25 June 1971

INTERFACE CONTROL DOCUMENTATION FOR A SPACE SHUTTLE SYSTEM

(NASA-CR-140294) INTERFACE CONTROL DOCUMENTATION FOR A SPACE SHUTTLE SYSTEM (North American Rockwell Corp.) 217 p

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Approved by

B. Hello
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DRL M010, DRL Item 9
DRD CM009M

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SUMMARY

Late in December, 1970, the following preliminary Interface Control Documents (ICD's) were delivered to NASA:

(1) ICD No. SR 2.4.4-11083 - Booster Vehicle/Orbiter Vehicle, dated 17 December 1970

(2) ICD No. SR 2.4.4-11082 - Orbiter Vehicle/Space Station/Payload Module, dated 17 December 1970

(3) ICD No. SR 2.4.4-11144 - Booster Vehicle/Orbiter Vehicle/ Payload Module to the Launch Pad Complex, dated 10 December 1970

(4) ICD No. SR 2.4.4-11147 - Booster Vehicle/Orbiter Vehicle/ Payload Module to M&R Complex, dated 17 December 1970

(5) ICD No. SR 2.4.4-11145 - Booster Vehicle/Orbiter Vehicle/ Communications Network, dated 17 December 1970

Subsequently, mid-way in February, 1971, the ICD's were reworked and reviewed informally by NASA and NR/GDC. Item (2) was divided into two ICD's:

(6) ICD - Orbiter/Space Station, dated 8 February 1971

(7) ICD - Orbiter/Payload, revised 11 February 1971

The scopes of the other ICD's were unchanged, but they were up-dated to mid-February. For the 270-day data submittal, a preliminary version of the report "Interface Control Documentation" was submitted including, as appendices, updated drafts of items (1), (6) and (7). Items (3) and (5) were updated in the form of Interface Definition Documents, for reasons discussed below. Furthermore, item (4) was similarly re-oriented and divided into two Interface Definition Documents, one for the previous M&R Complex less landing sites, and the second for the Landing Sites.

This report is the final Phase B submittal of the same document with the exception that item (6) has been deleted. The deletion was made for two reasons: (a) the Phase B study shifted from sole emphasis on the Space Station mission to emphasis on a broad spectrum of missions; the 33-foot Space Station (Phase B level of definition) was replaced by the Shuttle-launched Modular Space Station (Phase A level of definition); the result is a de-emphasis of the Space Station and a less well-defined interface; (b) the Orbiter/Payload ICD - item (7) - is applicable to the Modular Space Station and includes docking interfaces and radio frequency interfaces for detached payloads (or Space Station); the result is that the Orbiter/Payload ICD serves for the Space Station, with the exception of procedural interfaces and payload-transfer interface while docked.

INTERFACE CONTROL DOCUMENTATION REQUIREMENTS

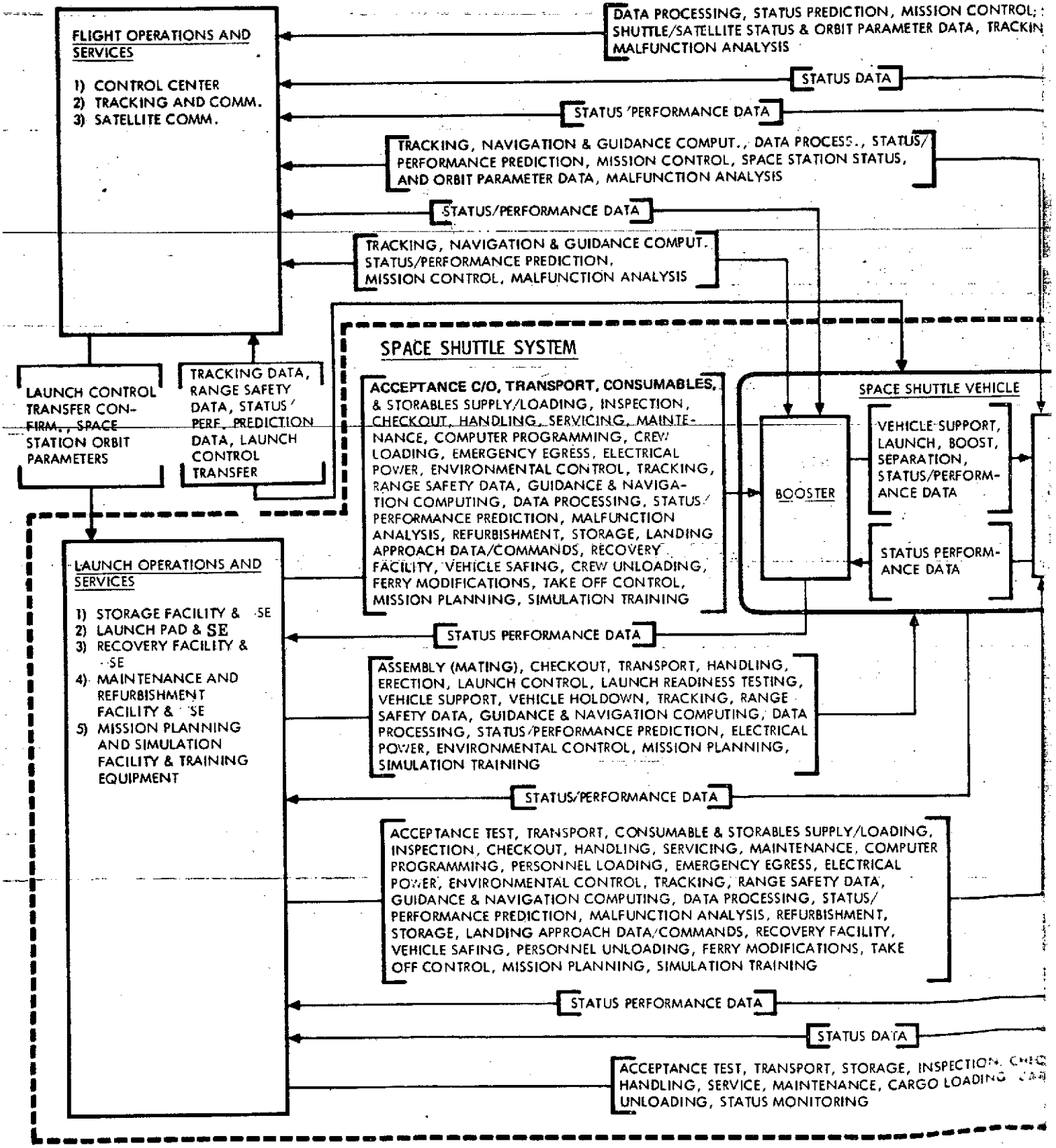
DRD No. CM-09M defines Interface Control Documentation to be prepared during Phase B, consisting of physical, functional and procedural ICD's. With the exception of the flight elements, very few physical interface requirements have been determined as yet. Even for the flight elements, only a minimal number of gross physical interface requirements can be documented at this time. Consequently, the interface documents in the appendices are limited mostly to functional interface requirements.

As in previous preliminary versions of the ICD's, the intent of this document is to encompass the full scope of interfaces which must be controlled in development of the Shuttle System. Since ICD's must normally be negotiated by the interested parties, any ICD's prepared during Phase B can only be considered as criteria recommended to the development contractors selected for Phase C-D. At this time, it appears advisable to document the interfaces in both ICD's and Interface Definition Documents. ICD's are being retained for those interfaces which can be defined to reflect contractual relationships anticipated for Phase C-D. Interface Definition Documents have been prepared and included as appendices herein for multi-element, multi-party interfaces which will be divided, in Phase C-D, into a number of ICD's for more effective development and control. In the case of the Booster-Orbiter-Shuttle to Launch Operations Complex interface, considerable uncertainty exists as to whether a particular vehicle-support equipment interface will be subject to external ICD or to internal contractor control. For the present, the Interface Definition Documents merely identify and define the interface without specifying whether or not a formal ICD will ultimately be required.

PREPARATION OF INTERFACE CONTROL DOCUMENTATION

Interface identification and definition starts with the Shuttle System Specification and the interface requirements specified therein. The top-level Schematic Block Diagram (SBD) shown in Figure 1, which is also a part of the System Specification, graphically identifies and grossly defines the main interfaces to be controlled. The SBD included in each Interface Definition Document is an expansion of a portion of the top-level SBD. It identifies more limited interfaces and identifies potential ICD's required to control each interface. At this time, ICD's are being identified between a particular flight element and all items of support equipment although it should be noted that, for items of support equipment peculiar to a particular flight element, control of the interface may be internal to the contractor and not the subject of an external ICD.

For the ICD's included in this document, an attempt was made to structure each so as to allow easy growth into an ICD suitable for Phase C-D negotiation. Data believed necessary to control the interface has been identified and described even if it is not available now and can only be identified as "TBD". The following considerations were kept in mind during ICD preparation.


FLIGHT OPERATIONS AND SERVICES
1) CONTROL CENTER
2) TRACKING AND COMM.
3) SATELLITE COMM.
DATA PROCESSING, STATUS PREDICTION, MISSION CONTROL, SHUTTLE/SATELLITE STATUS & ORBIT PARAMETER DATA, TRACKIN MALFUNCTION ANALYSIS
STATUS DATA
STATUS PERFORMANCE DATA
TRACKING, NAVIGATION & GUIDANCE COMPUT., DATA PROCESS., STATUS/PERFORMANCE PREDICTION, MISSION CONTROL, SPACE STATION STATUS, AND ORBIT PARAMETER DATA, MALFUNCTION ANALYSIS
STATUS/PERFORMANCE DATA
TRACKING, NAVIGATION & GUIDANCE COMPUT. STATUS/PERFORMANCE PREDICTION, MISSION CONTROL, MALFUNCTION ANALYSIS
SPACE SHUTTLE SYSTEM
LAUNCH CONTROL TRANSFER CONFIRM., SPACE STATION ORBIT PARAMETERS
TRACKING DATA, RANGE SAFETY DATA, STATUS/PERF. PREDICTION DATA, LAUNCH CONTROL TRANSFER
ACCEPTANCE C/O, TRANSPORT, CONSUMABLES, & STORABLES SUPPLY/LOADING, INSPECTION, CHECKOUT, HANDLING, SERVICING, MAINTENANCE, COMPUTER PROGRAMMING, CREW LOADING, EMERGENCY EGRESS, ELECTRICAL POWER, ENVIRONMENTAL CONTROL, TRACKING, RANGE SAFETY DATA, GUIDANCE & NAVIGATION COMPUTING, DATA PROCESSING, STATUS/PERFORMANCE PREDICTION, MALFUNCTION ANALYSIS, REFURBISHMENT, STORAGE, LANDING APPROACH DATA/COMMANDS, RECOVERY FACILITY, VEHICLE SAFING, CREW UNLOADING, FERRY MODIFICATIONS, TAKE OFF CONTROL, MISSION PLANNING, SIMULATION TRAINING
SPACE SHUTTLE VEHICLE
BOOSTER
VEHICLE SUPPORT, LAUNCH, BOOST, SEPARATION, STATUS/PERFORMANCE DATA
STATUS PERFORMANCE DATA
LAUNCH OPERATIONS AND SERVICES
1) STORAGE FACILITY & SE
2) LAUNCH PAD & SE
3) RECOVERY FACILITY & SE
4) MAINTENANCE AND REFURBISHMENT FACILITY & SE
5) MISSION PLANNING AND SIMULATION FACILITY & TRAINING EQUIPMENT
STATUS PERFORMANCE DATA
ASSEMBLY (MATING), CHECKOUT, TRANSPORT, HANDLING, ERECTION, LAUNCH CONTROL, LAUNCH READINESS TESTING, VEHICLE SUPPORT, VEHICLE HOLDOWN, TRACKING, RANGE SAFETY DATA, GUIDANCE & NAVIGATION COMPUTING, DATA PROCESSING, STATUS/PERFORMANCE PREDICTION, ELECTRICAL POWER, ENVIRONMENTAL CONTROL, MISSION PLANNING, SIMULATION TRAINING
STATUS/PERFORMANCE DATA
ACCEPTANCE TEST, TRANSPORT, CONSUMABLE & STORABLES SUPPLY/LOADING, INSPECTION, CHECKOUT, HANDLING, SERVICING, MAINTENANCE, COMPUTER PROGRAMMING, PERSONNEL LOADING, EMERGENCY EGRESS, ELECTRICAL POWER, ENVIRONMENTAL CONTROL, TRACKING, RANGE SAFETY DATA, GUIDANCE & NAVIGATION COMPUTING, DATA PROCESSING, STATUS/PERFORMANCE PREDICTION, MALFUNCTION ANALYSIS, REFURBISHMENT, STORAGE, LANDING APPROACH DATA/COMMANDS, RECOVERY FACILITY, VEHICLE SAFING, PERSONNEL UNLOADING, FERRY MODIFICATIONS, TAKE OFF CONTROL, MISSION PLANNING, SIMULATION TRAINING
STATUS PERFORMANCE DATA
STATUS DATA
ACCEPTANCE TEST, TRANSPORT, STORAGE, INSPECTION, CHEC HANDLING, SERVICE, MAINTENANCE, CARGO LOADING UNLOADING, STATUS MONITORING

3, 4 A.

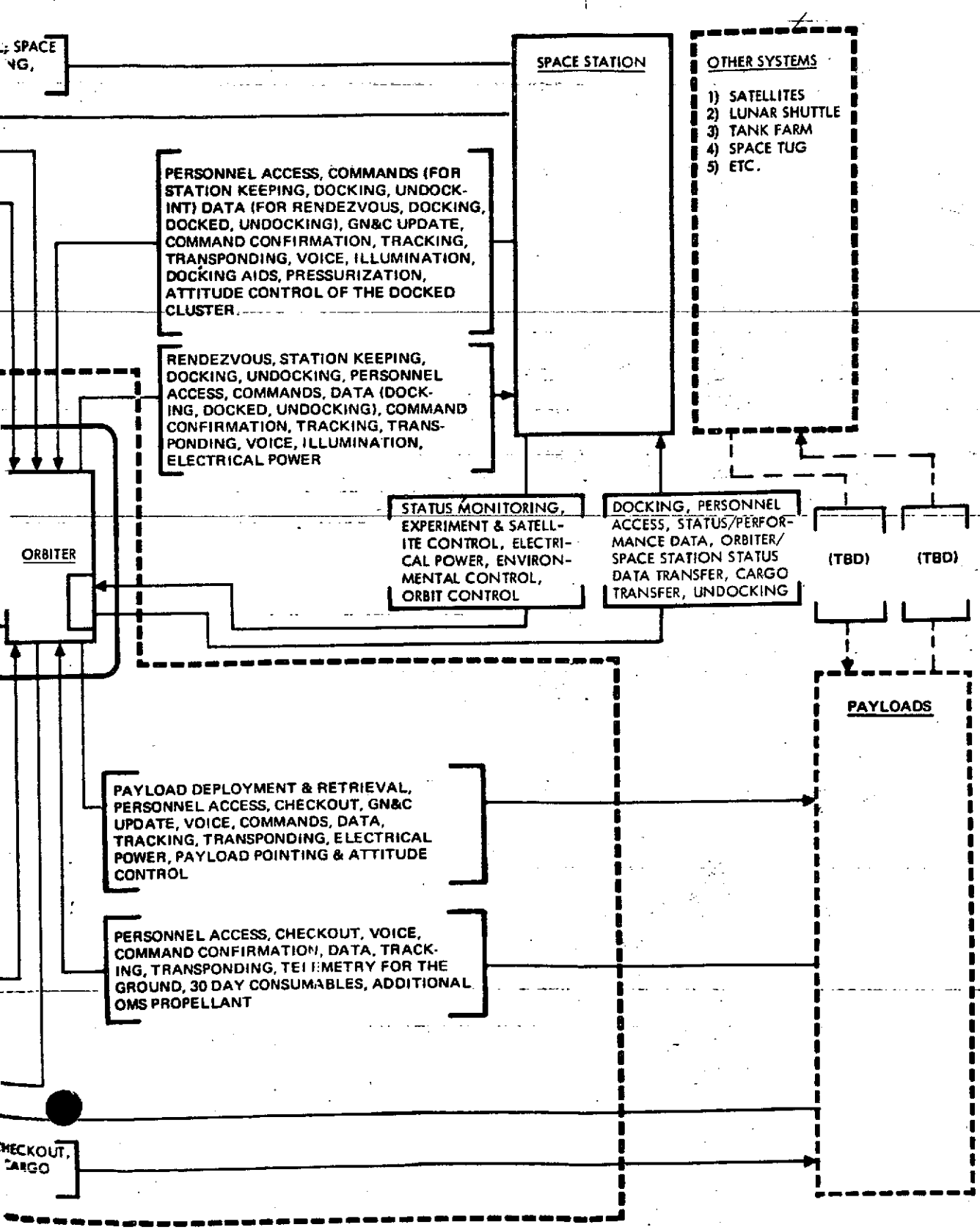


Figure 1. Top Level Schematic Block Diagram

(a) The ICD is a legal document, equivalent to a contract, which binds two or more parties to satisfy explicitly stated requirements. Consider and negotiate it as such a contract.

