIRCRAFT
ND
TE MAINTENANCE OF EQUIPMENT
IED TOOLS AND TEST EQUIPMENT
RACTOR FURNISHED MAINTENANCE

OMER PERSONNEL

TESTS TASKS
E WITH EACH WEAPON SUIT
APON LIST INSTALLED

EPARATION TESTS TASKS
STRATE CLEAN WEAPON SEPARATION
CH SPECIFIED WEAPON FROM SELECTED
LOCATIONS AT SPECIFIED SPEEDS AND
DES.

LEASE ACCURACY TESTS TASKS
CONDUCT WEAPON RELEASE ACCUR-ACY TESTS FOR EACH SPECIFIED WEAPON OVER A RANGE OF SPEEDS AND ALTITUDES

USN CARRIER COMPATIBILITY TESTS TASKS
1. DEMONSTRATE COMPATIBILITY OF CONFORMAL CARRIAGE EQUIPMENT WITH CVA OPERATIONS AND MAINTENANCE PROCEDURES

TEST REPORTS TASKS
1. PREPARE TEST REPORT FOR EACH TEST CONDUCTED DURING TEST PROGRAM
2. ANALYZE TEST RESULTS. PRE-PARE REPORT OF RECOMMENDED CHANGES TO BE INCORPORATED IN FLEET MOD KITS

PRODUCITON ENGINEERING TASKS
1. INCORPORATE CHANGES IN DRAWINGS & SPECS AS DICTATED BY FLIGHT TEST PROGRAM & PRODUCITON REQUIREMENTS
2. FINALIZE MAINTENANCE MANUALS
3. FINALIZE SPARES SUPPORT PLAN
4. PREPARE DETAILED FLEET MOD PLAN

FAB TASKS
1. FABRICATE CONFORMAL CARRIAGE HARDWARE KITS
2. FABRICATE AIRCRAFT MODIFICATION KITS
3. FABRICATE SUPPORT EQUIPMENT ITEMS

ACCEPTANCE TESTS TASKS
1. CONDUCT KIT INSPECTIONS
2. CONDUCT ELECTRICAL CONTINUITY TESTS

PREPARATION FOR DELIVERY TASKS
1. PREPARE REQUIRED FORMS
2. PACK AND CRATE AS REQUIRED
3. SHIP TO MOD CENTER AS REQUIRED

FLEET MODIFICATION TASKS
1. INSTALL CONFORMAL CARRIAGE KITS ON FLEET AIRCRAFT IN ACCORDANCE WITH ESTABLISHED SCHEDULE
2. CONDUCT SAFETY OF FLIGHT CERTIFICATION

Table 1. F-4B/J Conformal Carriage External Stores

STORE	QUANTITY INSTALLED		
	NWC		FEASIBLE
	DESIRED	REQUIRED	
ROCKEYE II	12	6	11
APAM	12	6	11
MK-82-GP/SE	12	6	12
MK-83-GP/SE	6	3	5
MK-84-GP/SE	–	–	3
CBU-72 (HSFAE)	4	2	3
MK-77	12	6	6
MK-82LGB	4	1	5
MK-83LGB	2	1	3
MK-84LGB	1	1	1
CTU-1	2	1	1
HARM	4	2	3
LAU-69	4	2	3
LAU-10	4	2	3
SUU-40	4	2	4
SUU-44	4	2	4
CBU-58	–	–	8
CBU-38	–	–	11
ASP	–	–	6
SUU-25C/A	–	–	4
SUU-51	–	–	6
B-57	–	–	3
MK-84 EOGB	–	–	1
AGM-65	–	–	4
B-43, B-61	–	–	1

Table 2. F-4B/J Conformal Carriage External Stores Trade Study

STORE	QUANTITY INSTALLED	
	WITH INTERNAL GAU-9A (FROM TABLE I)	WITHOUT INTERNAL GAU-9A
MK-84LGB	1	3
MK-84EOGB	1	2
MK-77	6	8
SUU-51	6	8
MK-82LGB	5	6
ASP	6	8
CBU-72 (HSFAE)	3	5
GAU-9 POD	–	1

NOTE: STORES SHOWN ARE THOSE AFFECTED BY THE INTERNAL GAU-9A INSTALLATION. ALL OTHER STORES AND QUANTITIES IN TABLE 1 CAN BE CARRIED WITH OR WITHOUT INTERNAL GAU-9A INSTALLATION.