(b) The ICD is incorporated in each specification controlling elements meeting at the interface. Since it is contractually part of such specifications, use the same approach as would be used in preparation of Section 3 of the same specifications.

(c) Define the interface, not the equipment/software items which interface; viz., include only the requirements/criteria necessary to define and control the interface.

At this time, the data in the ICD's must be considered very preliminary in nature. In general, they will not be handled as controlled documentation and so will not be kept continuously updated. The exception will be the Booster Vehicle to Orbiter Vehicle ICD which will be informally maintained to document NR/GDC interface design decisions.

DSTE

APPENDIX A
SD71-127
(MSC 03305)

FINAL SUBMITTAL

INTERFACE CONTROL DOCUMENT (ICD)

BOOSTER VEHICLE TO ORBITER VEHICLE

(Also available separately as SR 2.4.4-11186)

25 June 1971

SPACE DIVISION

NORTH AMERICAN ROCKWELL CORPORATION

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1. SCOPE

1.1 Technical Interface

This Interface Control Document (ICD) specifies functional, physical and procedural requirements for the interface(s) between the Booster Vehicle and the Orbiter Vehicle from initiation of Shuttle Vehicle mating (preparatory to launch) until command of either the Booster or Orbiter Vehicle (whichever commits to land earlier) is transferred to the air traffic control function at the landing site, as defined in the sub-paragraphs below. It includes design requirements to be observed in design of the interfacing equipment in accordance with requirements specified in this ICD.

1.1.1 Initiation of Shuttle Vehicle Mating.

Initiation of Shuttle Vehicle mating shall be defined as that time at which first physical contact occurs between the Booster and Orbiter Vehicles during their final mating, as part of the pre-launch operations, preparatory to launch in the mated configuration.

1.1.2 Transfer of Vehicle Command.

Transfer of command of either the Booster or Orbiter Vehicle to the air traffic control function at the landing site shall be defined as that time at which the vehicle involved first acknowledges an instruction concerning traffic pattern, landing, etc. from the air traffic control function at the landing site.

2. APPLICABLE DOCUMENTS

The following documents, of the issue in effect on date of original official release of this ICD, form a part of this ICD to the extent specified herein. In the event of conflict between documents referenced herein and the contents of this ICD, the contents of this ICD shall govern.

2.1 Specifications

(a) Specification No. SS613M0001: System Specification for a Space Shuttle System

(b) Specification No. 76Z0500 Booster Vehicle Prime Item Part I

(c) Specification No. CP613M0002 Space Shuttle Orbiter Prime Item

(d) Specification No. 76Z0548 Airborne Separation Sequence Software

2.2 Interface Control Documents

13M15000B Space Shuttle Vehicle/Engine 550K(SL) Interface Control Document.

3. INTERFACE REQUIREMENTS

3.1 Mass Properties

3.1.1 Ground Operations.

The mass properties of the Shuttle Vehicle, the Booster Vehicle, and the Orbiter Vehicle - during ground handling and transportation of the mated Shuttle Vehicle - shall be constrained within the limits shown in Table 3.1-1. Values shown are maximum values unless otherwise indicated.

Table 3.1-1. Prelaunch-Mated Vehicles Roll-Out Mass Properties (B9U Booster + 161C Orbiter)

Element	Weight	C.G.X	C.G.Y.	C.G.Z
B9U Booster	631228	3172	0	348
161C Orbiter (Payload in)	264253	2228	0	751
161C Orbiter (Payload Out)	224253	2224	0	745
Combined (Payload In)	895481	2893	0	467
Combined (Payload Out)	855481	2923	0	452
Payload	40000	2251	0	783

NOTED:

1. Each element contains only the closed system fluids.
2. All c.g.'s in Booster coordinate system.
3. Booster nose = 1000
4. Booster tank centerline = 400

3.1.2 Flight Operations.

The mass properties of the Shuttle Vehicle, the Booster Vehicle, and the Orbiter Vehicle - during ascent of the mated Shuttle Vehicle - shall be constrained within the limits shown in Table 3.1-2. Values shown are maximum values unless otherwise indicated.

3.2 Structural Support

The Orbiter Vehicle shall be supported by the Booster Vehicle by means of the Mating/Separation Subsystem from initiation of Shuttle Vehicle mating until Booster/Orbiter separation. The attachment point locations shall be as shown in Figure 3.2-1. Geometry of the linkage shall be as shown in Figure 3.2-2. The Mating/Separation System shall be capable of withstanding the loads shown in Figure 3.2-3 for launch pad operations and mated ascent, and Figure 3.2-4 through 3.2-13 for Booster/Orbiter separation.

3.2.1 Booster and Orbiter Dynamic Characteristics.

The dynamic characteristics of the Booster and Orbiter Vehicles shall meet the requirements given in Table 3.2-1. The requirements in the table are minimum natural frequencies of each body in primary axial, lateral, and torsional modes when the body is attached to a rigid fixture. The attachment shall be at points where the interstage connecting structure attaches to the body.

Table 3.2-1. Booster & Orbiter Dynamic Characteristics (When Attached to Rigid Structure)

MODE	BOOSTER (Hz)	ORBITER (Hz)
AXIAL	TBD	TBD
LATERAL		
PITCH	TBD	TBD
YAW	TBD	TBD
TORSION	TBD	TBD

NOTE: The frequencies can only be specified after detailed stability analyses have been performed (probably after PDR) on the selected configuration.

TABLE 3.1-2: SPACECRAFT SEQUENCE MASS PROPERTIES STATEMENT

Page 1 Of 1

Configuration B-9U + 161C ORBITER

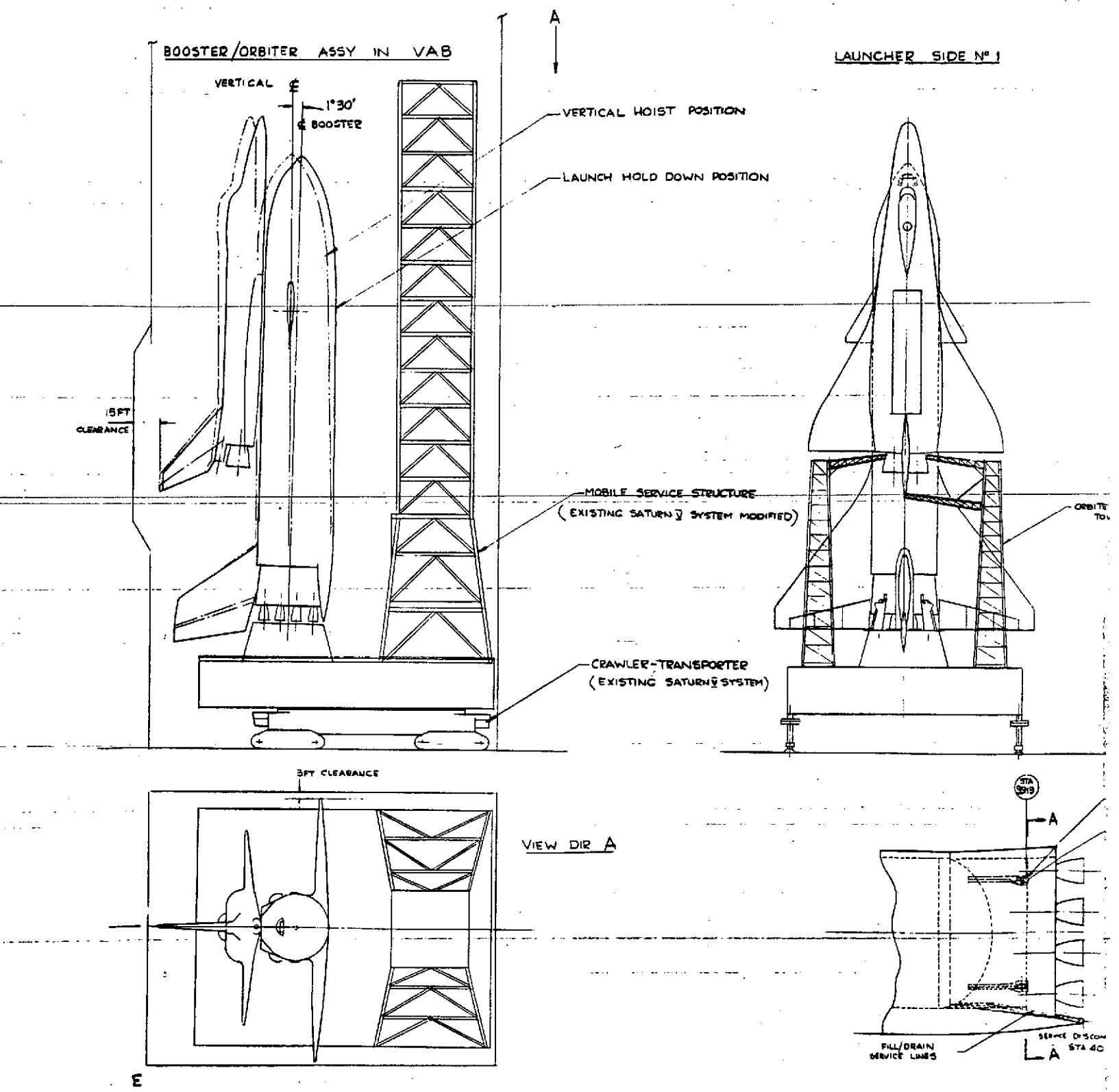
By GD/C

Date 6/10/71

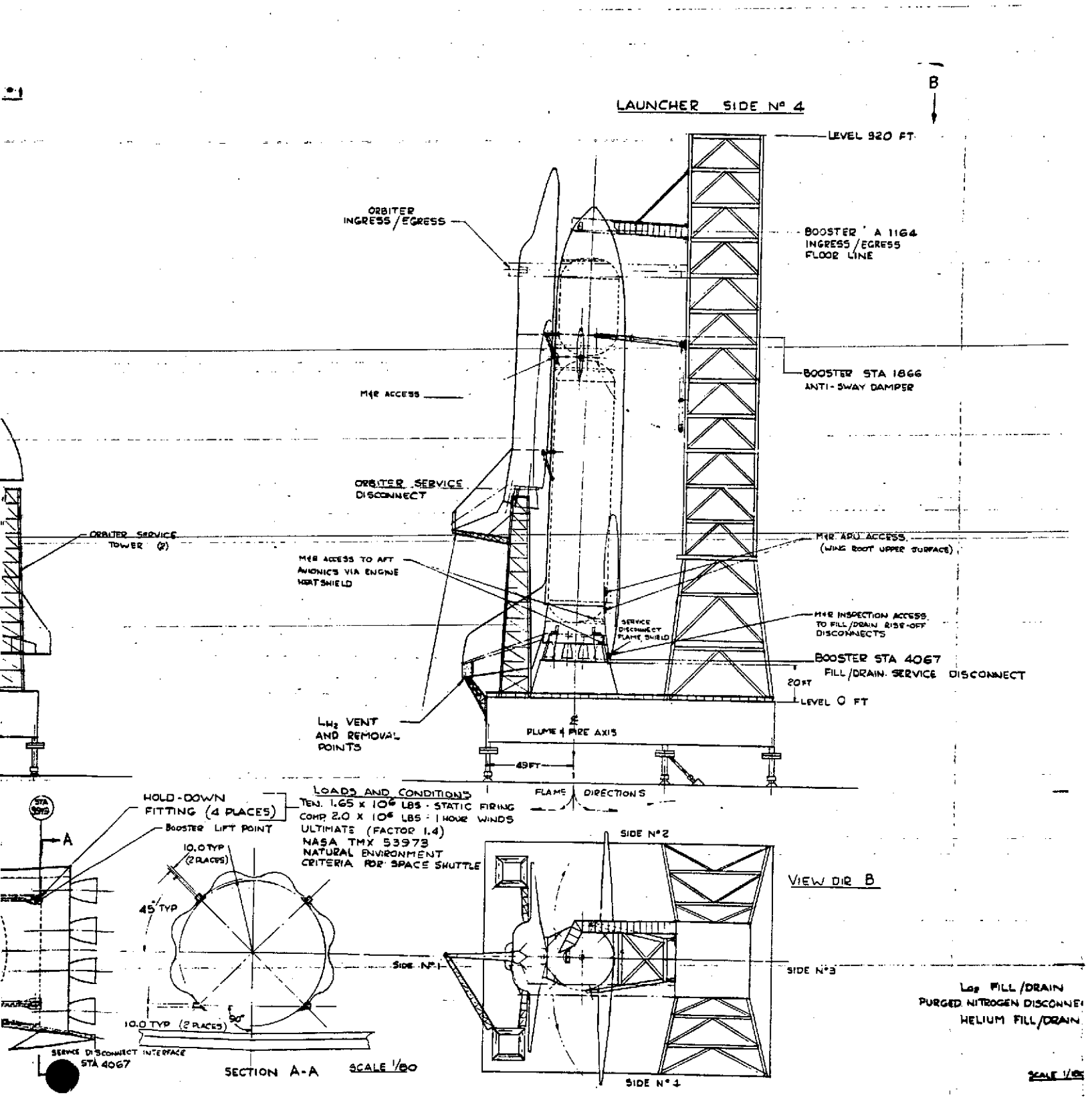
No.	Mission Event	Weight (lb)	Center of Gravity (feet) INCHES x	y	z	Moment of Inertia (slug-ft^2 x 10^6) I_{x-x}	I_{y-y}	I_{z-z}	Product of Inertia (slug-ft^2 x 10^6) I_{xy}	I_{xz}	I_{yz}
	BOOSTER										
	LIFTOFF	4188223	2143	0	370	15.340	552.800	552.700	0	-18.900	0
	MAX Q	2868223	2361	0	370	14.070	413.100	413.200	0	-14.900	0
	3-G	1548223	2720	0	345	12.510	249.400	249.900	0	-8.280	0
	BURNOUT (ENTRY)	805916	3058	0	329	9.774	128.900	130.500	0	-2.720	0
	START CRUISE	786845	3039	0	326	9.804	125.600	127.100	0	-2.990	0
	LANDING	638912	3144	0	337	9.444	100.100	101.700	0	-2.430	0
	ORBITER	859104	2052	0	733	5.004	32.190	35.930	0	0.517	0
	LIFTOFF										
	COMBINED										
	LIFTOFF	5047327	2127	0	440	39.560	605.500	589.800	0	-18.383	0
	MAX Q	3727327	2290	0	454	37.860	477.700	462.700	0	-14.383	0
	3-G	2407327	2481	0	483	35.490	352.700	339.000	0	-7.763	0
	BURNOUT	1665020	2539	0	538	29.400	266.400	257.100	0	-2.303	0

NOTES: All c.g's in booster coordinate system
Booster NOSE = 1000
Propellant Tank ℄ = 400

Ref. MIL-M-38310A or SP-6004


BOOSTER/ORBITER ASSY IN VAB
VERTICAL ℄
1°30'
℄ BOOSTER
A
VERTICAL HOIST POSITION
LAUNCH HOLD DOWN POSITION
15FT CLEARANCE
MOBILE SERVICE STRUCTURE
(EXISTING SATURN V SYSTEM MODIFIED)
CRAWLER-TRANSPORTER
(EXISTING SATURN V SYSTEM)
LAUNCHER SIDE Nº 1
3FT CLEARANCE
VIEW DIR A
FILL/DRAIN SERVICE LINES
STA 40
E

E-5,6- A


LAUNCHER SIDE Nº 4
B
LEVEL 920 FT
ORBITER INGRESS / EGRESS
BOOSTER A 1164 INGRESS / EGRESS FLOOR LINE
BOOSTER STA 1866 ANTI-SWAY DAMPER
M&R ACCESS
ORBITER SERVICE DISCONNECT
ORBITER SERVICE TOWER (2)
M&R APU ACCESS (WING ROOT UPPER SURFACE)
M&R ACCESS TO AFT AVIONICS VIA ENGINE HEAT SHIELD
SERVICE DISCONNECT FLAME SHIELD
M&R INSPECTION ACCESS TO FILL/DRAIN RISE-OFF DISCONNECTS
BOOSTER STA 4067 FILL/DRAIN SERVICE DISCONNECT
20 FT
LEVEL 0 FT
LH2 VENT AND REMOVAL POINTS
PLUME & FIRE AXIS
49 FT
FLAME DIRECTIONS
LOADS AND CONDITIONS
TEN. 1.65 x 10^6 LBS - STATIC FIRING
COMP 2.0 x 10^6 LBS - 1 HOUR WINDS
ULTIMATE (FACTOR 1.4)
NASA TMX 53973
NATURAL ENVIRONMENT
CRITERIA FOR SPACE SHUTTLE
HOLD-DOWN FITTING (4 PLACES)
BOOSTER LIFT POINT
STA 3913
A
10.0 TYP (2 PLACES)
45° TYP
90°
10.0 TYP (2 PLACES)
SERVICE DISCONNECT INTERFACE STA 4067
SECTION A-A
SCALE 1/80
SIDE Nº 2
SIDE Nº 1
SIDE Nº 3
SIDE Nº 4
VIEW DIR B
LO2 FILL/DRAIN
PURGED NITROGEN DISCONNE
HELIUM FILL/DRAIN
SCALE 1/

E-5,6 B

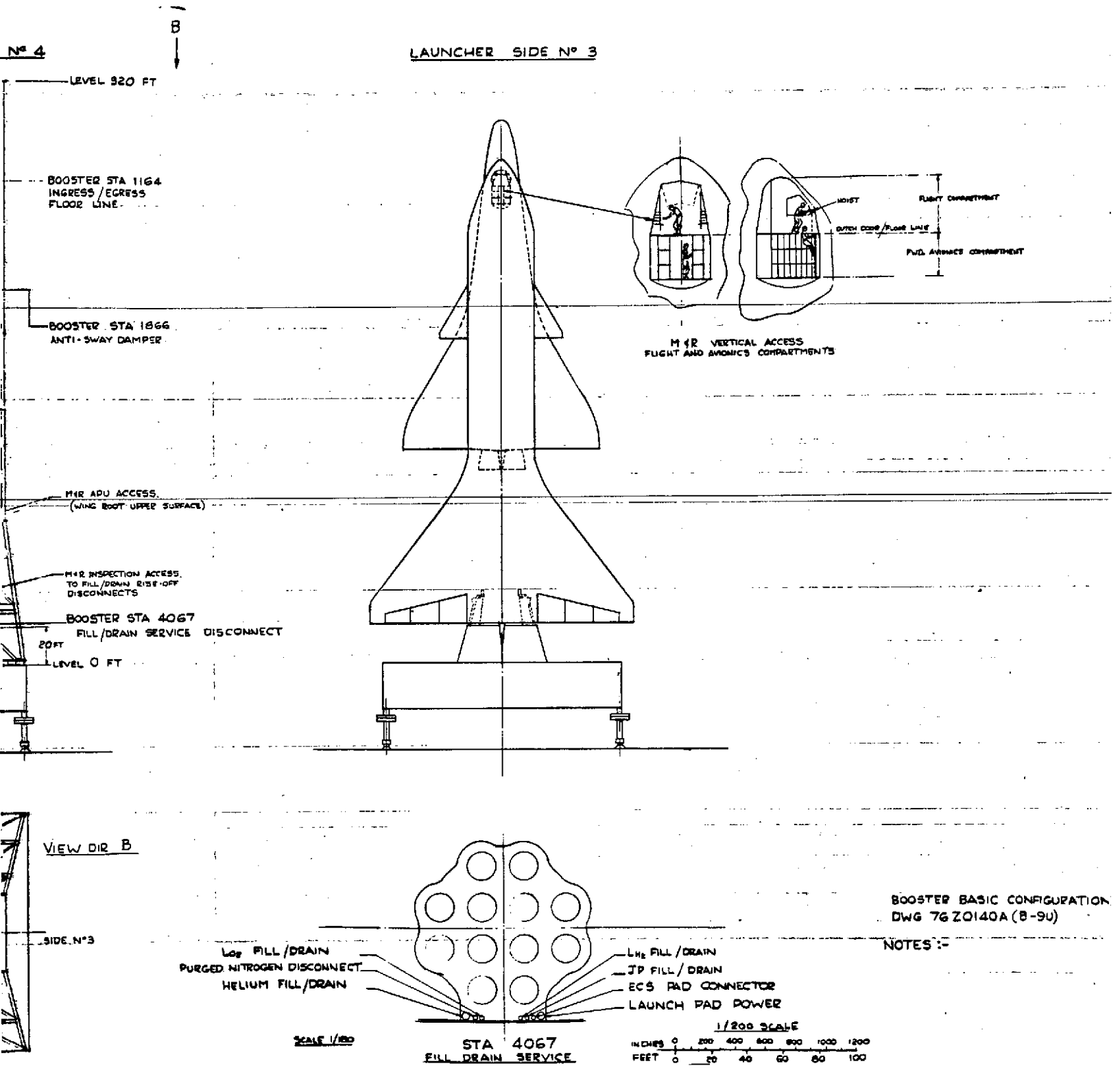
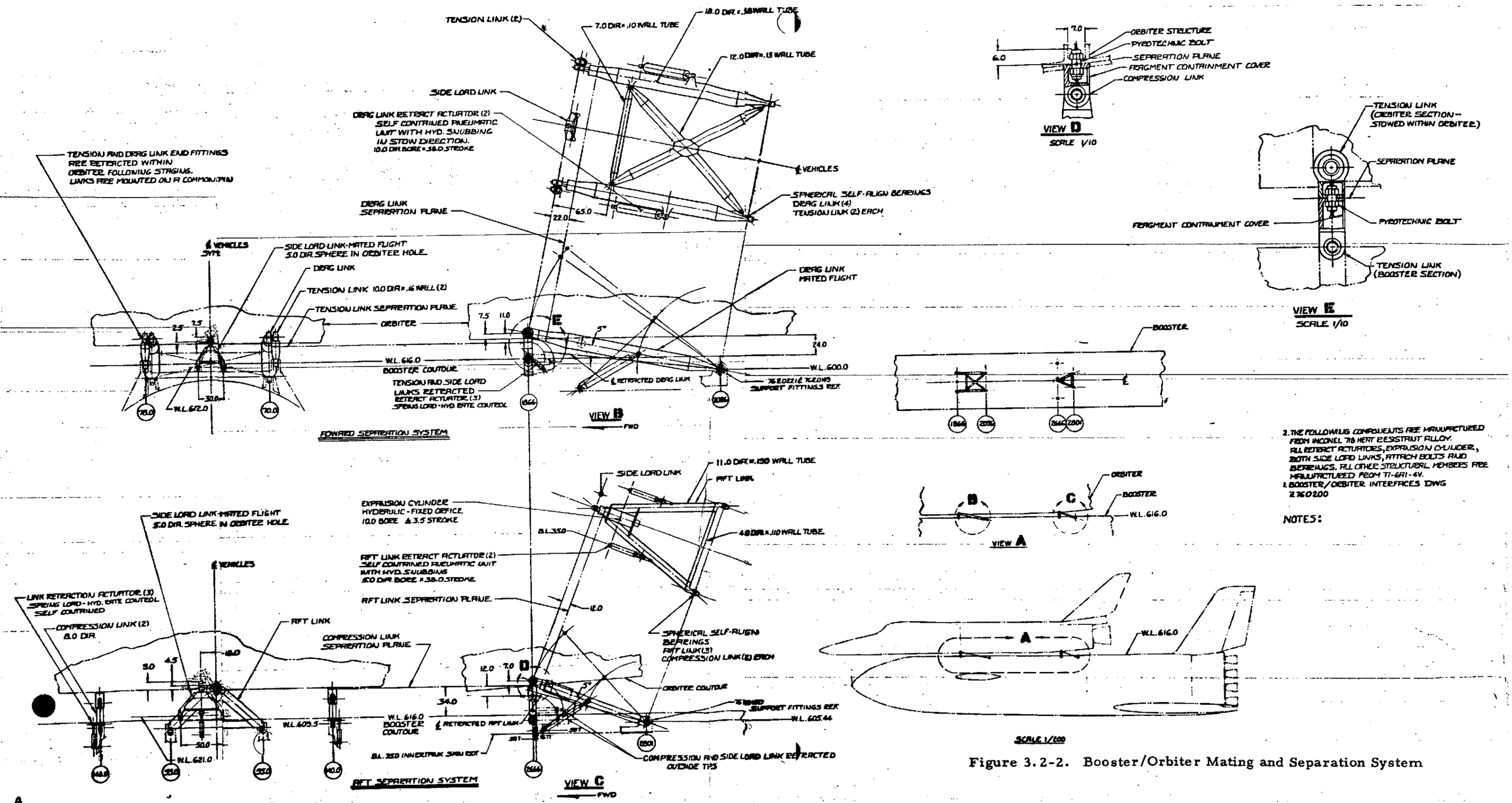


Figure 3-2. Booster/Orbiter Launcher Interfaces



2. THE FOLLOWING COMPONENTS ARE MANUFACTURED FROM INCONEL 718 HEAT RESISTANT ALLOY. ALL RETRACT ACTUATORS, EXPANSION CYLINDER, BOTH SIDE LOAD LINKS, ATTACH BOLTS AND BEARINGS. ALL OTHER STRUCTURAL MEMBERS ARE MANUFACTURED FROM TI-6Al-4V.

1. BOOSTER/ORBITER INTERFACES DWG 2760200

NOTES:

Figure 3.2-2. Booster/Orbiter Mating and Separation System

A

A-7, 8 (A)

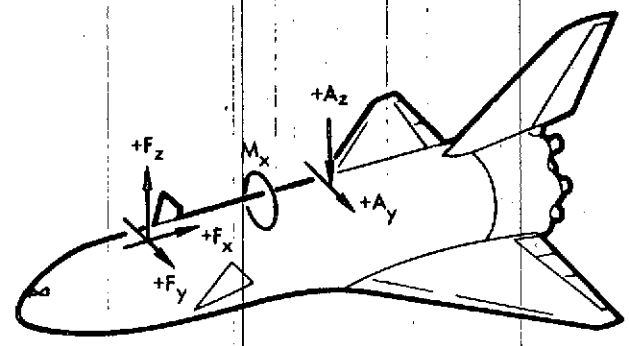
A-7, 8 (B)

BOOSTER B-9U

BOOST PHASE

SEPARATION SYSTEM

LIMIT LOADS



CONDITION	WIND	F_x (KIPS)	F_y (KIPS)	F_z (KIPS)	A_y (KIPS)	A_z (KIPS)	M_x (X 10^6 IN-LB)
TWO-WEEK GROUND WINDS, UNFUELED, WITH TOWER SUPPORT	HEAD	268	0	56.9	0	-33.0	0
	TAIL	268	0	-119.0	0	149.0	0
	SIDE	268	±98.5	28.8	±30.2	34.9	∓17.1
ONE-DAY GROUND WINDS, FUELED, WITH TOWER SUPPORT	HEAD	859	0	95.2	0	62.7	0
	TAIL	859	0	-0.1	0	161.0	0
	SIDE	859	±53.3	80.0	±16.3	99.5	∓9.28
ONE-HOUR GROUND WINDS, FUELED, UNSUPPORTED	HEAD	859	0	89.5	0	76.5	0
	TAIL	859	0	30.0	0	138.0	0
	SIDE	859	±33.3	80.0	±10.2	99.5	∓5.80
DYNAMIC LIFTOFF PLUS ONE-HOUR GROUND WINDS	HEAD	1296	0	119.0	0	134.0	0
	TAIL	1295	0	82.2	0	182.0	0
	SIDE	1296	±20.5	121.0	±2.92	150.0	∓4.14
MAX α-q α-q = 2800 / α-q = -2800	HEAD	1798	0	224.8	0	234.8	0
	TAIL	1804	0	83.0	0	950.3	0
	NO WIND	1808	0	137.4	0	625.6	0
MAX β-q ±2400	SIDE	1802	±81.2	128.8	±166.8	653.7	∓72.3
3g MAX THRUST $N_x = 3.3$ $N_y = 0$ $N_z = -0.35$		2849	0	135.2	0	424.5	0
$N_x = 3.3$ $N_y = \pm 0.1$ $N_z = -0.25$		2849	±55.4	179.3	±30.7	394.5	∓7.6
BOOSTER BURNOUT $N_x = 3.3$ $N_y = 0$ $N_z = -0.46$		2841	0	62.9	0	459.0	0
$N_x = 3.3$ $N_y = \pm 0.1$ $N_z = -0.36$		2841	±55.4	118.3	±30.7	428.0	∓7.6