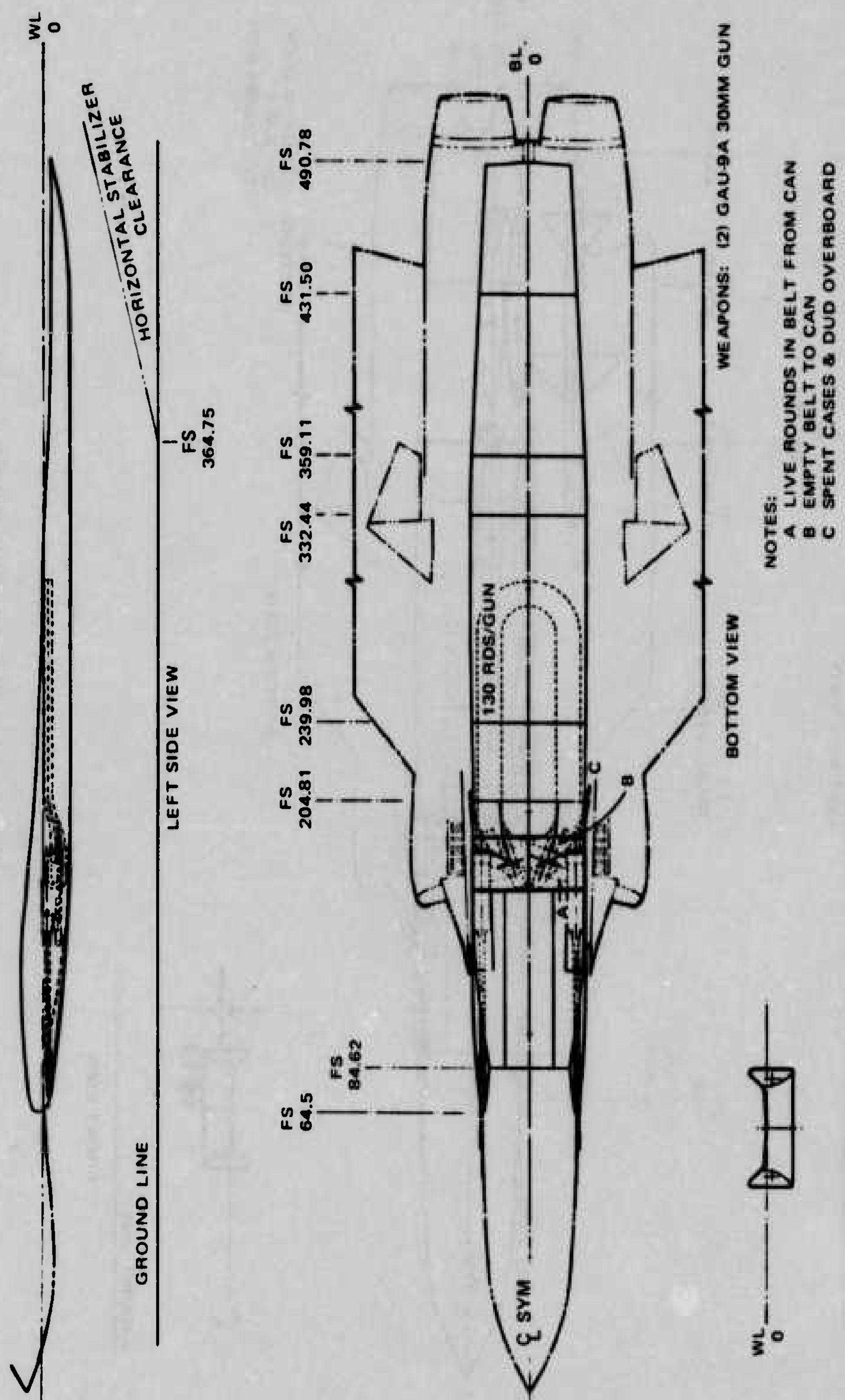


Figure 3 : Weapon Arrangement

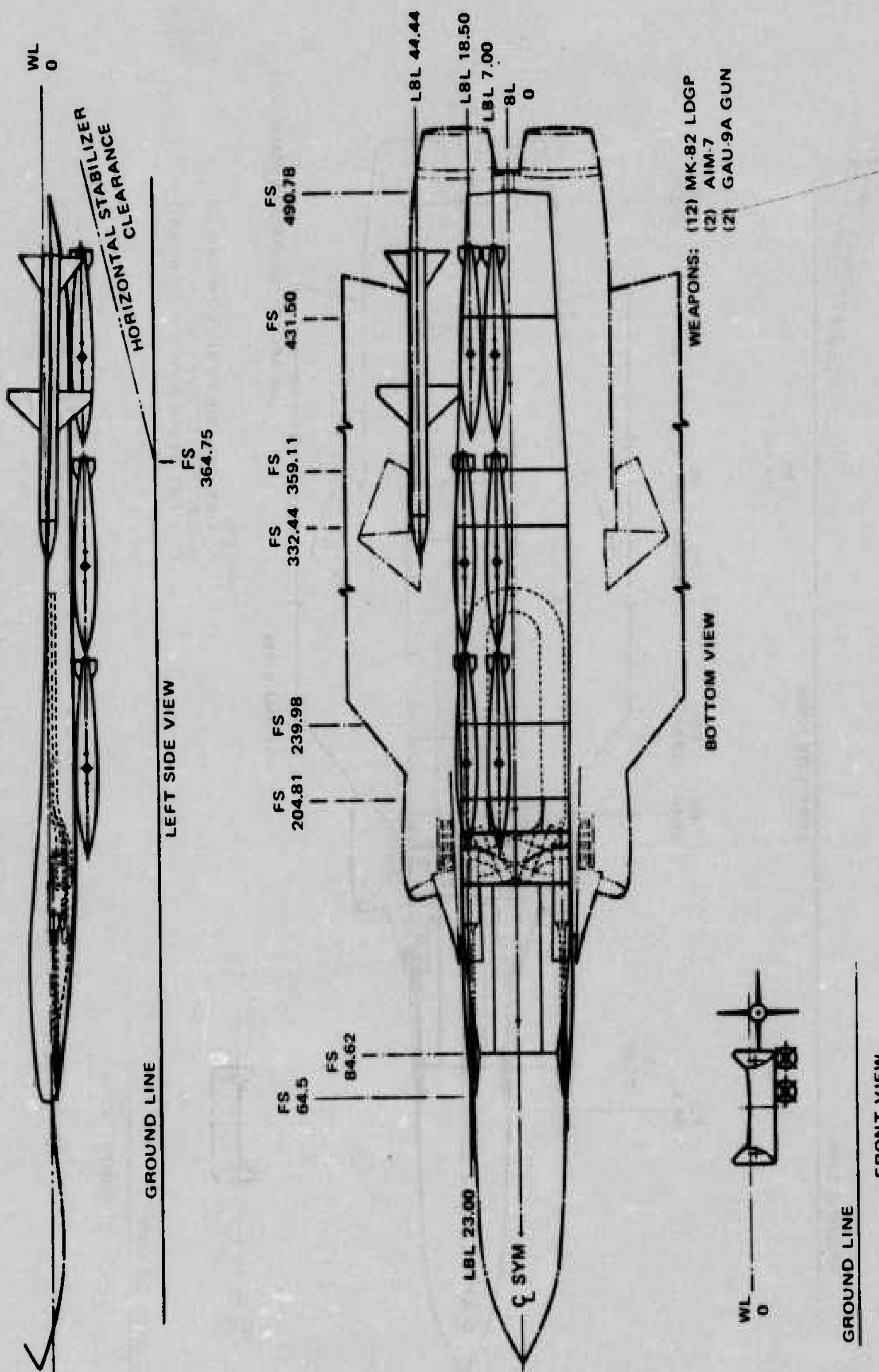


Figure 4 : Weapon Arrangement

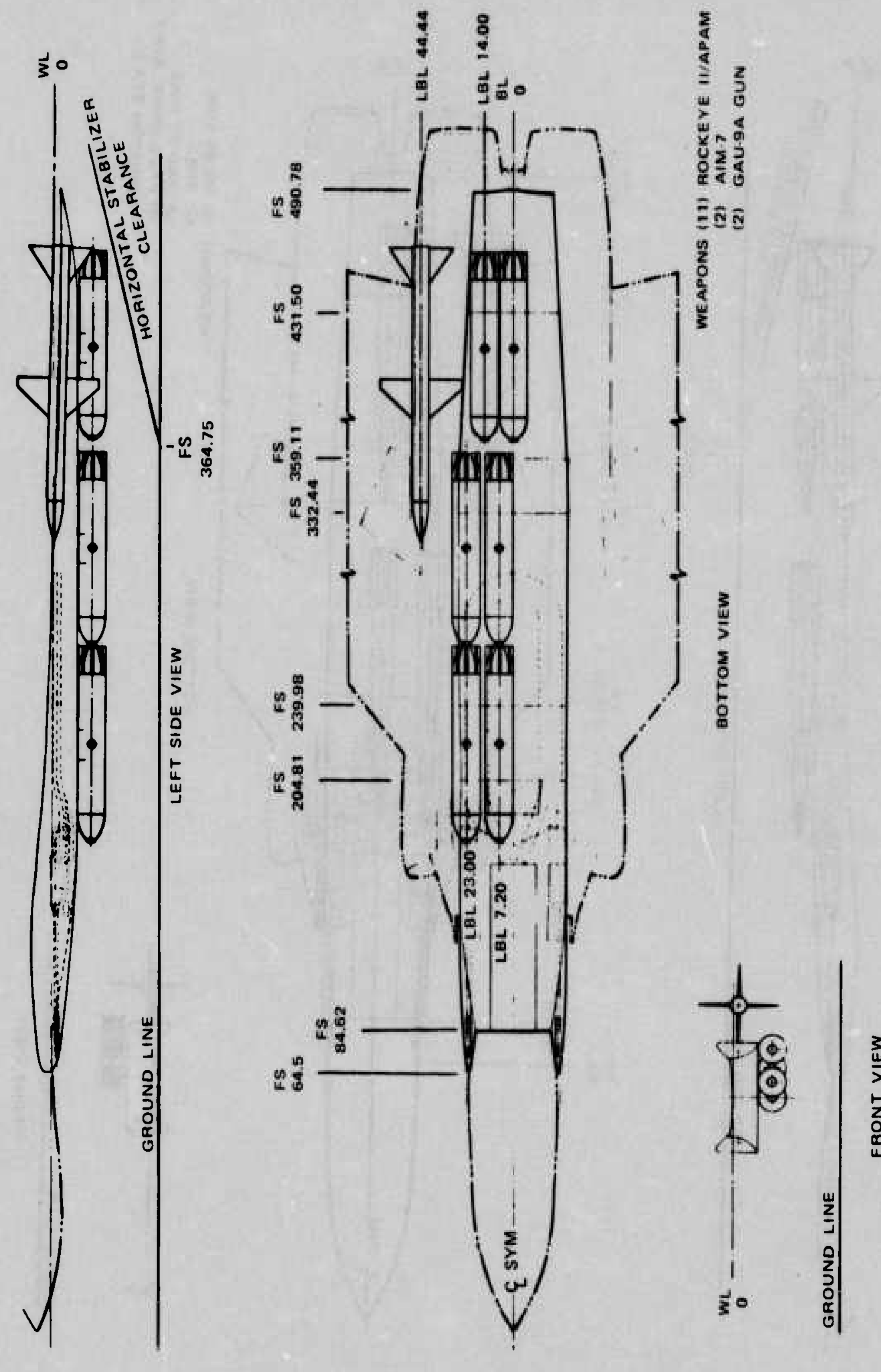


Figure 5 : Weapon Arrangement

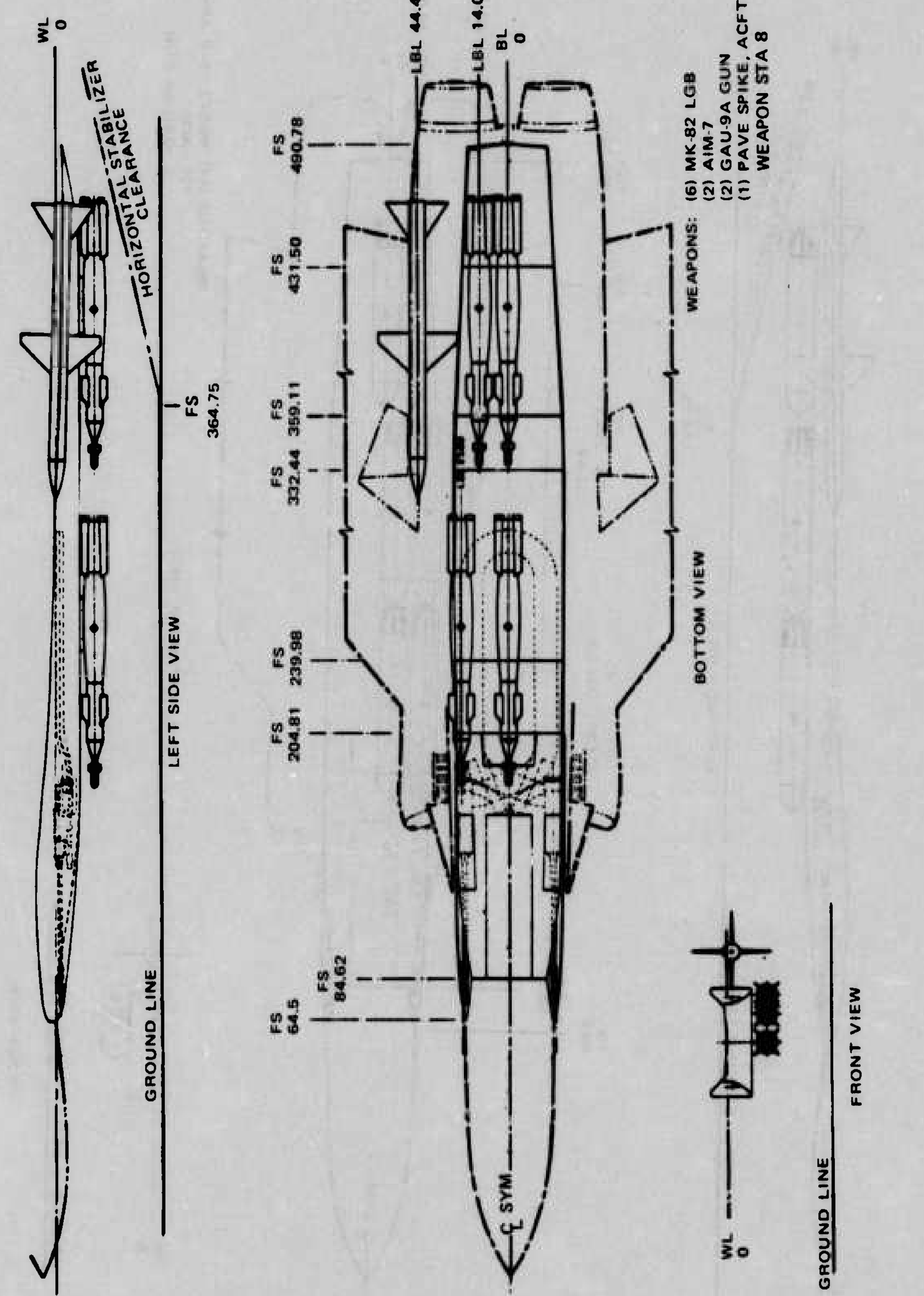


Figure 6 : Weapon Arrangement

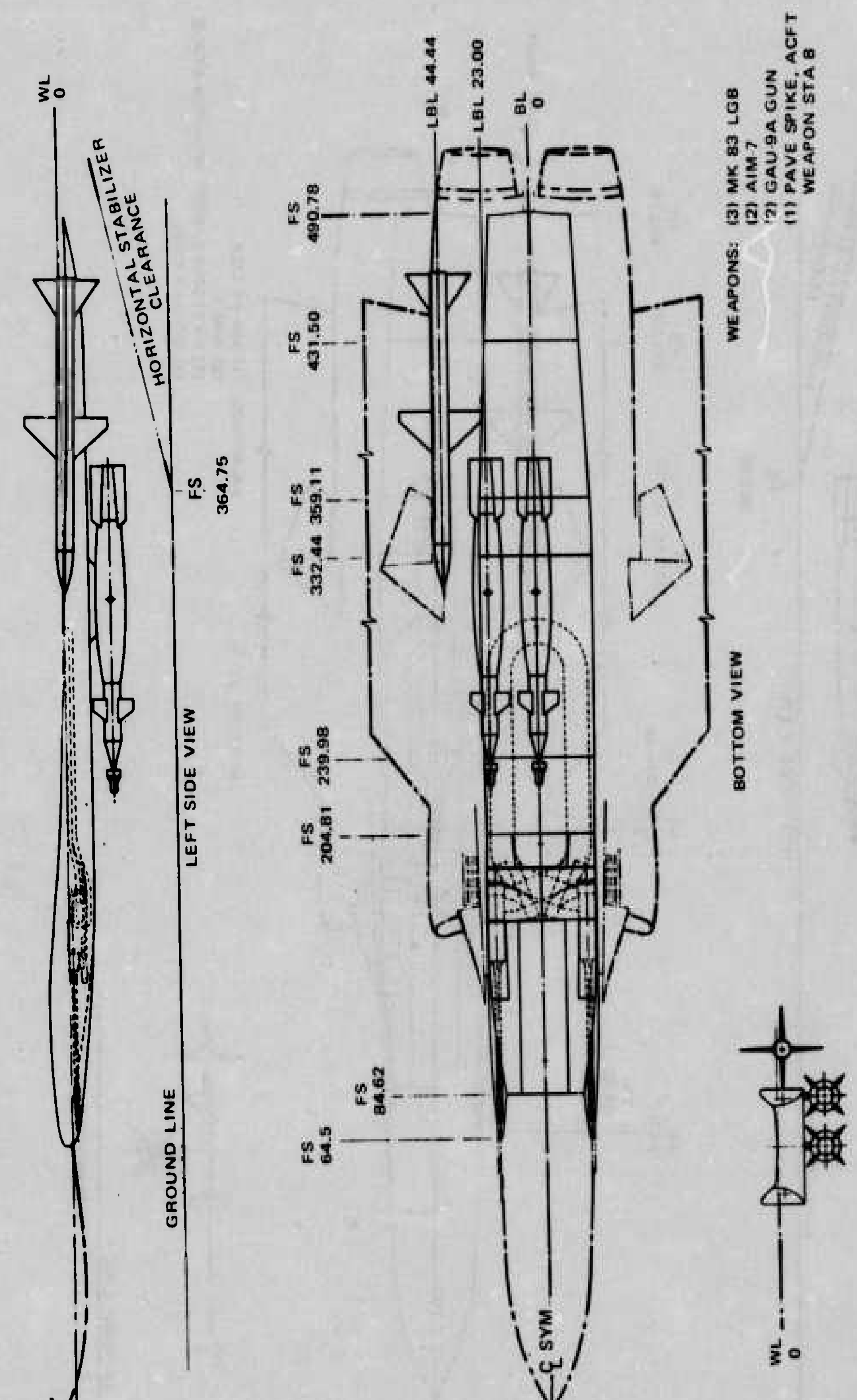


Figure 7 : Weapon Arrangement

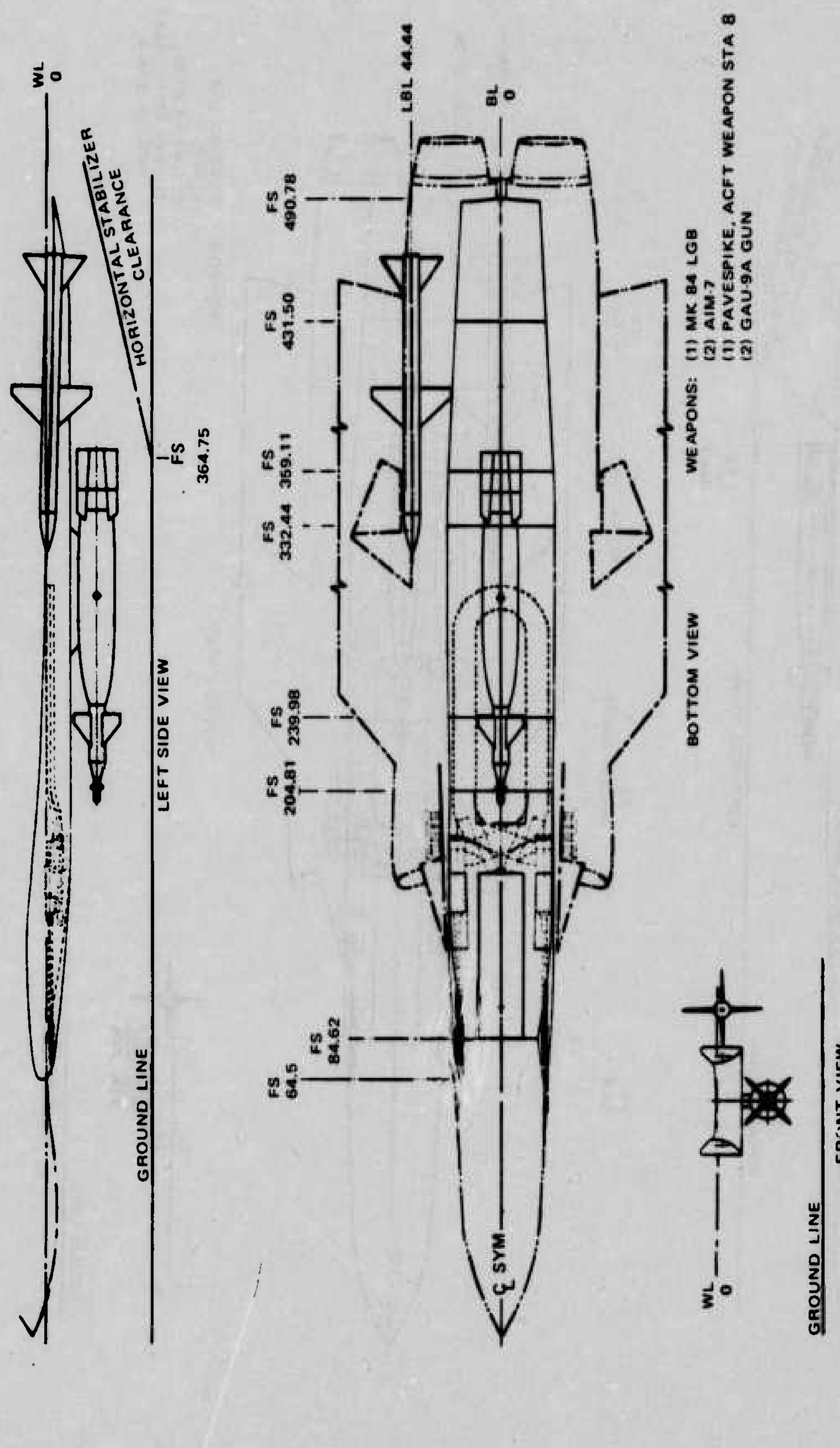


Figure 8 : Weapon Arrangement

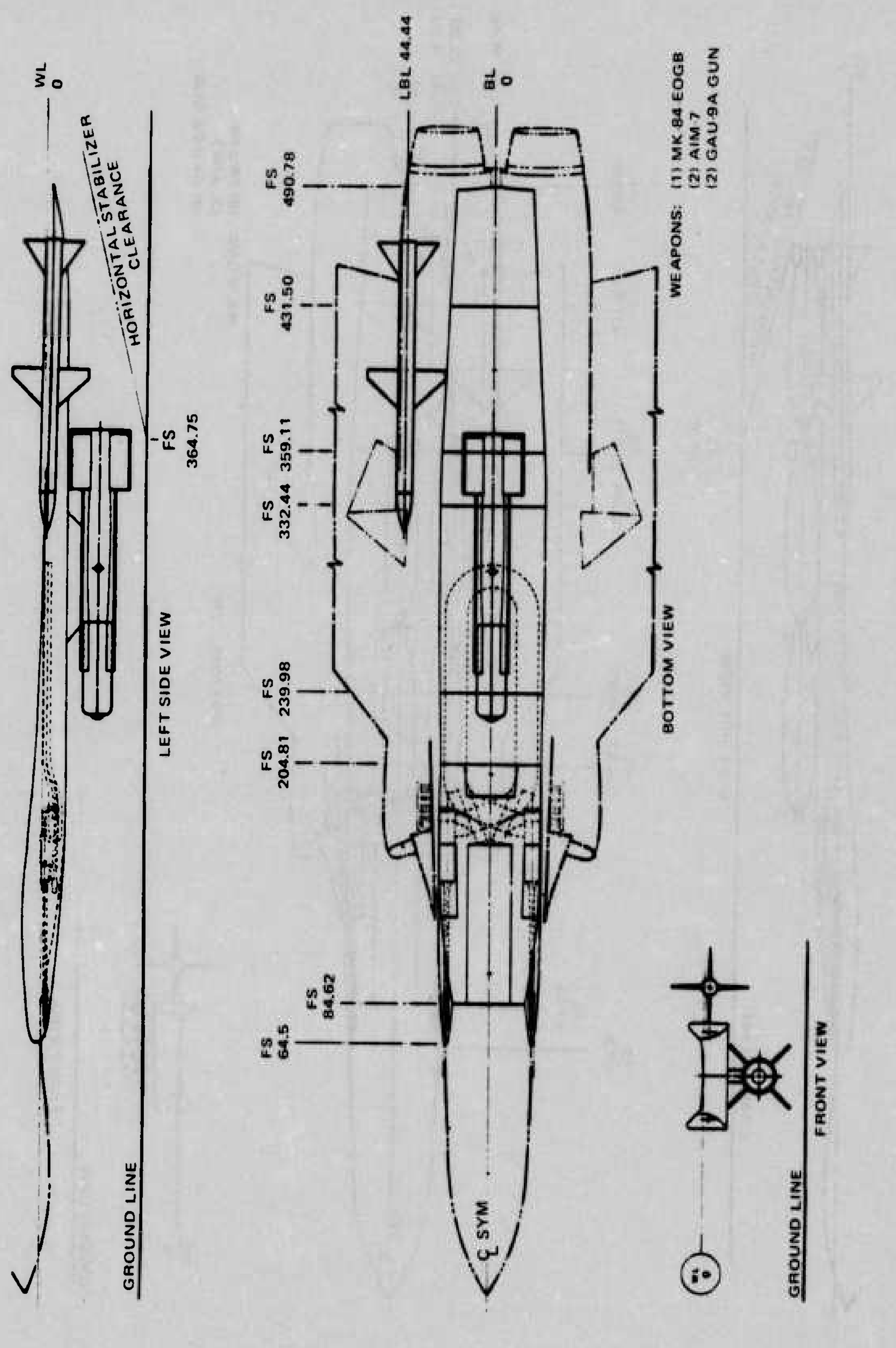


Figure 9: Weapon Arrangement

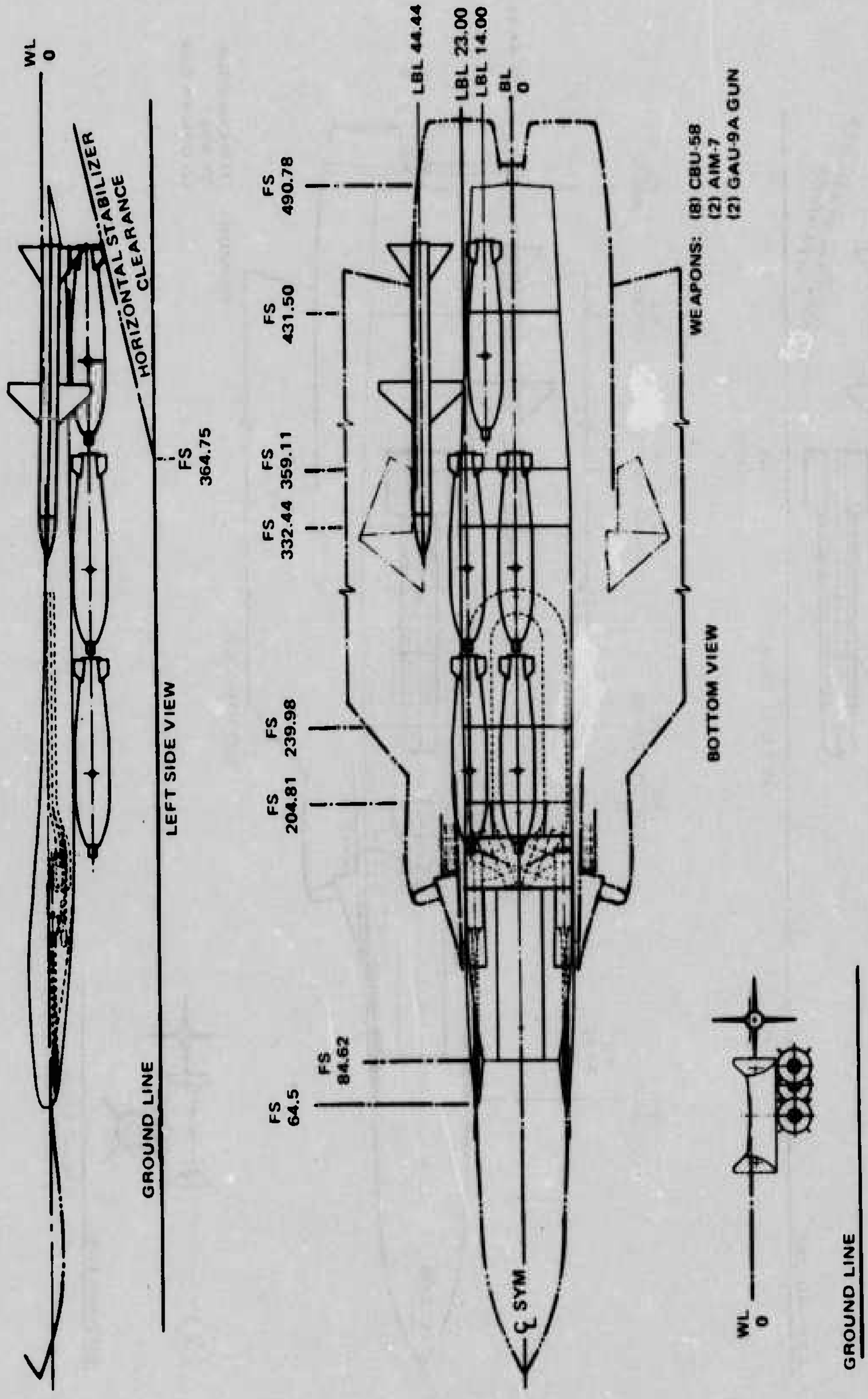


Figure 10 : Weapon Arrangement

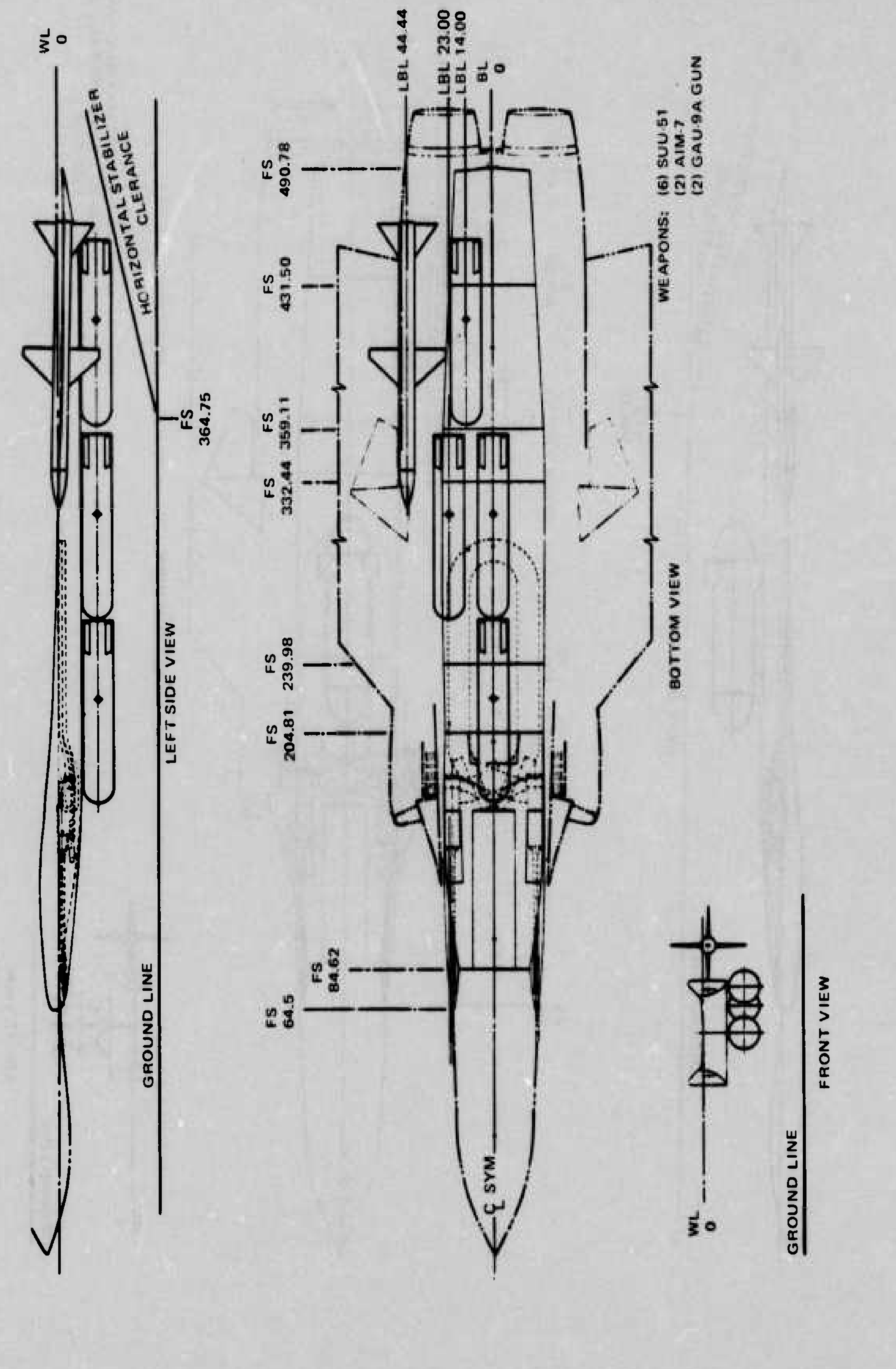


Figure 11: Weapon Arrangement

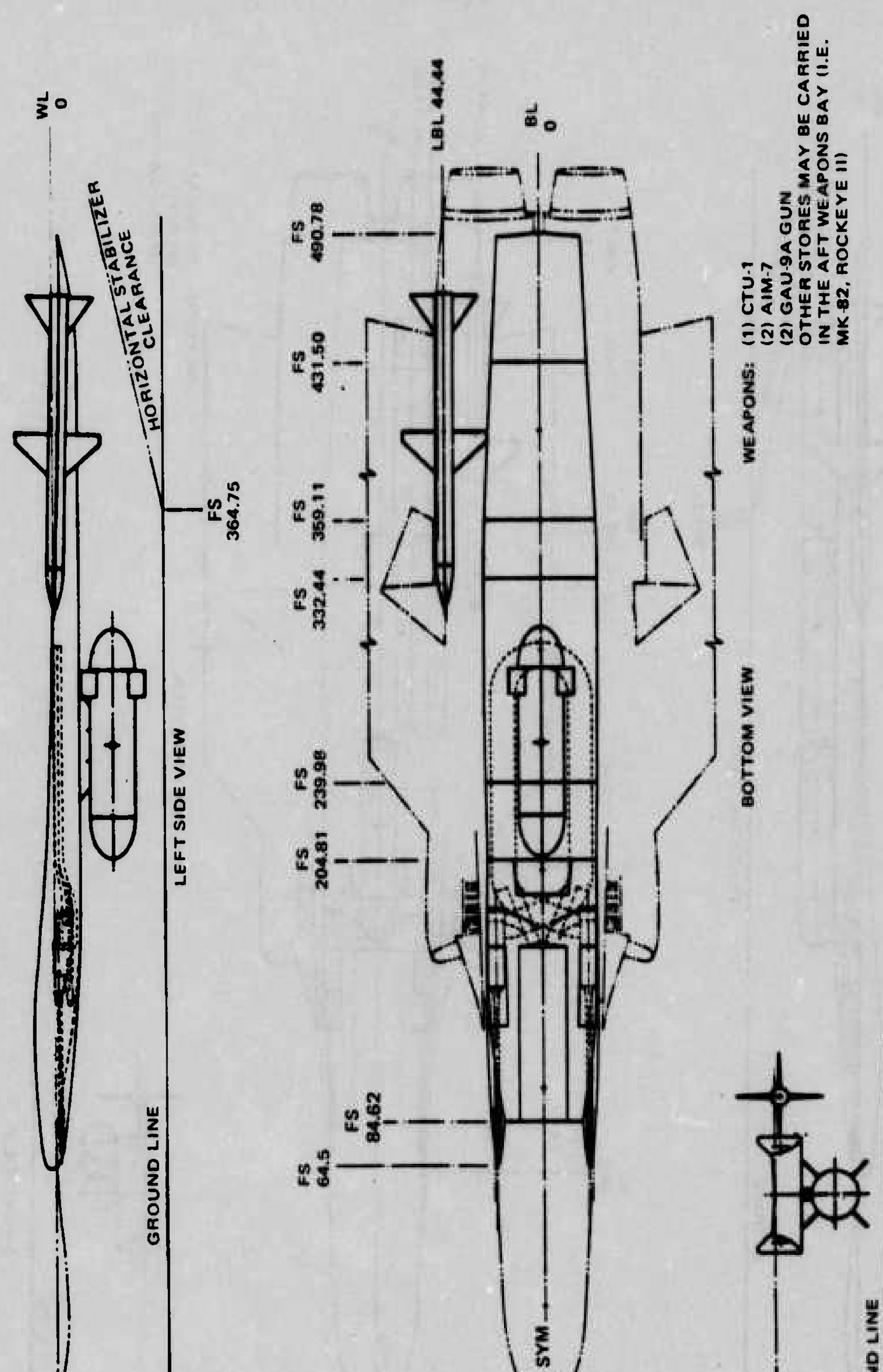


Figure 12 : Weapon Arrangement

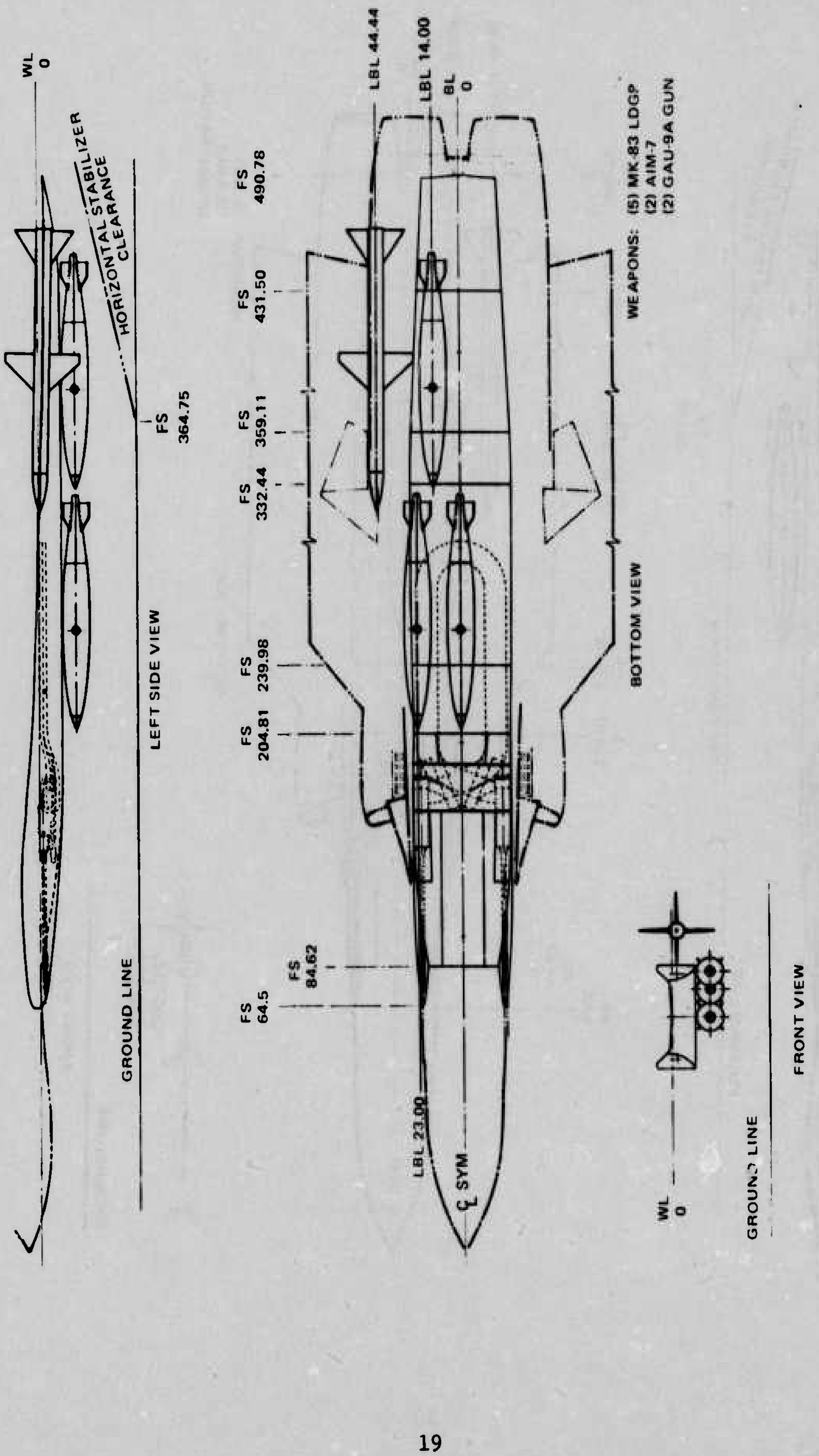


Figure 13 : Weapon Arrangement

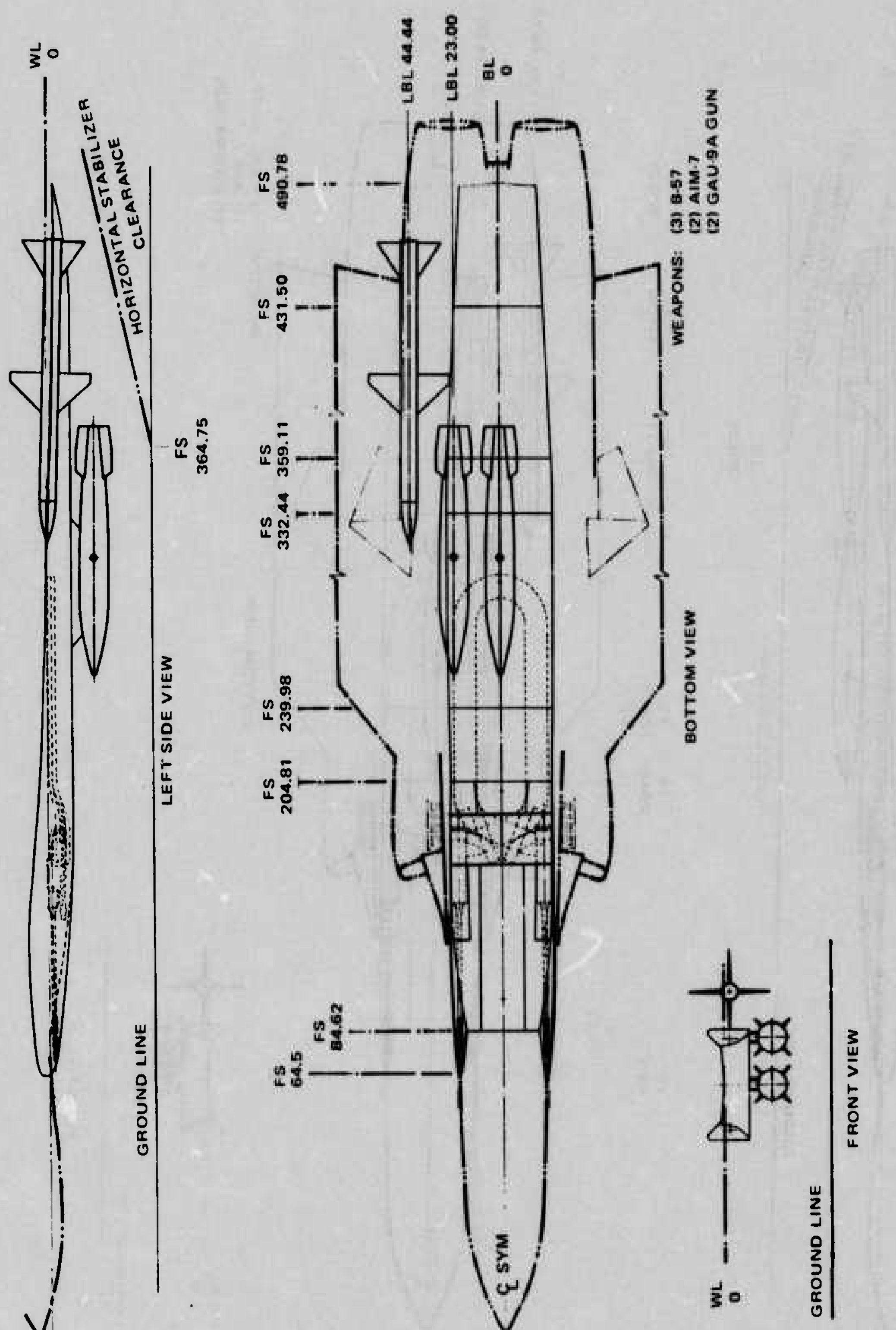


Figure 14: Weapon Arrangement

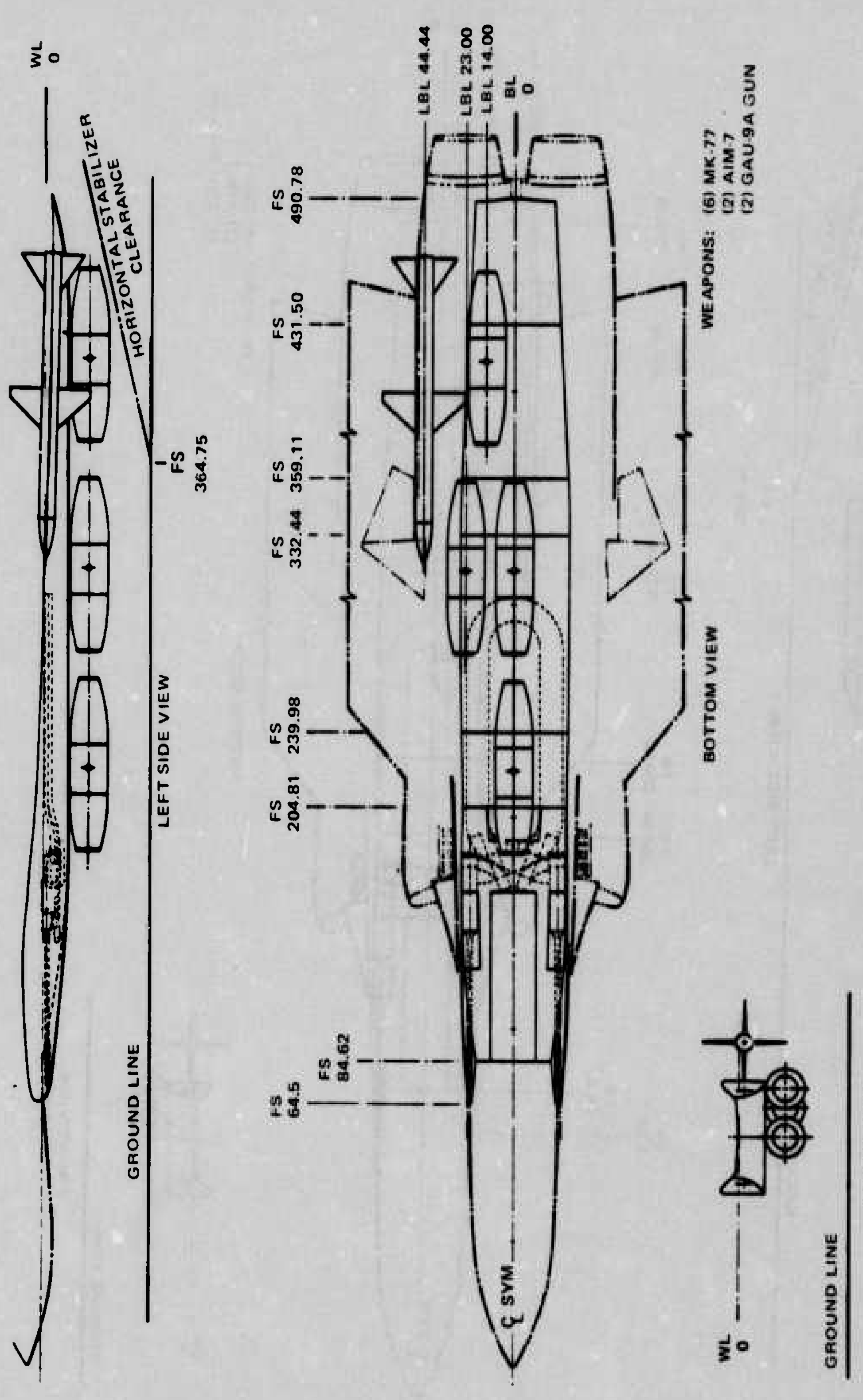


Figure 15: Weapon Arrangement

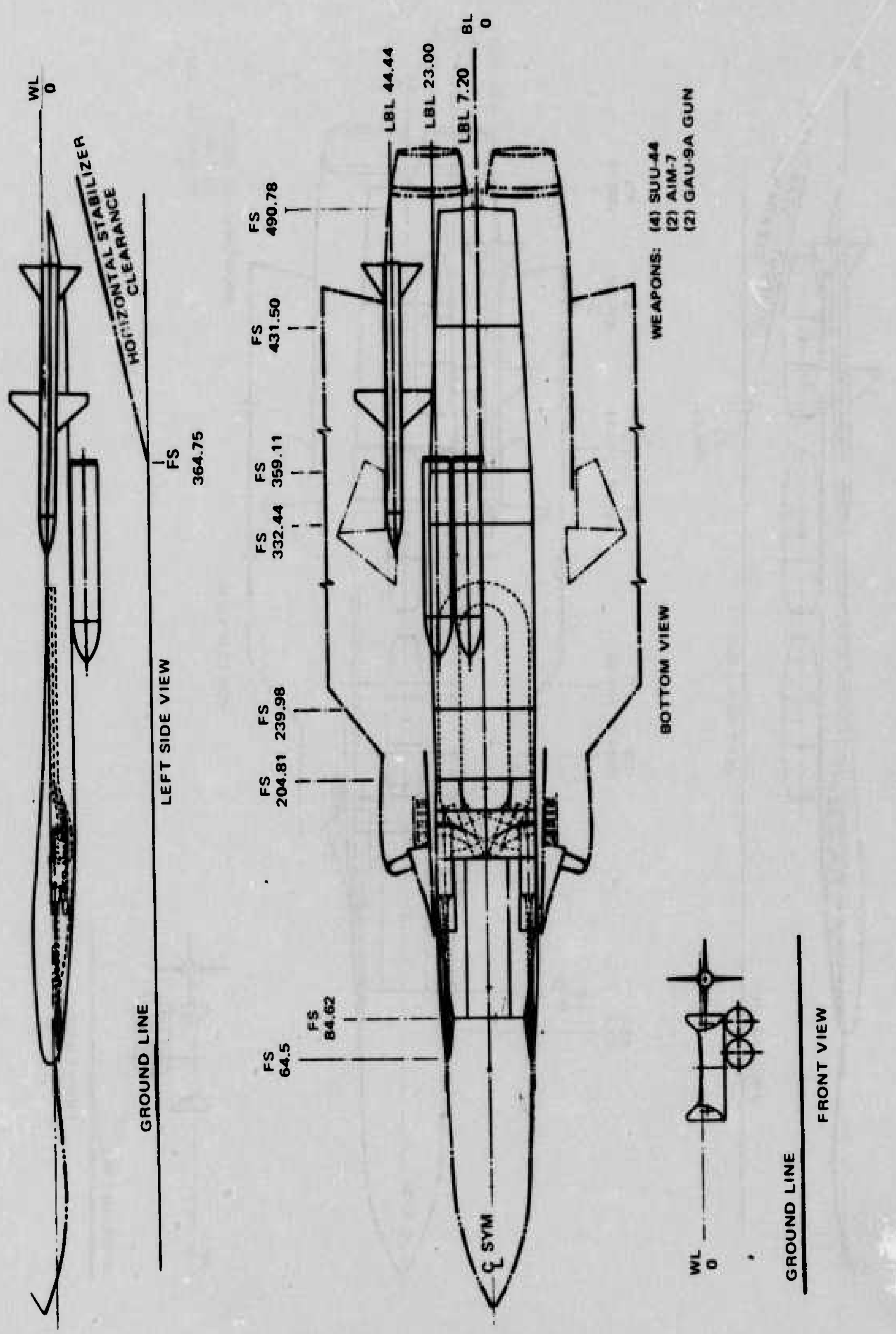


Figure 16: Weapon Arrangement

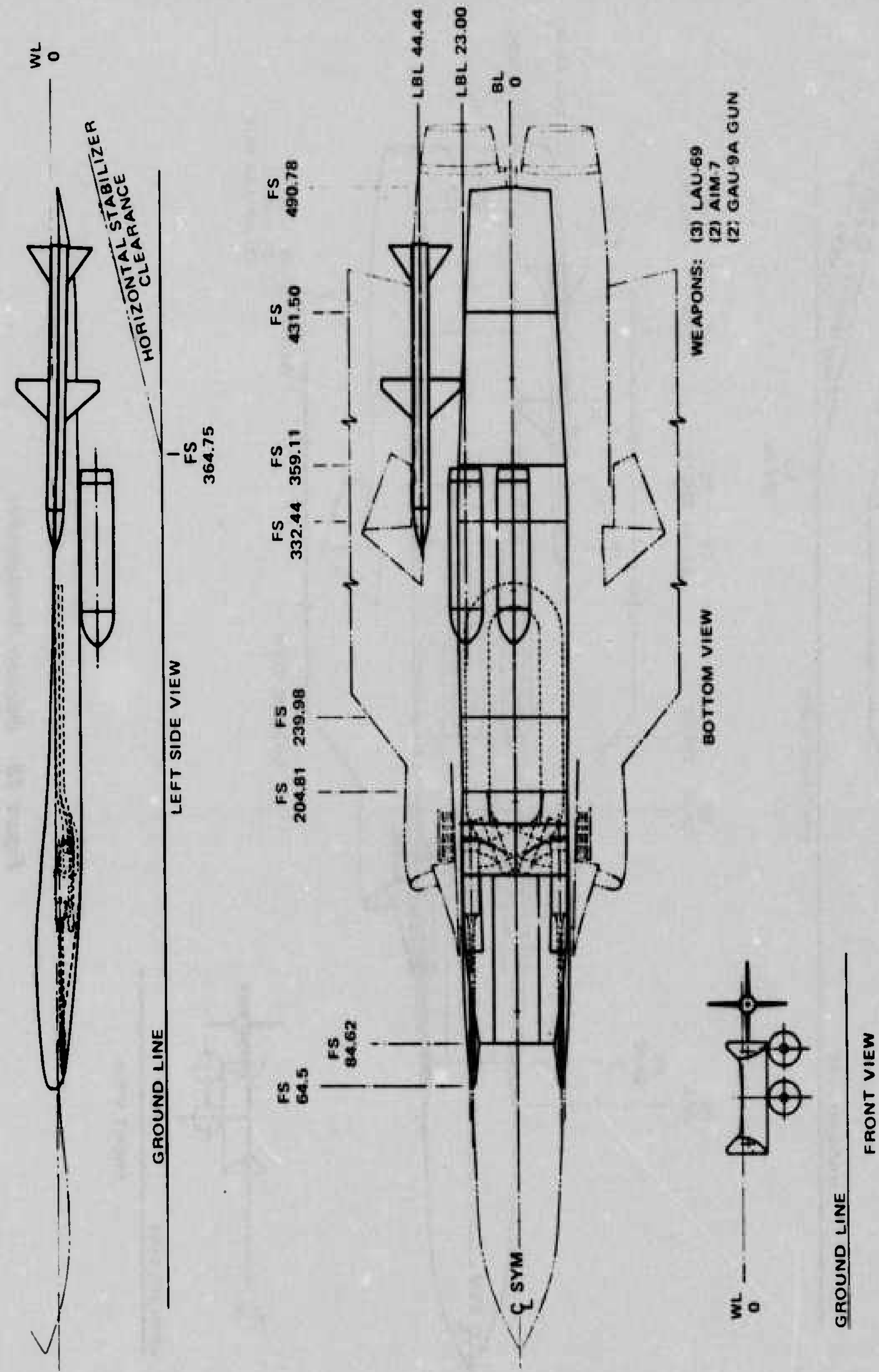


Figure 17: Weapon Arrangement

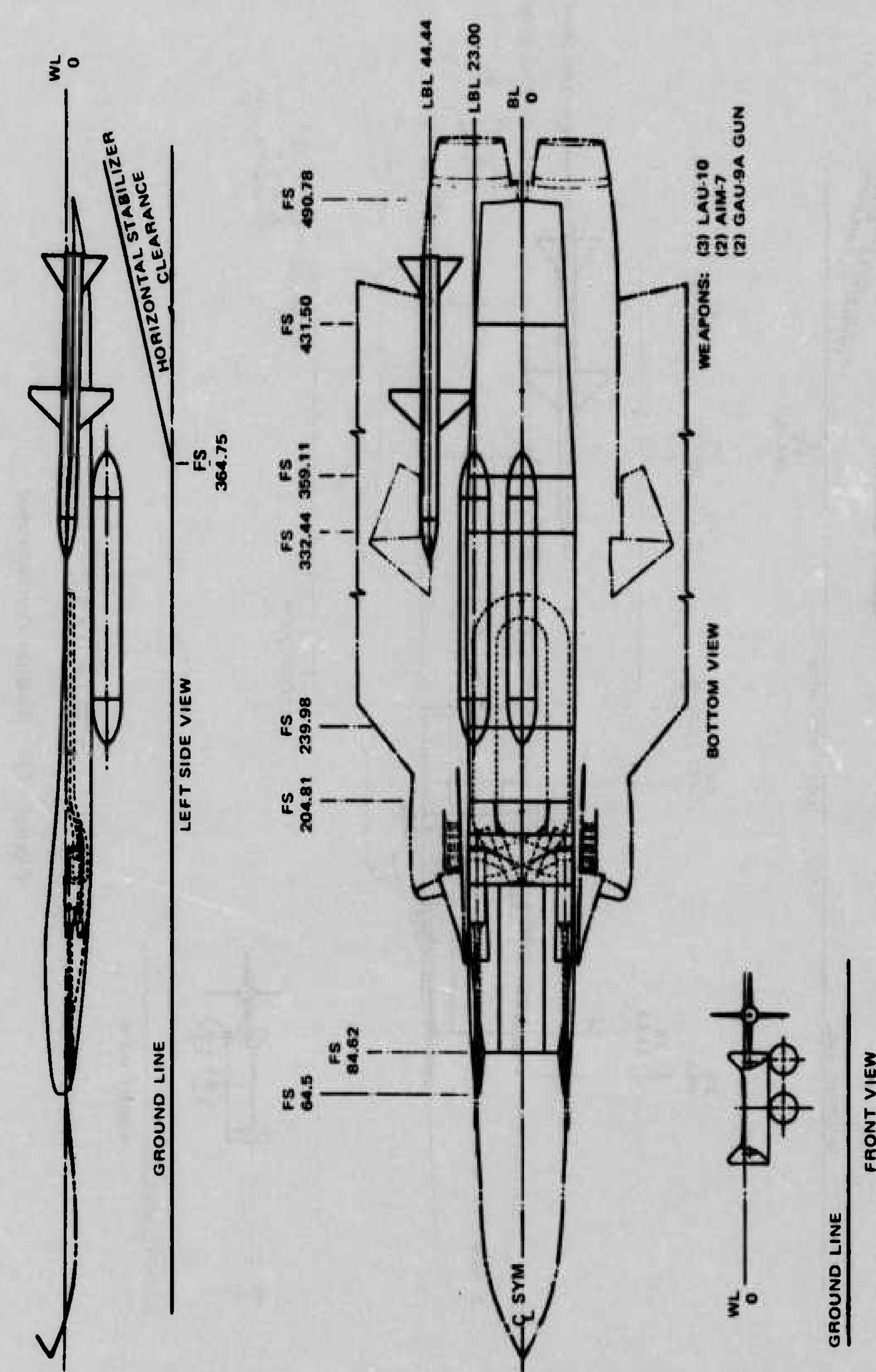


Figure 18: Weapon Arrangement

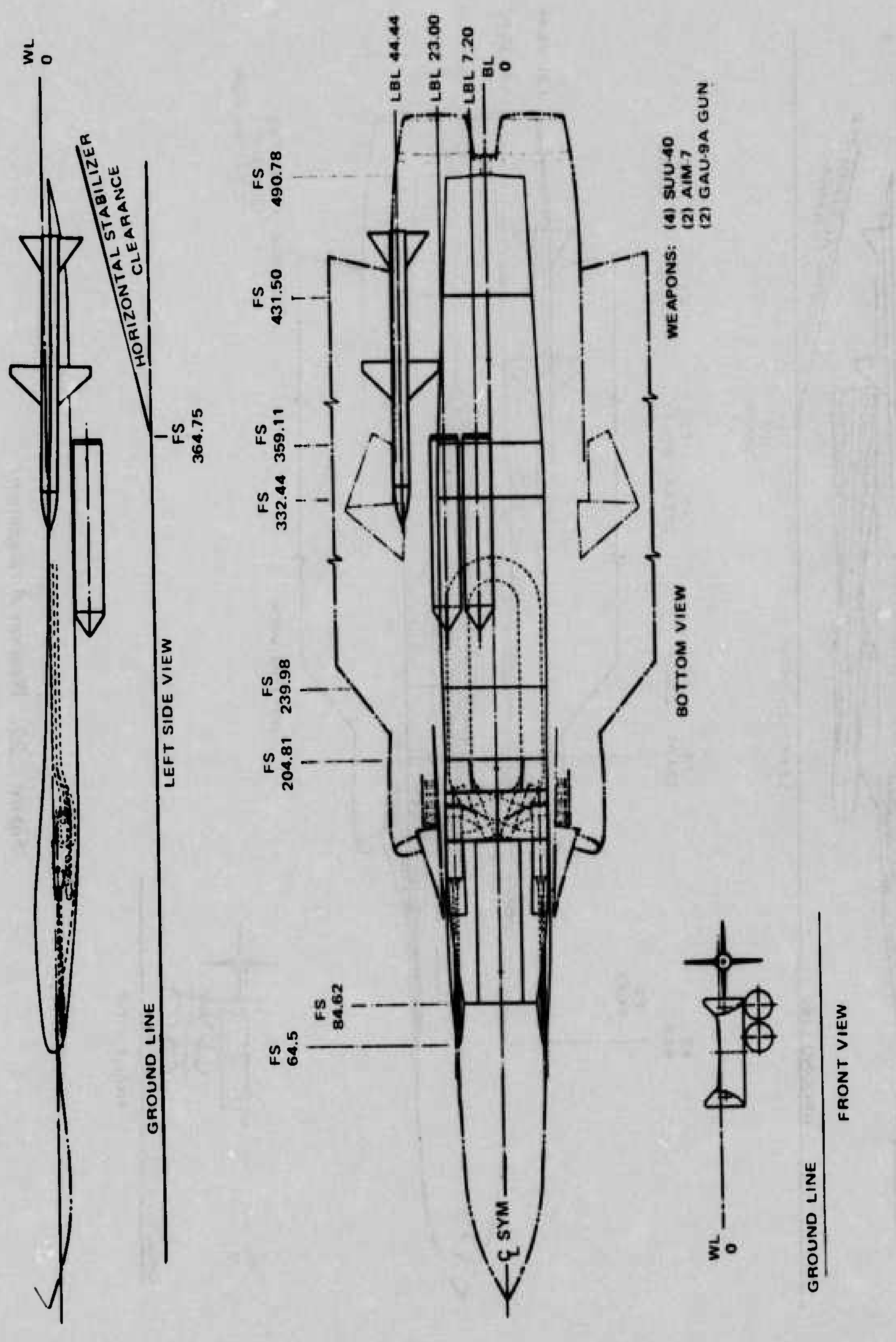
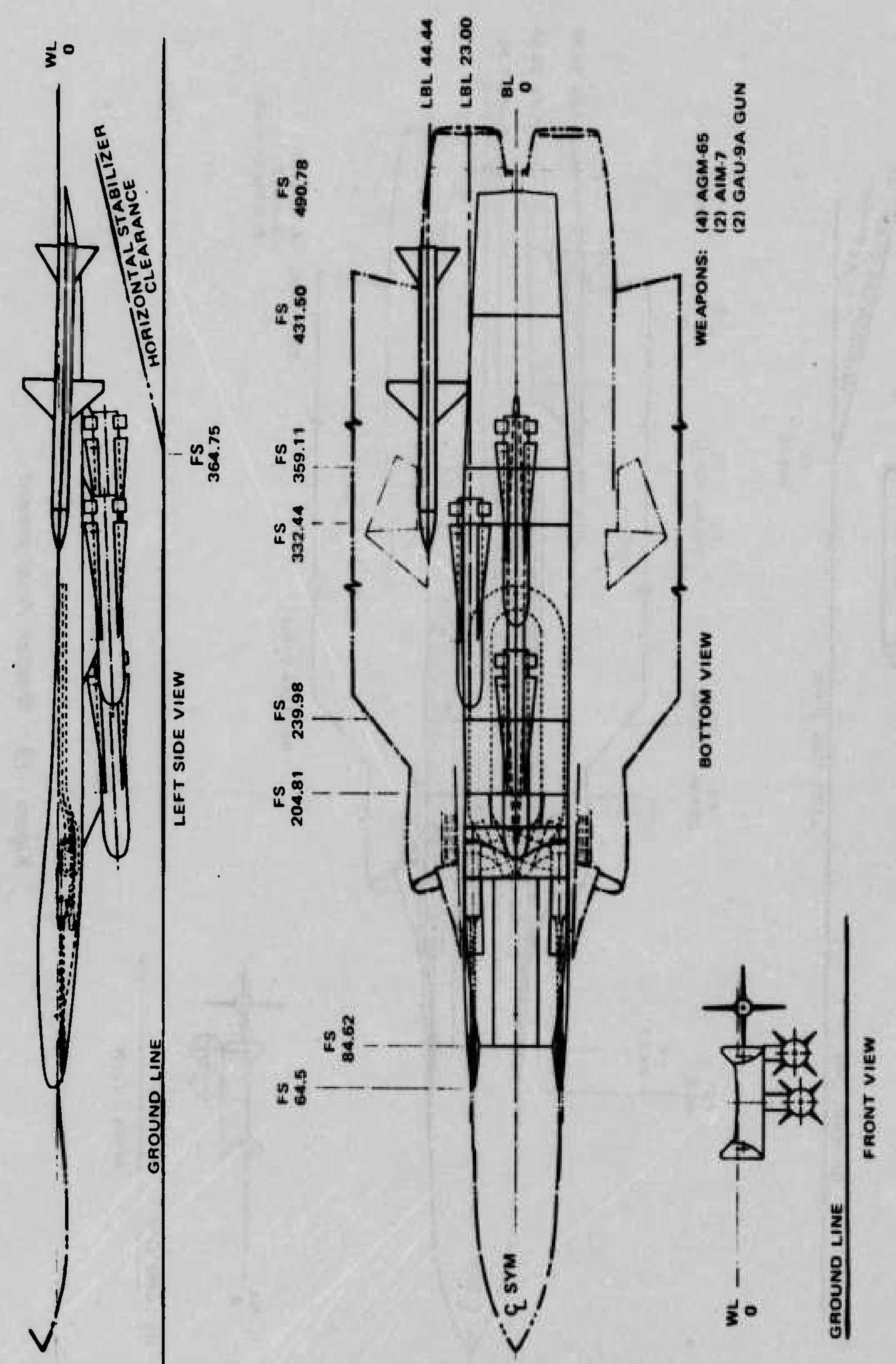


Figure 19: Weapon Arrangement



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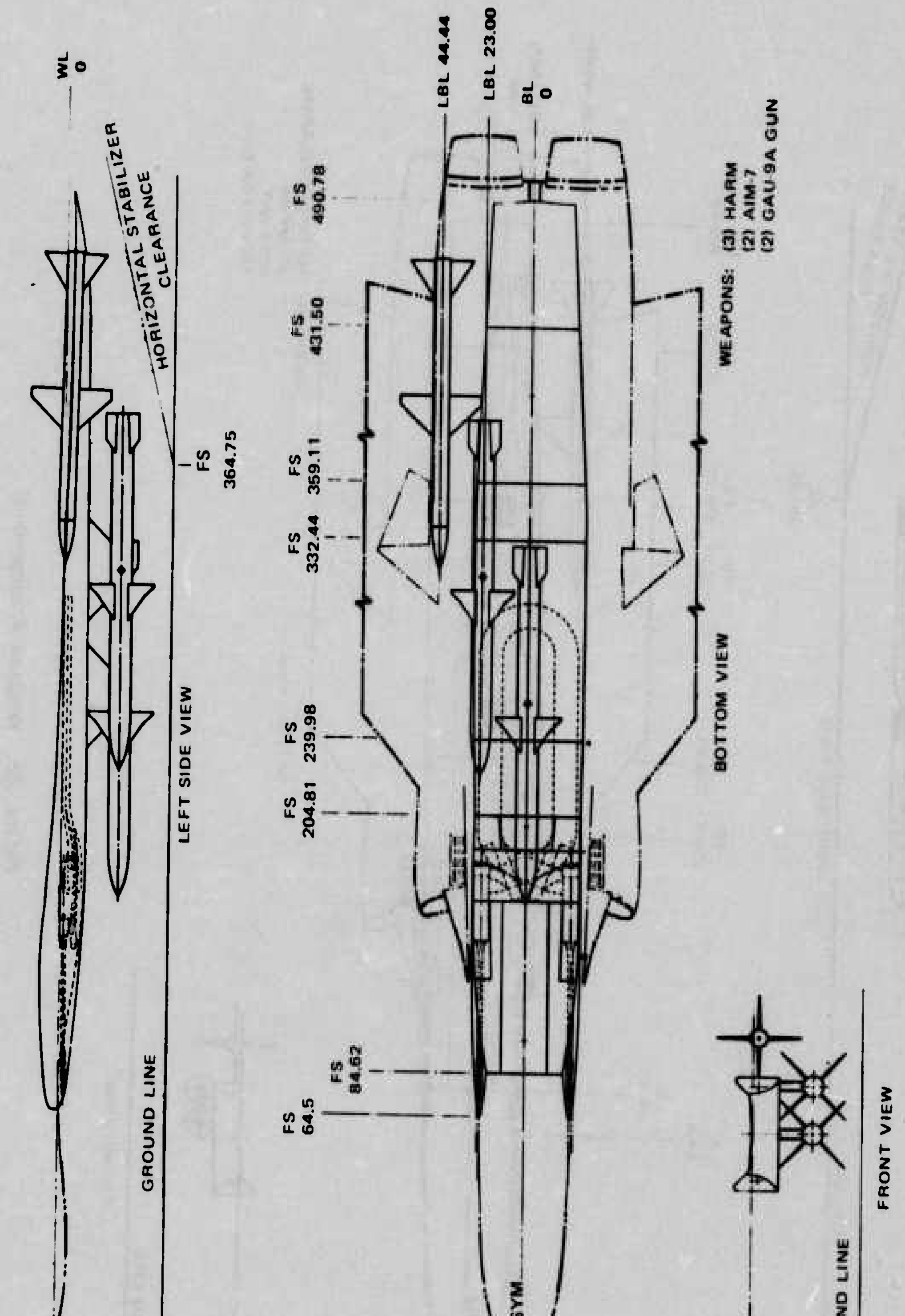