Fig 3.2-3

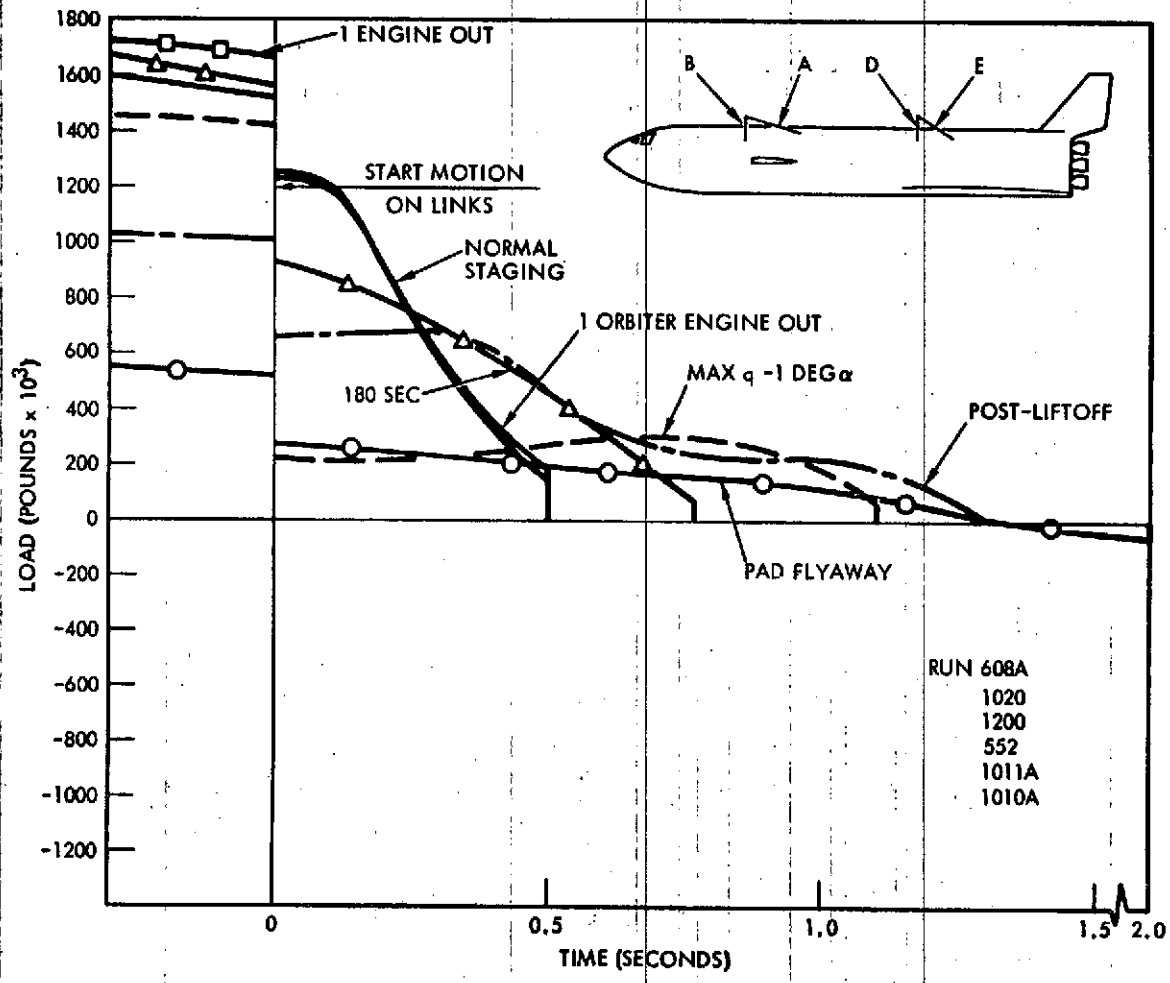

1 ENGINE OUT
START MOTION
ON LINKS
NORMAL
STAGING
1 ORBITER ENGINE OUT
180 SEC
MAX q -1 DEGα
POST-LIFTOFF
PAD FLYAWAY
RUN 608A
1020
1200
552
1011A
1010A
B
A
D
E
LOAD (POUNDS x 10³)
1800
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
-800
-1000
-1200
0
0.5
1.0
1.5
2.0
TIME (SECONDS)

Fig 3.2-4

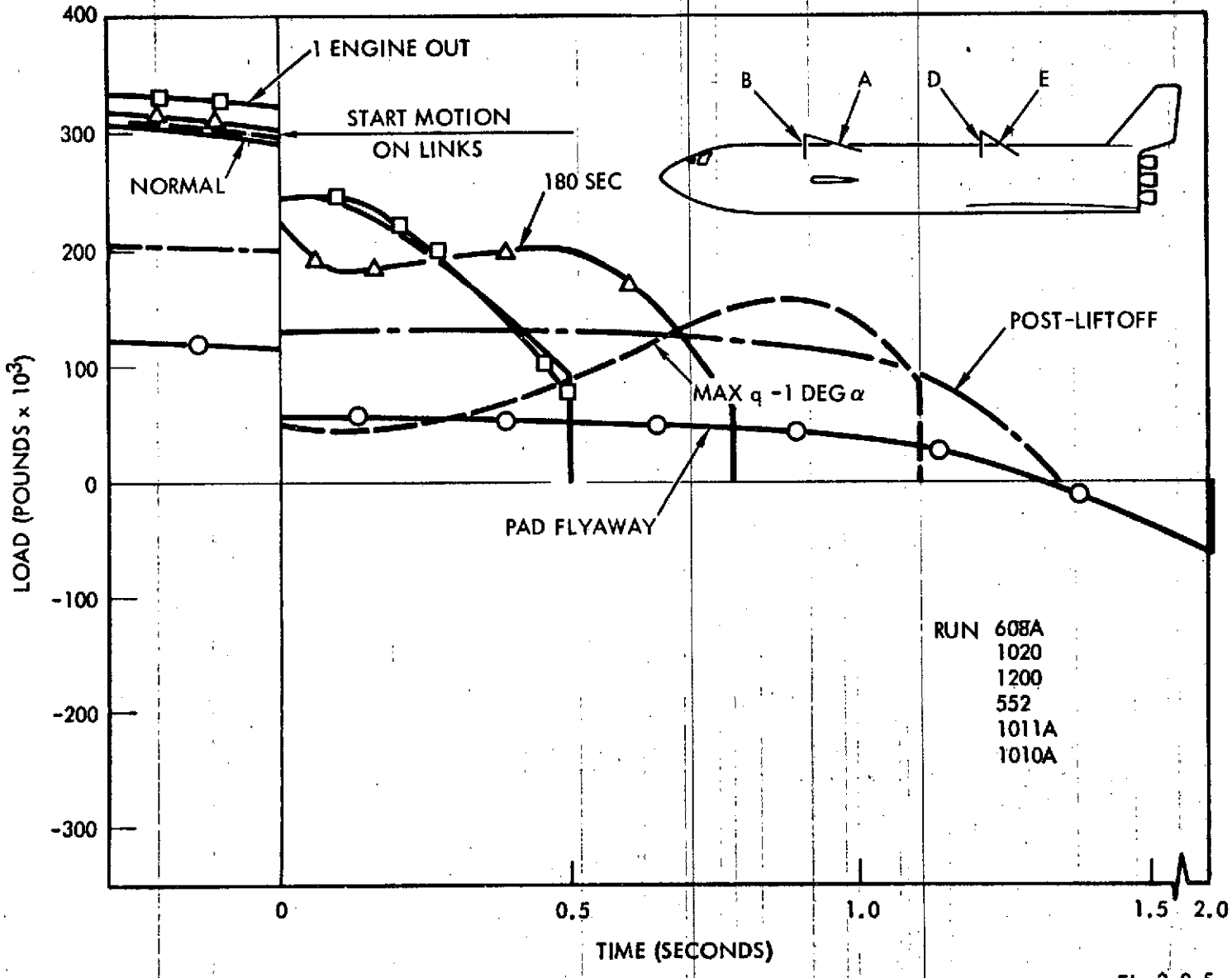
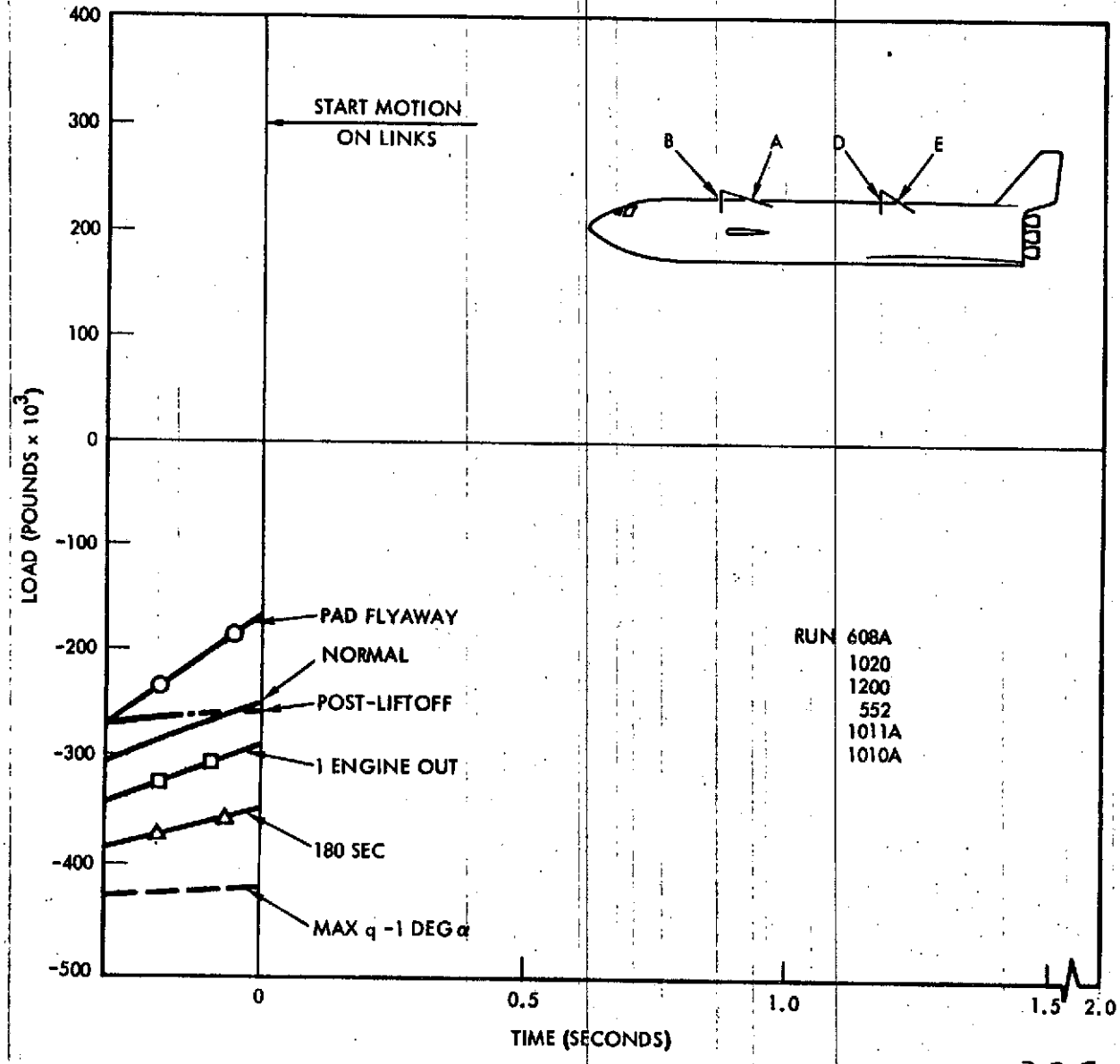

400
300
200
100
0
-100
-200
-300
LOAD (POUNDS x 10³)
1 ENGINE OUT
START MOTION
ON LINKS
NORMAL
180 SEC
POST-LIFTOFF
MAX q -1 DEG α
PAD FLYAWAY
B
A
D
E
RUN 608A
1020
1200
552
1011A
1010A
0
0.5
1.0
1.5
2.0
TIME (SECONDS)

Fig 3.2-5


START MOTION
ON LINKS
B
A
D
E
PAD FLYAWAY
NORMAL
POST-LIFTOFF
1 ENGINE OUT
180 SEC
MAX q -1 DEG α
RUN 608A
1020
1200
552
1011A
1010A
LOAD (POUNDS x 10^3)
400
300
200
100
0
-100
-200
-300
-400
-500
0
0.5
1.0
1.5
2.0
TIME (SECONDS)

3.2-6

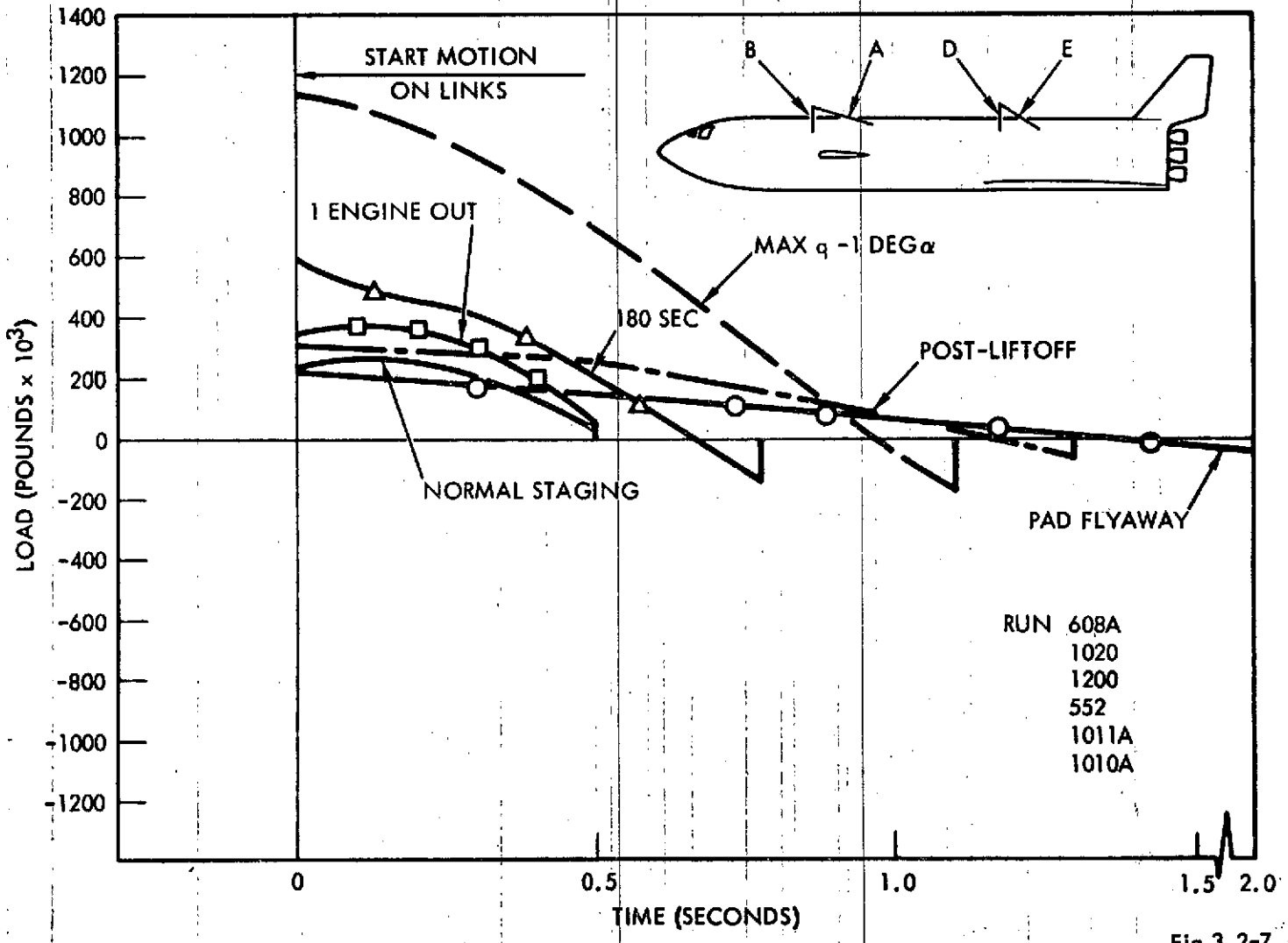

START MOTION
ON LINKS
B
A
D
E
1 ENGINE OUT
MAX q -1 DEGα
180 SEC
POST-LIFTOFF
NORMAL STAGING
PAD FLYAWAY
RUN 608A
1020
1200
552
1011A
1010A
LOAD (POUNDS x 10³)
1400
1200
1000
800
600
400
200
0
-200
-400
-600
-800
-1000
-1200
0
0.5
1.0
1.5
2.0
TIME (SECONDS)

Fig 3.2-7

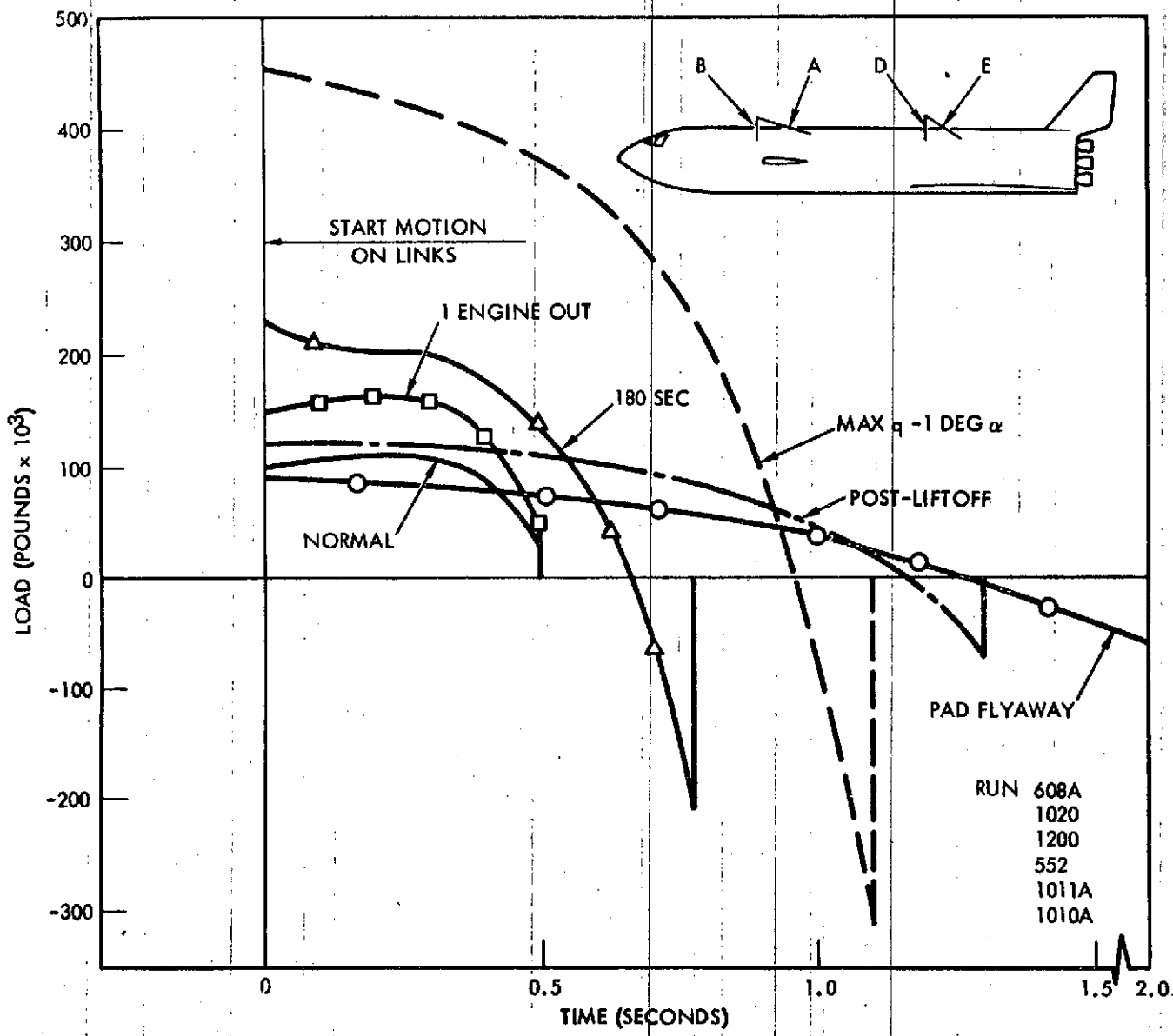

500
400
300
200
100
0
-100
-200
-300
LOAD (POUNDS x 10³)
0
0.5
1.0
1.5
2.0
TIME (SECONDS)
B
A
D
E
START MOTION
ON LINKS
1 ENGINE OUT
180 SEC
MAX q -1 DEG α
POST-LIFTOFF
NORMAL
PAD FLYAWAY
RUN 608A
1020
1200
552
1011A
1010A

Fig 3.2-8

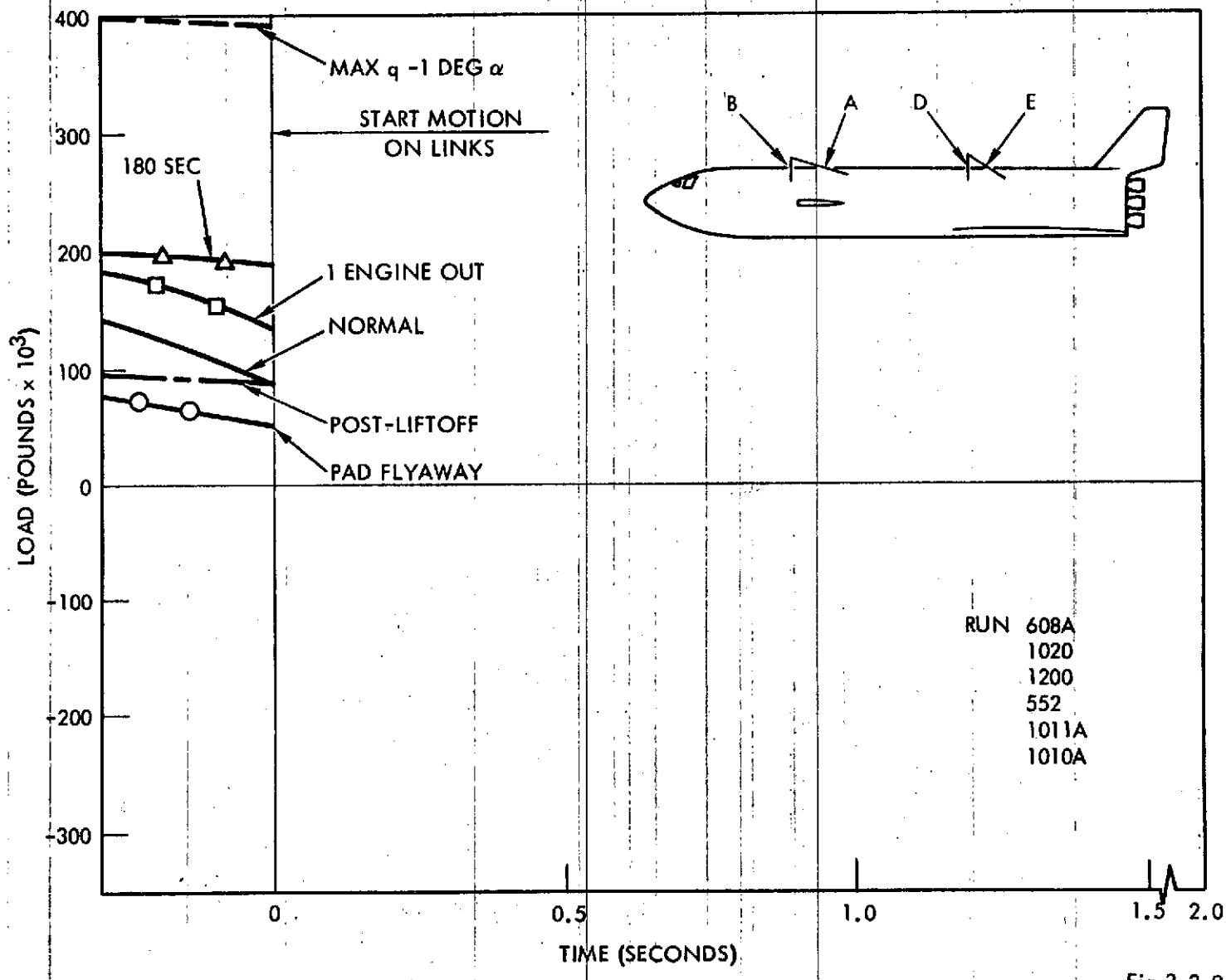

400
300
200
100
0
-100
-200
-300
LOAD (POUNDS x 10^3)
MAX q -1 DEG α
START MOTION
ON LINKS
180 SEC
1 ENGINE OUT
NORMAL
POST-LIFTOFF
PAD FLYAWAY
B
A
D
E
RUN 608A
1020
1200
552
1011A
1010A
0
0.5
1.0
1.5
2.0
TIME (SECONDS)

Fig 3.2-9

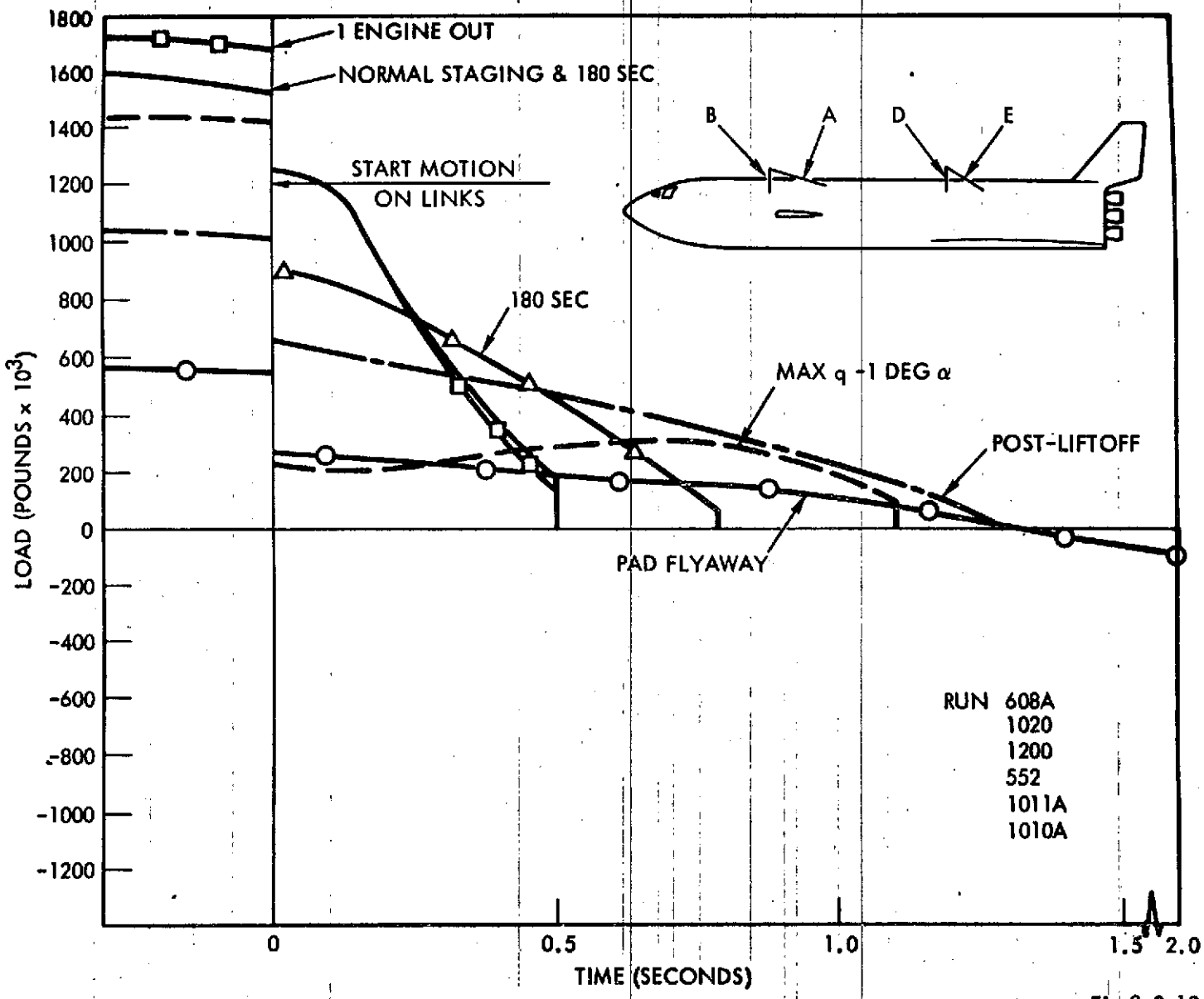

1 ENGINE OUT
NORMAL STAGING & 180 SEC
START MOTION ON LINKS
180 SEC
MAX q -1 DEG α
POST-LIFTOFF
PAD FLYAWAY
B
A
D
E
RUN 608A
1020
1200
552
1011A
1010A
LOAD (POUNDS × 10³)
1800
1600
1400
1200
1000
800
600
400
200
0
-200
-400
-600
-800
-1000
-1200
0
0.5
1.0
1.5
2.0
TIME (SECONDS)

Fig 3.2-10

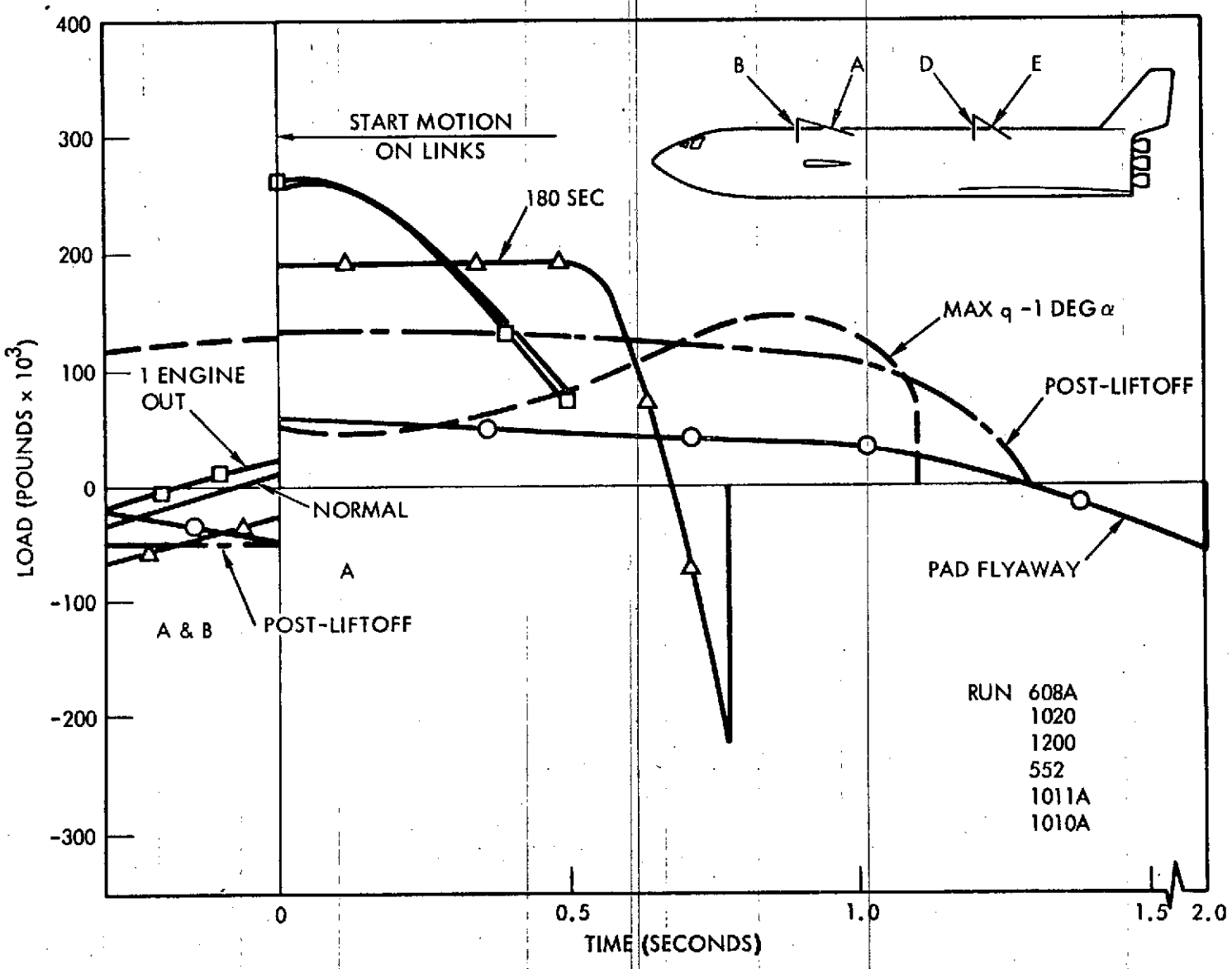

400
300
200
100
0
-100
-200
-300
LOAD (POUNDS x 10^3)
START MOTION
ON LINKS
180 SEC
MAX q -1 DEG α
POST-LIFTOFF
1 ENGINE
OUT
NORMAL
A
A & B
POST-LIFTOFF
PAD FLYAWAY
B
A
D
E
RUN 608A
1020
1200
552
1011A
1010A
0
0.5
1.0
1.5
2.0
TIME (SECONDS)