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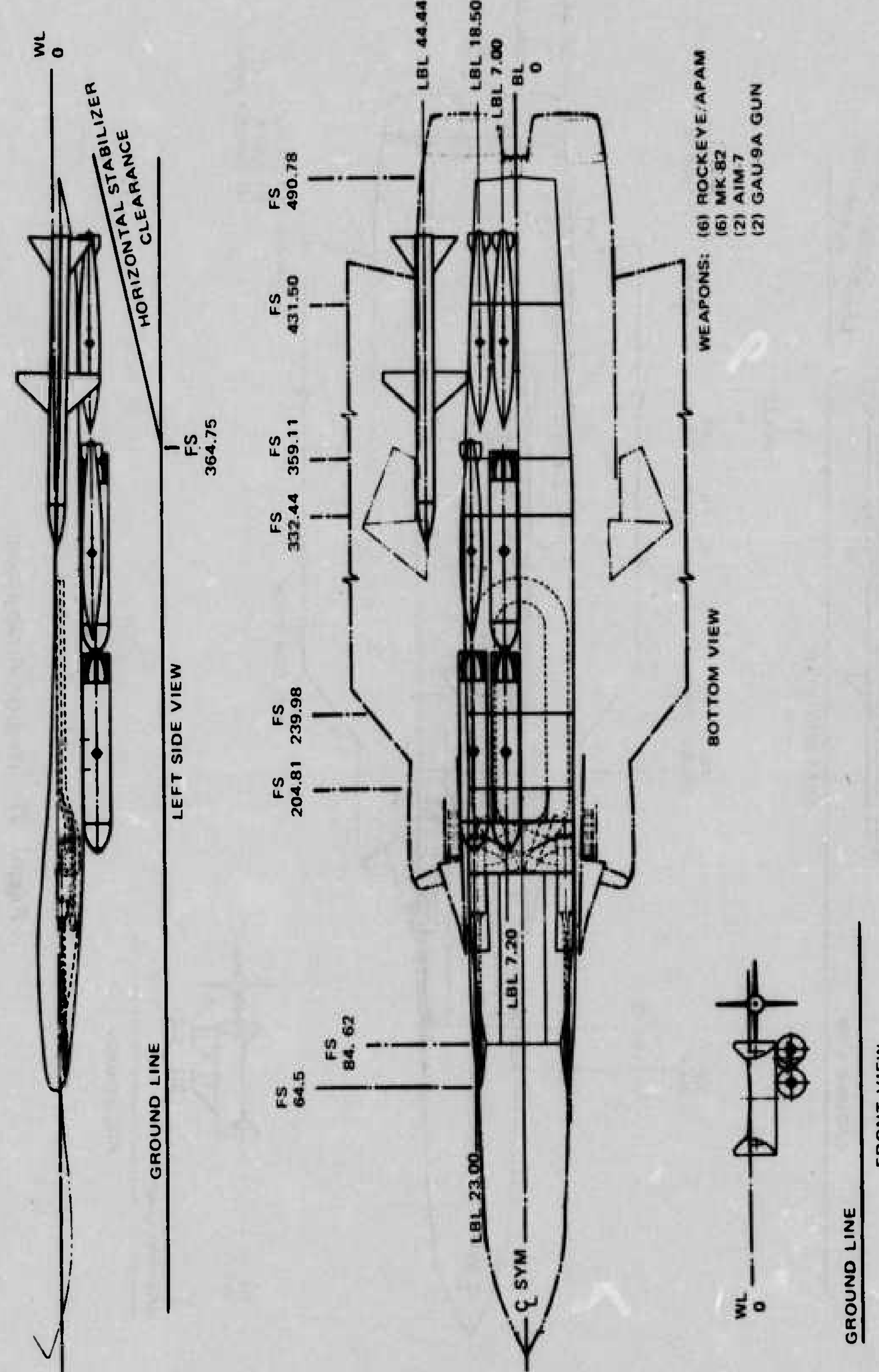

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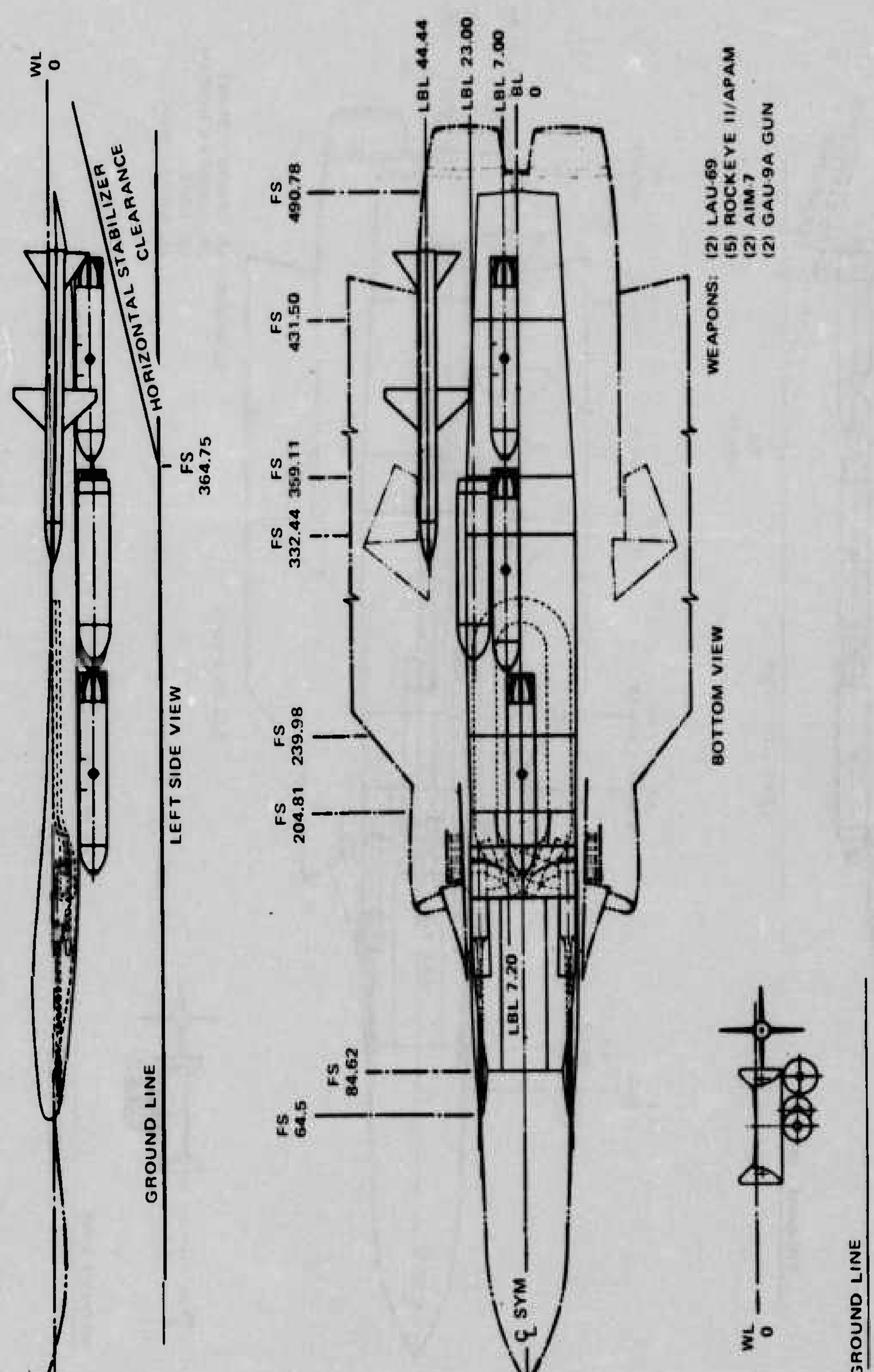

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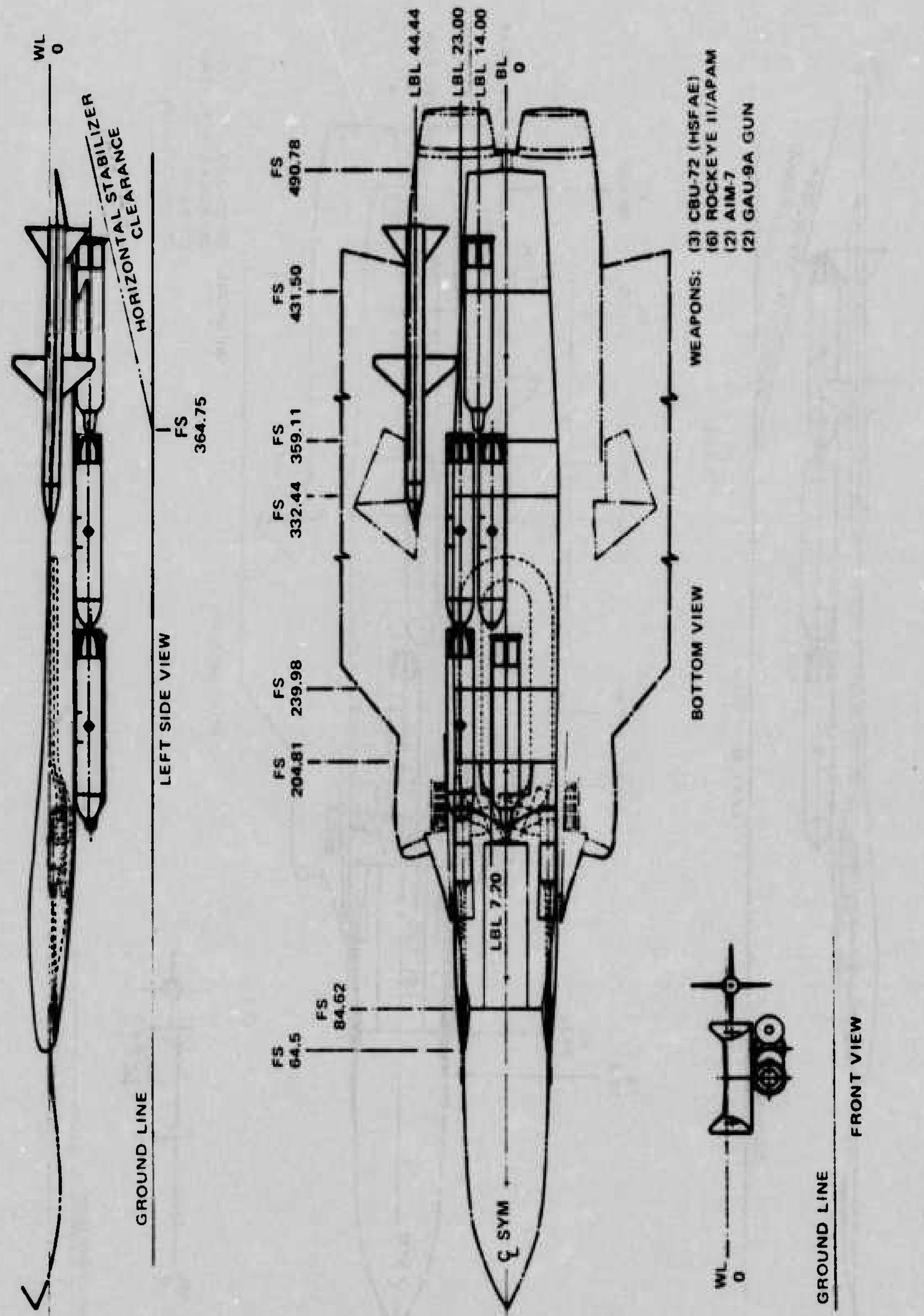

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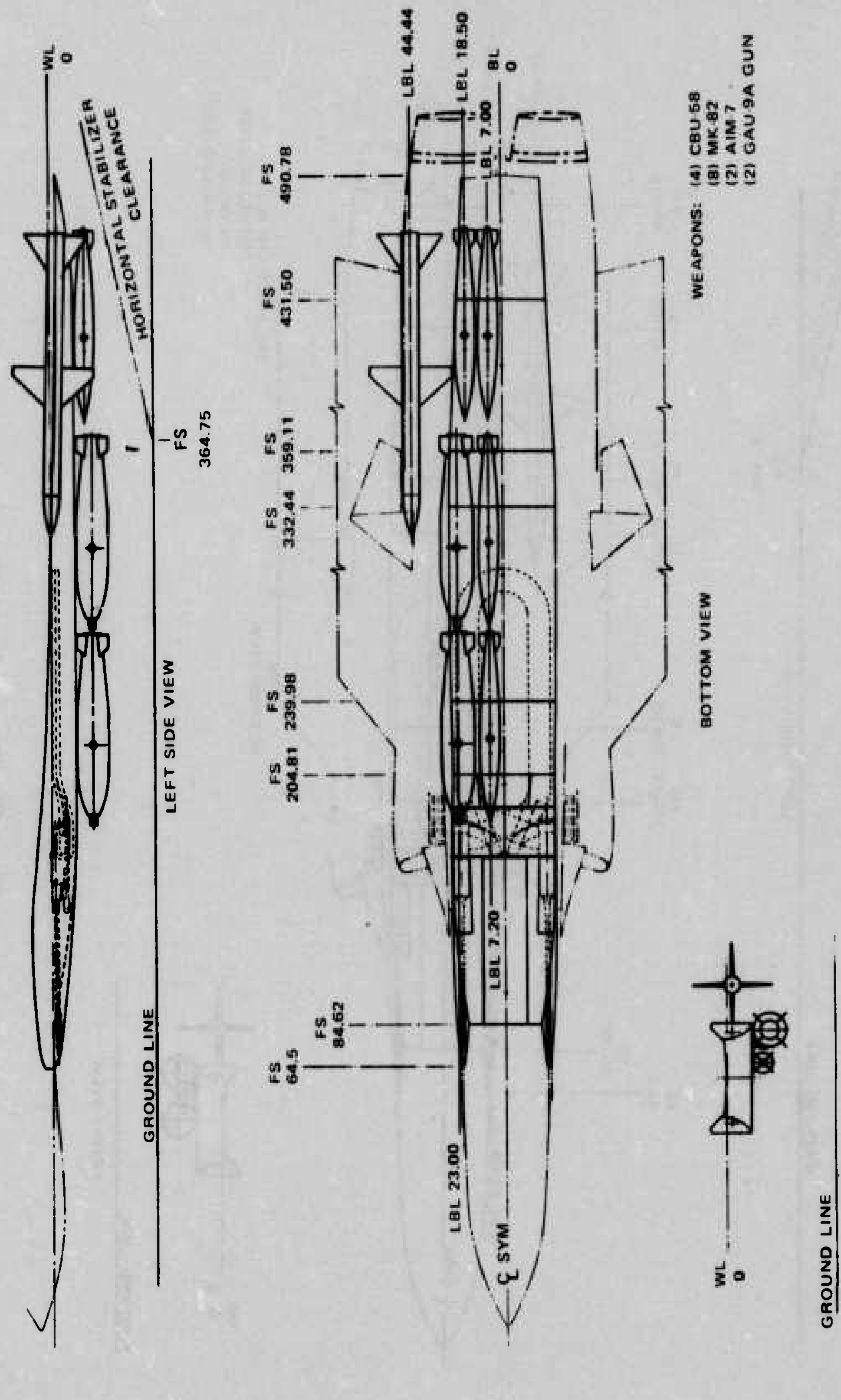

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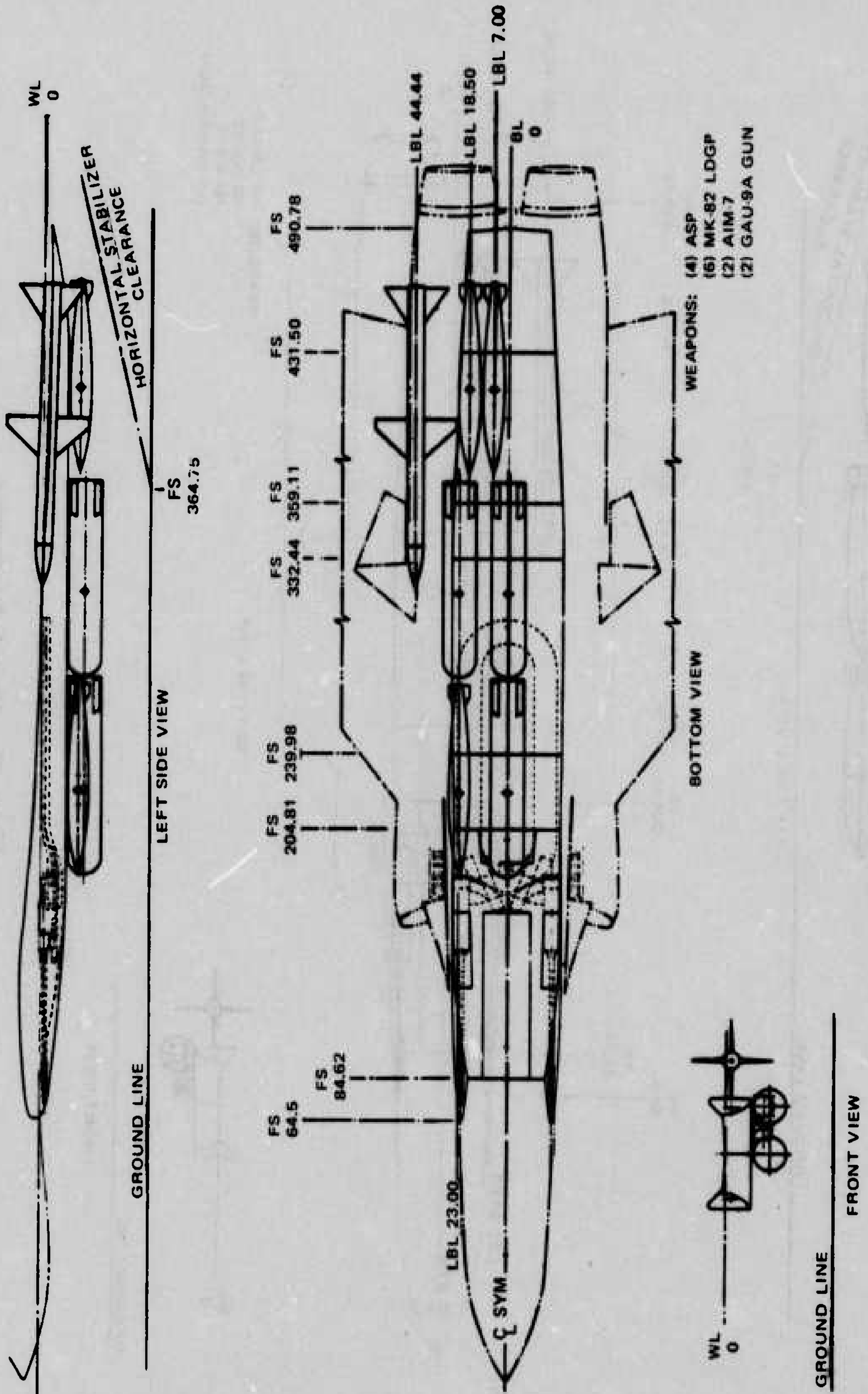

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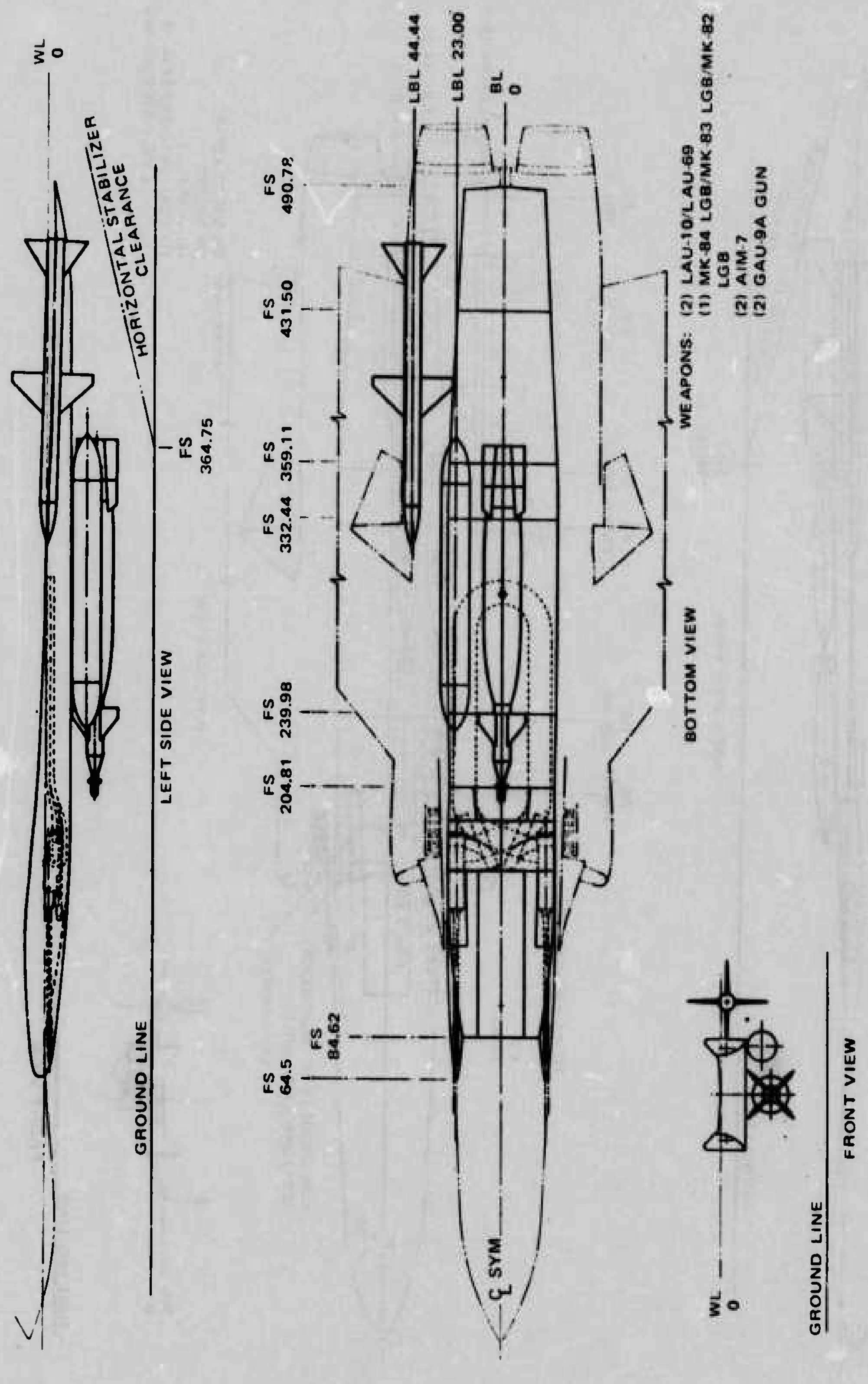

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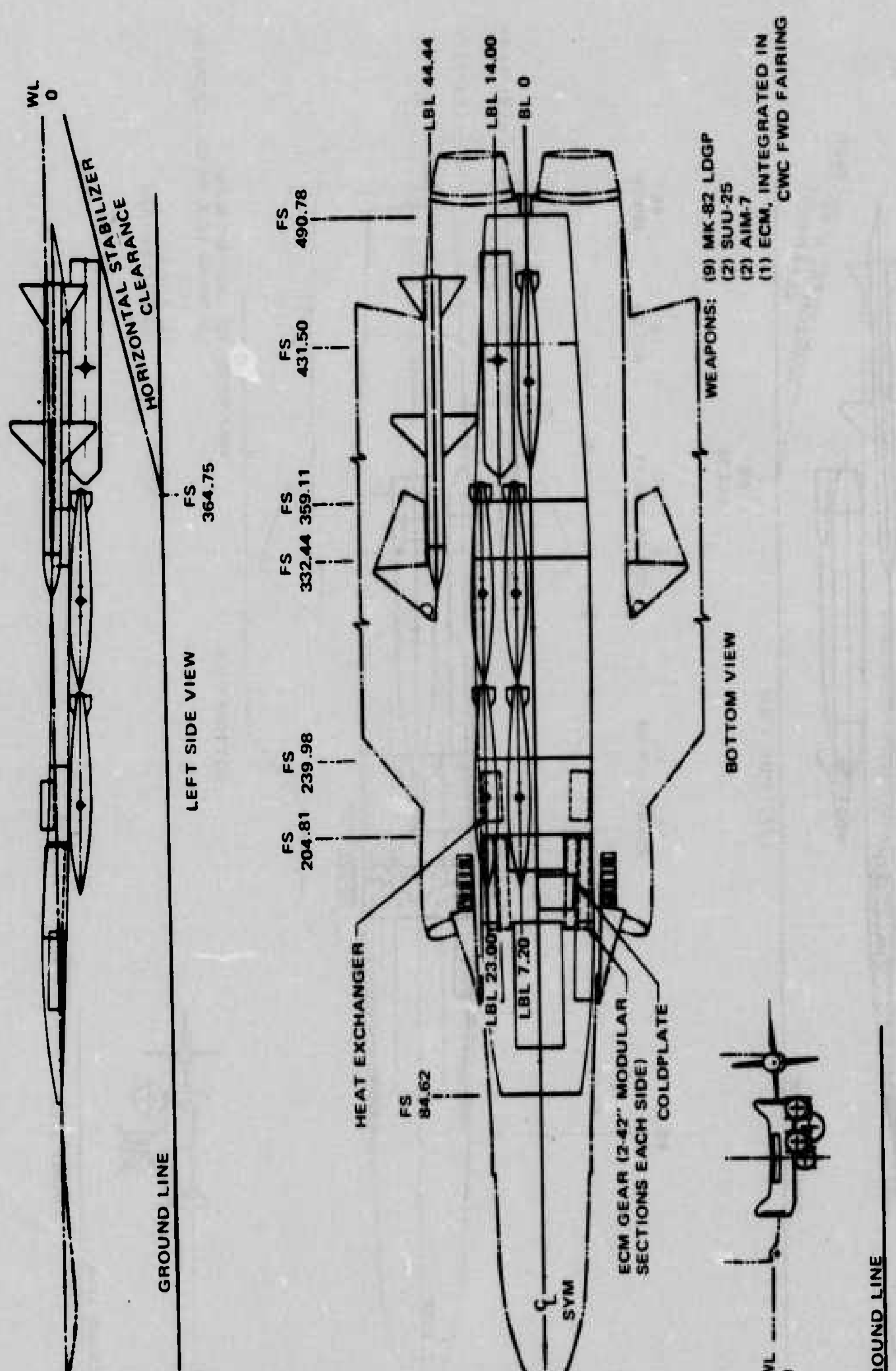

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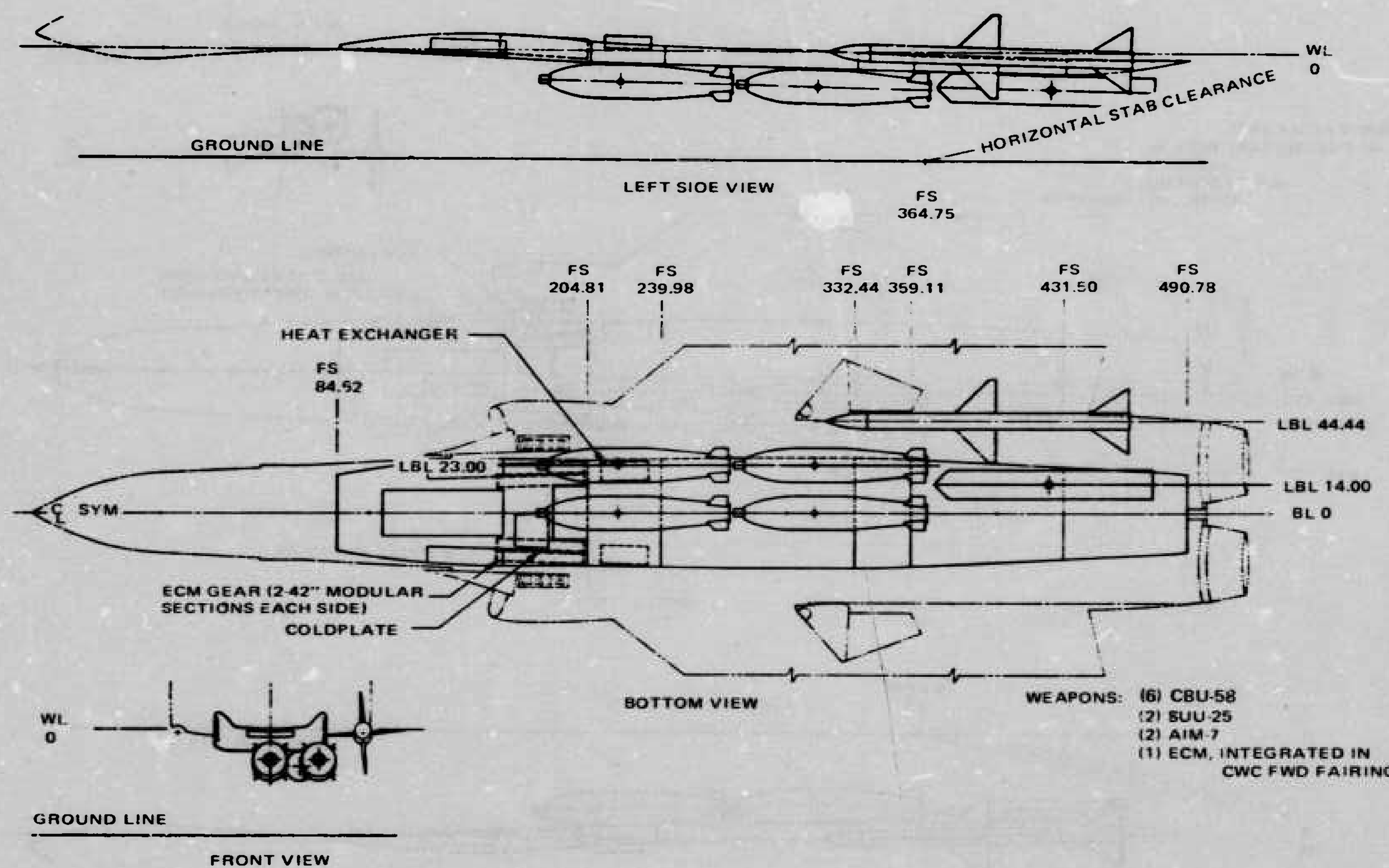

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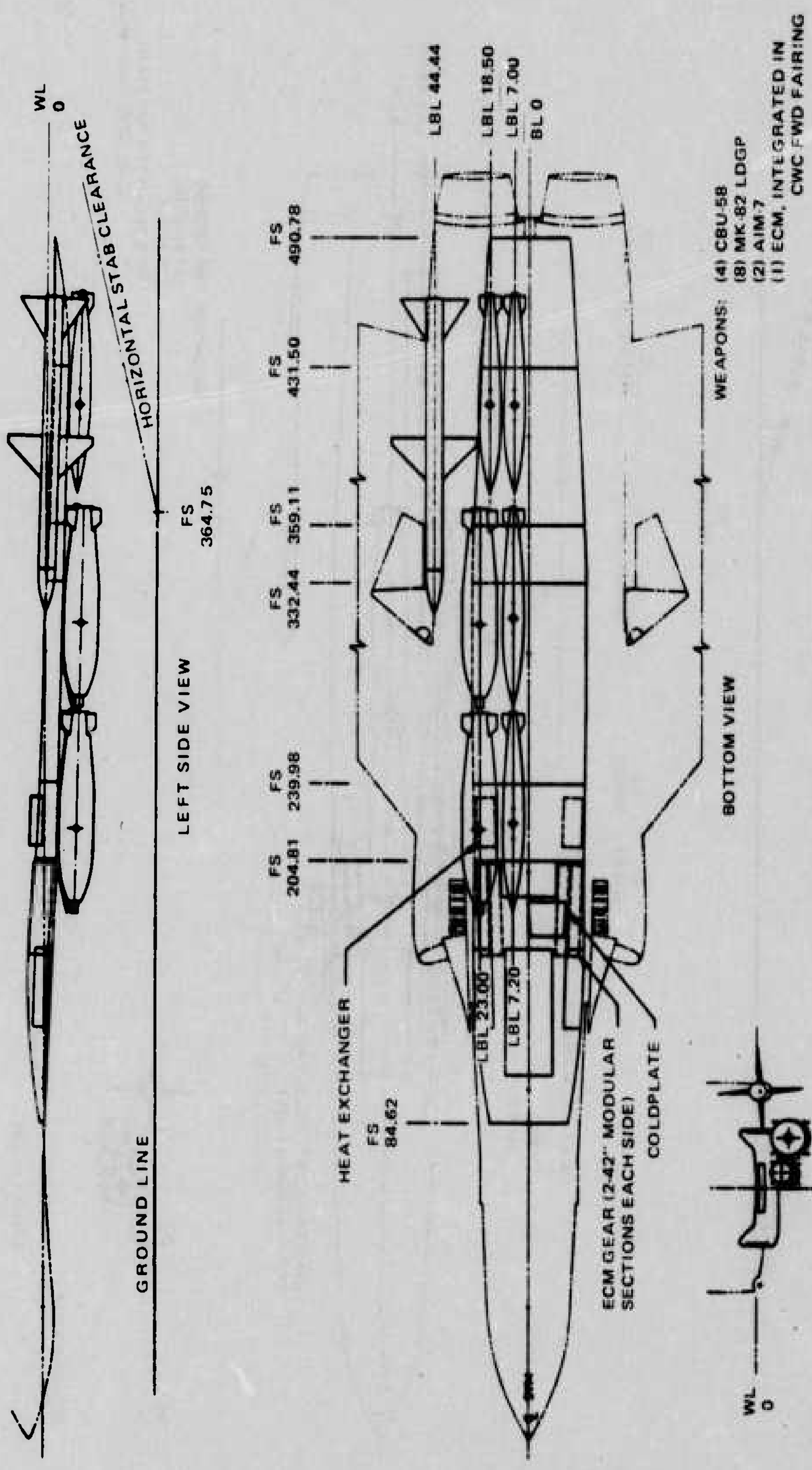


Figure 30: Weapon Arrangement

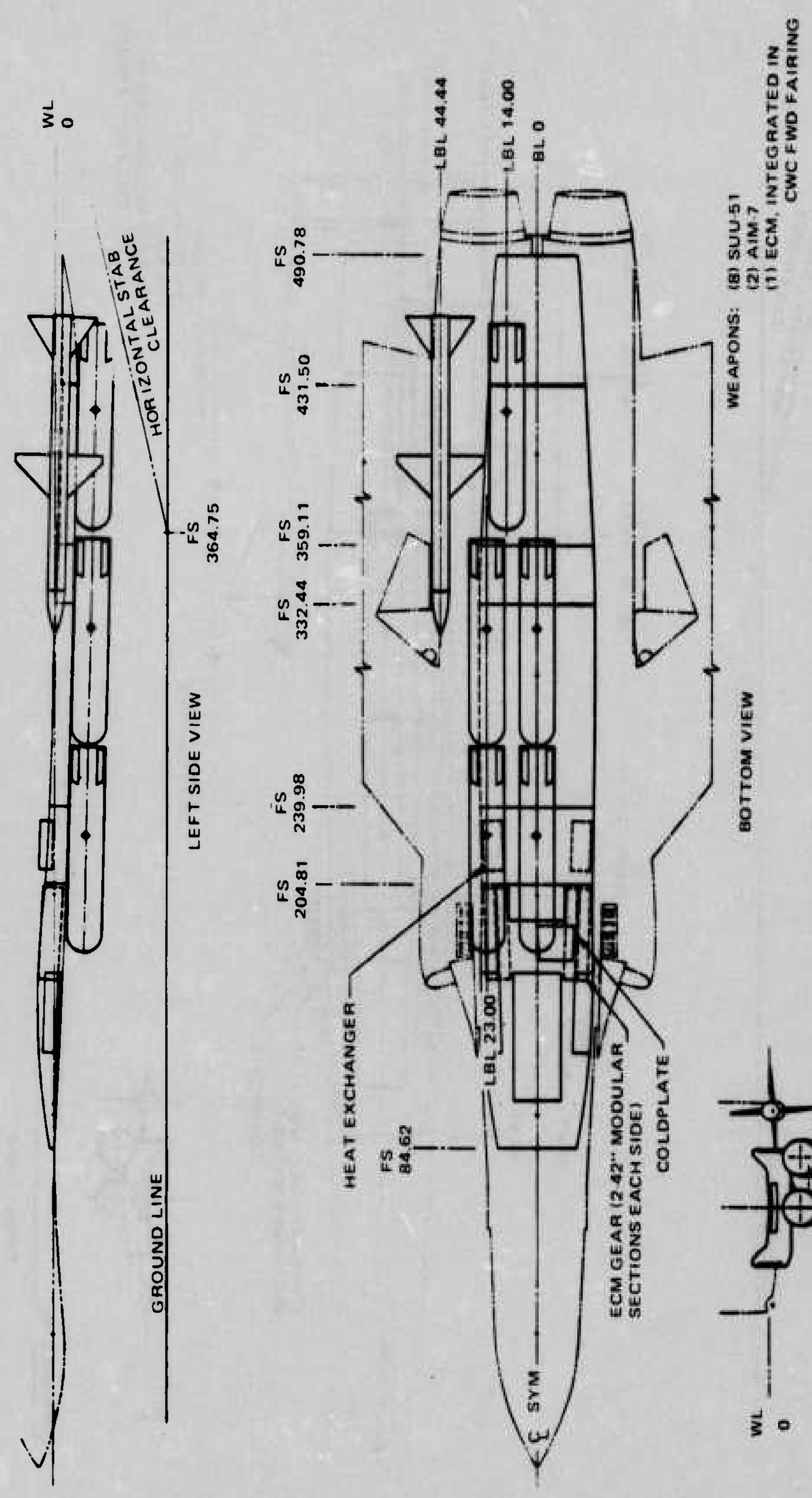
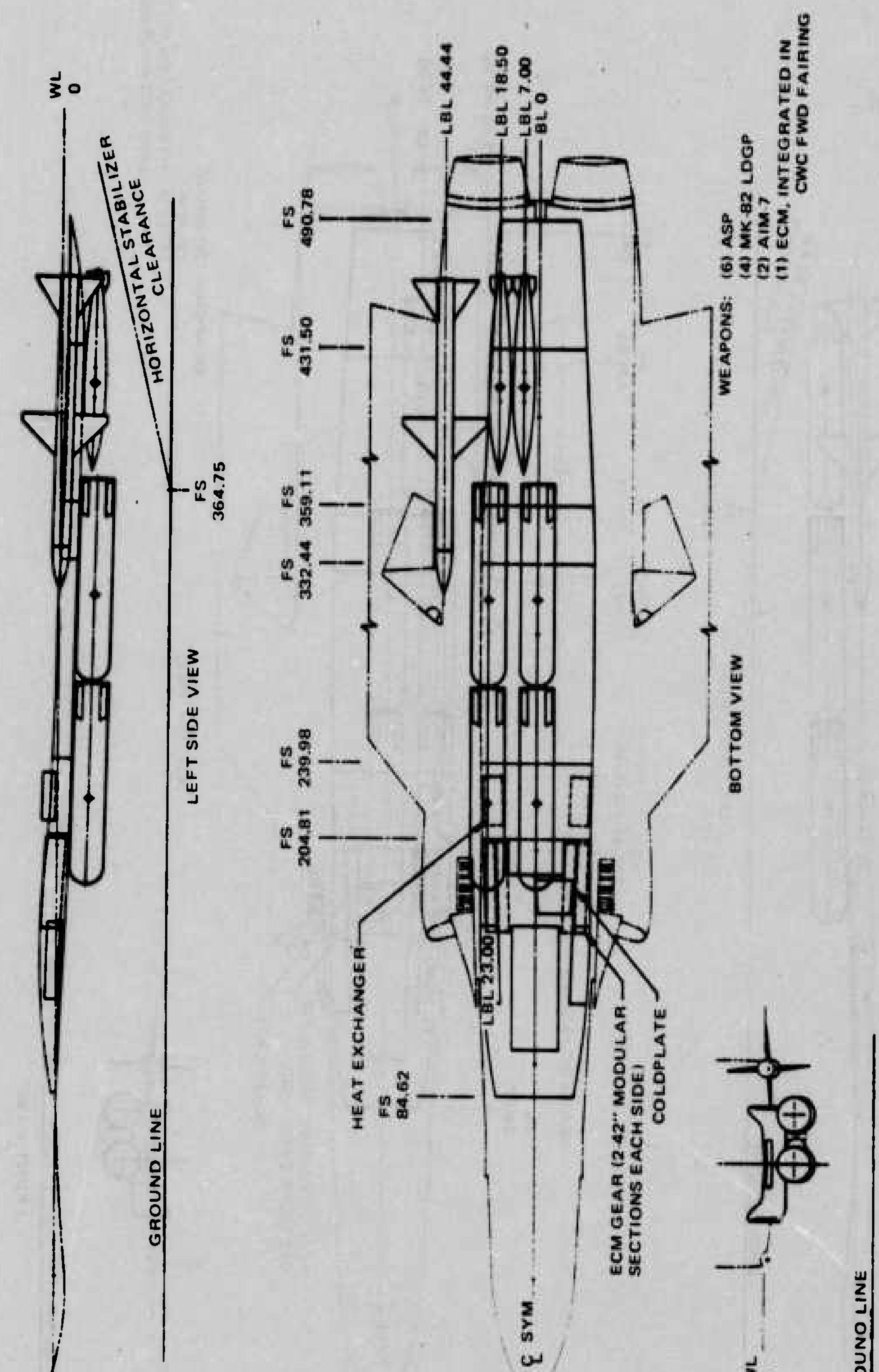


Figure 31: Weapon Arrangement



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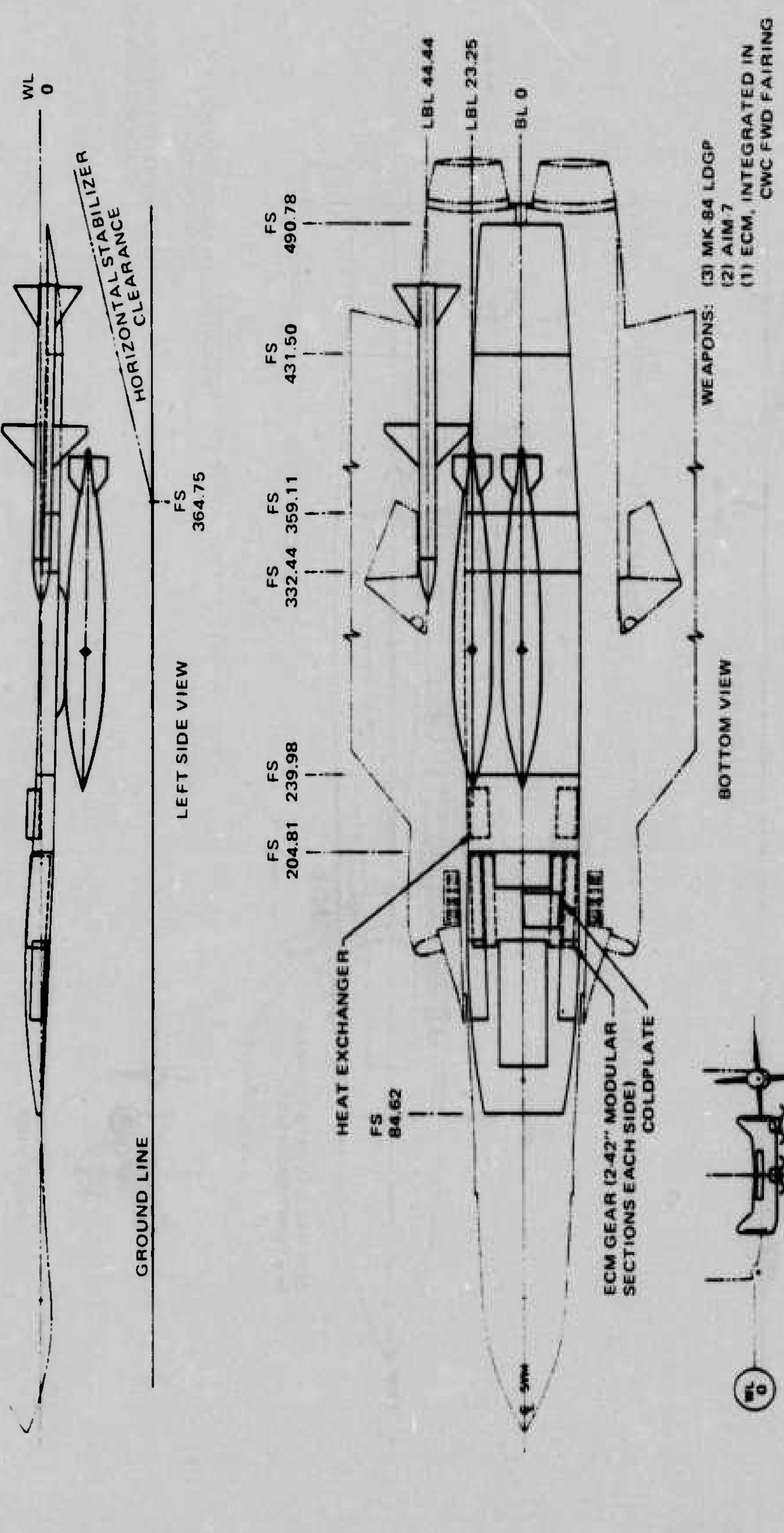


Figure 33: Weapon Arrangement

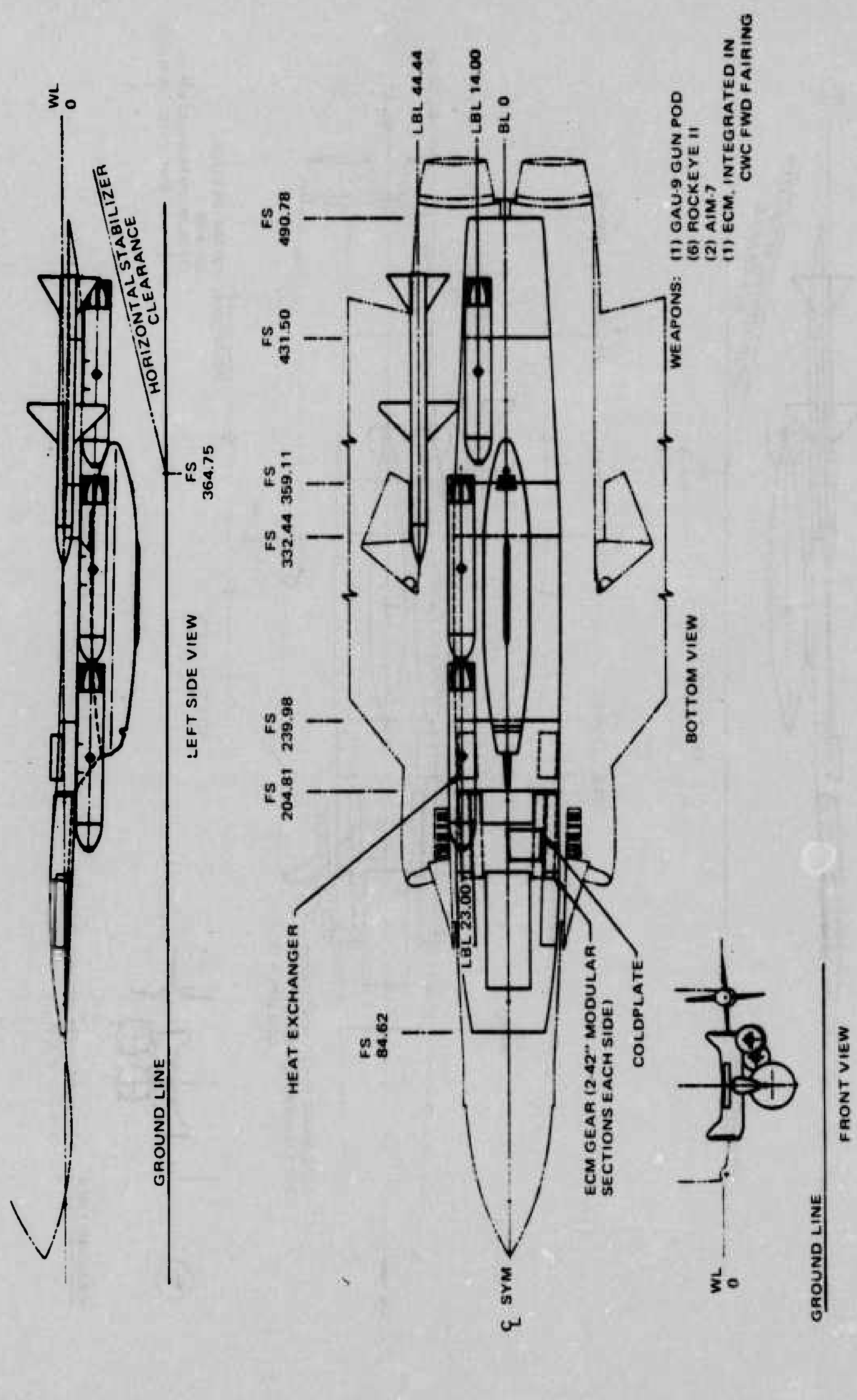


Figure 34: Weapon Arrangement

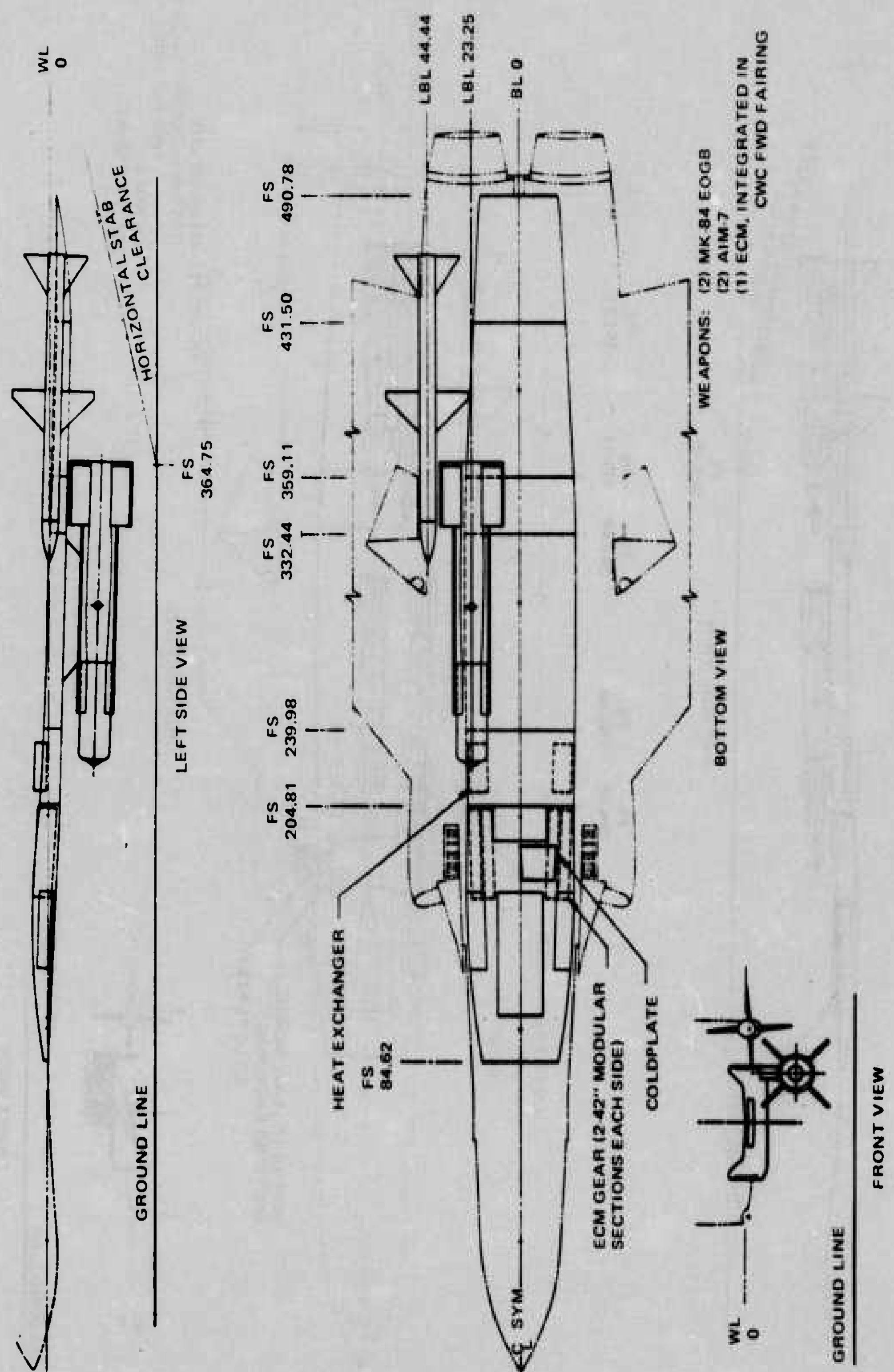


Figure 35: Weapon Arrangement

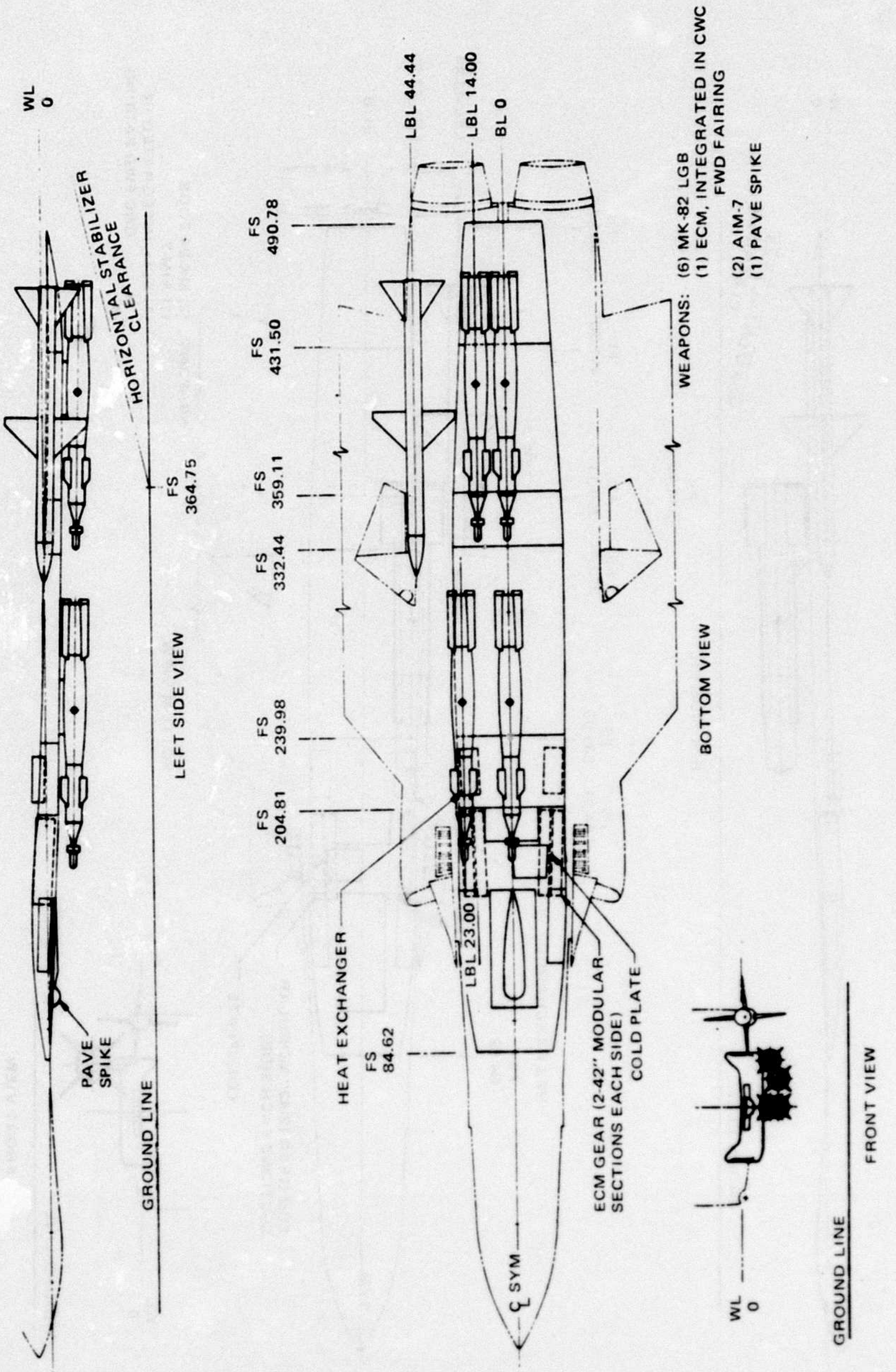


Figure 36: Weapon Arrangement

CONFIGURATION

An objective of this study was integration of weapons, suspension system and aircraft to produce a configuration with maximum performance both as a bomber and as a fighter. The aircraft structural arrangement and maintenance access requirements limited the configuration alternatives available, the large number of weapon types and load mixes required necessitated a complex weapon mounting matrix, and aerodynamic drag considerations tended to require as small a conformal carriage as possible. It was therefore mandatory that all constraints be simultaneously considered so that the compromises between conflicting requirements could be most easily developed.

The feasibility of integrating modular ECM components within the conformal carriage volume instead of the GAU-9A guns was investigated near the end of the study. The ECM model chosen as typical of this equipment was the ALQ-131 which is composed of several modules 5.3 x 9.0 x 42 inches with one 9.0 x 42 inch side against a cold plate serving as a heat sink for the electronic elements. Figure 36 illustrates a possible method of integrating four full modules within the forward missile wells. Antenna placement etc was not examined since such work was considered beyond the contract scope. The volume required for storage of these components is such that the conformal carriage depth can be reduced from that required for GAU-9A gun installation.

AERODYNAMIC SHAPE

Although study of ECM equipment integration was not required, the preliminary data indicated such a total system integration offered large performance gains. Therefore two alternative conformal carriage shapes were developed. The thicker conformal carriage was developed for the GAU-9A gun installation and is shown in Figure 39, while the thinner conformal carriage shown in Figure 40 provides sufficient volume for the ECM equipment only.

The feasibility prototype conformal carriage width was adopted as an initial configuration because of the excellent flight test performance exhibited by the prototype. No wind tunnel tests were scheduled as part of this study, however, extensive tests were conducted as part of the parallel U.S. Air Force Study.

The conformal carriage tested did not contain the GAU-9A installation and was consequently the same thickness as the flight test prototype. The results of these wind tunnel tests indicated subsonic performance of a narrow carriage only wide enough to house the weapon ejectors was equivalent to that of a carriage as wide as the flight test prototype. The supersonic performance of the narrow carriage was superior to that of the wide carriage. The test data is summarized in Figures 37 and 38.

The narrower conformal carriage was considered to be less complex, less costly, lighter, and required less extensive aircraft modification than the wide version. Therefore the narrow conformal carriage was chosen as the recommended conformal carriage plan form shape.

The conformal carriage aft fairing as defined in Figures 39 and 40 contains approximately nine cubic feet of volume.

The shape and volume of the aft fairing could be changed if necessary to accommodate chaff dispensers, decoy flare dispensers, and other passive defensive systems without materially affecting the aircraft performance. One advantage to dispensing a decoy flare in this location is the fact that the flare is deployed at the very location which the incoming I.R. seeking threat is locked on. Probability of successful decoy action is higher in this case than for the case where the flare appears at some lateral displacement from the engine nozzles.

EJECTOR MATRIX

The ejector matrix developed for support of the weapons given in Table 1 and 2 represents a compromise between an infinitely flexible mounting matrix where each weapon suit is optimally carried and a very limited mounting matrix with only a single set of weapon locations. An infinitely flexible mounting matrix is unattainable because ejectors have a finite width, and length, and require a supporting structure. There is therefore a limit to how closely spaced in width ejector mounting can be. There is also a limit to the length spacing if the ejector support structure is a permanent assembly. The store stations shown in Figure 41 illustrate the ejector mounting matrix developed to fit the F-4B/J conformal carriage. Flexibility is achieved by moving ejectors from one location to another as required by mission weapon loads.

Ejector utilization is summarized in Table 3.

STRUCTURAL ARRANGEMENT

The conformal carriage structure has been configured to permit package loading of preloaded weapons bays to facilitate aircraft turnaround. All components of the conformal carriage are quickly removable except the fwd fairing. The structure contains cavities into which weapon ejectors can be installed. Twenty spaces for 14 inch ejectors are provided and three spaces for either 14 inch or 30 inch ejectors.

Each weapon bay is composed of two or more cross beams transferring weapon inertia loads to the weapon bay attachment points; five or more longitudinal beams supporting the weapon ejectors and transferring weapon inertia loads from the ejectors to the cross beams; an external skin with stiffeners spaced at three and one-half inches to provide resistance to panel flutter, the skin provides horizontal shear strength to react the weapon inertia loads; two or more provisions for quickly attaching the weapon bay to the attachment fittings on the aircraft; and fairing panels covering the unused ejector cavities.

Each weapon bay also contains a hoisting mechanism capable of being operated by an external power source such as; hand held drill, electric motor, hydraulic motor, pneumatic motor, or hand operated speed wrench. The hoisting system contains a builtin braking system to preclude dropping the weapon bay when removing it from the aircraft.

A built in hoist system is not required in the aft fairing since its estimated weight is only sixty pounds and it can easily be handled by two men.

The forward fairing contains the nose landing gear door, LOX converter door, ECM and Pave Spike equipment and maintenance access doors. Figure 42 illustrates the structural arrangement for the conformal carriage GAU-9A gun installation while Figure 43 depicts the recommended configuration without the internal guns.

Moments developed by side loads acting upon the suspended weapons are reacted by the weapon bay attachments and the sway braces in the weapon bays. The sway braces are adjusted from outside the weapon bay and bear against the lower surface of the aircraft.

The conformal carriage contains two new auxiliary air doors which move along tracks when driven by hydraulic cylinders operated by the landing gear extension hydraulic system. The attachment fitting installed in the aircraft center line stores ejector cavity contains a space available for conformal carriage electrical system installation. The conformal carriage auxiliary air door structural support assy contains a tubular guide on one side to provide alignment for the electrical safety pin. The guide aligns the pin with the ejector grounding switches inside the center line attachment fitting.

The configuration illustrated in Figures 42 and 43 is designed for carriage of AIM-7 missiles in stations 3 and 7 only, with the fwd missile wells (stations 4 and 6) occupied by either the GAU-9A guns or by ECM equipment.

CONFORMAL CARRIAGE ELECTRICAL SYSTEM

The conformal carriage electrical system will interface with the aircraft system at the center line stores electrical connector. The conformal carriage ground safety switch and addressing functions are located within the centerline attachment fitting. The two wire bundles leaving this fitting carry the necessary electrical data to the center and aft weapon bays. Two methods of connection are feasible. In one method, the wire bundle connection is located at the side of the conformal carriage and must be manually completed with a multiple jumper connector. The structural attachment latch release must interface with this connector so that the connector must be removed before the weapon bays can be removed from the aircraft, conversely the weapon bay latches must be locked before the connector can be installed.

This arrangement requires manual insertion of the jumper connector after closing of the structural latch. Design of the connector and latch control is complex because of the interactions.

The alternate system provides for automatic connection of the electrical cables during the weapon bay installation and is recommended for inclusion in the conformal carriage because of its inherent simplicity.

In this recommended method the wire bundles from the center line attachment fitting terminate in female connectors flexibly mounted on the attachment fitting. The male mating connectors on the weapon bays are rigidly connected to the weapon bay structure. Cone shaped alignment pins move the female connector into proper alignment with the male connector during weapon bay installation. The structural latch control is independent of the electrical connection since the electrical connector opens automatically during lowering of the weapon bay on the builtin hoist system. A similar connection between the center and fwd weapon bays is located on the left side of the conformal carriage near the structural attachment fitting at F.S. 239.98.

Figure 44 illustrates such a system for the conformal carriage.

PACKAGE LOADING

The conformal carriage weapon bays can be preloaded with weapons and transported to the aircraft position on existing bomb skids with minimal auxiliary equipment or the weapons can be brought to the aircraft spotting position on bomb skids and loaded onto the weapon bays. Hoisting the loaded weapon bay into latched and locked position is accomplished with the builtin hoist. Mounting of weapons on the weapon bays must take place on the CVA flight deck rather than on the mess deck because in some cases a loaded weapon bay will be too long and too wide to maneuver on the mess deck simultaneously with other weapon transport operations. Installation of weapon fuze and attachment of fuze lanyards must take place after the weapons have been mounted on the weapon bay and prior to hoisting the weapon bay into latched and locked position. This sequence of operation is necessary because the longitudinal separation of the weapons when the aircraft is completely loaded is insufficient for fuze installation. The weapon lateral separation is also insufficient for insertion of the inboard weapon fuze lanyards into the solenoids when all four weapons in a row are installed on the weapon bay and all the weapon bays are attached to the aircraft.

Table 3. Ejector Utilization

STATION	WEAPONS
15,17	MK-83GP, SE; MK-82LG8; MK-83LG8
16	MK-83GP, SE; MK-82LGB; MK-83LGB; MK-82GP, SE; CTU-1
18, 22	MK-82GP, SE; MK20-MODO; CBU-58; C8U-38; ASP; SUU-51; MK-83GP, SE; APAM; AGM-65; LAU-61; ASP MK-83LG8 SUU-40; SUU-44; MK-77
19, 21	MK-82GP, SE; MK20-MODO; C8U-38; APAM
20	CBU-58; ASP; SUU-51; MK20-MODO; C8U-72(HSFAE); SUU-40; SUU-44; AGM-65; MK-83LGB; MK-82GP, SE; MK-77
23, 25	MK-83GP, SE; MK-83LG8
24	MK-82GP, SE; MK-83GP, SE
26, 32	MK-82GP, SE; SUU-25 C/A; MK-82LG8
27, 31	MK20-MODO; C8U-58; CBU-38; ASP; SUU-51; MK-82GP, SE; APAM; CBU-72(HSFAE) MK-82LGB
28, 30	MK-82GP, SE; SUU-25 C/A; MK20-MODO; APAM
29	MK20-MODO; C8U-38; MK-82LGB; APAM
33, 35	B-57; MK-84GP, SE; LAU-10; LAU-69; AGM-45; HARM; AGM-65; MK-84LG8
34	MK-84GP, SE; MK-83LG8; 8-57; 8-43; 8-61; LAU-10; LAU-69; AGM-65; AGM-45; HARM; MK-84LG8; MK-84EOG8
10, 14	MK-82GP, SE; MK20-MODO; CBU-58; CBU-38; ASP, SUU-51; APAM; CBU-72 (HSFAE); MK-77
11, 13	MK-82GP, SE; MK20-MODO; C8U-38; APAM
12	C8U-58; ASP; SUU-51; AGM-65; C8U-72(HSFAE); MK-77

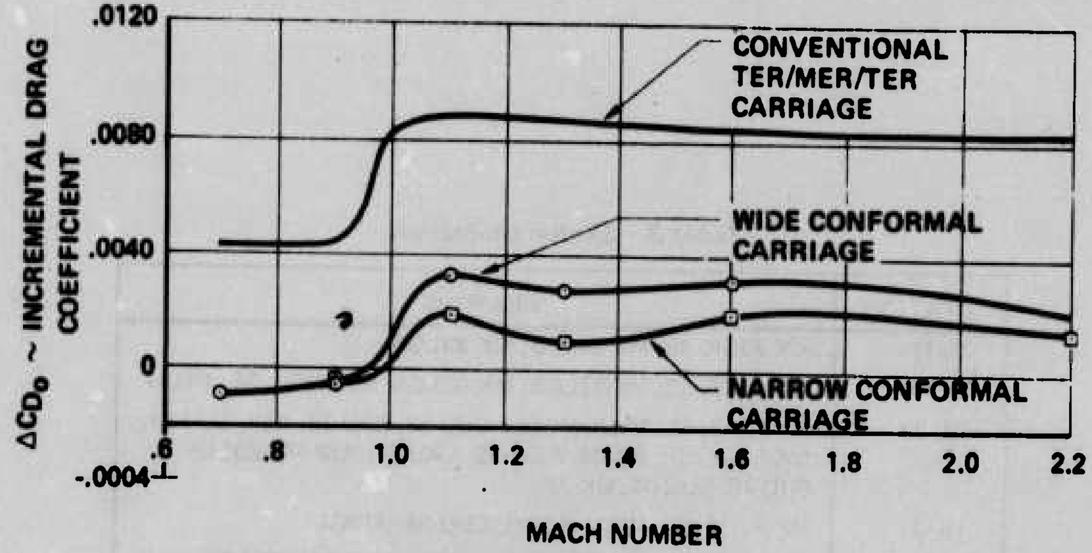


Figure 37: Incremental Drag Due to Weapon Carriage System

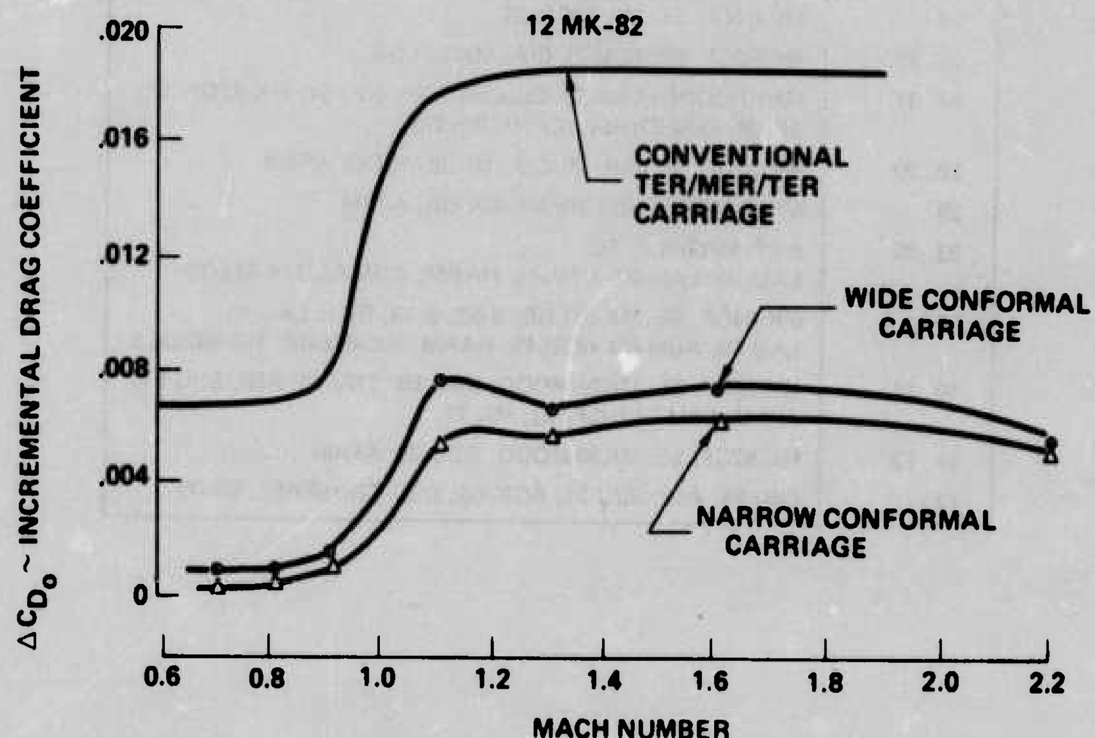


Figure 38: Reduced External Store Drag With Conformal Carriage

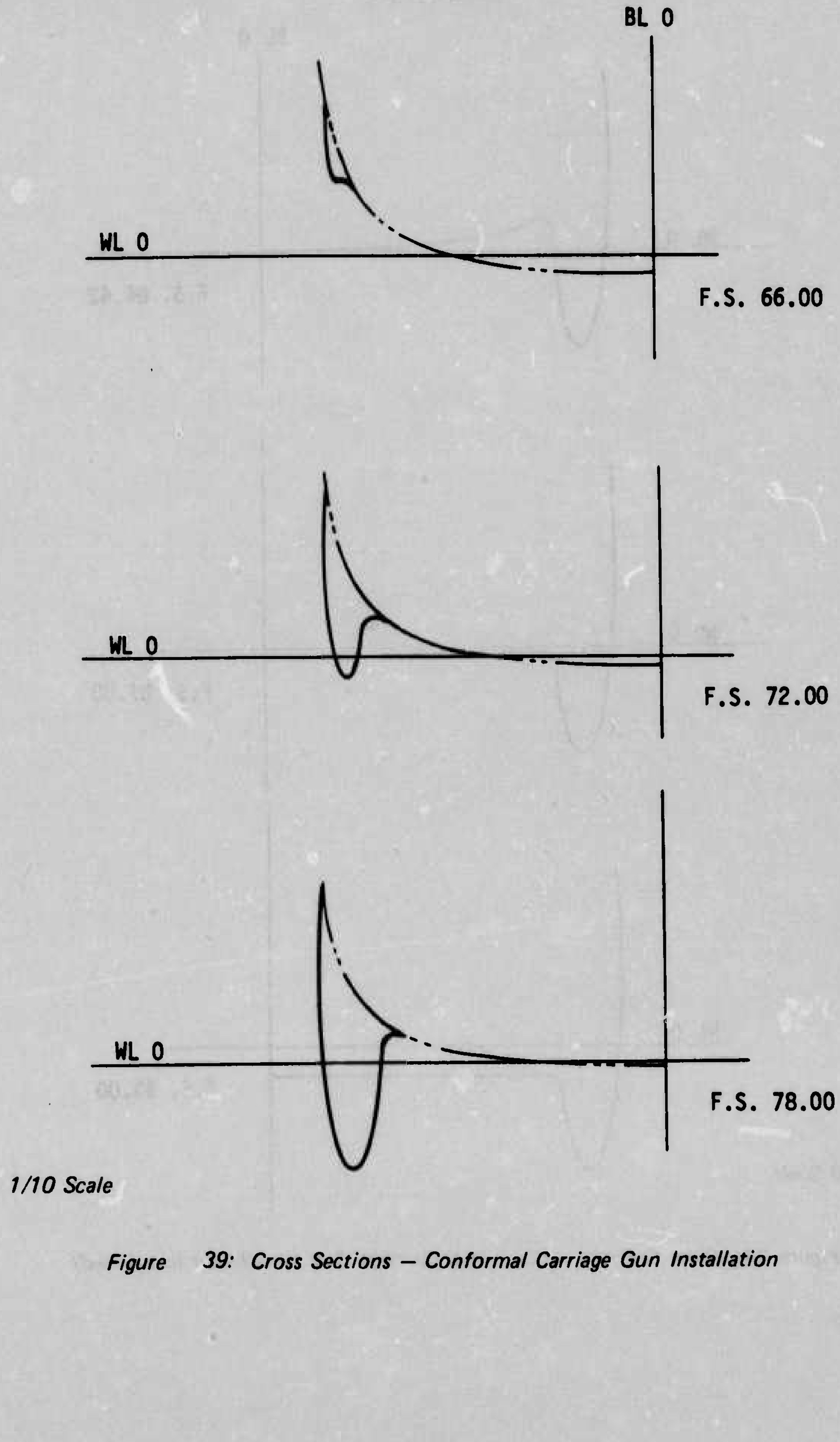


Figure 39: Cross Sections — Conformal Carriage Gun Installation

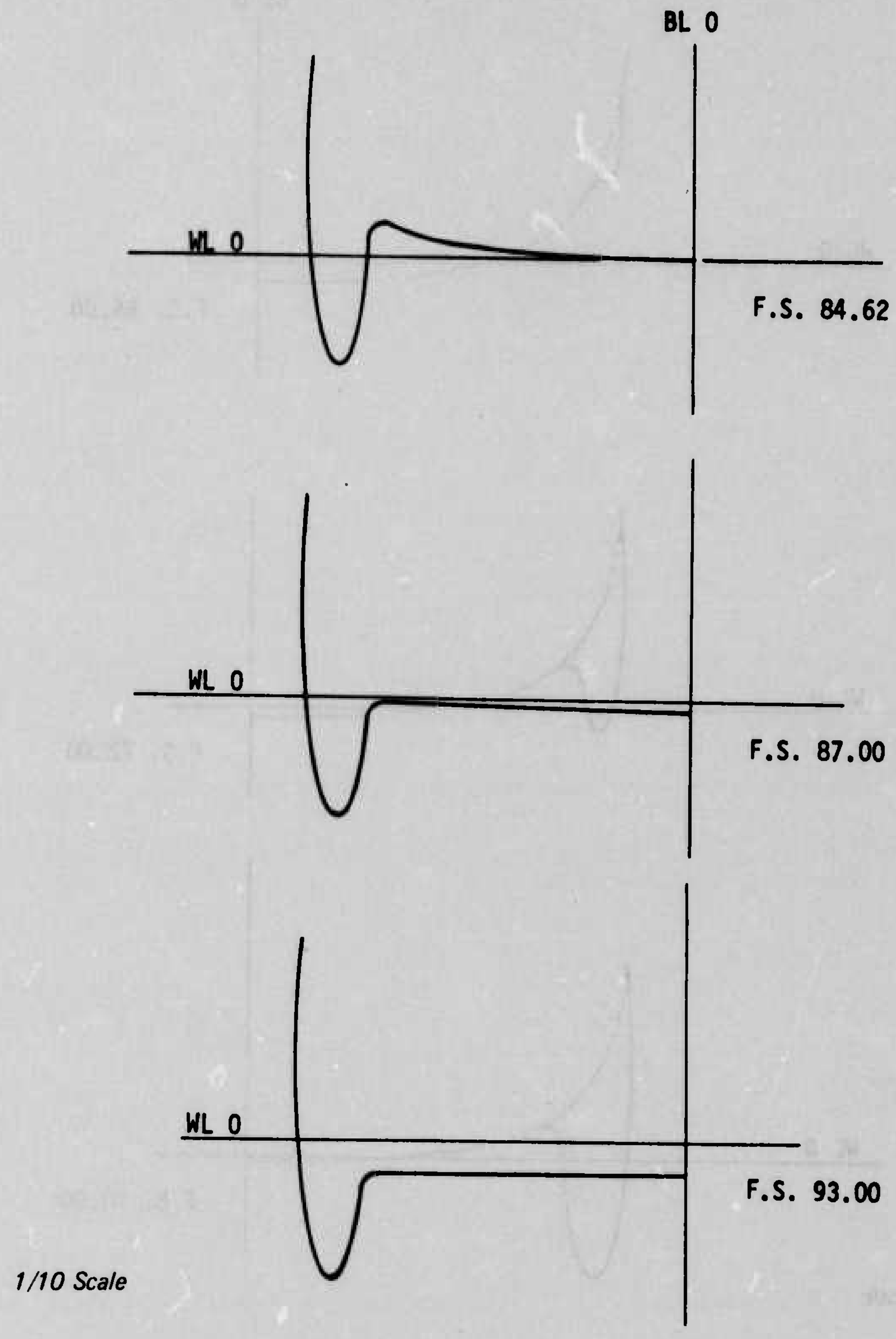


Figure 39: Cross Sections – Conformal Carriage Gun Installation (continued)