Fig 3.2-11

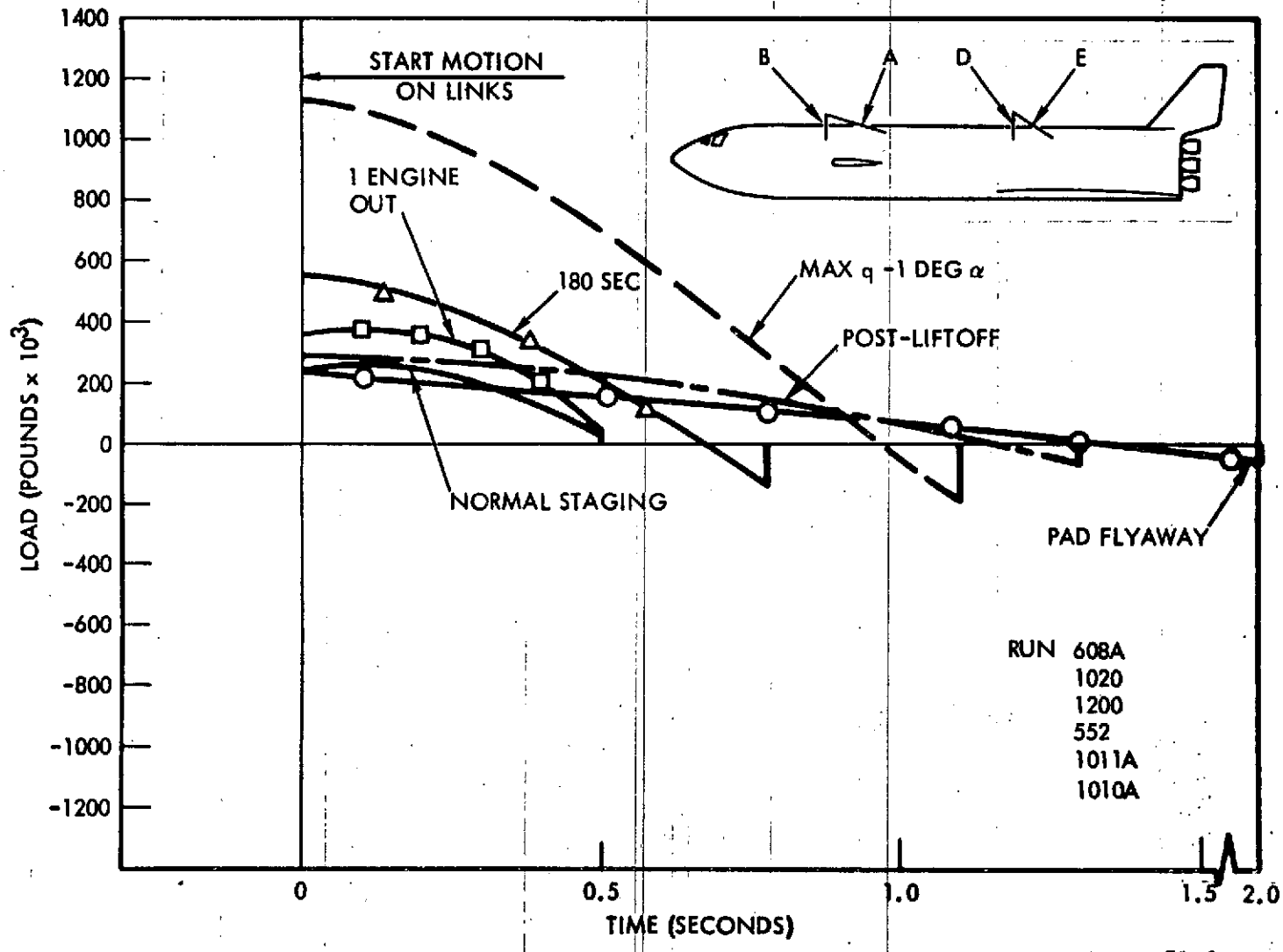

START MOTION
ON LINKS
B
A
D
E
1 ENGINE
OUT
180 SEC
MAX q -1 DEG α
POST-LIFTOFF
NORMAL STAGING
PAD FLYAWAY
RUN 608A
1020
1200
552
1011A
1010A
LOAD (POUNDS x 10³)
1400
1200
1000
800
600
400
200
0
-200
-400
-600
-800
-1000
-1200
0
0.5
1.0
1.5
2.0
TIME (SECONDS)

Fig 3.2-12

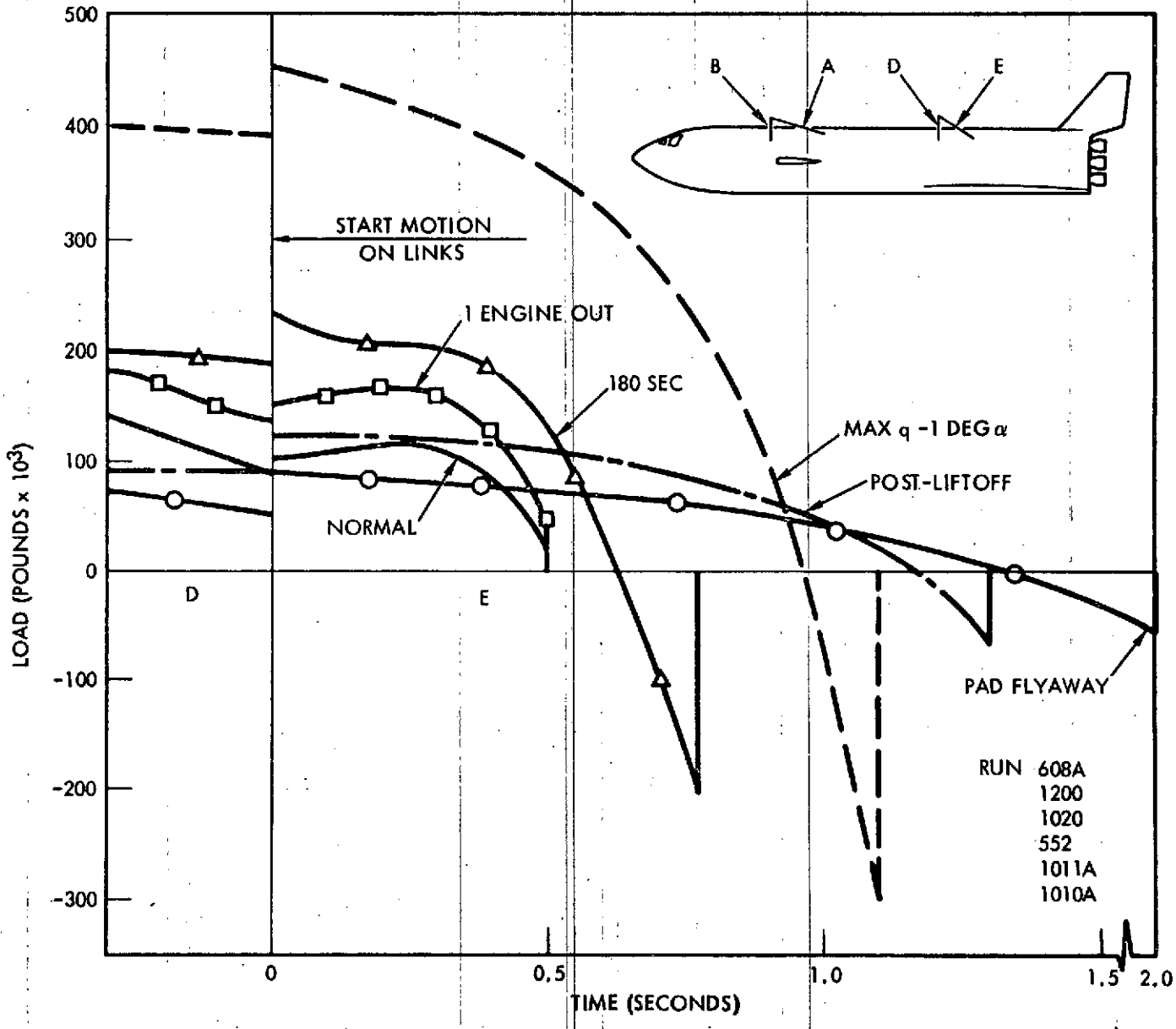

500
400
300
200
100
0
-100
-200
-300
LOAD (POUNDS x 10³)
0
0.5
1.0
1.5
2.0
TIME (SECONDS)
D
E
B
A
D
E
START MOTION
ON LINKS
1 ENGINE OUT
180 SEC
MAX q -1 DEG α
POST-LIFTOFF
NORMAL
PAD FLYAWAY
RUN 608A
1200
1020
552
1011A
1010A

Fig 3.2-13

3.3 Propulsion

Booster main engine/vehicle systems performance shall be in accordance with 13M15000B Space Shuttle Vehicle/Engine 550K(SL) Interface Control Document. The Booster Vehicle shall provide all propulsive power to the Shuttle Vehicle from lift-off to stage separation. The separation thrust/time history and sequence of events for normal separation staging shall be in accordance with Paragraph 3.9.1. Booster Vehicle shutdown impulse shall be controlled at nominal staging to prevent recontact of the vehicles.

For nominal separation conditions, the Booster and Orbiter Vehicles shall be capable of separating under the following conditions:

a. Loss of thrust or thrust vector control from one or two Booster engines.

b. Loss of thrust or thrust vector control from one Orbiter engine.

A signal from the Booster LO_2 or LH_2 depletion sensors shall normally initiate the Booster/Orbiter separation sequence.

3.4 Flight Mechanics

3.4.1 Acceleration.

Maximum axial acceleration of the mated Shuttle Vehicle shall not exceed 3 g's. At no time during the separation maneuver shall the Orbiter axial stead-state acceleration drop below 0.2g at the engine sumps. This requirement is void if the Orbiter engines have not been able to achieve ignition.

3.4.2 Dynamic Pressure.

Maximum dynamic pressure (q) shall not exceed 576 PSF. Maximum $q\alpha$ shall not exceed $\pm$ 2800 PSF degrees, including during abort separation.

3.4.3 Staging Envelope.

The booster Vehicle shall be capable of boosting a 900,000 pound Orbiter Vehicle to an altitude of 232,500 $\pm$ 7,500 feet, to a final velocity of 10,750 $\pm$ 150 feet per second at a flight angle of 6 $\pm$ 1 degrees along any azimuth with a single engine out.

3.4.4 Separation System Performance.

At the nominal staging point, the Booster Vehicle shall be capable of releasing a fully-functioning Orbiter Vehicle at a prearranged attitude (pointing vector) ± 2 degrees about all three body axes. The Orbiter body rates at release shall be 7 ± 3 degrees/second in pitch and zero ± 2 degrees/second in roll and yaw.

Under these nominal conditions, the minimum axial clearance between the Orbiter main engines and the Booster hard structure shall not be less than 35 feet; the minimum vertical clearance (between skinlines) shall not be less than that at the mated position.

At any point on the ascent trajectory, the Booster Vehicle shall be capable of safely releasing a fully-functioning Orbiter Vehicle within 5.0 second from an Initiate-Separation signal.

The elapsed time from the Initiate-Separation Signal to 1000 feet (vector-sum) clearance shall fall within the envelope given in Figure 3.4-1.

Under extreme emergency conditions (e.g., imminent explosion necessitating immediate termination of Booster thrust), the Booster Vehicle shall be capable of safely releasing a non-thrusting Orbiter Vehicle within 1.5 second and attaining zero thrust within 3.0 second of an Emergency Release Signal.

3.5 Aerodynamic Characteristics

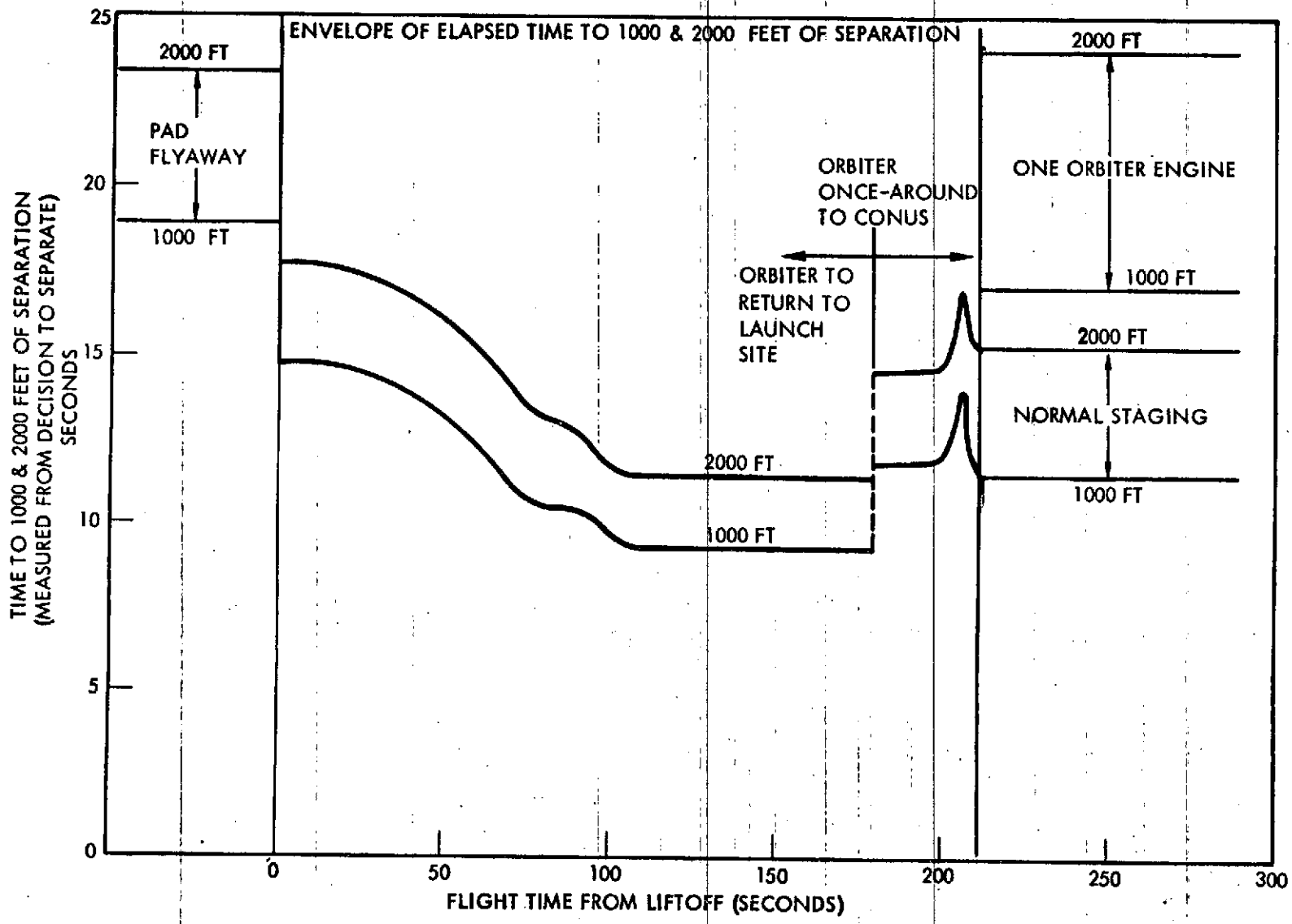
3.5.1 Post-Separation Interference Airloads.

The airload sustained by each vehicle shall account for interference effects and shall be coordinated.

3.5.2 Acoustics and Buffetting.

The Booster and Orbiter Vehicles shall be designed to withstand the acoustic environments on the launch pad and during mated ascent as shown in Figures 3.5-1, 3.5-2, and 3.5-3. Noise sources include the rocket engines and various aerodynamic sources such as boundary layer turbulence, oscillating shocks, boundary layer shock interaction, and separated flow. Transient effects due to staging or abort conditions are not included.