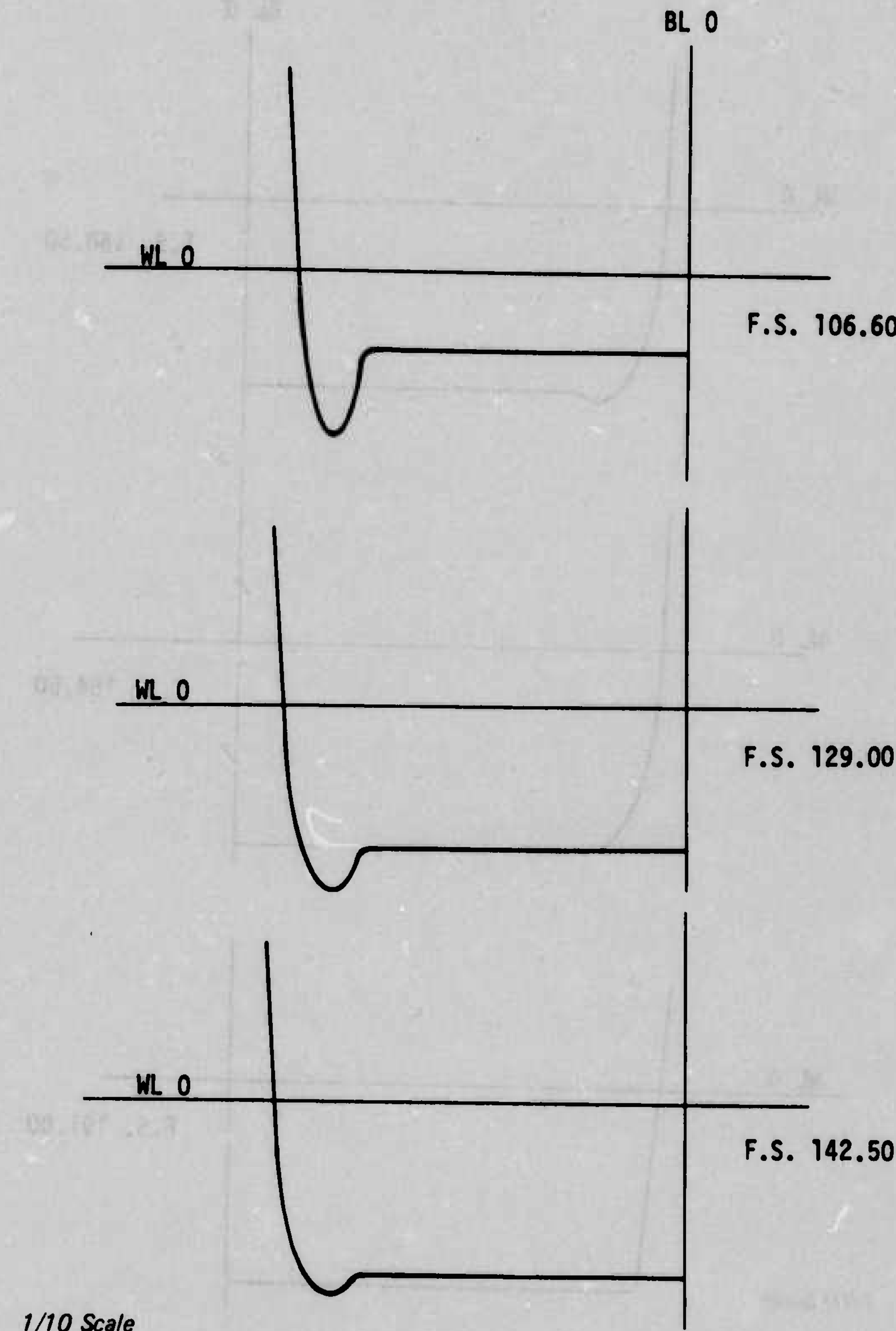


Figure 39: Cross Sections – Conformal Carriage Gun Installation (continued)

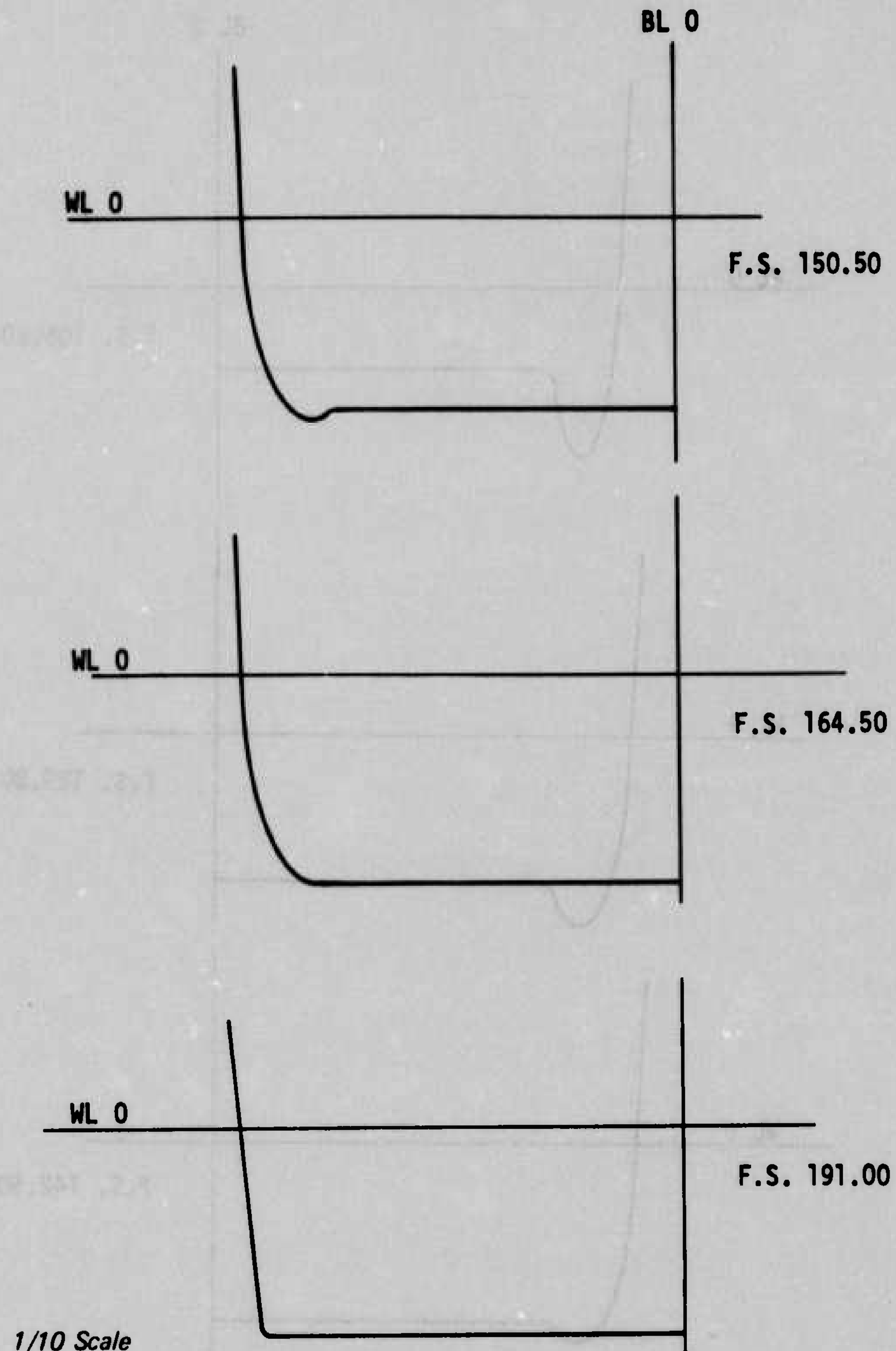


Figure 39: Cross Sections – Conformal Carriage Gun Installation (continued)

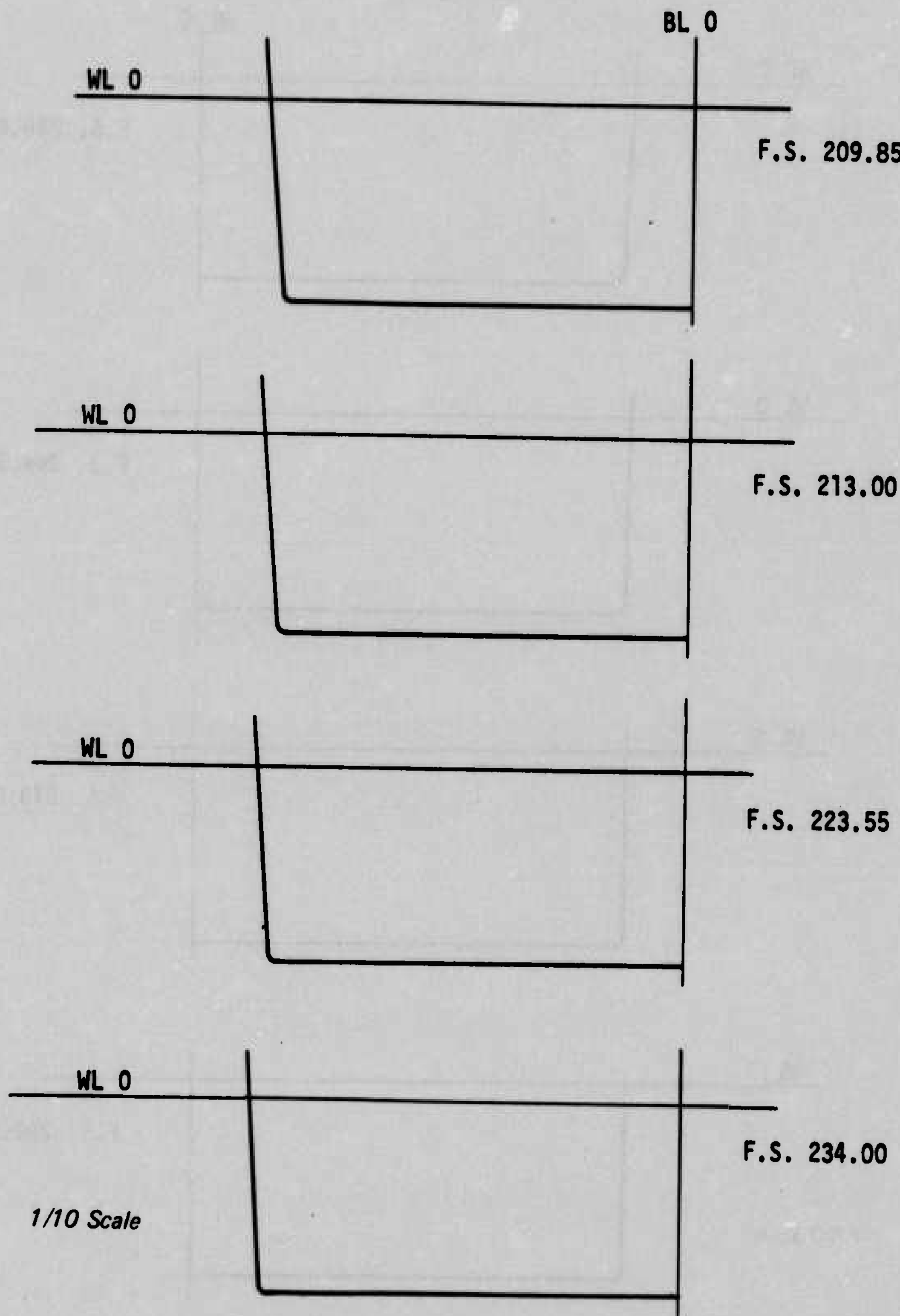


Figure 39: Cross Sections – Conformal Carriage Gun Installation (continued)

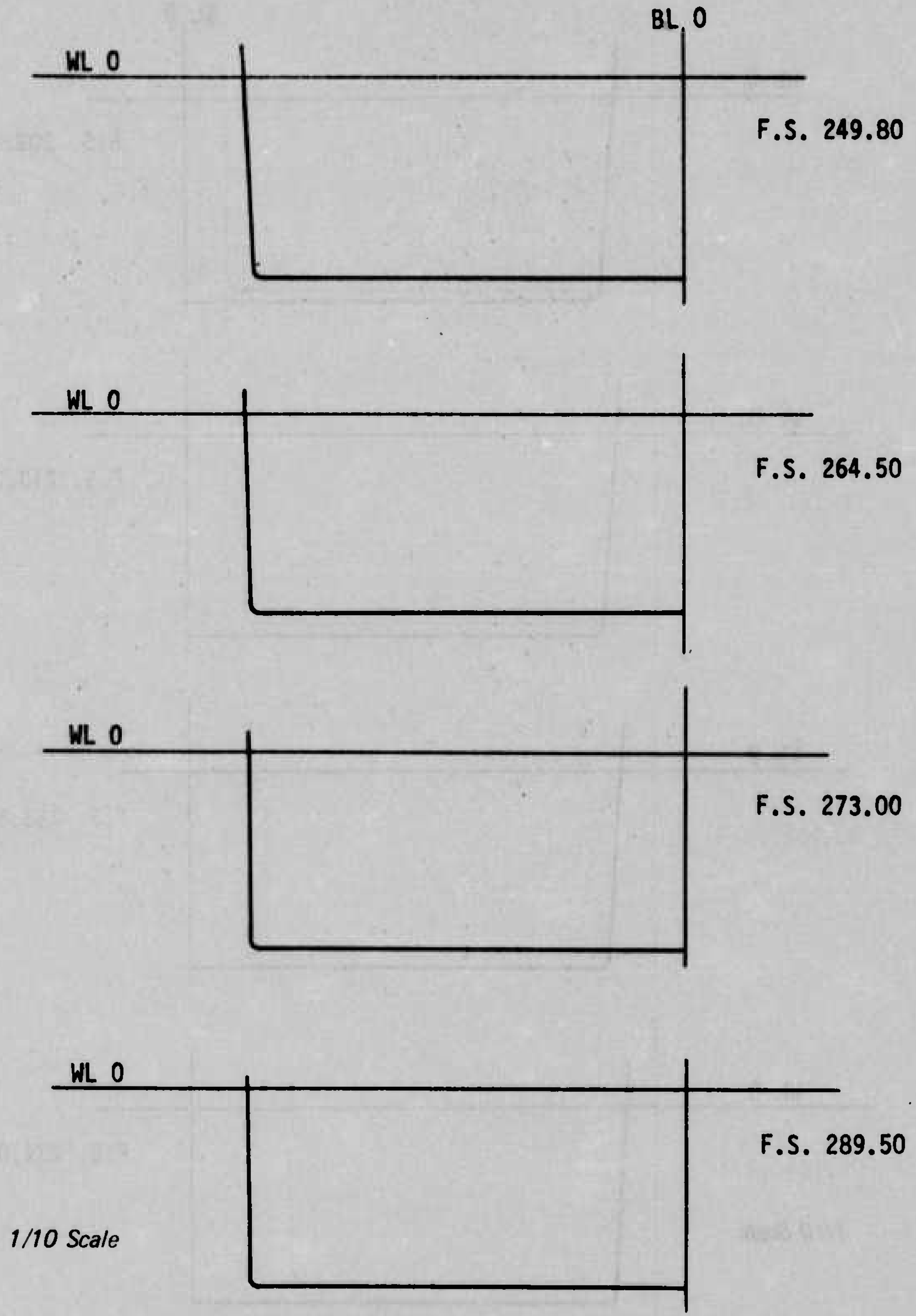


Figure 39: Cross Sections – Conformal Carriage Gun Installation (continued)

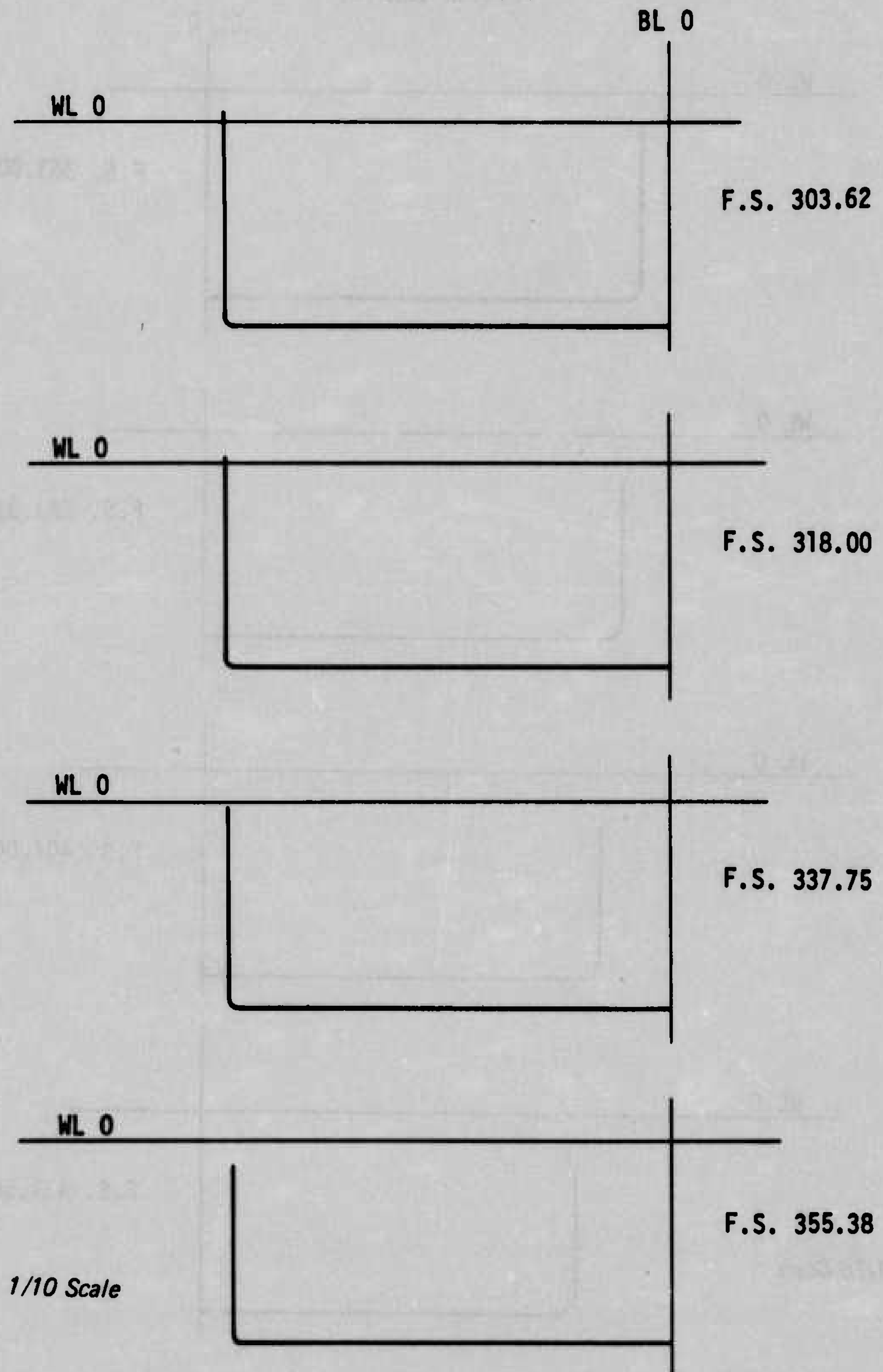


Figure 39: Cross Sections — Conformal Carriage Gun Installation (continued)

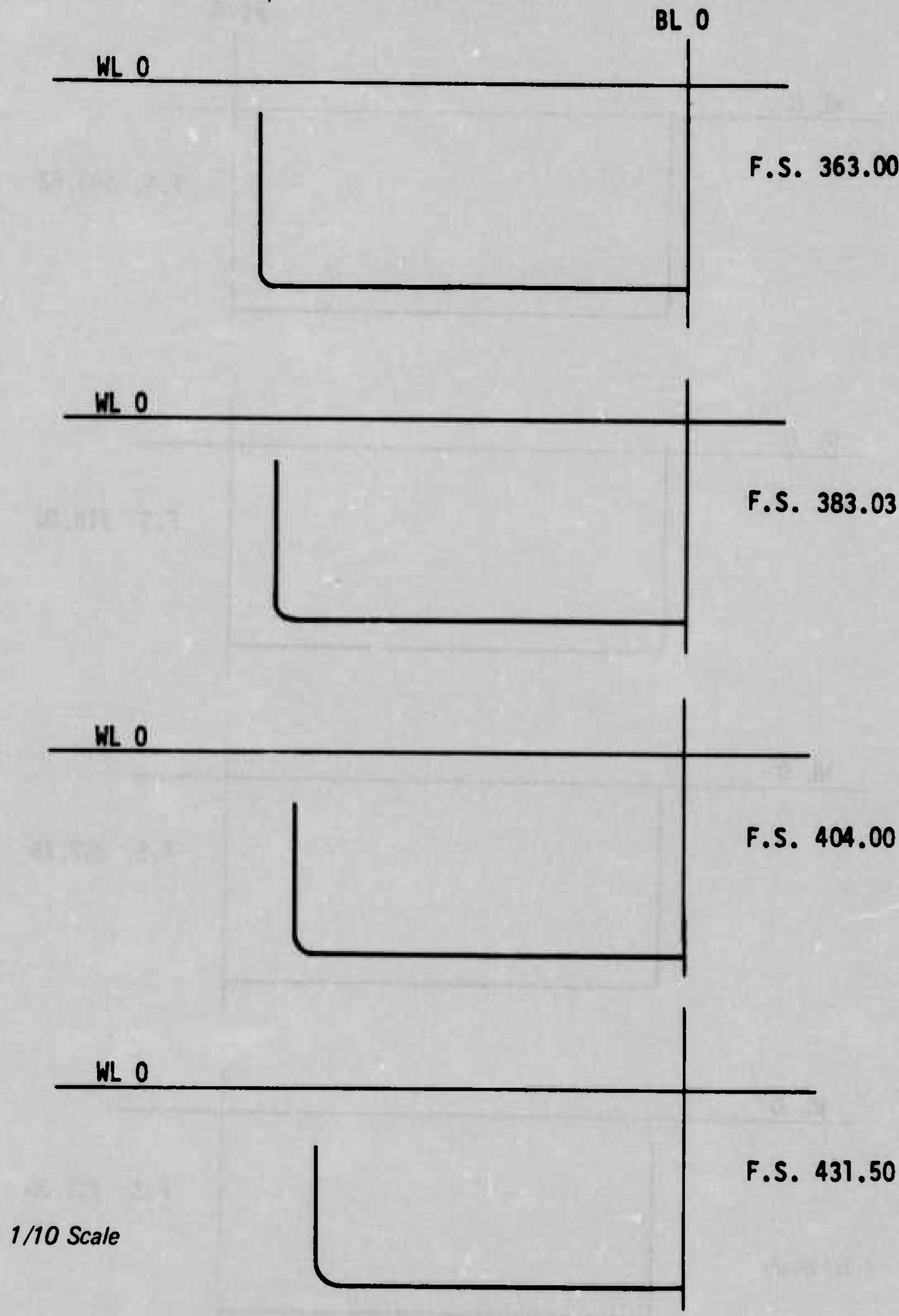


Figure 39: Cross Sections – Conformal Carriage Gun Installation (continued)

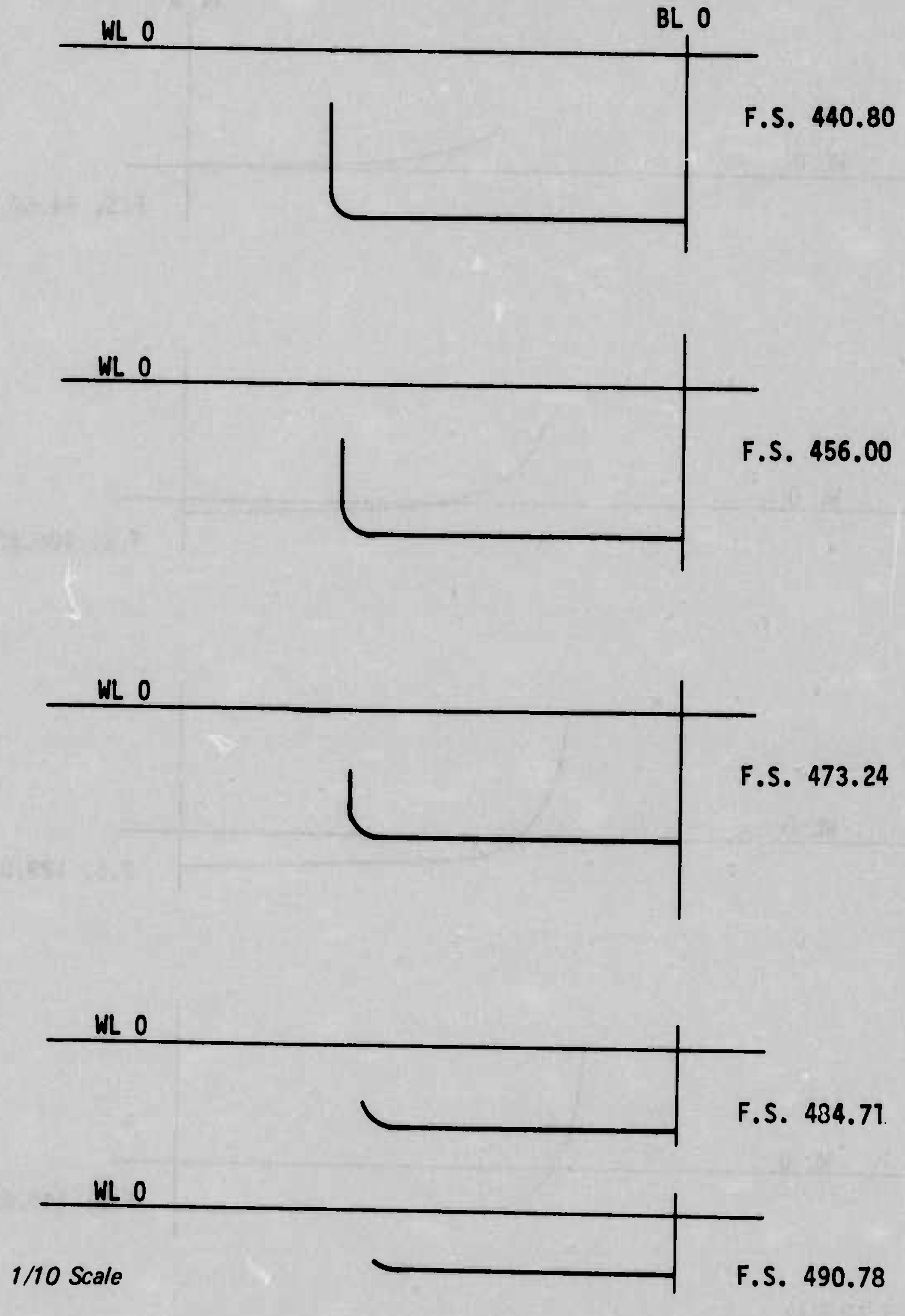
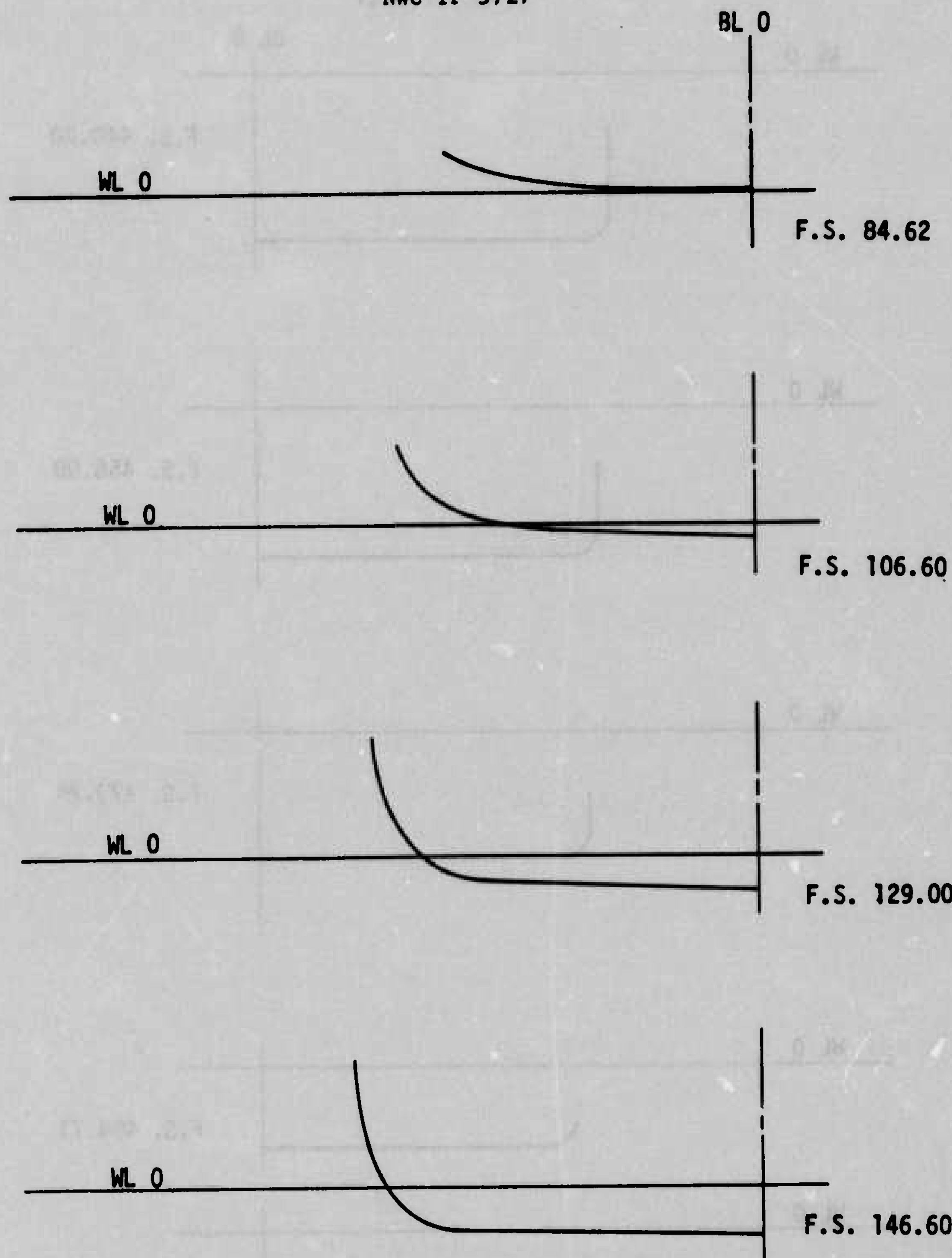


Figure 39: Cross Sections – Conformal Carriage Gun Installation (concluded)



1/10 Scale

Figure 40: Cross Sections – Conformal Carriage

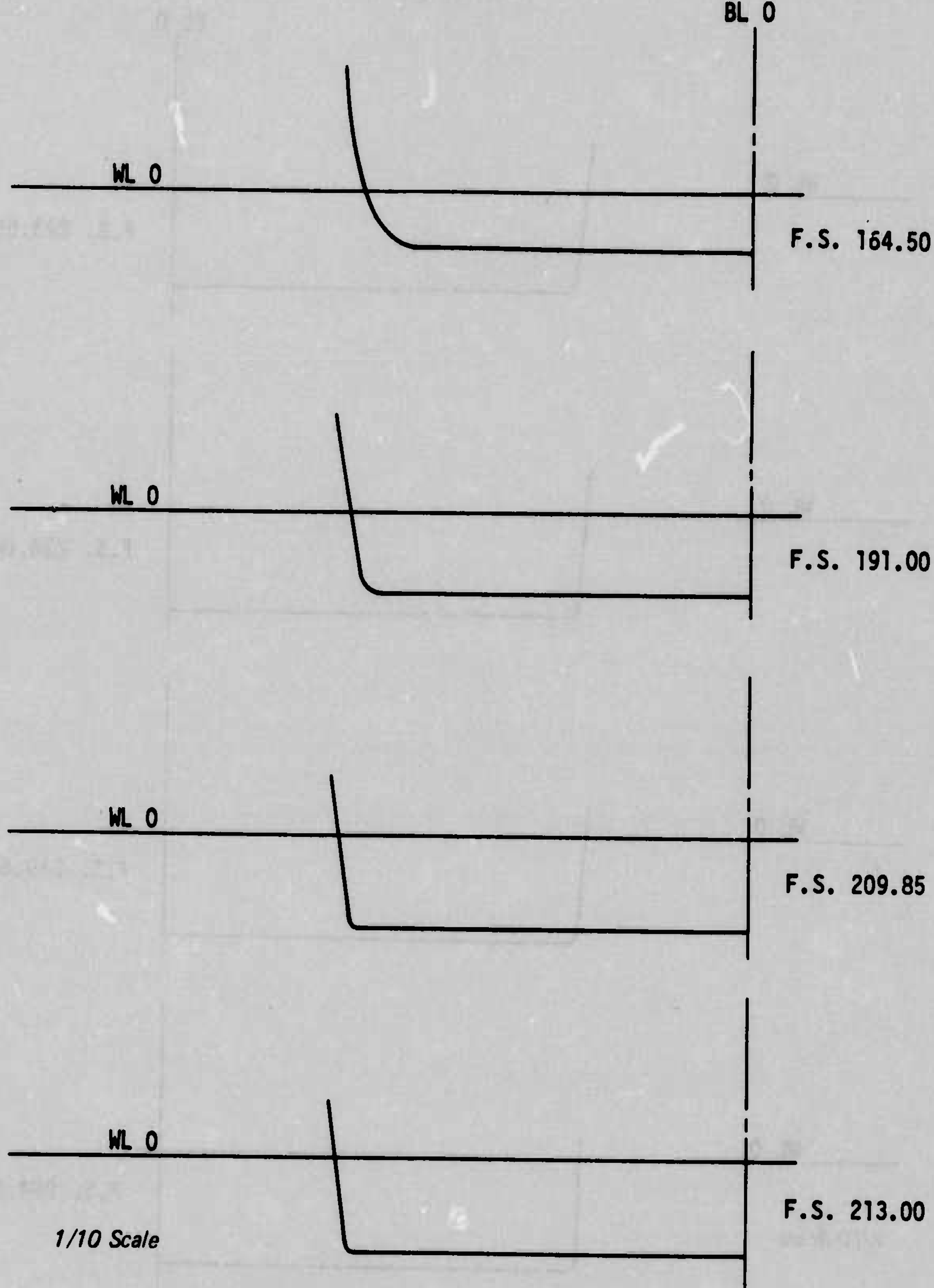


Figure 40: Cross Sections – Conformal Carriage (continued)

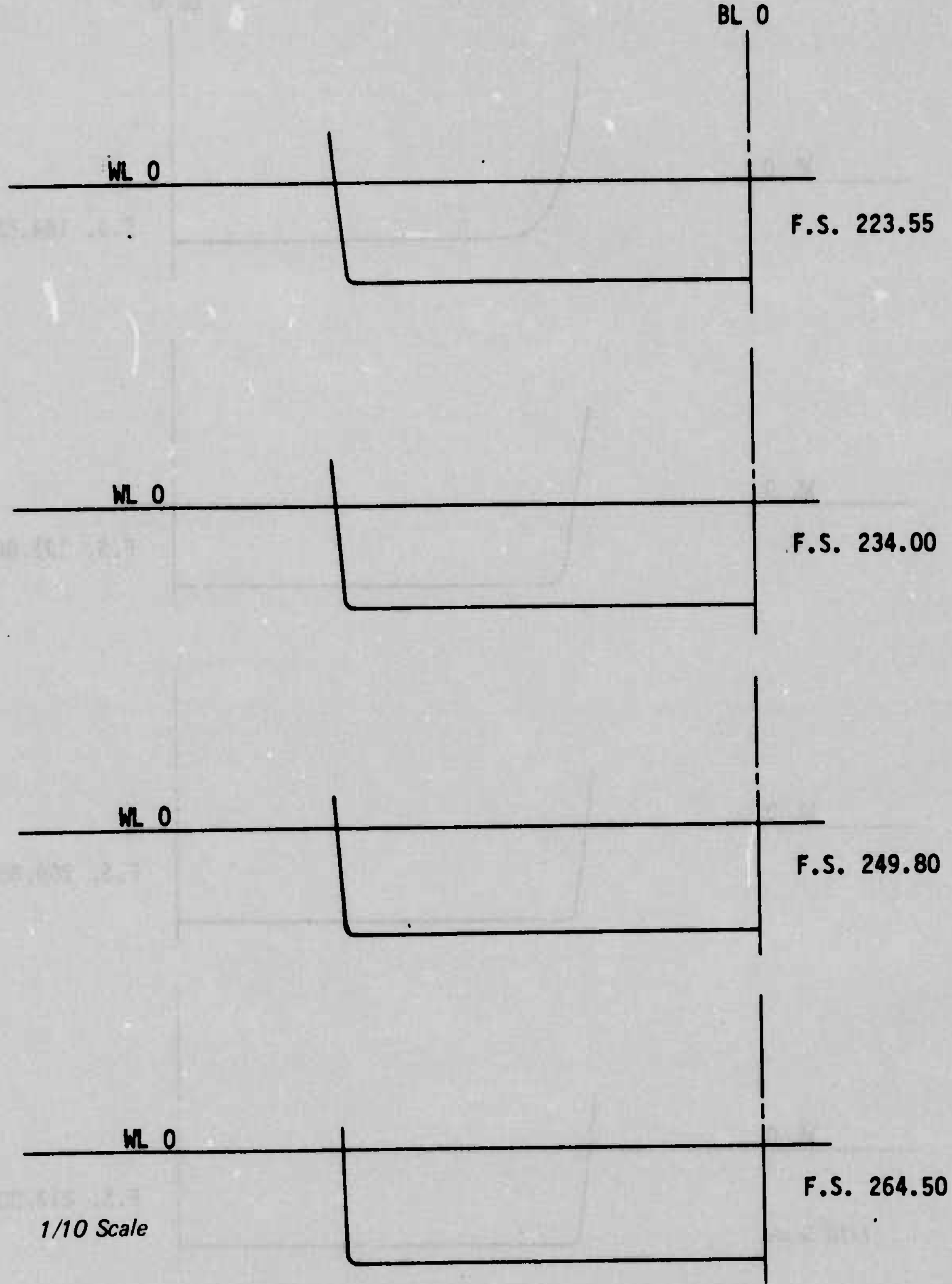


Figure 40: Cross Sections – Conformal Carriage (continued)

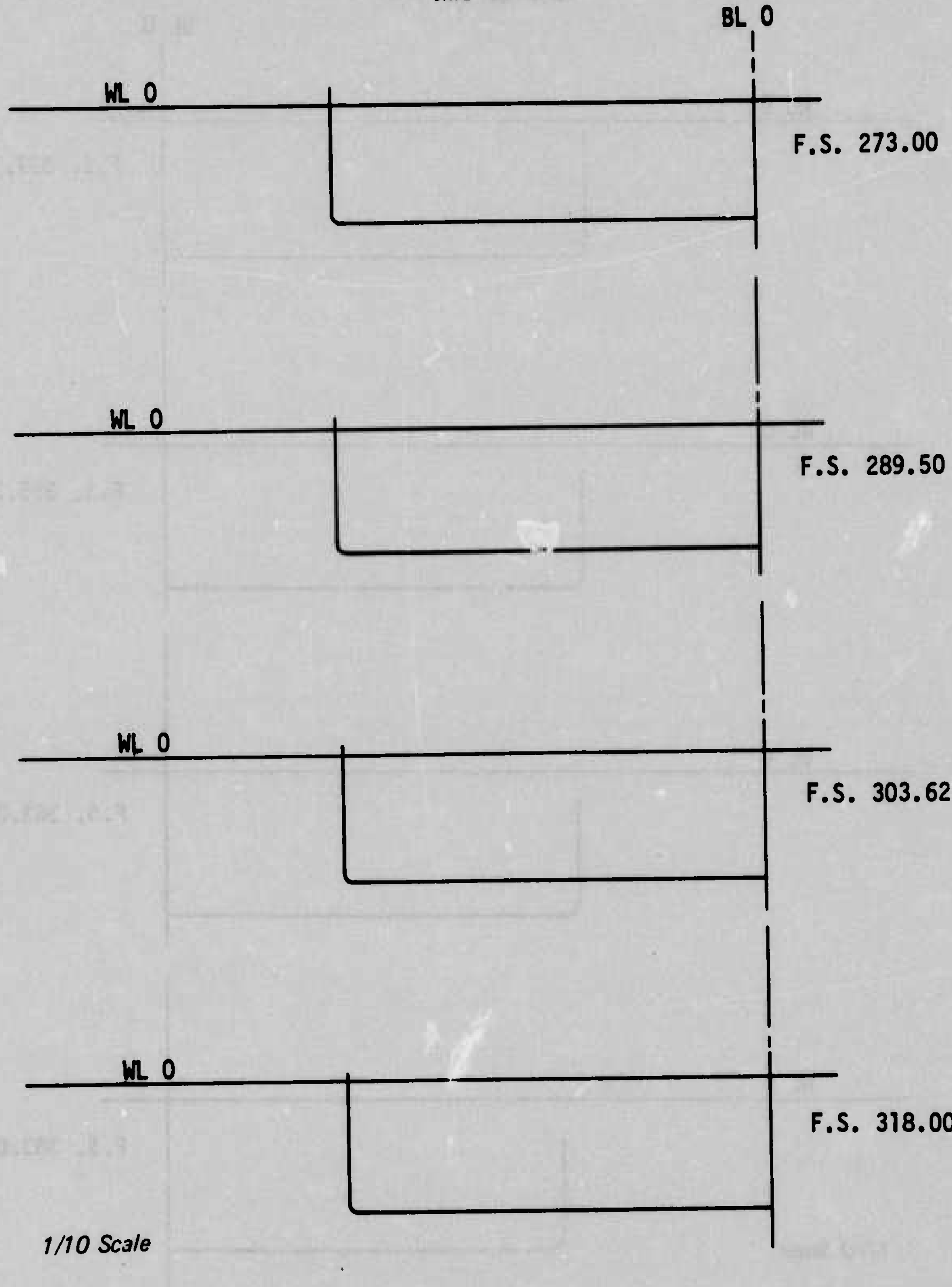


Figure 40: Cross Sections – Conformal Carriage (continued)

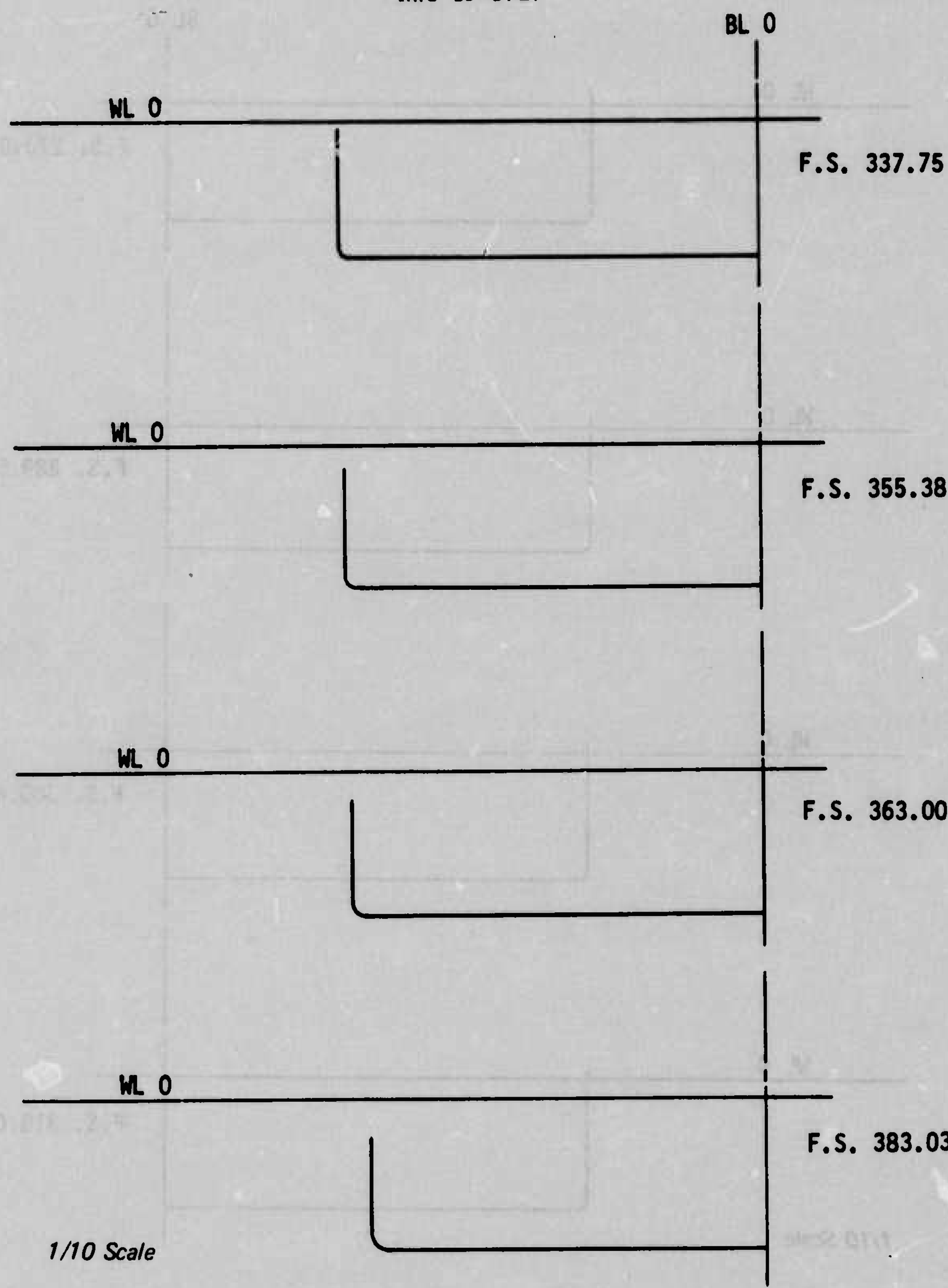


Figure 40: Cross Sections — Conformal Carriage (continued)

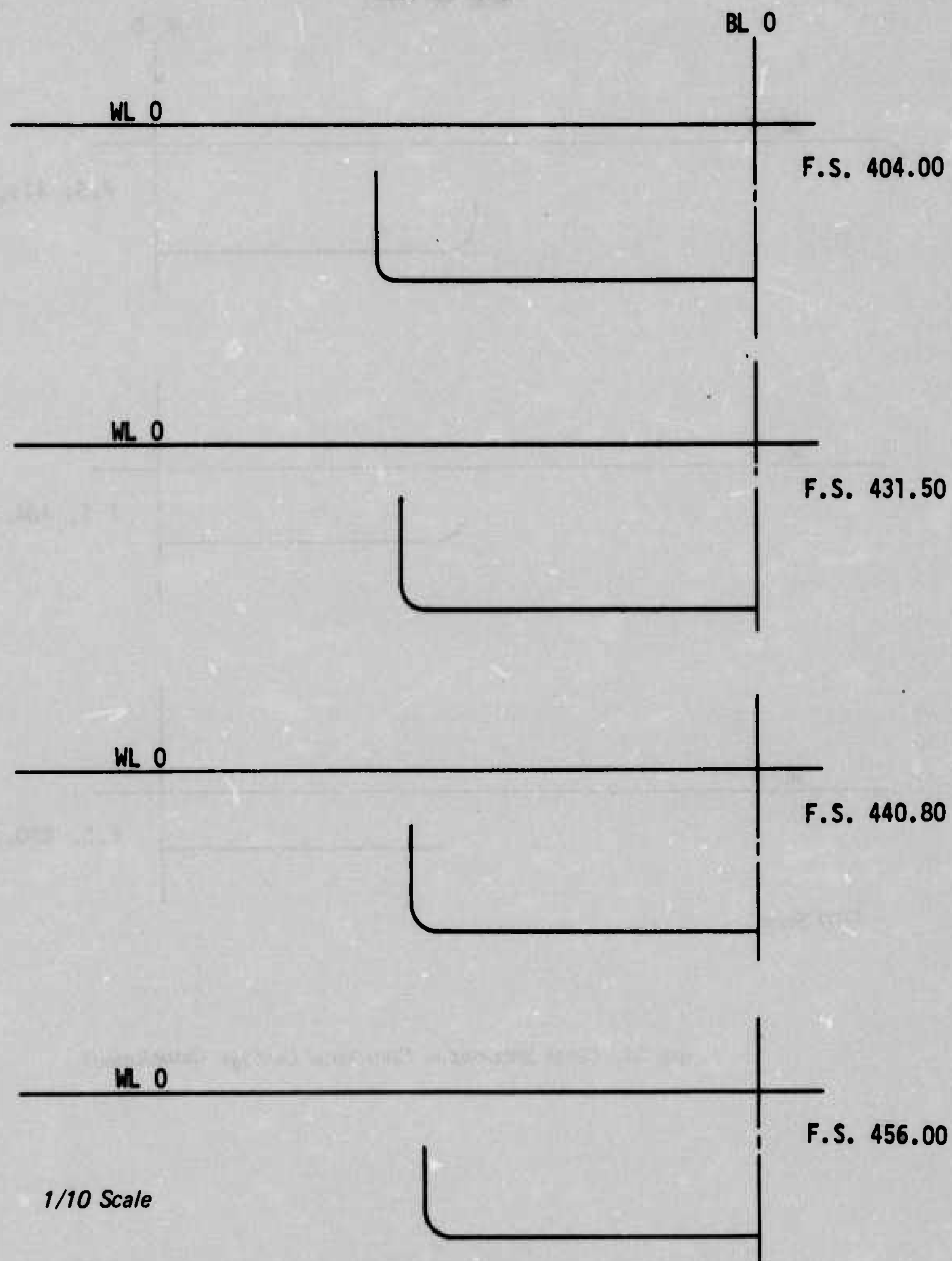


Figure 40: Cross Sections — Ccnformal Carriage (continued)

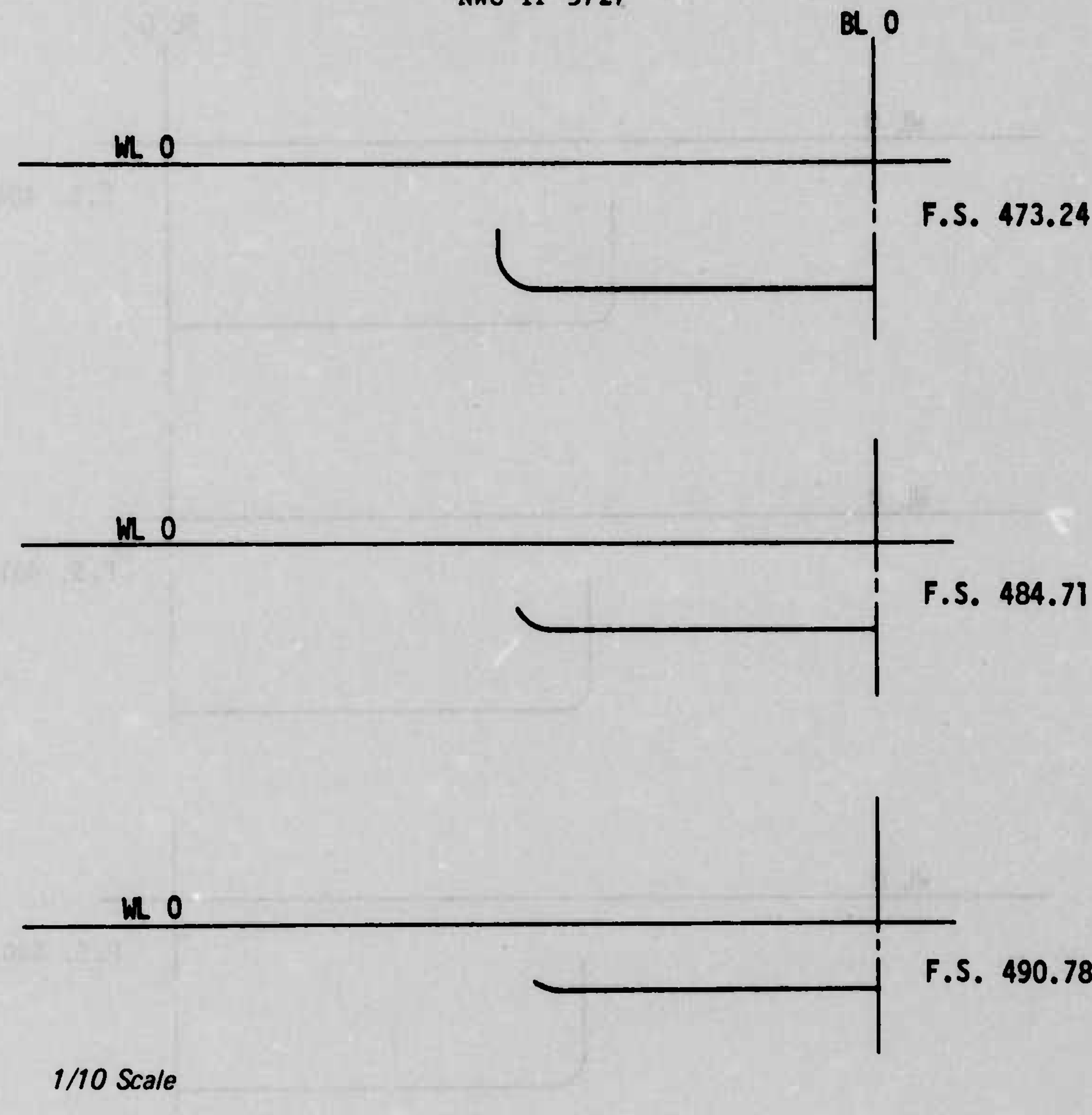


Figure 40: Cross Sections — Conformal Carriage (concluded)

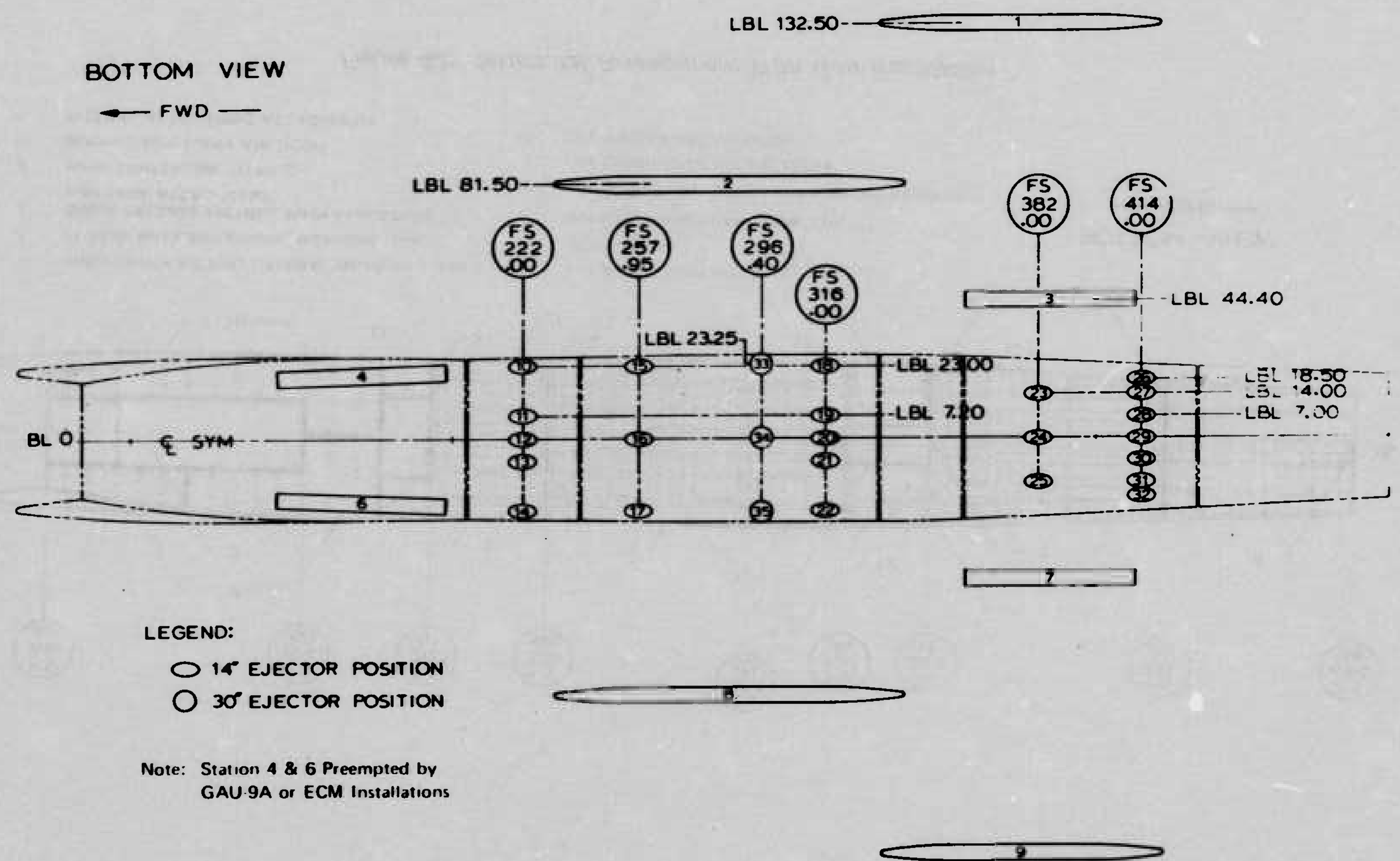
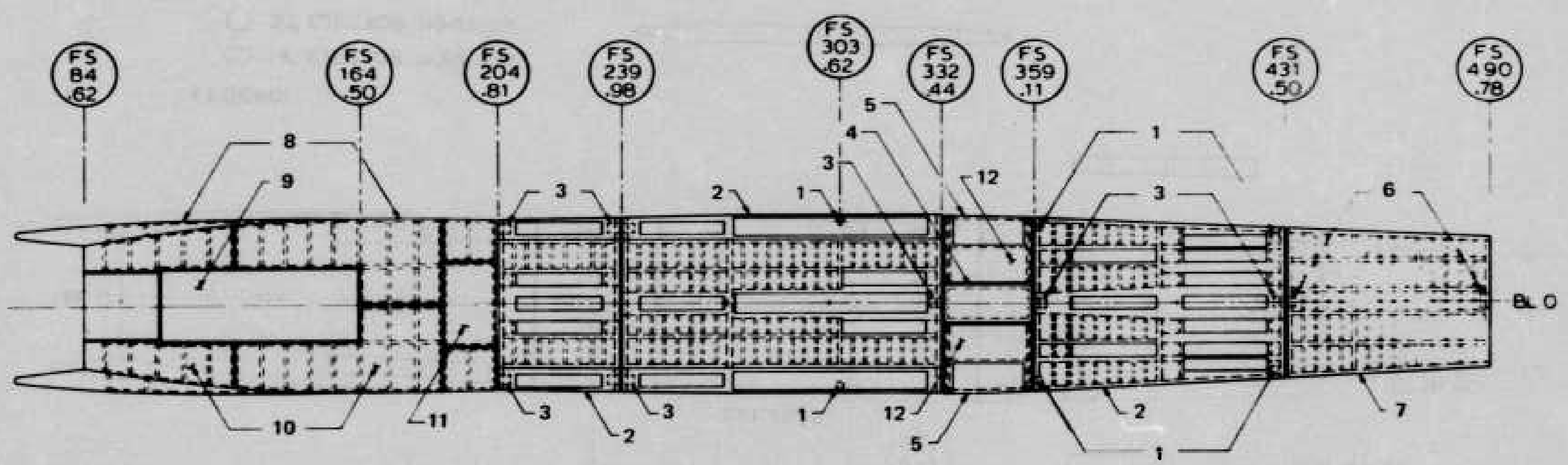
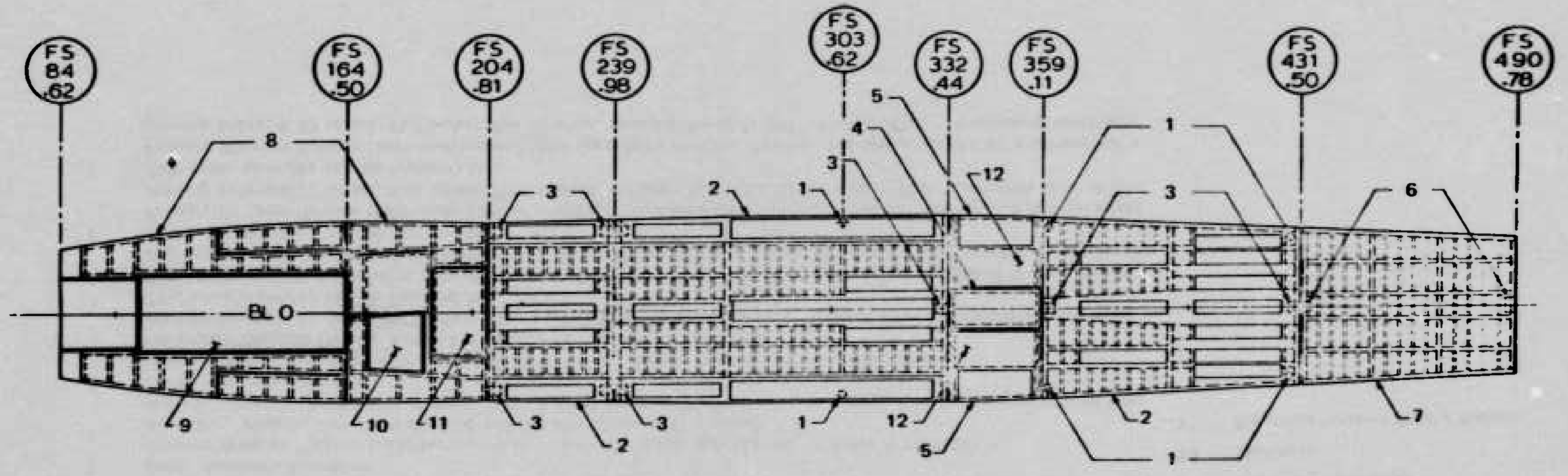


Figure 41: Armament Stations – F-4 Conformal Weapons Carriage



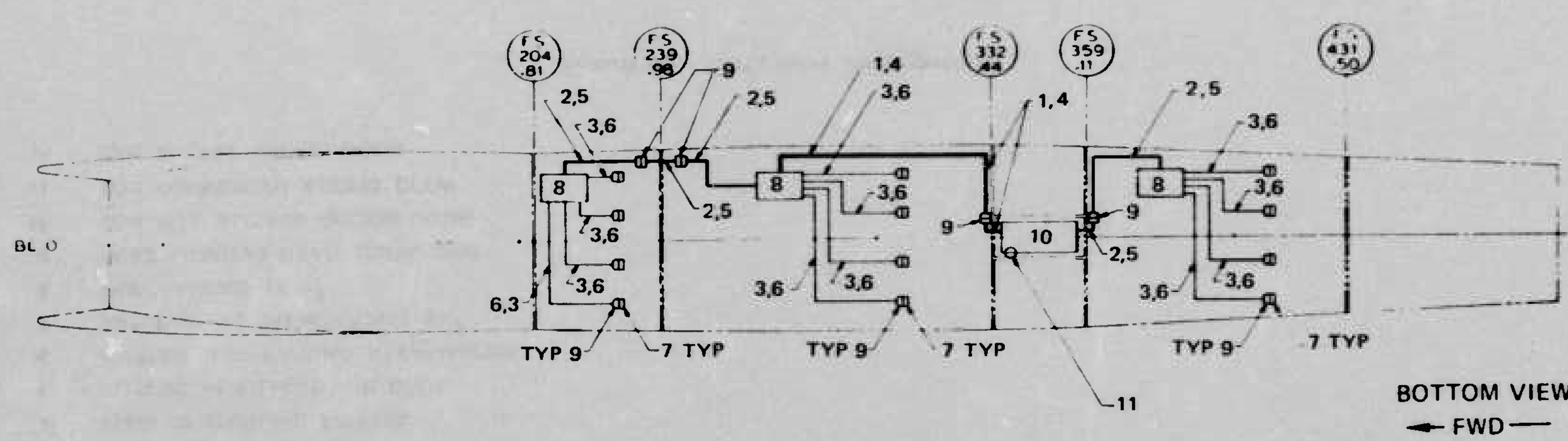
1 SWAY-BRACE FITTING LATERAL WEAPONS LOAD
2 PLUG-IN MAIN STRUCTURE, WEAPONS LOAD
3 QUICK RELEASE FITTING, MAIN STRUCTURE TO AIRPLANE ATTACHMENT
4 MAIN CENTERLINE FITTING
5 SLIDING AUXILIARY AIR DOOR
6 FITTING, AFT FAIRING ATTACHMENT
7 AFT FAIRING (REMOVABLE)
8 FWD FAIRING
9 NOSE LANDING GEAR DOOR, CWC
10 GAU-9A SERVICE DOOR LEFT & RIGHT REQUIRED
11 LOX CONVERTER ACCESS DOOR
12 CWC ENGINE ACCESS DOOR

Figure 42: Structural Arrangement With Gun Installation



1 SWAY-BRACE FITTING LATERAL WEAPONS LOAD
2 PLUG-IN MAIN STRUCTURE, WEAPONS LOAD
3 QUICK RELEASE FITTING, MAIN STRUCTURE TO AIRPLANE ATTACHMENT
4 MAIN CENTERLINE FITTING
5 SLIDING AUXILIARY AIR DOOR
6 FITTING, AFT FAIRING ATTACHMENT
7 AFT FAIRING (REMOVABLE) 9ft^3
8 FWD FAIRING 11 ft^3
9 NOSE LANDING GEAR DOOR, CWC
10 LOX FILL SLIDING ACCESS DOOR
11 LOX CONVERTER ACCESS DOOR
12 CWC ENGINE ACCESS DOOR

Figure 43: Structural Arrangement



1	Cable Assembly Contains: Primary Weapon Release (with redundancy) 2-shielded double twisted pairs (8 wires + 2 shields) Secondary Weapon Release 2-shielded twisted pair (4 wires + 2 shields) Arming Solenoid (4 wires), Pull Safety Pin (2 wires), Weapon Away Switch (8 wires), Plus 1 common ground wire
2	Cable Assembly Contains: Primary Weapon Release (with redundancy) 1-shielded double twisted pair (4 wires + 1 shield) Secondary Weapon Release 1-shielded twisted pair (2 wires + 1 shield) Arming Solenoid (2 wires), Pull Safety Pin (1 wire), Weapon Away Switch (4 wires), Plus 1 common ground wire
3	Cable Assembly Contains: Primary Weapon Release (with redundancy) 1-shielded double twisted pair (4 wires + 1 shield) Secondary Weapon Release 1-shielded twisted pair (2 wires + 1 shield) Arming Solenoid (2 wires),Pull Safety Pin (1 wire), Weapon Away Switch (1 wire), Plus 1 common ground wire
4	This cable assembly can be replaced by: Primary Weapon Release (with redundancy) and Secondary Weapon Release, 1-shielded bundle of 6 coaxial wires Arming Solenoid (4 wires), Pull Safety Pin (2 wires), Weapon Away Switch (8 wires), Plus 1 common ground wire
5	This cable assembly can be replaced by: Primary Weapon Release (wtih redundancy) and Secondary Weapon Release, 1-shielded bundle of 3 coaxial wires Arming Solenoid (2 wires), Pull Safety Pin (1 wire), Weapon Away Switch (4 wires), Plus 1 common ground wire
6	This cable assembly can be replaced by: Primary Weapon Release (with redundancy) and Secondary Weapon Release, 1-shielded bundle of 3 coaxial wires Arming Solenoid (2 wires), Pull Safety Pin (1 wire), Weapon Away Switch (1 wire), Plus 1 common ground wire

7	Weapon Ejector Connector
8	Terminal Box Plus Stepper Switch
9	Separable Connector
10	Multiplex
11	Electrical Ground Safety Switch

Figure 44: Circuit Diagram 1B-Weapon Release System — F-4 Conformal Weapons Carriage

AIRCRAFT MODIFICATIONS

Some aircraft systems will require modification for ease of service when the conformal carriage is loaded with weapons.

PNEUMATIC SYSTEM

The system pressure gage and aircharge valve presently located behind door 28R will be relocated to the conformal carriage bulkhead along the right side of the nose wheel well. The canopy emergency air pressure gages located behind door 16 will be moved to the right side of the nose wheel well.

UTILITY HYDRAULIC SYSTEM

Service fittings will be installed in the aft end of the conformal carriage bulkhead along the left side of the nose wheel well. The hydraulic lines from these new fittings will connect to the existing aircraft hydraulic lines at "T's" to be added directly behind the existing fittings located behind door 23.

The utility hydraulic system accumulator reservoir indicator arm will be extended through the use of a flexible drive shaft to an indicator to be located within the nose wheel well.

LOX SYSTEM

Aircraft door 16 will be removed and replaced with a new door located in the conformal carriage surface. The LOX converter bottle will be mounted on the new door with the entire converter assembly rotated 90° about its vertical axis to place the fill/vent valve at the forward right corner of the installation.

Access to the fill/vent valve when weapons prevent opening of the new LOX converter door will be though a sliding door fwd of the LOX converter door.

AIRCRAFT ELECTRICAL SYSTEM

The electrical elements now located on the nose landing gear door will be moved to similar locations on the new nose landing gear door.

AUXILIARY AIR DOOR SYSTEM

Aircraft doors 81 L and R and their associated actuators will be removed from the aircraft and functionally replaced by a sliding auxiliary air door system driven by new actuators deriving their energy from the hydraulic system operating the existing doors 81 L and R. The auxiliary air door open switch will be relocated to provide reliable indication of proper closure of the new system doors. Aircraft doors 82 L and R will be modified to permit opening with the conformal carriage in place and provide a plenum seal when the auxiliary air doors are closed.

PNEUMATIC STARTER INLET

The pneumatic starter inlet on door 92 L will be moved outboard on the door to clear the weapons mounted on the aft weapon bay.

GROUND REFUELING SYSTEM ACCESS

The existing MIL-N-5877 pressure fuel servicing nozzle requires rotation of the locking collar 15° after insertion into the aircraft fueling fitting. Because of the angle in the nozzle and the close proximity of the conformal carriage, the delivery valve cannot be opened unless the nozzle is inserted in only one of the three possible orientations. The MS 28518 fuel valve fitting on the aircraft will be rotated 60° and reinstalled to permit insertion of the MIL-N-5877 nozzle in any of the three possible orientations and subsequent operation of the delivery valve.

STORES MANAGEMENT SYSTEM

The conformal carriage has the capability of carrying up to 12 weapons simultaneously compared to the existing F-4 center line MER capacity of only six weapons. The wire bundle capacity from the cockpit to the center line stores point is incapable of carrying fuze function control, weapon addressing in release sequence, weapon release signals, and other stores management functions for twelve weapons unless an advanced stores management system is employed. Such advanced systems are in the development stage, most employ digital data processing techniques. The conformal carriage will require such a system if the full potential of the F-4 conformal carriage concept is to be realized.

STRUCTURAL MODIFICATIONS

The aircraft structure will be modified by installing permanently on the aircraft keel beam, in the center line stores ejector cavity, and in the fwd missile wells conformal carriage structural attachment details. The fwd fairing of the conformal carriage will be permanently attached to the aircraft fwd fuselage.

<u>Aft Structural Attachment Fitting</u>

The aft end of the aft structural attachment fitting will be located at F.S. 439 just fwd of the catapult hold back fitting door. The fitting will extend fwd to F.S. 427 to support the aft weapon bay. Existing rivet locations should be used for attachment bolts to minimize keel beam area reduction due to hole out. The attachment fittings and all parts in contact with the aircraft keel beam longeron, stiffeners, and web should be steel to minimize corrosion of the titanium parts. The fitting width should permit opening of doors 92 L and R without removing the fitting.