Figure 3.5-1 is a plot of overall sound pressure level (OASPL) at launch as a function of Booster vehicle station, measured from the exit plane of the rocket nozzles. Figure 3.5-2 comprises a plot for various Booster Vehicle stations of 1/3 octave band sound pressure levels


ENVELOPE OF ELAPSED TIME TO 1000 & 2000 FEET OF SEPARATION
2000 FT
PAD
FLYAWAY
1000 FT
ORBITER
ONCE-AROUND
TO CONUS
ORBITER TO
RETURN TO
LAUNCH
SITE
2000 FT
1000 FT
2000 FT
ONE ORBITER ENGINE
1000 FT
2000 FT
NORMAL STAGING
1000 FT
TIME TO 1000 & 2000 FEET OF SEPARATION
(MEASURED FROM DECISION TO SEPARATE)
SECONDS
25
20
15
10
5
0
0
50
100
150
200
250
300
FLIGHT TIME FROM LIFTOFF (SECONDS)

3.4.4-1

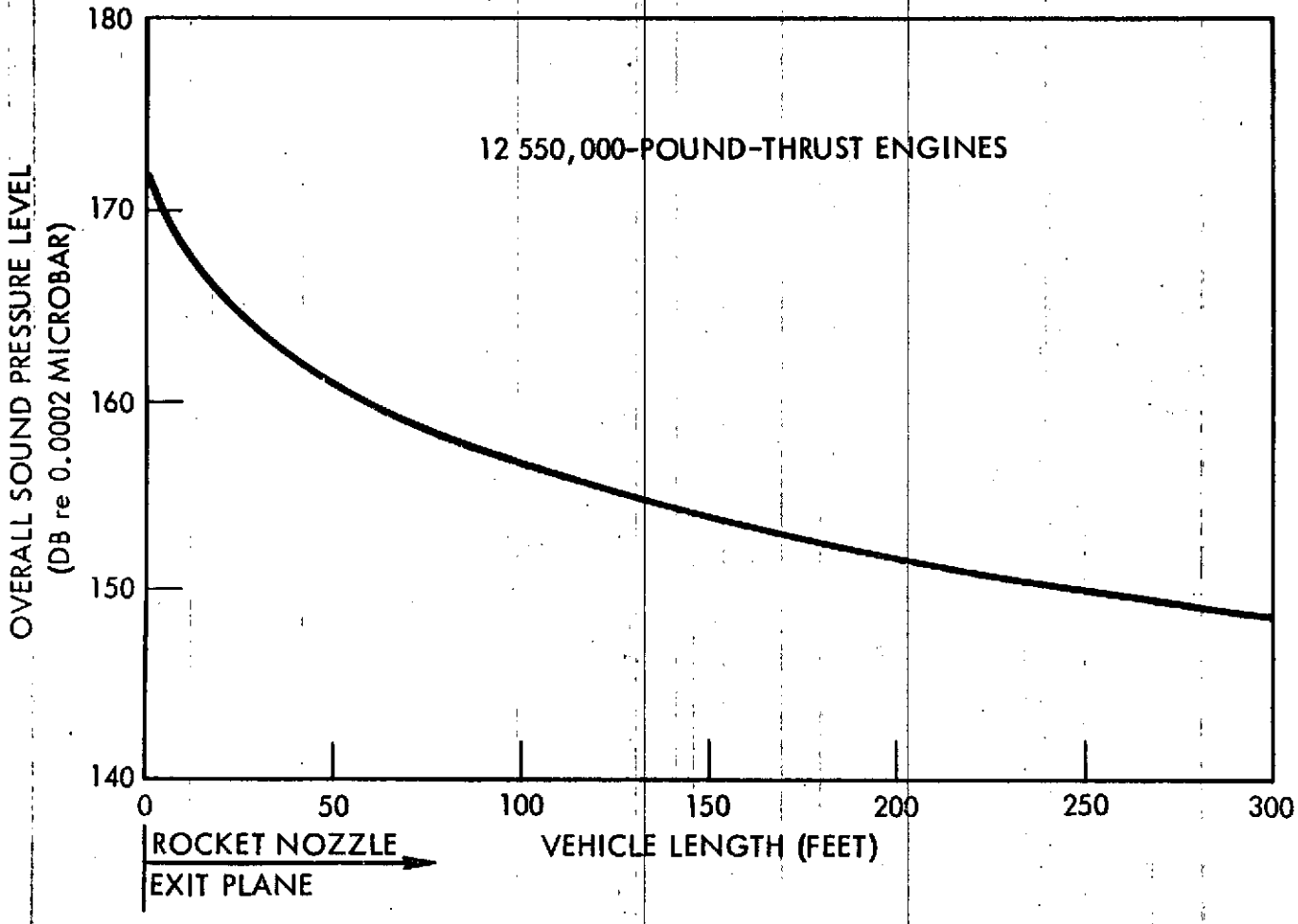

12 550,000-POUND-THRUST ENGINES
OVERALL SOUND PRESSURE LEVEL
(DB re 0.0002 MICROBAR)
180
170
160
150
140
0
50
100
150
200
250
300
ROCKET NOZZLE
EXIT PLANE
VEHICLE LENGTH (FEET)

Fig 3.5-1

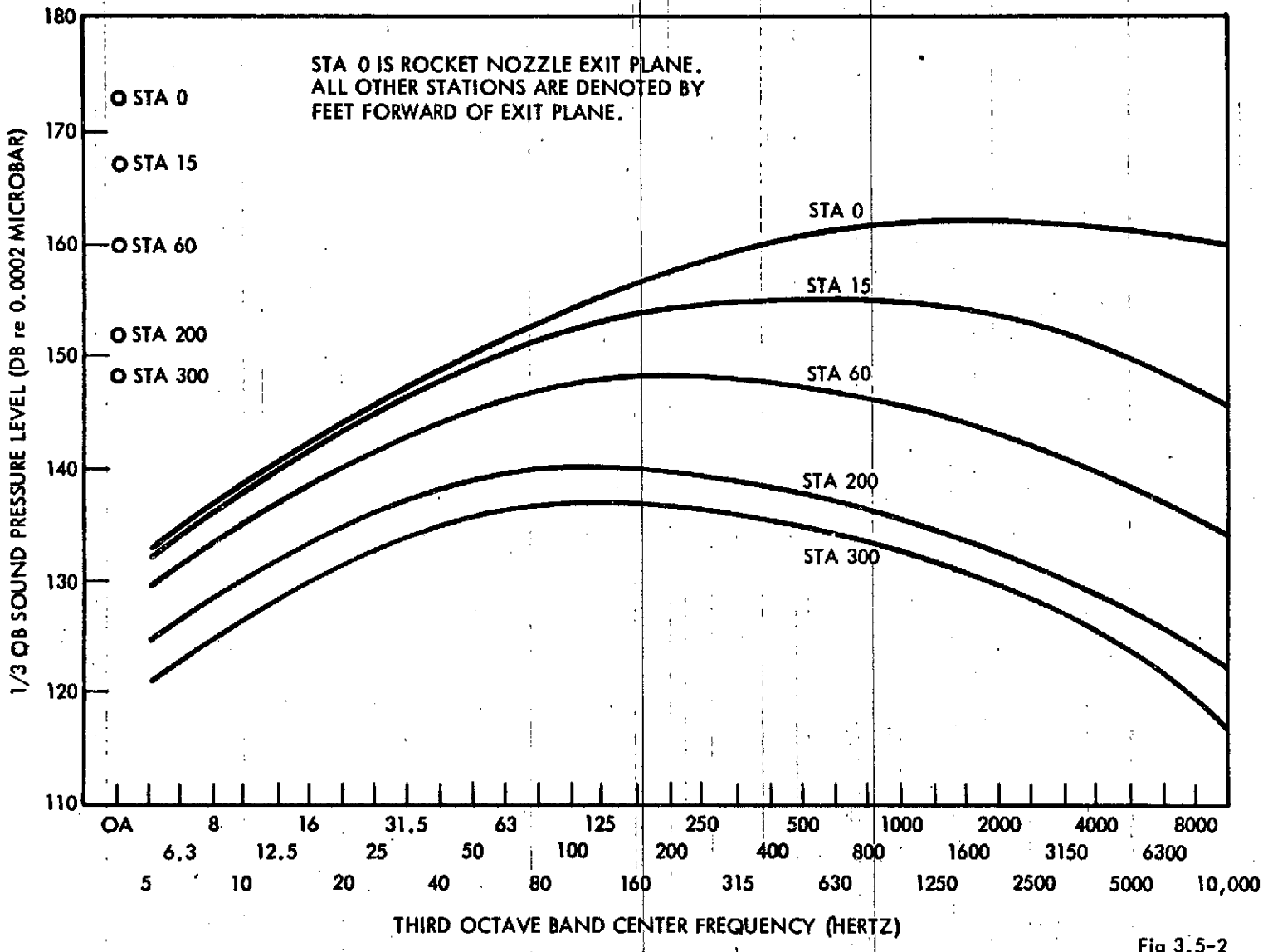

STA 0 IS ROCKET NOZZLE EXIT PLANE.
ALL OTHER STATIONS ARE DENOTED BY
FEET FORWARD OF EXIT PLANE.
O STA 0
O STA 15
O STA 60
O STA 200
O STA 300
STA 0
STA 15
STA 60
STA 200
STA 300
1/3 OB SOUND PRESSURE LEVEL (DB re 0.0002 MICROBAR)
180
170
160
150
140
130
120
110
OA
5
6.3
8
10
12.5
16
20
25
31.5
40
50
63
80
100
125
160
200
250
315
400
500
630
800
1000
1250
1600
2000
2500
3150
4000
5000
6300
8000
10,000
THIRD OCTAVE BAND CENTER FREQUENCY (HERTZ)

Fig 3.5-2

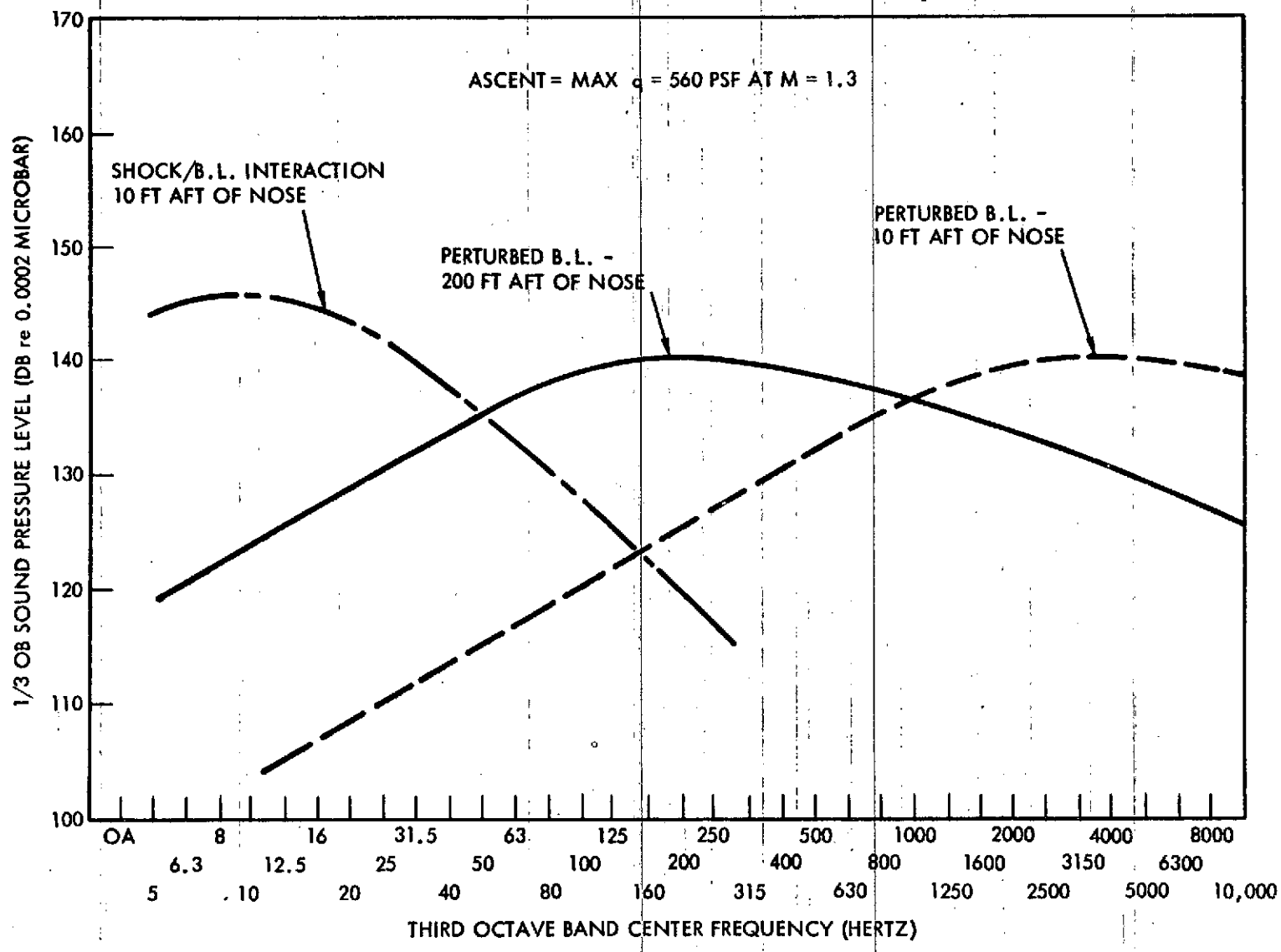

ASCENT = MAX q = 560 PSF AT M = 1.3
SHOCK/B.L. INTERACTION
10 FT AFT OF NOSE
PERTURBED B.L. -
200 FT AFT OF NOSE
PERTURBED B.L. -
10 FT AFT OF NOSE
1/3 OB SOUND PRESSURE LEVEL (DB re 0.0002 MICROBAR)
170
160
150
140
130
120
110
100
OA
5
6.3
8
10
12.5
16
20
25
31.5
40
50
63
80
100
125
160
200
250
315
400
500
630
800
1000
1250
1600
2000
2500
3150
4000
5000
6300
8000
10,000
THIRD OCTAVE BAND CENTER FREQUENCY (HERTZ)

Fig 3.5-3

(1/3 OBSPL's). The effects of launch pad geometry (Kennedy Space Center Launch Pad No. 39B) and vehicle surface reflection are included. The launch noise level shown in Figures 3.5-1 and 3.5-2 are valid for approximately 8 to 10 seconds after liftoff, at which time they will have decreased by about 3 db. At about 15 seconds, the noise levels will have decreased another 3 db since the vehicle will be at an altitude above 1000 feet and the noise radiation may be considered as effectively spherical rather than hemispherical, which is the case while on or near the ground place. After 15 seconds, the rocket noise on the vehicle will decrease with altitude as a function of the reduction in the characteristic impedance of the atmosphere, i.e., density times speed of sound. When the local flow velocity reaches Mach 1, rocket noise will not be propagated forward on the vehicle.

Figure 3.5-3 shows aerodynamically induced pseudo-noise during ascent of the vehicle, at maximum dynamic pressure.

3.6 Thermal Characteristics

Computations of thermal interactions between the Booster and Orbiter Vehicles shall be based on the Booster/Orbiter configuration shown in Figure 3.2-1. The ascent trajectory on which heating environments are based shall be consistent with the flight mechanics constraints delineated in paragraph 3.4.

3.6.1 Launch Pad Thermal Interaction

The exterior surface of the Booster and Orbiter Vehicles shall be maintained within the temperature range of 33 to 86 F for an effective surface emmittance of 0.85.

3.6.2 Ascent Thermal Interaction

The surface temperatures and internal thermal response of the Booster and Orbiter shall be based on the thermal interaction influence of the surface temperature histories as presented by Figures 3.6-1 through 3.6-8 for surface emissivities of 0.85 and 0.80 for the Booster and Orbiter, respectfully.