Aft Fairing Support Fitting

The aft fairing rear support fitting will be located at approximately F.S. 490. The fitting should be attached to the aircraft keel beam longeron with bolts through existing fastener holes. The fitting width should permit opening of doors 96L and R without removing the fitting.

Center Line Stores Attachment Fitting

A center line/stores structural attachment fitting will be designed to fit within the cavity provided for the Aero-27A ejector. The fitting aircraft interface will be identical to that for the Aero-27A/ejector. The fitting will contain,on the fwd and aft ends, attachment fittings to mate with the center and aft weapon bay attachment lugs. The fitting should also provide a cavity accessible from the bottom of the aircraft into which the conformal carriage electrical sequence circuitry can be installed. The cavity should be such that installation of a sealing plate on the bottom surface will hermetically seal the electronic elements from contamination.

Fwd Missile Well Attachment Fittings

Two attachment fittings will be designed to fit within each of the two fwd missile wells. One of the fittings will be capable of supporting the fwd end of the center weapon bay and the aft end of the fwd weapon bay. The other fitting will be capable of supporting the fwd end of the fwd weapon bay. The fittings must transfer the loads from the weapon bays into the aircraft fwd body longerons, shear webs, and skin.

Fwd Fairing Installation

The conformal carriage fwd fairing designed to fair the aircraft body surface at F.S. 84.62 to the conformal carriage fwd weapon bay surface at F.S. 204.81 will be permanently attached to the aircraft structure.

The fairing bulk heads and frames should be attached to the aircraft bulkheads and frames through the aircraft skin by installation of blind fasteners in the rivet holes attaching aircraft skin to aircraft bulkheads and frames. The new fasteners for the most part will be blind fasteners, provision should be made to remove the drilled out portion of the previously installed rivets.

The fairing will contain the new nose gear door, the new LOX converter door, and the new LOX service door.

Lox Converter Door. The existing LOX converter door (door 16) will be removed from the aircraft and replaced with a door located in the conformal carriage surface. The new door will support the LOX converter in a manner similar to door 16 except the coverter should be rotated 90° about its vertical axis to bring the fill/vent valve to the fwd right corner of the new door. The new door should also contain some armor material to provide additional protection for the LOX converter.

Ram Air Exhaust Fittings. The ram air exhaust louvers will be replaced with new louvered fittings located in the fwd fairing surface and the ram air exhaust duct extended to the new fittings.

Catapult Holdback Fitting

The existing catapult holdback link will be replaced with a longer link to extend beyond the aft end of the aft fairing. The link will contain a shock absorber to reduce the spring back load when the tension bar is ruptured at catapult launch. The link will not retract and will be supported vertically by the aft fairing attachment fitting. The link and fitting will be designed to maintain the hold back force at the same angular position relative to the aircraft attitude without requiring revision of the NAEL 609789 catapult holdback assembly.

FUEL COMPARTMENT DRAINS

The fuel drains in aircraft doors 92L and R which are covered by the conformal carriage aft fairing will be moved outboard as necessary to clear the fairing. The aft fairing will contain oversize drainpipes sealed into the fairing and located under the aft fuselage compartment drains to permit inspection of the fuel compartment drains with the conformal carriage in place.

The fwd drain for the number one fuel compartment lies outside the conformal carriage and need not be modified. The aft drain for the number one fuel compartment and the drain for the number two fuel compartment are located at about B.L. 8 L and R and just fwd of the wing front spar at F.S. 248. These two drains must be moved outboard to approximately B.L. 26 in order to clear the conformal carriage. The drain tubes will be cut off within the pneumatic compressor compartment and angle fittings installed to move the exit points outboard as required.

The main fuel control seal drain will be extended through the center line attachment fitting to the lower surface of the conformal carriage to simplify inspection for seal leakage.

BATTERY VENT

The battery vent will be extended to the exterior surface of the conformal carriage forward fairing.

OIL DRAINS

The engine gear box drains and constant speed drive drains will be moved laterally to clear the conformal carriage.

The left engine sump vent drain will be relocated to clear the conformal carriage.

CONFORMAL CARRIAGE F-4B/J SERVICING PROCEDURES

The specific servicing functions affected by the conformal carriage installation are described in separate subsections. Figure 45 illustrates the revisions to aircraft servicing and drain points.

JACKING PROCEDURE

The jacking procedure now used has to be modified to include removal of the center weapon bay to provide access to the fuselage ℄ jacking point.

GROUND TEST OF LANDING GEAR RETRACTION

No change is required in this inspection procedure except as required to install the fuselage centerline jack. A specific prohibition should be added to prevent use of the utility hydraulic system servicing points in the nose wheel well during this inspection.

REFUELING PROCEDURE

No change will be required in the refueling procedure because the conformal carriage installation does not interfere with the fueling nozzle insertion. The fuel cell air pressure gage is required only for early model F-4B and RF-4B aircraft which will not be modified to the conformal carriage configuration. This operation should be completed during post flight inspection so that the wing tank manual drains can be opened for fuel contamination inspection while the center weapon bay is lowered for loading of external stores.

DEFUELING PROCEDURE

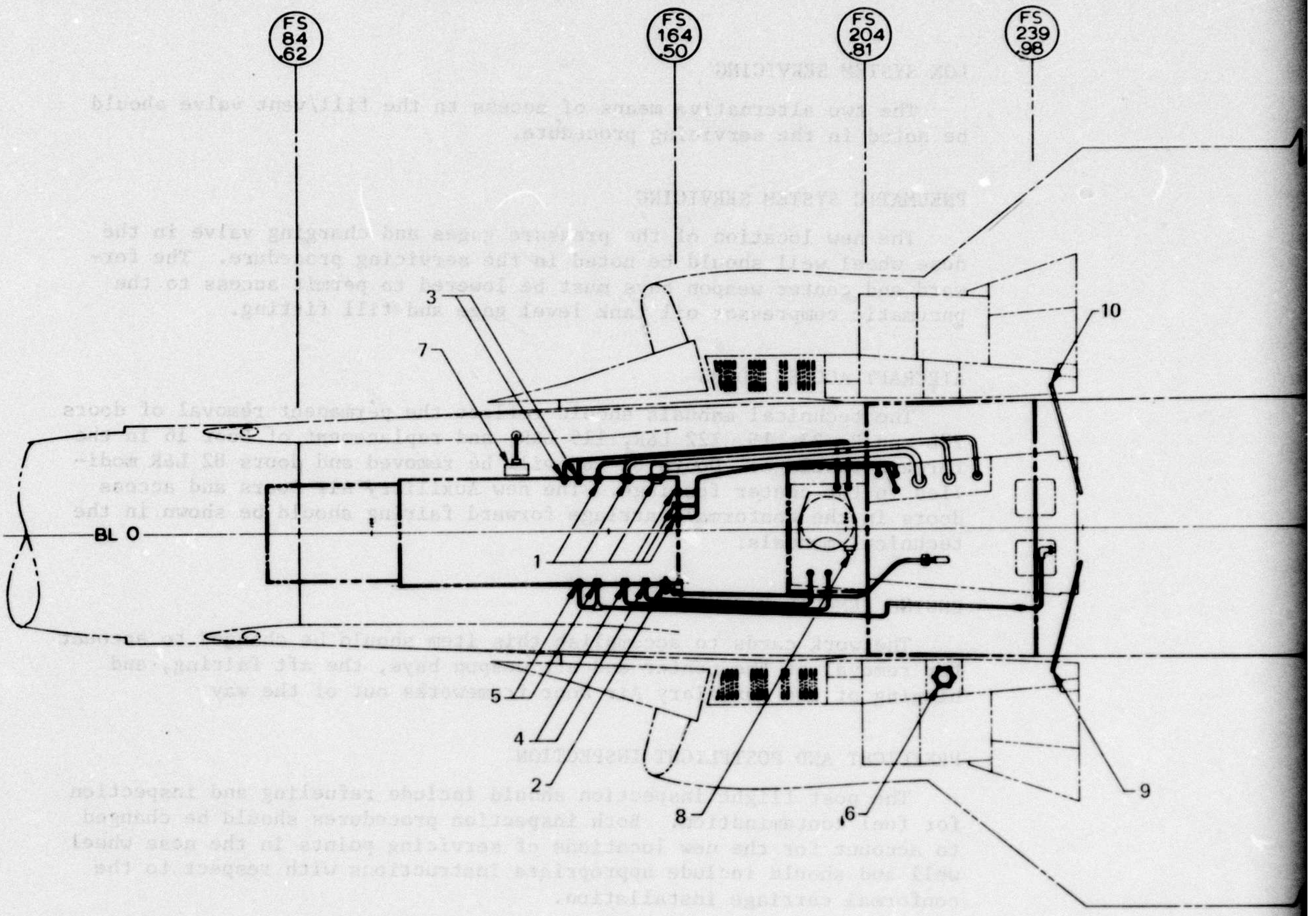
The defueling procedure should be changed to reflect the necessity of removing the forward and center weapon bays to gain access to the external pressure connection.

ENGINE OIL SERVICING

No change will be required in the existing engine oil servicing procedure.

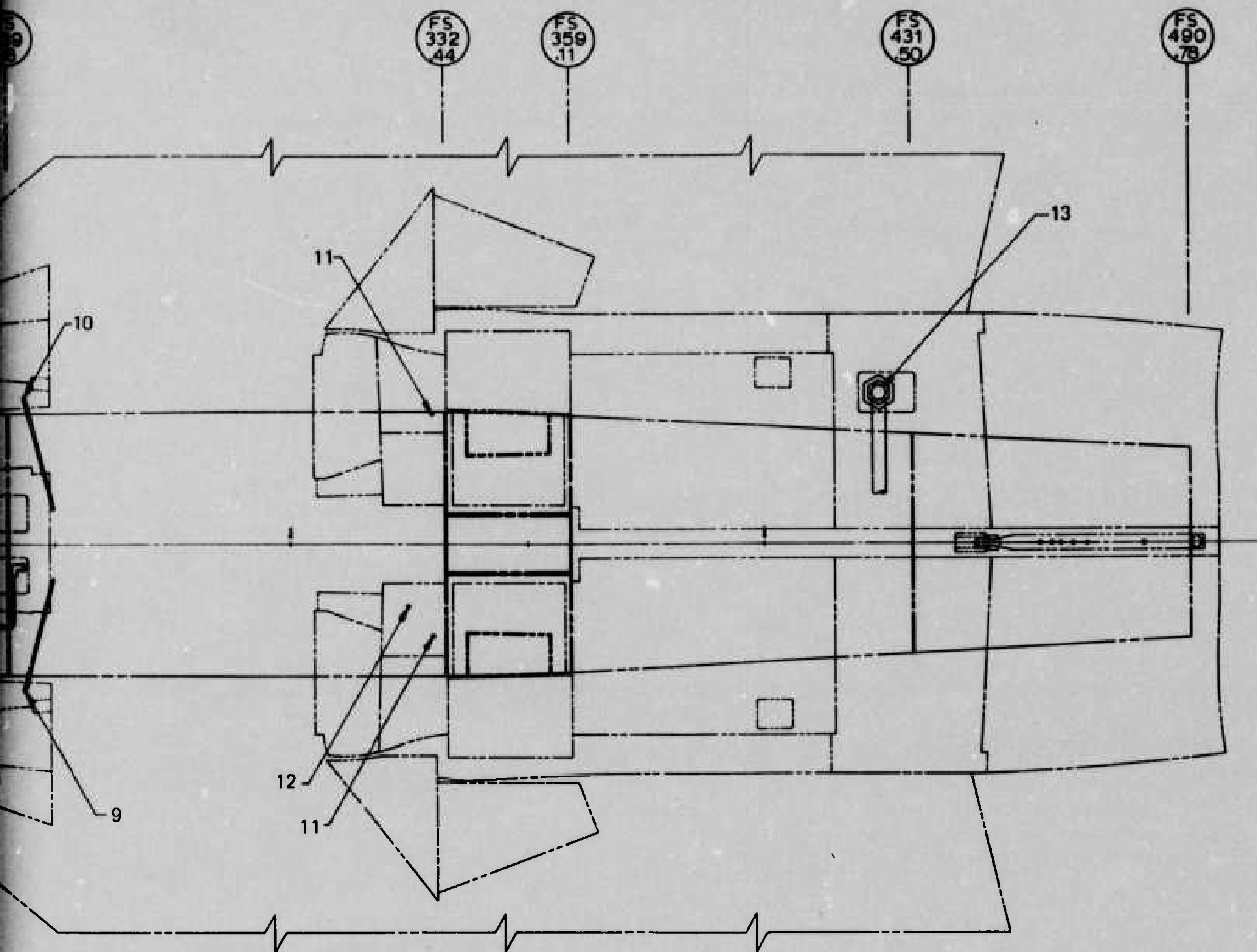
UTILITY HYDRAULIC SYSTEM SERVICING

The servicing procedure should be changed to provide servicing of this system through the nose wheel well only except for the previously noted ground cycling test of landing gear retraction.



1 UTILITY HYDRAULIC SYSTEM SERVICE FITTINGS
   a. SUCTION RETURN
   b. RESERVOIR FILL
   c. UTILITY PRESSURE
   d. RESERVOIR AIR BLEED VALVE
   e. ACCUMULATOR PRESSURE GAGE
   f. ACCUMULATOR AIR CHARGE VALVE
2 UTILITY HYDRAULIC SYSTEM RESERVOIR FLUID LEVEL INDICATOR
3 PITOT AND STATIC DRAINS
4 FWD AND AFT CANOPY EMERGENCY AIR BOTTLE PRESSURE GAGES
5 AIR CHARGE VALVE AND PNEUMATIC SYSTEM MANIFOLD PRESSURE GAGE
6 REFUELING SYSTEM FITT
7 BOMB RELEASE INTERVA
8 LIQUID OXYGEN CONVER
9 NUMBER 1 COMPARTMEN
10 NUMBER 2 COMPARTMEN
11 GENERATOR DRAIN
12 CONSTANT SPEED DRIVE
13 ENGINE STARTING AIR R

FIGURE 45. Service and Drain Modifications - F-4J Conformal Weapons Carriage.



BOTTOM VIEW

← FWD —

REFUELING SYSTEM FITTING, ROTATE 60°
BOMB RELEASE INTERVALOMETER
LIQUID OXYGEN CONVERTER FILL VALVE
NUMBER 1 COMPARTMENT DRAIN (AFT)
NUMBER 2 COMPARTMENT DRAIN
GENERATOR DRAIN
CONSTANT SPEED DRIVE AND HYDRAULIC PUMP SEAL DRAIN
ENGINE STARTING AIR RECEPTACLE (RELOCATE OUTBD)

lage.

LOX SYSTEM SERVICING

The two alternative means of access to the fill/vent valve should be noted in the servicing procedure.

PNEUMATIC SYSTEM SERVICING

The new location of the pressure gages and charging valve in the nose wheel well should be noted in the servicing procedure. The forward and center weapon bays must be lowered to permit access to the pneumatic compressor oil tank level gage and fill fitting.

AIRCRAFT ACCESS DOORS

The technical manuals should reflect the permanent removal of doors 28L and R, 23, 15, 122 L&R, 115 L&R, and replacement of Door 16 in the forward fuselage. Doors 81 L&R will be removed and doors 82 L&R modified in the center fuselage. The new Auxiliary Air Doors and access doors in the conformal carriage forward fairing should be shown in the technical manuals.

ENGINE REMOVAL PROCEDURE

The work cards to accomplish this item should be changed to account for removal of the center and aft weapon bays, the aft fairing, and hinging of the Auxiliary Air Door frameworks out of the way.

PREFLIGHT AND POSTFLIGHT INSPECTION

The post flight inspection should include refueling and inspection for fuel contamination. Both inspection procedures should be changed to account for the new locations of servicing points in the nose wheel well and should include appropriate instructions with respect to the conformal carriage installation.

AUXILIARY ARMAMENT EQUIPMENT

Installation of specialized external stores on the conformal carriage requires adapters configured for the particular store. The MK-84 LGB guidance package contains a large cruciform canard which necessitates an adapter to provide the canard tip clearance from the conformal carriage. A similar but deeper adapter will be required by the MK-84 EOGB because of the large wing span. The HARM missile also has a large wing span, therefore requires an adapter to provide the necessary clearance.

Rail launched missiles such as AGM-65 will require a special individual launching rail with a short standoff to permit launch of these weapons parallel to a flat surface and to provide the requisite wing tip clearance.

The conformal carriage installation poses unique requirements for weapon ejector operating and servicing characteristics because the ejectors are essentially buried behind the lower surface. Several existing ejector designs could be modified to satisfy these peculiar requirements and at least two new designs specifically configured for this type of installation can be available if required. Preliminary ejector specifications were developed and are included as Appendix A. Among the existing ejector designs which could be modified for conformal carriage installation are: Douglas LODE 14A, Douglas Super 14, EDO 14, and AERO-27A. New designs are the CWES 14 and 30 inch ejector, the Boeing Non-Pyrotechnic ejector, and the ALKAN Types 110, 112, 180, 190, and 195.

GROUND SUPPORT EQUIPMENT

The conformal carriage installation requires no special ground support equipment in order to function although use of some specialized support equipment would enhance the operational application of the conformal carriage system.

RECOMMENDATIONS AND CONCLUSIONS

The results of this study indicate an F-4B/J conformal carriage can be designed, built and installed which can be operated and maintained in conjunction with existing F-4B/J aircraft. The study results further indicate the conformal carriage F-4B/J is a high speed attack aircraft with greatly improved performance over that of a standard F-4B/J. Validation of the study results can only be accomplished through design, fabrication, and test of a small number of modified aircraft in an operational environment. Such an R.D.T.&E. program would also provide high speed test bed aircraft for use in development of advanced supersonic weapon attack systems at relatively low cost both initially and logistically. Therefore a Research, Development Test and Evaluation program is recommended in which up to six or more aircraft are modified by installation of conformal carriages designed in accordance with the arrangements and configurations given in this document.

A parallel ejector development program is also recommended in order to fully exploit the operational advantages inherent in the F-4B/J conformal carriage concept. Particularly important is the concept of using clean gas as the energy source. Total system maintenance requirements will be equivalent to conventional F-4B/J aircraft equipped with the same type of ejector. Service access in the conformal carriage F-4E is equivalent to that of conventional aircraft except for the weapon ejectors.

The study has shown the conformal carriage F-4B/J is a viable weapon system concept with very high performance potential.

APPENDIX A

CONFORMAL CARRIAGE EJECTOR DESIGN REQUIREMENTS

Those requirements peculiar to conformal carriage only are identified with an asterisk (*). All other requirements are extracted from the USN advanced suspension and release specifications XAS-3759 and XAS-3760 and other sources and are applicable to all advanced ejector designs.

PHYSICAL DIMENSIONS*

The ejector envelope and mounting provisions shall be that shown in Figures 46 and 47.

WEIGHT

The ejector weight shall be minimized consistent with reasonable engineering practice and minimal fabrication cost. Use of expensive exotic materials shall be avoided except where the cost increment associated with that use can be justified at the rate of $100 per pound of weight saved.

CORROSION CONTROL

Galvanic corrosion of the ejector components shall be minimized through judicious choice of materials and/or use of protective paints or coatings.

EJECTION FORCE

The ejection force developed shall not exceed the limit defined in Figure 48.

The ejection force time history shall be such that ejection velocities obtained fall within the envelope given in Figure 49.

ATTITUDE CONTROL

The ejection system shall be capable of producing a nose down pitch attitude at ejection when the center of gravity of the store is located 3.0 inches forward of the midpoint between weapon suspension lugs.

The ejection system shall be capable of producing a nose up pitch attitude at ejection when the center of gravity of the store is located 3.0 inches aft of the midpoint between the weapon suspension lugs.

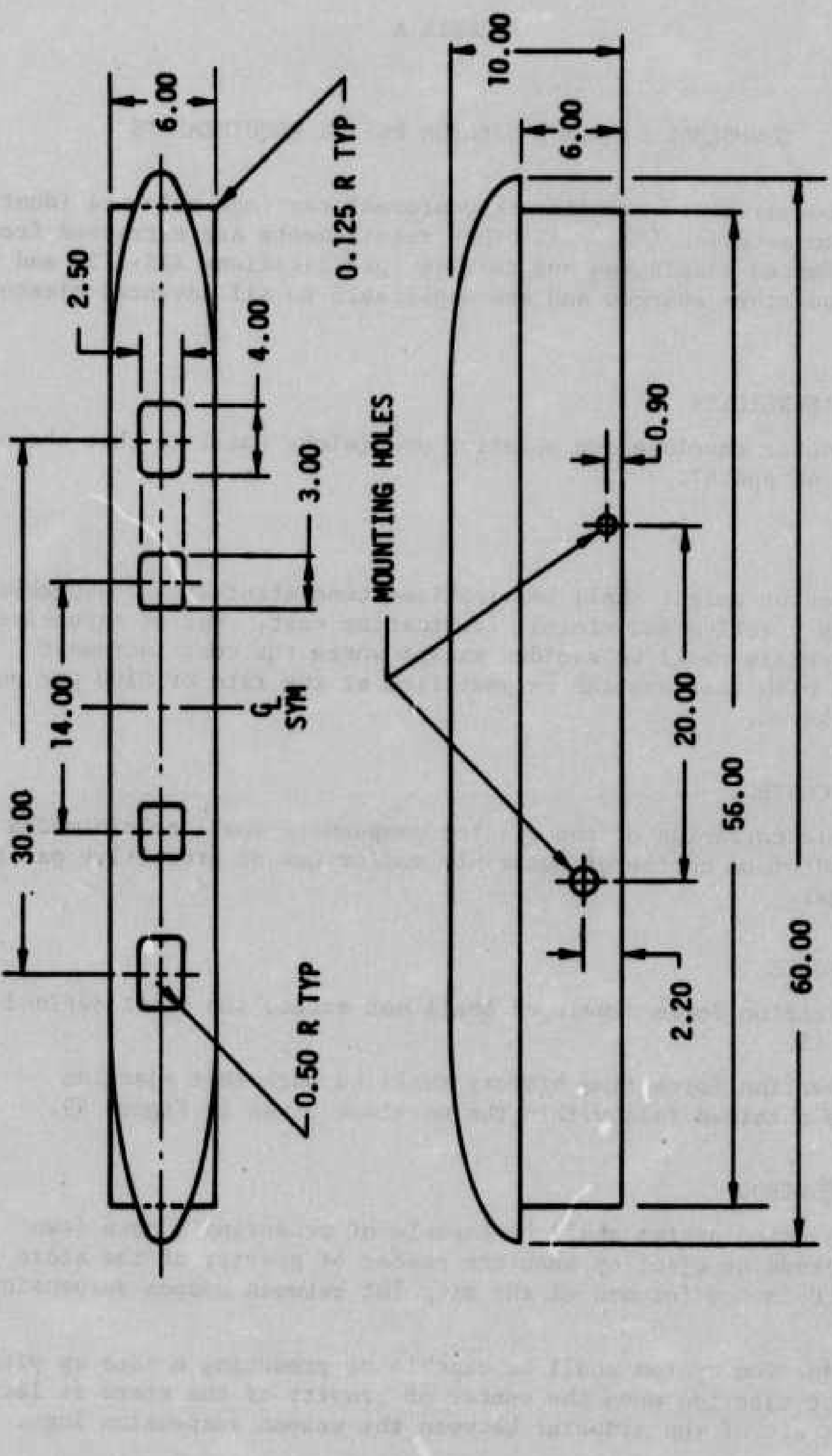


*Figure 46: Thirty Inch Ejector Envelope**

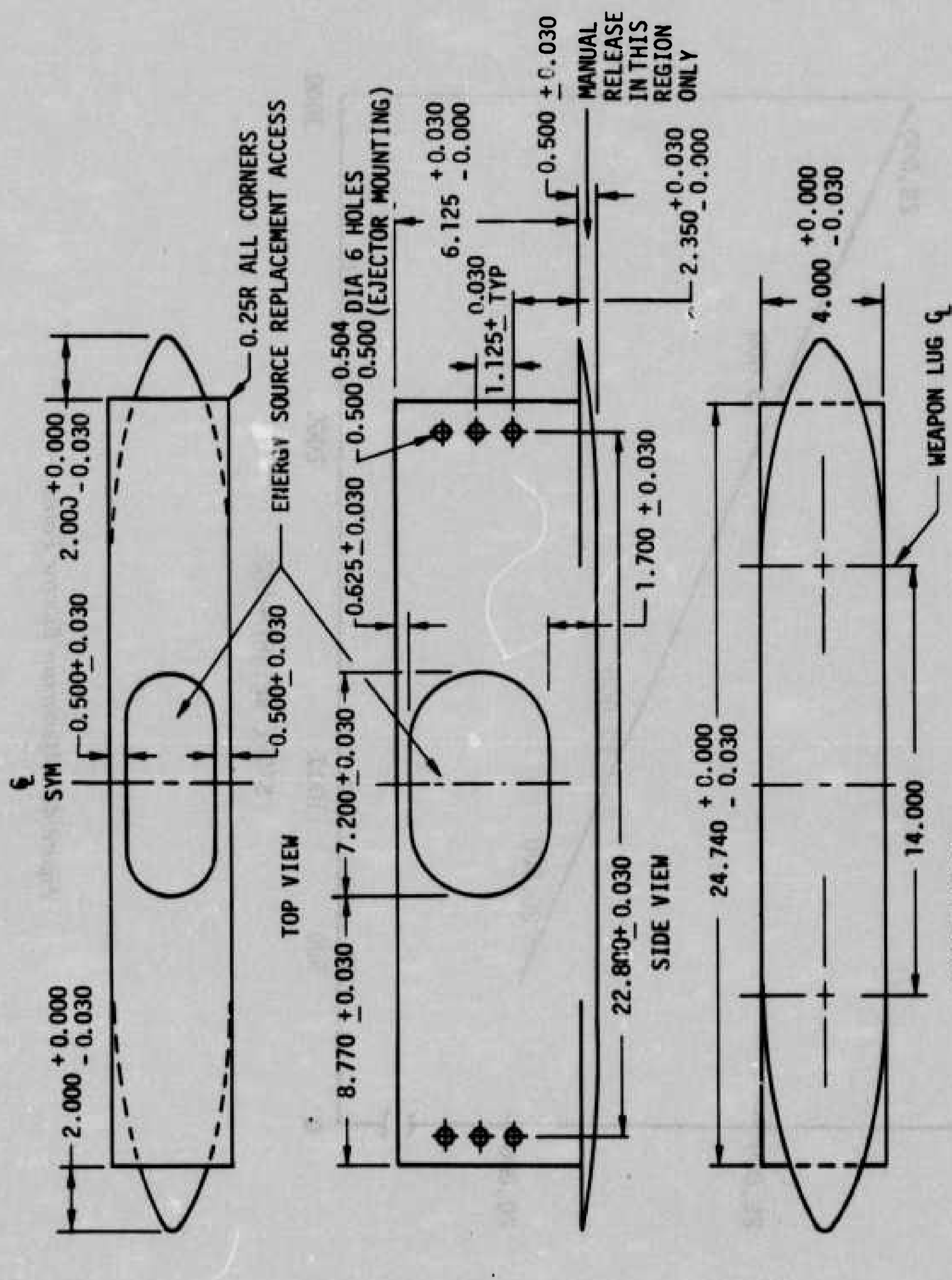


*Figure 47: Fourteen Inch Ejector Envelope**

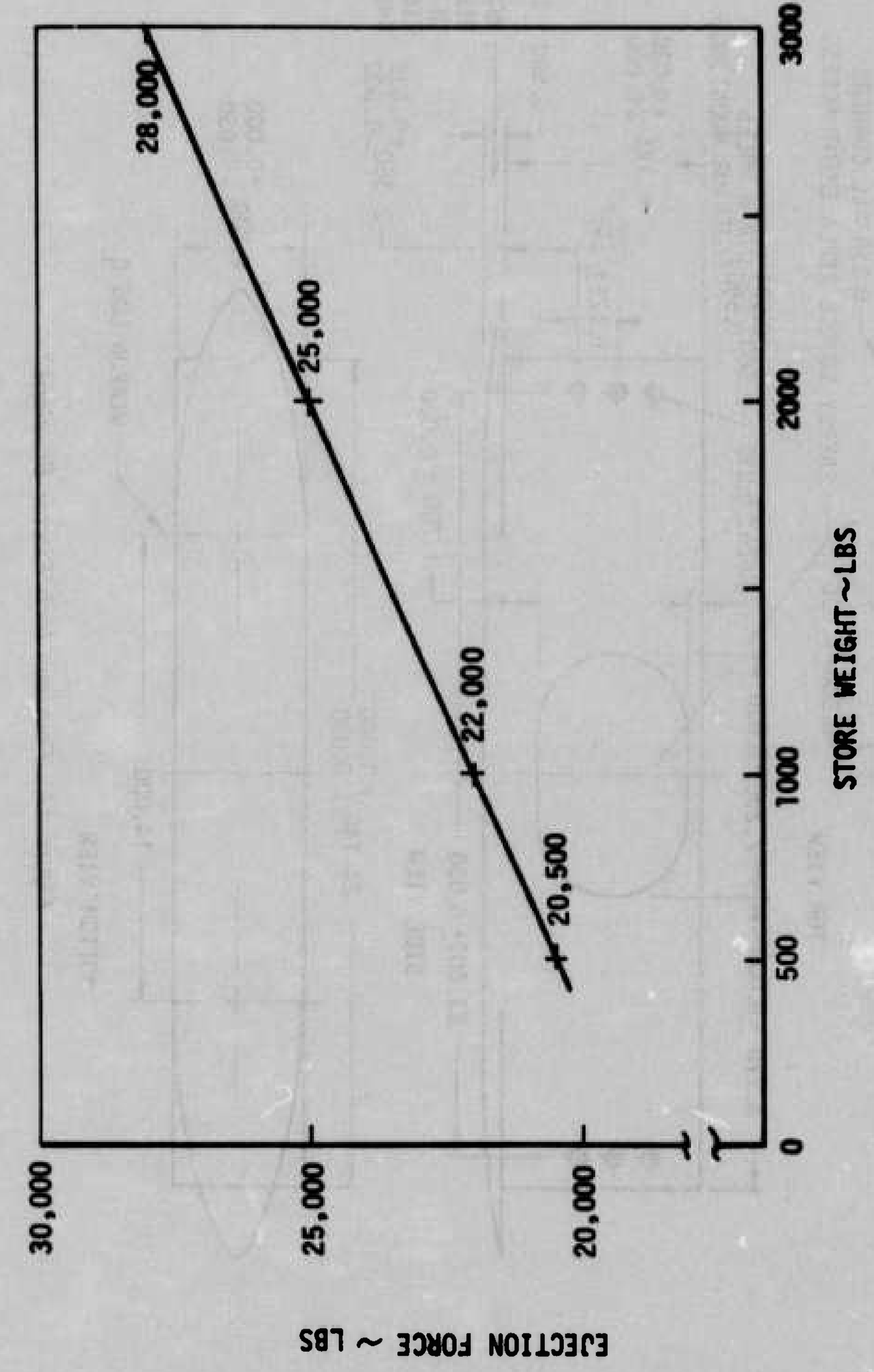


Figure 48: Maximum Ejector Force

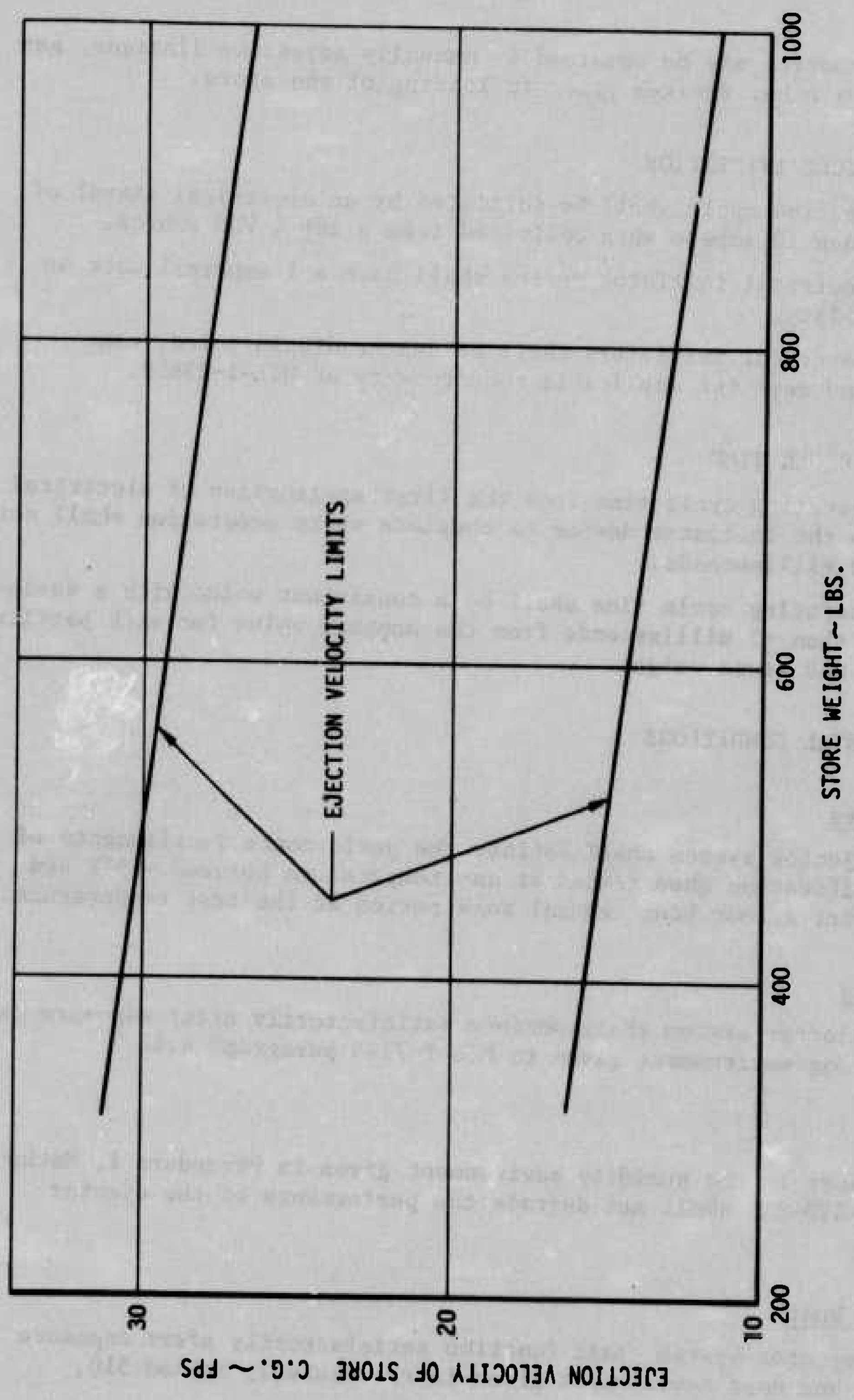


Figure 49: Ejection Velocity

Pitch control may be obtained by manually adjusting linkages, gas orifices, or other devices prior to loading of the store.

EJECTION CYCLE INITIATION

The ejection cycle shall be initiated by an electrical signal of not more than 10 ampere when delivered from a 28± 4 VDC source.

The electrical initiator device shall have a 1 ampere/1 watt no fire capability.

The electrical initiators shall be center single poled, case grounded and meet the applicable requirements of MIL-I-23659.

OPERATING CYCLE TIME

The operating cycle time from the first application of electrical current to the initiator device to complete store separation shall not exceed 100 milliseconds.

The operating cycle time shall be a consistent value with a deviation less than ±5 milliseconds from the nominal value for each particular store and store weight.

ENVIRONMENTAL CONDITIONS

Temperature

The ejector system shall satisfy the performance requirements of this specification when tested at any temperature between -65°F and +180°F after a four hour thermal soak period at the test temperature.

Salt Spray

The ejector system shall perform satisfactorily after exposure to the salt fog environment given in MIL-T-7743 paragraph 4.12.

Humidity

Exposure to the humidity environment given in Procedure 1, Method 507, MIL-STD-810 shall not degrade the performance of the ejector system.

Sand and Dust

The ejector system shall function satisfactorily after exposure to the sand and dust environment given in Procedure 1, Method 510, MIL-STD-810.

Icing Conditions

Exposure to the icing conditions described in MIL-T-7745 shall not prevent satisfactory operation of the ejector system.

Vibration

The ejector system shall function satisfactorily after exposure to the vibration environment of MIL-STD-810B, Method 514, Procedure II, Part 3, Curve A.F.

Electromagnetic Radiation

The ejection sequence shall not be initiated by exposure to the radiation levels given in Figure 50. The initiator devices shall be designed in accordance with MIL-STD-1512 and demonstrated to satisfy the requirements of MIL-P-24014.

STRUCTURAL

Pressure Components

All pressure components shall be designed to withstand without failure the greater pressure of either 2.5 times the maximum pressure developed on that component during a locked shut firing of the ejection system or 1.5 times the pressure developed in that component during ejection of the maximum weight store for which the ejector is qualified.

Ejector Mechanism

The ejector mechanism shall be capable of withstanding the loads generated during ejection of the maximum weight weapon for which the ejector is qualified while in a +5g vertical maneuver. The yield and ultimate factors of safety shall be 1.15 and 1.50 respectively as defined in MIL-A-8591.

Ejector Assembly

The entire ejector assembly and its locking mechanism shall be capable of reacting the static loads developed by the maximum weight weapon for which the ejector is qualified acted upon by the limit load factors given in Figure 9 of MIL-A-8591D. The yield factor of safety shall be 1.15. The ultimate factor of safety for these load factors shall be 1.50.

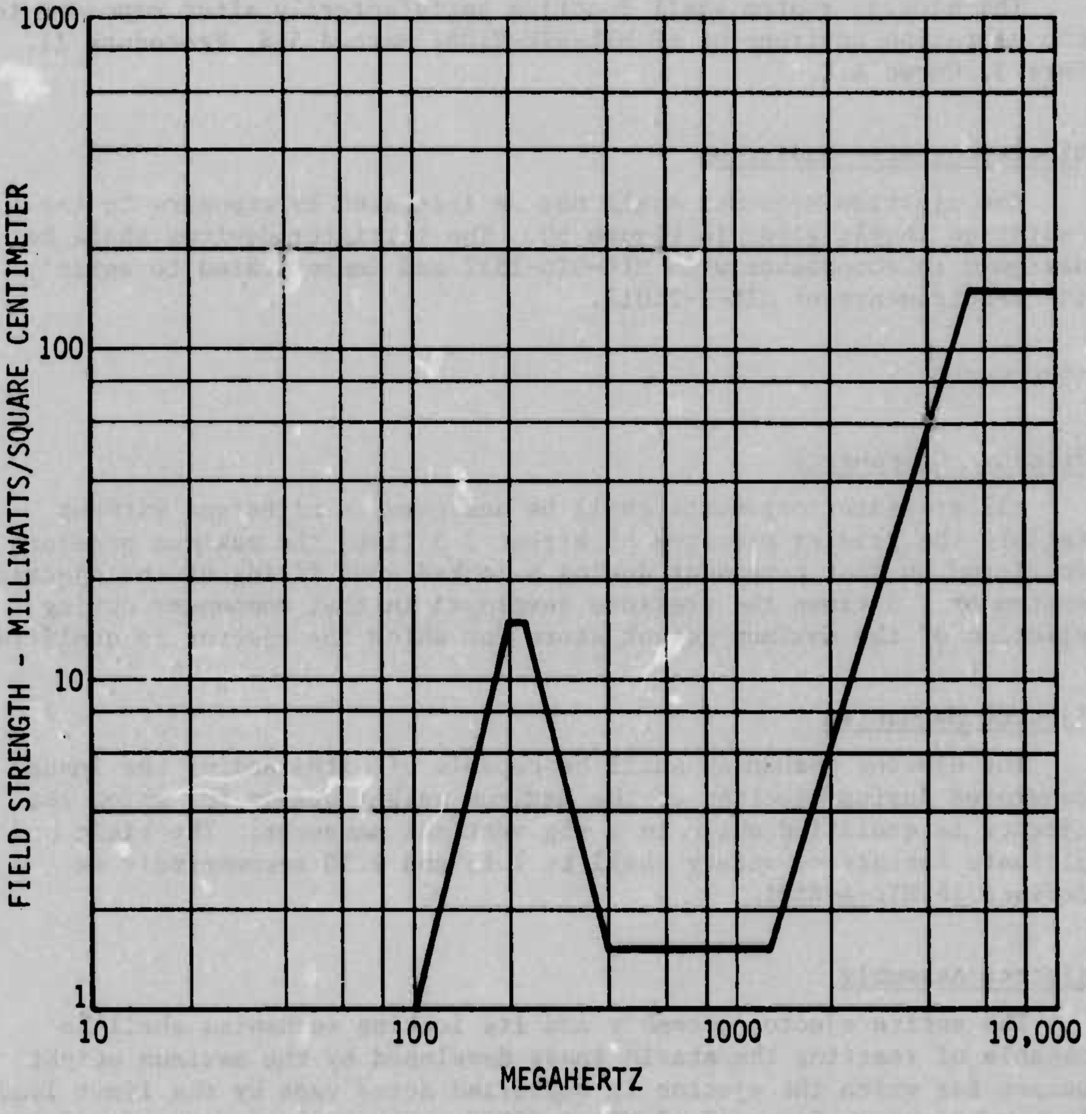


Figure 50 : Electromagnetic Field Strength Test Levels

Vibration

The ejector assembly shall be designed to withstand and shall function satisfactorily after imposition of the loads developed by the maximum weight store for which the ejector is qualified when the rigid ejector mounting structure is subjected to the following sinusoidal vibrations.

Vertical Axis. One hour of vibration where the frequency is swept from 10 Hz to 200 Hz and back to 10 Hz in four minutes at a steady sweep rate. The acceleration amplitude shall be a mean load of 2.33 "g's" upward with a superimposed ±6.33 "g's".

Lateral Axis. One hour of vibration where the frequency is swept from 10 Hz to 200 Hz and back to 10 Hz in four minutes at a steady sweep rate. The acceleration amplitude shall be ±1.5 "g's".

Longitudinal Axis. One hour of vibration where the frequency is swept from .6 Hz to 12 Hz and back to .6 Hz in four minutes at a steady rate. The acceleration amplitude shall be .5 "g's" forward ±7.5 "g's".

RELIABILITY

Manufacturing tolerances in the detail design of the ejector assembly shall be as liberal as possible consistent with operating reliability.

MAINTAINABILITY

The design shall permit servicing, cleaning, weapon up loading weapon down loading, and routine maintenance by a minimal number of personnel with limited skill levels operating in severe environmental conditions.

Cleaning

The ejector shall be capable of functioning without cleaning or maintenance for a minimum of 50 ejections except for replenishment of expendable materials. The ejector shall be capable of being cleaned without removal from its mounting structure.

FUNCTIONAL BYPRODUCTS

The ejector system shall be designed to retain within the breech assembly all solid byproducts of the combustion process if the ejector energy source is pyrotechnic. When a clean gas is used as the energy source, no solid particles shall be permitted to pass through the gas release valve and downstream toward the orifice control valves. Residual high pressure gases shall be vented to the atmosphere after the ejection cycle has been completed.

FUNCTIONAL CHARACTERISTICS

Arming And Safing (IFOBL)

The ejector shall be designed with an inflight operable ejector lock which positively precludes inadvertant operation of the ejection mechanism through accident, or external environmental influences. When the ejector is armed an indicator device shall be externally visible as a warning device.

Cocking The Ejector Mechanism

When the ejection sequence has been completed, the ejector mechanism shall remain in a cocked condition ready to receive another store. There shall be no external proturberances presented to the air stream when the ejector is in this condition.

Reloading The Ejector

The ejector shall be designed so that the energy source may be replenished through either the bottom prior to uploading the store, through one side or through the top before or after the store has been uploaded and locked in position.

Manual Release*

The ejector design shall contain a manual release mechanism so that stores can be down loaded manually without requiring aircraft electrical, hydraulic, or mechanical power sources to operate the inflight operable ejector locking device. The manual release system shall be readily operable when the ejector is submerged in a structure.

Retraction Of The Ejector Pistons

After completion of the ejection function, the ejector pistons shall automatically retract to a position within the confines of the ejector assembly and shall not protrude into the air stream in this condition.

Weapon Lug

The 14 inch ejector design shall be compatible with MIL-A-8591D 14 inch 1,000 lb. weight class lugs, the 30 inch ejector design shall be compatible with MIL-A-8591D 30 inch 2,000 lb. weight class lugs.

Sway Braces *

The ejector assembly shall contain sway braces which are automatically adjusted to stabilize the external store against side loads. The sway braces may extend into the airflow when a weapon is mounted on the ejector but shall be retracted out of the airflow after the weapon has been ejected.

Fuze Arming Solenoids

The ejector assembly shall provide mounting positions for and include nose and tail fuze arming solenoids arranged with the solenoid slot aligned with the ejector longitudinal center line.

Electrical Fuze Provision

The ejector assembly shall provide internal volume for an electrical fuze connection located in accordance with MIL-A-8591D.

Secondary Release *

The ejector mechanism shall include a capability for releasing the external store through operation of an independent release system which may or may not produce a powered ejection sequence. The system shall be electrically operable from the cockpit in the event the primary ejection system fails to operate. The secondary release system shall bypass the IFOBL so that the store can be jettisoned if the IFOBL malfunctions.

Energy Source

The ejector energy source shall be made to function by an initiating device operable by the electrical signal noted under Ejection Cycle Initiation.

Cartridge Type. If the ejector design employs pyrotechnic cartridges as the energy source, the cartridges shall be those presently used within the military forces. Development and deployment of new cartridges shall not be required. The cartridge breech shall be dual and the arrangement shall be such that ignition of either of the cartridges will sympathetically ignite the other.

Non Pyrotechnic Type. If a non pyrotechnic energy source is employed, it shall be a single storage container containing two initiating devices which are arranged so that operation of either will cause the ejection sequence and which are wired in parallel to the ejection signal source or alternatively a single initiating device containing dual wiring such that an initiating signal from the parallel wire bundles to either wiring circuit in the device will cause the ejection sequence.

ELECTRICAL WIRING

All ejector wiring associated with initiation of the ejection function shall be dual circuits of shielded twisted pairs or shielded coaxial wiring to minimize induced currents caused by external electromagnetic fields. There shall be an electrical sensor which can indicate the store is loaded and locked in place. It should also indicate the store has been released and has successfully separated from the ejector.

SERVICE LIFE

The ejector shall be designed to provide ejection velocities given in Figure 49 for a minimum of 500 ejections without requiring overhaul of system components.

APPENDIX B

DESIGN REQUIREMENTS FOR F-4 B/J R.D.T.&E. PROGRAM

The design requirements are the basis for configuration development of any weapon system and generally comprise a set of system requirements which mutually interact with one another to produce a set of design specifications for an optimal total weapon system. Mutually opposing requirements for interacting systems are usually eliminated from the design specifications during the preliminary design trade studies. Trade studies for the F-4 conformal carriage have been conducted during the recently completed preliminary design contracts and the design requirements for a usable total system developed. The resulting specifications have been subdivided into system areas and are further described under appropriate subsections.

WEAPON MANAGEMENT SYSTEM

The F-4B/J conformal carriage weapon management system shall permit cockpit selection of any one of several optional release sequences. Each of the optional release sequences shall either be permanently stored in the system memory or be programmed into the system memory by the ordnance loading personnel in accordance with the external stores mounted on the aircraft. The system shall contain safety provisions programmed into the system memory so that only safe release sequences can be initiated.

A builtin test circuit shall be provided which when actuated by ground maintenance personnel will test circuit continuity from the pilots release switch through the individual weapon ejector.

The system shall contain an emergency jettison circuit which releases the stores through a permanent jettison release sequence. It shall be possible to jettison the external stores whenever the aircraft is airborne. The system shall be compatible with advanced digital navigation and bombing systems and those elements of the F-4 B/J weapon management system retained in the F-4B/J conformal carriage aircraft.

F-4 B/J cockpit space is very critical, therefore; the cockpit release sequence control for the conformal carriage shall consist of as small a device as possible, placed on or within the F-4 B/J armament control panel. The device may consist of illuminated buttons identifying the optional release sequences, a small thumbwheel switch with numbered and illuminated detent positions, or other small devices requiring minimal space and operator attention.

Installation of cartridge actuated ejectors in the conformal carriage precludes circuit continuity check through the cartridges. Isolation of the cartridges during system checkout shall be provided by special switching in the conformal carriage demultiplexer unit (DeMux) located in the center line fitting. When cartridge actuated ejectors are installed the switch will be manually turned to the no test position. Thereafter, when the test button is pushed, the circuit shall be checked only through the DeMux unit and not through the ejectors and ejector cartridge circuits shall be grounded during the circuit test.

AERODYNAMIC SHAPE

The external shape of the basic conformal carriage shall be that defined by cross sections given in Figure 40. These cross sections are those developed and tested on the 5% wind tunnel model in April 1974 at the NASA Ames tunnel complex.

STRUCTURAL ARRANGEMENT

The conformal carriage shall be divided into three removable weapon carrying components, one removable aft fairing section, and one fixed forward fairing. Figure 43 illustrates the arrangement of components and the attachment points.

The forward weapon bay structure shall be assumed to be simply supported at each of the four corners, with no structural continuity between the forward fairing and the weapon bay nor between the forward weapon bay and the center weapon bay structures.

The center weapon bay structure shall be assumed to be simply supported at the two forward corners and on the rear edge at the aircraft centerline. The two sides at the aircraft mid spar shall be assumed restrained against upward motion by sway braces bearing against the aircraft structure. The sway braces shall be assumed incapable of resisting downward motion.

The weapon carrying structures and their attachments shall be designed to permit quick attachment to the aircraft of a component preloaded with weapons. Conversely the components shall also be designed for quick detachment from the aircraft.

The aft fairing shall be a removable assy simply supported at the forward and aft ends on the aircraft centerline. The four corners shall be assumed restrained against upward motion by sway braces bearing against the aircraft structure. The sway braces shall be assumed incapable of resisting downward motion.

The aft fairing shall be designed to dispense RR-170/AL and RR-170B/AL chaff, decoy flares and other passive defensive devices. The assembly shall be quickly removable with electrical connectors that automatically disconnect when the assembly is removed.

The forward fairing shall be permanently attached to the aircraft and shall contain the requisite doors for maintenance and operation of the aircraft.

The Pave Spike unit shall be rearranged to permit permanent installation within the forward fairing. Requisite heat sinks and access doors shall be provided in the forward fairing.

The ECM equipment shall be rearranged to permit permanent modular installation within the forward fairing. Heat sink provision shall be made and access doors shall be provided in the forward fairing. The forward fairing design shall be integrated with the redesign of the Pave Spike and ECM equipment so that the installed combination is efficient aerodynamically, optically, and electrically.

The auxiliary air doors shall be supported within a structural assembly hinged to the centerline structure of the conformal carriage and capable of being opened out of the way for engine removal. The door shall close tightly when the main landing gear is retracted and shall contain pressure relief valves capable of venting plenum chamber at 13.6 psi differential pressure. The auxiliary air doors shall open when the main landing gear is extended.

STRUCTURAL LOADS

The limit load factors for which the conformal carriage structure and its attachment shall be designed are those given in Figure 9 of MIL-A-8591D. Critical design limit load factors shall be those given in Table 4.

The structure and attachments shall not undergo permanent deformation under the moments and shears developed by any of the limit load factors applied to the center of gravity of each weapon in the weapon suits given in Tables 1, 2 and 3. The weapon ejector locations shall be those shown in Figure 41 and weapon ejector utilization shall be that shown in Table 3.

Permanent deformations of the structure and attachments after application of 1.15 times the above noted limit loads shall not adversely affect the aerodynamic performance, mechanical operation and function or store installation, nor shall they be readily apparent upon inspection.

Structural failure of the conformal carriage or its attachments shall not occur when loads 1.50 times the above noted limit loads are applied.

Skin gages, and skin panel sizes shall be designed to be stable against panel flutter as defined in Figures 51 and 52.

TEST CONDITIONS

Except for Government Furnished Equipment, such as weapon ejector racks, all assemblies of the conformal carriage shall be subjected to the test conditions described herein and shall satisfy the appropriate

Table 4: Design Limit Load Conditions

CONDITION	NO.	N_x	N_y	N_z
FLIGHT	1	± 1.5	± 1.5	± 8.67
	2	± 1.5	± 1.5	−4.00
ARRESTED	3	− 2.0	± 1.5	− 7.00
LANDING	4	− 2.0	± 1.5	− 3.50
	5	+ 2.0	± 1.5	+ 7.00
	6	+ 2.0	± 1.5	− 3.50
	7	+ 8.0	± 1.5	+ 3.00
	8	+ 8.0	± 1.5	− 1.50
*CATAPULT	9	−7.00	± 1.00	+ 5.00
LAUNCH	10	− 7.00	± 1.00	− 1.00
	11	+ 2.00	± 1.00	+ 5.00
	12	+ 2.00	± 1.00	− 1.00

* CATAPULT LAUNCH CONDITION REQUIRED ONLY FOR CARRIER OPERATED AIRCRAFT

$+N_x$ PRODUCES A FORWARD ACTING LOAD ON THE STRUCTURE

$\pm N_y$ PRODUCES A SIDE ACTING LOAD ON THE STRUCTURE

$+N_z$ PRODUCES A DOWNWARD ACTING LOAD ON THE STRUCTURE

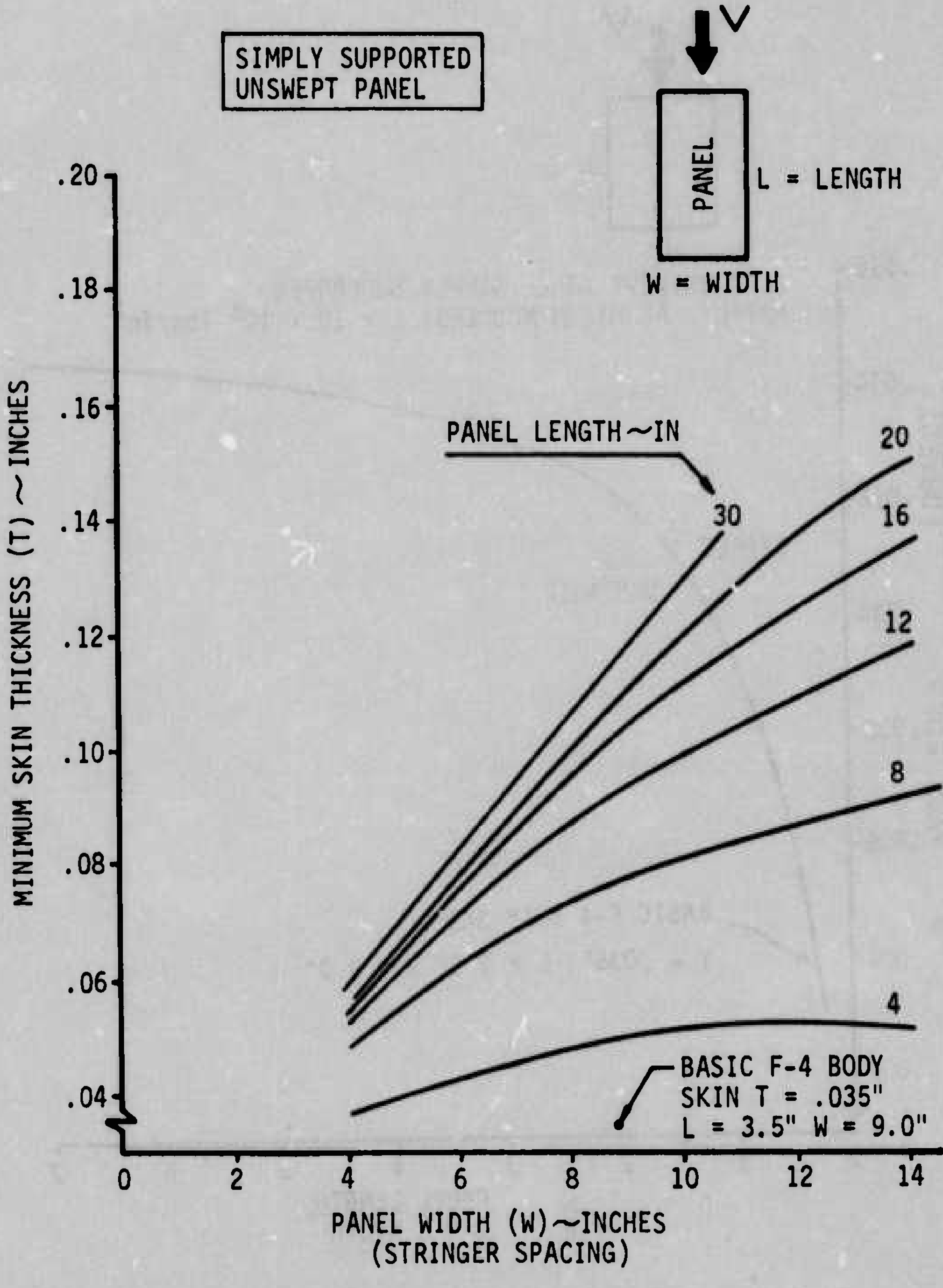


Figure 51: Conformal Carriage Panel Flutter Requirements

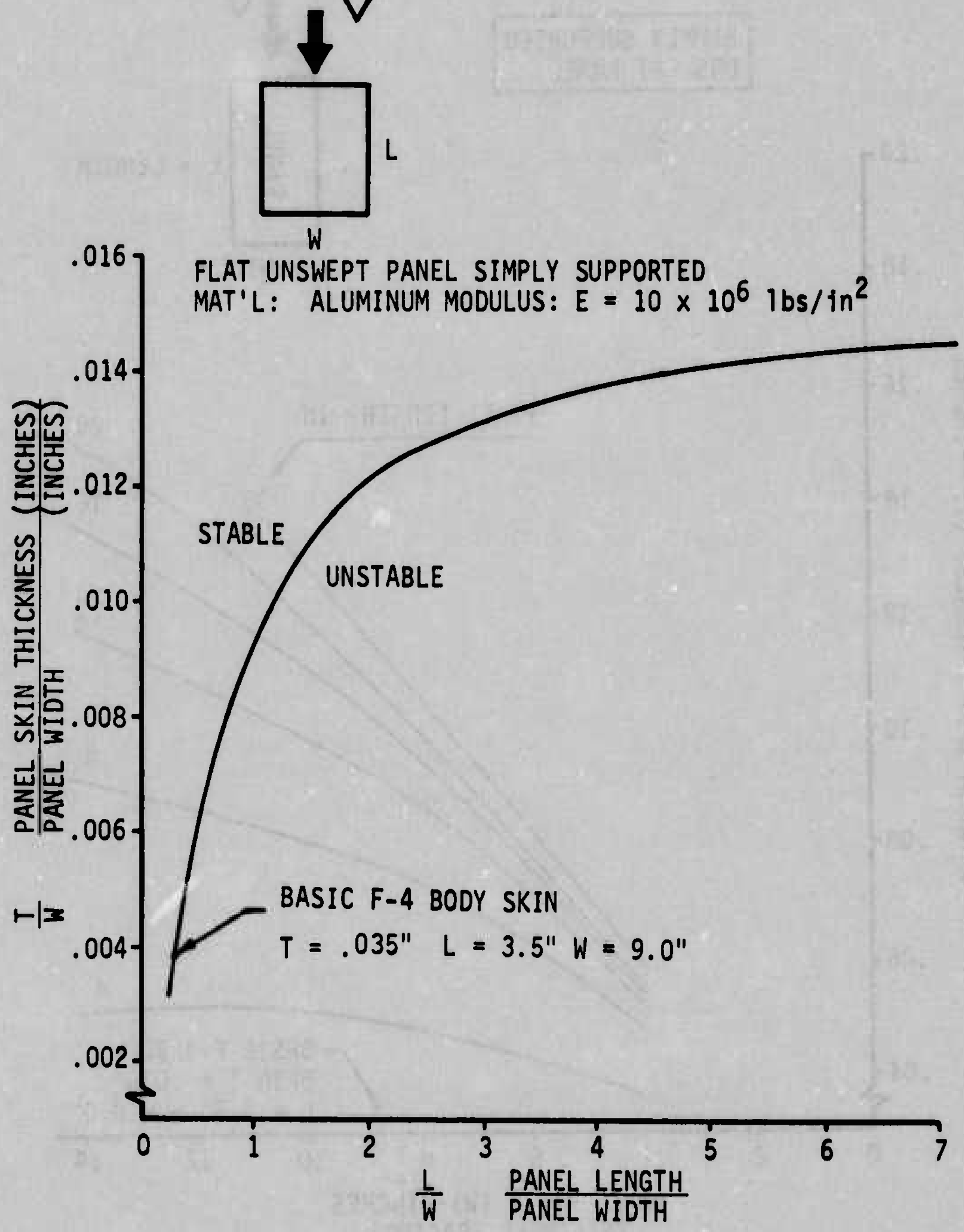


Figure 52: Panel Flutter Prevention Requirements

operational criteria after testing. Government Furnished Equipment shall be assumed to be qualified for service use withour further testing.

ENVIRONMENTAL EXPOSURE

All hinges, latches, and electrical connections shall be subjected to the following test conditions. Following the exposure tests the items must function satisfactorily.

The test items shall be placed in the test chamber in an operational condition; latches closed and safetied, hinges closed, electrical connections made with plug sealed as in an operational use.

Operation Under Icing Conditions

The test item shall be placed in the test chamber and temperature of the test item reduced to -70°F and stabilized for one hour at that temperature to ensure uniform temperature throughout the test item. The test chamber conditions shall then be raised to +100°F with a 90% relative humidity and maintained at those conditions until all evidence of frost on the test item has disappeared.

The test chamber conditions shall then be reduced to -70°F within five minutes and held at this condition one hour. Electrical continuity and dielectric breakdown tests shall be conducted for each lead in the electrical connector. The line resistance across the connector shall not vary more than ±1 ohm from that measured before the test. Following removal from the test chamber all parts shall be tested for functional operation within five minutes of removal. Electrical connections shall be tested for continuity and dielectric breakdown within five minutes of removal and also after stabilized room temperature has been achieved throughout the connector.

The dielectric breakdown test shall consist of an alternating current test voltage of 1,000 ±50 volts rms applied between the test lead and the grounded connector case, all other leads shall be grounded to the connector case during this test. The frequency of the alternating current may be any value between 50 and 100 herz and the wave shape shall be approximately sinusoidal. The voltage shall be increased from zero to test voltage within one half minute and shall be maintained at the test voltage for a period of one minute. Any indication of current flow in excess of 0.001 amperes during the one minute test period shall be considered a failure and cause for rejection of the test item. Each lead in the connector shall be tested under this condition.

Salt Spray Test

The test items shall be subjected to the salt spray test Method 811.1 of Federal Test Method Standard Number 151 for 120 hours. At the end of the spraying period, the item shall be removed. Electrical connectors shall be subjected to the continuity and dielectric breakdown tests within one hour after removal from the spray chamber and after drying for 48 hours.

All nonelectrical parts shall be tested for functional operation after drying for 48 hours following removal from the spray chamber. No test parts shall be operated, rotated, or disconnected during the period between removal from the spray chamber and the test following the 48 hour drying period.

Salt Spray Altitude Test

Electrical connectors shall be subjected to the salt spray environment conditions for 24 hours and immediately upon removal from the spray chamber placed in an altitude chamber and subjected to 70,000 ±5% feet altitude conditions for one hour. Electrical continuity and dielectric breakdown tests shall be conducted while the part is in the high altitude environment and also upon return to room ambient pressure. The unit shall complete three salt/altitude cycles without evidence of failure.

Sand Test

All test items shall function satisfactorily after exposure to the sand tests described in this section. Electrical connections shall be subjected to the continuity and dielectric breakdown tests within one hour of removal from the test chamber.

Apparatus. The test facility shall consist of a chamber and accessories to control dust concentration, velocity, temperature, and humidity of dust laden air. In order to provide adequate circulation of the dust laden air, no more than 50 percent of the cross-sectional area (normal to air flow) and 30 percent of the volume of the chamber shall be occupied by the test item(s). The chamber shall be provided with a suitable means of maintaining and verifying the dust concentration in circulation. A minimum acceptable means for doing this is by use of a properly calibrated smoke meter and standard light source. The dust laden air shall be introduced into the test space in such a manner as to allow it to become approximately laminar in flow before it strikes the test item.

Dust Requirements. The dust used in this test shall be fine sand (97 - 99% by weight SiO_2) of angular structure, and shall have the following size distribution as determined by weight, using the U.S. Standard Sieve Series.

a. 100 percent of this dust shall pass through a 100-mesh screen

b. 98 ±2 percent of the dust shall pass through a 140-mesh screen

c. 90 ±2 percent of the dust shall pass through a 200-mesh screen

d. 75 ±2 percent of the dust shall pass through a 325-mesh screen

Procedure. Place the item in the chamber, positioned as near the center as possible. No surface of the test item shall be closer than 4 inches from any wall of the test chamber. Orient the item so as to expose the most critical or vulnerable parts to the dust stream. Parts of the item normally protected when installed on the aircraft shall be adequately covered during the test.

Set the chamber control to maintain an internal chamber temperature of 23°C (73°F) and a relative humidity of less than 22 percent. Adjust the air velocity to 1,750 ± 250 feet per minute. Adjust the dust feeder to control the dust concentration at 0.3 ± 0.2 gms. per cubic foot. With test item nonoperating, maintain these conditions for 6 hours. Turn off all chamber controls and allow the test item to return to ambient conditions.

E.M.I. Effects

All electrical components of the conformal carriage shall be subjected to the electro magnetic field intensity given in Figure 50. There shall be no breakdown of the dielectric between circuits when a 28 ± 4 VDC potential is impressed across the terminals while the component is subjected to this E.M.I. field intensity.

STATIC STRUCTURAL

All hinges, latches, and attachments shall be mounted on fixtures in the manner in which they will be mounted in the conformal carriage installation on the F-4B/J aircraft.

Each part shall be subjected to the maximum limit load calculated for that part for each of the load conditions given in Table 4. The test parts shall not develop permanent deformation due to application of any of the limit loads above described. Permanent deformations of the parts developed after application of 1.15 times the limit load shall not adversely affect subsequent mechanical operations of the test item.

Structural failure of the test part shall not occur when 1.50 times the limit loads are applied. The test part shall be tested to failure in each of the critical conditions.

The static load shall be increased at a steady rate to achieve the calculated limit load in 20 minutes. When the part is tested to failure, the same loading rate used in the limit load test shall be continued beyond limit until failure occurs.

Each weapon bay of the conformal carriage shall be mounted on its attachment fittings which shall be attached to a test fixture to represent the aircraft installation arrangement. Suitable loading fixtures shall be installed in the ejector locations to provide locations for load application. Loads shall be applied to each of the loading fixtures to represent the load conditions given in Table 4 applied to the weapon suits given in Tables 1, 2, and 3.

The maximum applied load shall be 1.15 times the calculated limit loads from Table 4. Permanent deformations of the conformal carriage installation shall not occur under limit load conditions. Permanent deformations caused by application of 1.15 times the calculated limit load conditions shall not adversely affect the aerodynamic shape of the conformal carriage or its functional characteristics. The weapon bay structures shall not be tested to destruction.

STRUCTURAL DYNAMIC

Each weapon bay of the conformal carriage shall be mounted on its attachment fittings which shall be attached to a test fixture representing the aircraft installation arrangement.

Loading fixtures shall be installed in the ejector locations. The loading fixtures shall be equivalent to the weight of the ejector class they represent. The weapon bay shall be vibrated in each of three mutually perpendicular axes, vertical, lateral, and forward and aft. All testing shall be completed in one axis prior to testing in the next axis. The test fixture shall be capable of transmitting to the conformal carriage structure the vibration conditions specified herein. Vibration amplitudes and frequencies shall be measured by techniques that will not significantly affect the controlled input to the conformal carriage or the response of the conformal carriage. The control signal shall be the average of the output from accelerometers located at each of the conformal carriage attachment fittings.

When external weights representing attached external stores are fixed to the conformal carriage loading fixtures, the weights shall have the mass properties of the store they represent. The attachment details between weights and loading fixture shall duplicate those for the represented store.

<u>Sinusoidal Vibration</u>

The test article without simulated weapons attached shall be subjected to the vibration conditions corresponding to the 2 'g' and 10 'g' lines shown in Figure 53. The test article shall be vibrated

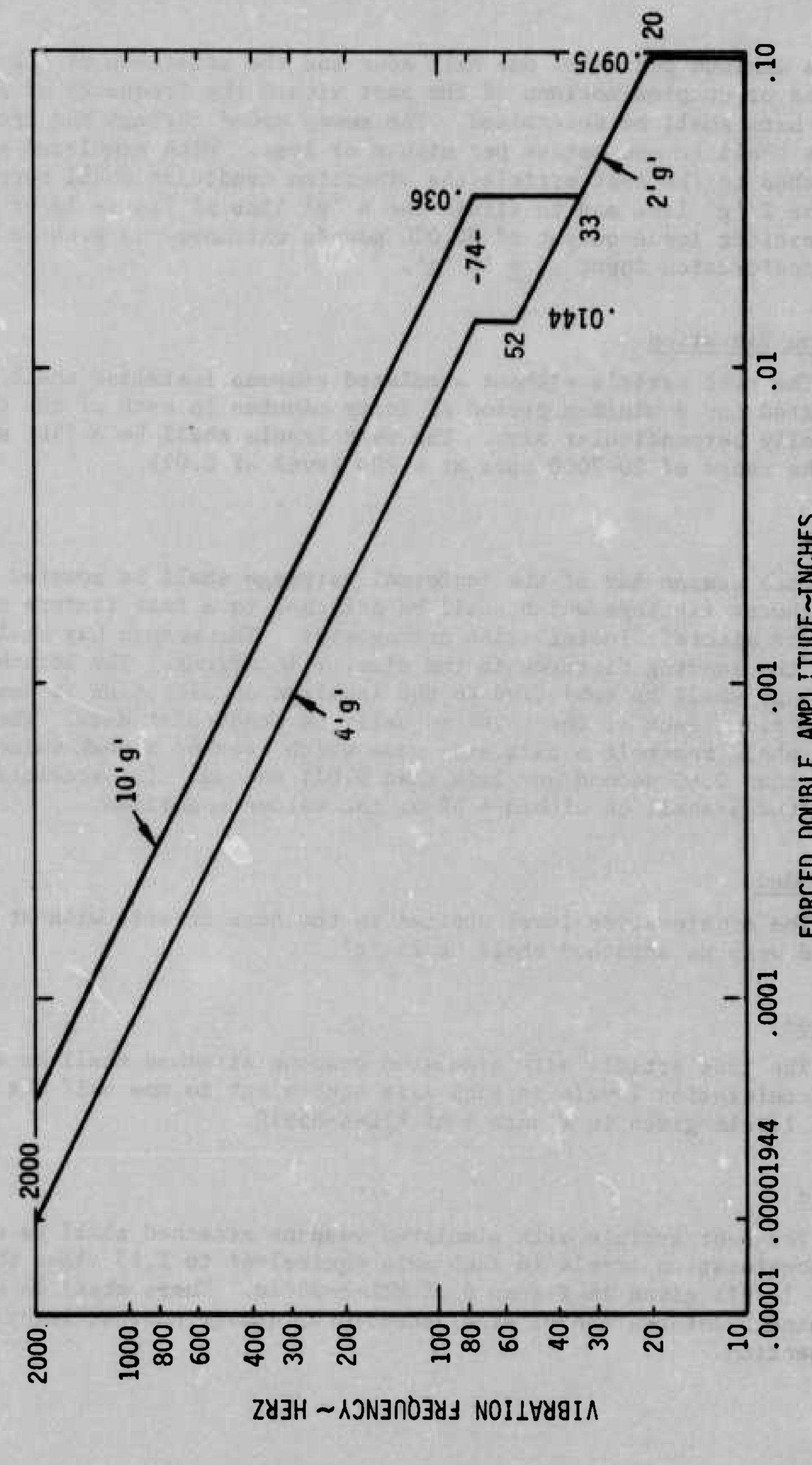


Figure 53: Input Sinusoidal Vibration

for a minimum period of one half hour and the existence of all resonance points or complex motions of the part within the frequency of 5 to 2000 herz shall be determined. The sweep speed through the frequency range shall be one octave per minute or less. With simulated stores attached to the test article the vibration condition shall correspond to the 2 'g' line and to either the 4 'g' line of Figure 53 or a maximun exciter force output of 30,000 pounds whichever is greater up to an acceleration input of ± 10 'g'.

Random Vibration

The test article without simulated weapons installed shall be vibrated for a minimum period of forty minutes in each of the three mutually perpendicular axes. The test levels shall be a flat spectrum in the range of 20-2000 Herz at a PSD level of 0.011.

SHOCK

Each weapon bay of the conformal carriage shall be mounted on its attachment fittings which shall be attached to a test fixture representing the aircraft installation arrangement. The weapon bay shall contain the loading fixtures in the ejector locations. The attachment fittings shall be subjected to the required acceleration in both directions along each of the three mutually perpendicular axes. The wave form shall resemble a half sine wave which reaches a peak value in not more than 0.60 second nor less than 0.015 second. The acceleration amplitudes shall be within ± 5% of the values specified.

Unloaded

The acceleration level applied to the test article without simulated weapons attached shall be 25 'g'.

Loaded

The test article with simulated weapons attached shall be subjected to acceleration levels in each axis equivalent to one half the limit load levels given in Figure 9 of MIL-A-8591D.

Yield

The test article with simulated weapons attached shall be subjected to acceleration levels in each axis equivalent to 1.15 times the limit load levels given in Figure 9 of MIL-A-8591D. There shall be no permanent deformation or other structural damage noticeable by visual inspection.

Catapult and Arrested Landing

Shock tests shall be conducted in both the forward and aft directions. The half sine wave shall reach a peak value in not less than 0.4 seconds nor more than 0.75 seconds.

FUNCTIONAL

After successfully completing the shock tests required, the simulated weapons shall be removed from the conformal carriage weapon bays. Each weapon bay shall be removed from its attachment fittings in the manner intended for operational service. Each weapon bay shall be reinstalled on its attachment fittings and this functional test repeated for a total of 2000 removal and installation cycles.

FLIGHT TEST EVALUATION

One F-4B/J aircraft shall be equipped with a PDM or FM instrumentation system where the data is recorded on magnetic tape. The data recorded shall be airspeed, fuel flow, altitude, ambient conditions and clock time in the flight. The tape recorded data system shall derive its electrical power from a filtered power supply which draws its power from the aircraft main power bus and provides to the data sensors, processors and recorder clean power with a minimum of background noise. The entire system with the exception of the data sensors shall fit within the back seat of the aircraft. The system except for the data sensors shall be removable to permit aircraft operation with a full crew.

The test aircraft with the conformal carriage installed shall be flown in a stabilized flight condition at several altitude/speed combinations to determine the performance envelope for the F-4B/J conformal carriage configuration without external stores. Representative external store configurations shall be added to the conformal carriage and the aircraft flown at several altitude/speed combinations to determine the performance envelope for the combination of aircraft, conformal carriage, and external stores. Representative external stores shall be separated from the conformal carriage at several speed and altitudes to determine the safe release envelope for the external store when mounted on the F-4B/J conformal carriage.

AIRCRAFT MAINTAINABILITY

During the flight test evaluation program, the clock time and manhours required to maintain the modified aircraft shall be determined and compared to maintenance time required for a conventional F-4B/J aircraft configured for the same missions. The conformal carriage installation shall be designed to provide service and maintenance access equal or superior to that for a conventional F-4B/J aircraft configured for the same mission as the conformal carriage aircraft.

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