3.7 Guidance and Navigation

During the mated ascent phase, the Booster Vehicle shall perform all guidance and navigation functions to control the mated Shuttle Vehicle along the desired trajectory until completion of Booster/Orbiter release. The Orbiter Vehicle shall perform similar guidance and navigation computations as a contingency backup to the Booster Vehicle. Two-way voice and data communications, as defined in Paragraph 3.10.1, shall be provided. Following abort separation, both vehicles shall be capable of continuing

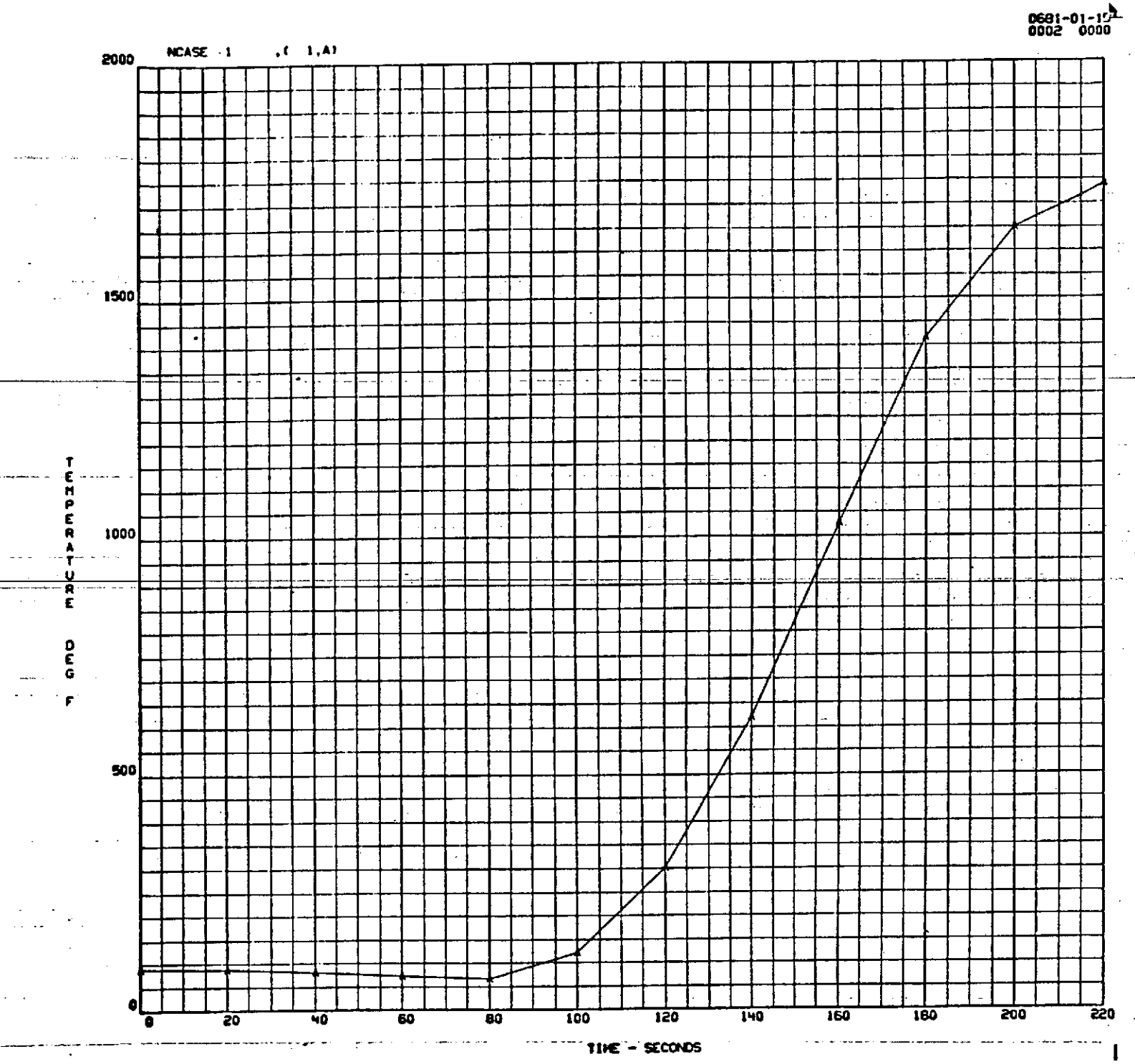


Figure 3.6-1 Booster Surface Temperature (STA 1116)

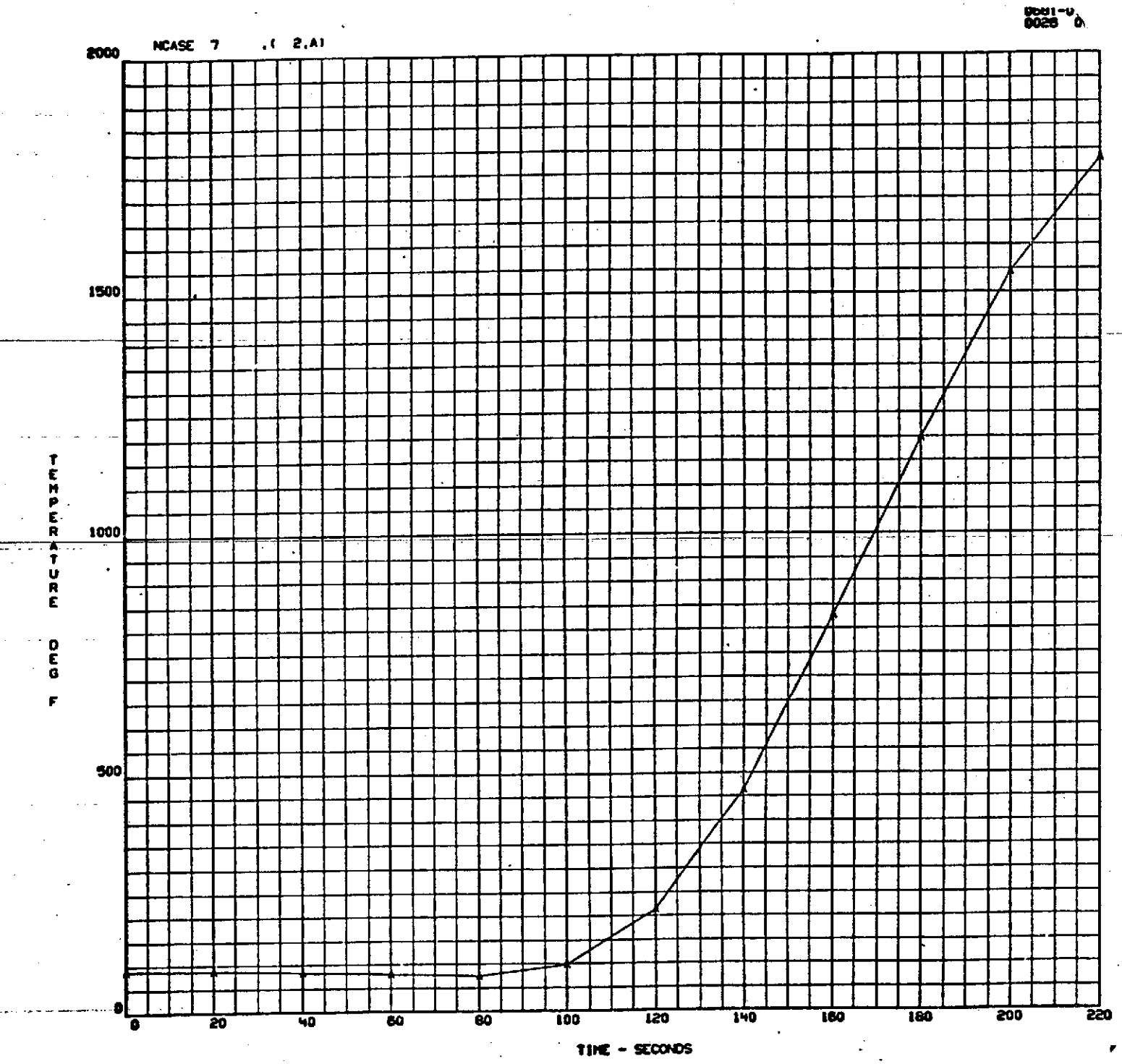


Figure 3.6.2 Booster Surface Temperature (STA 1460)

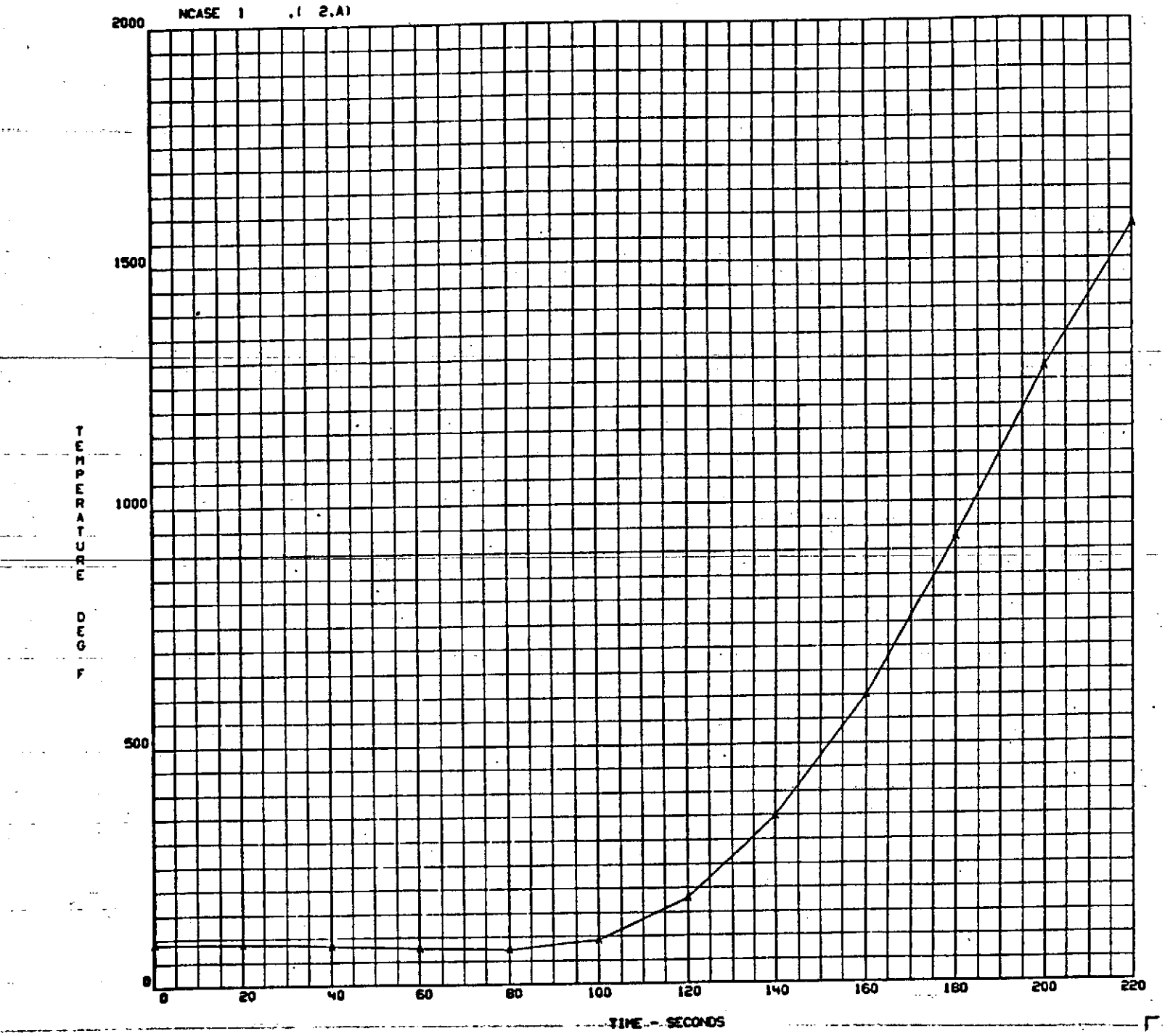


Figure 3.6-3 Booster Surface Temperature (STA 1805)

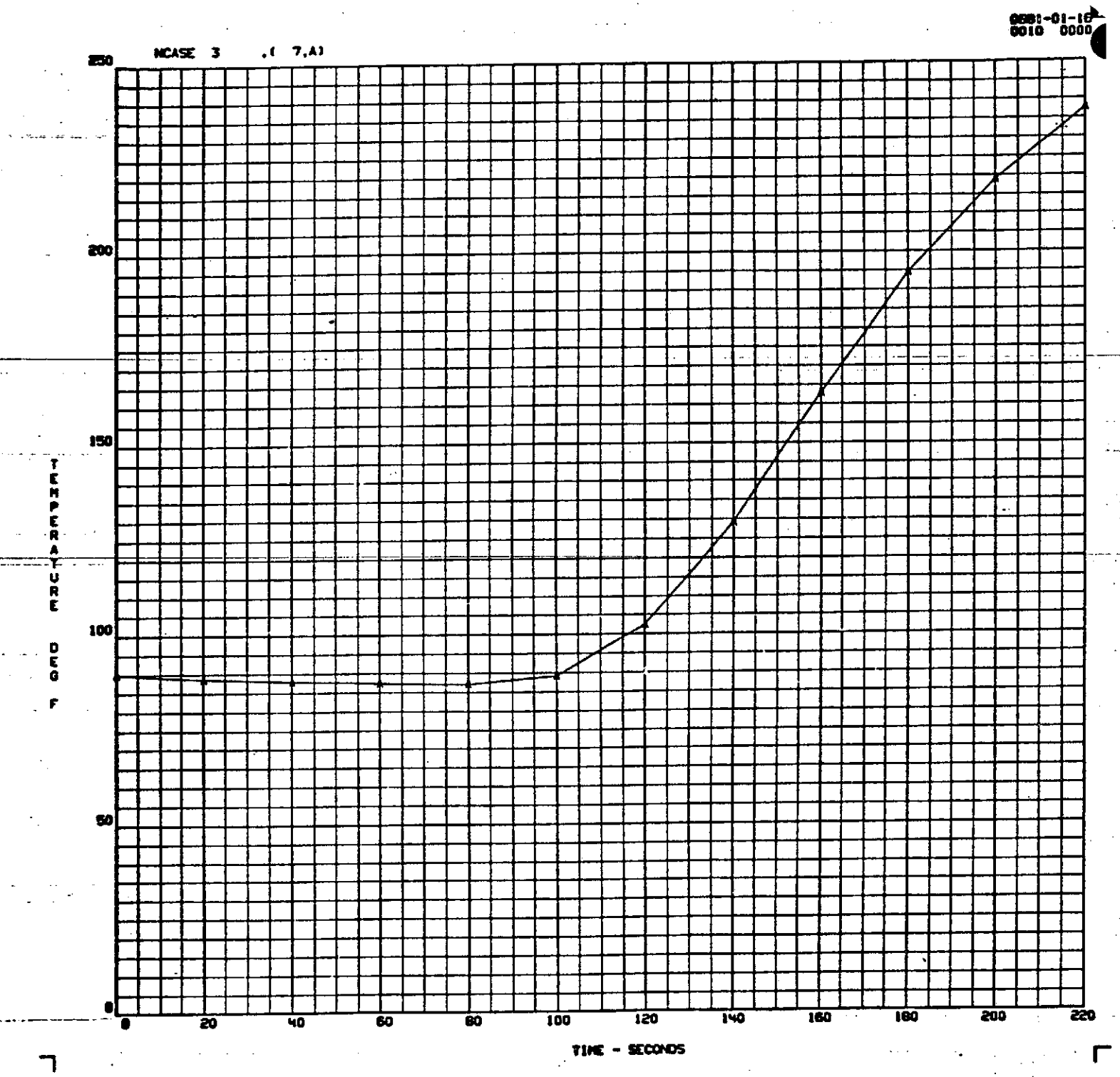


Figure 3.6-4 Booster Surface Temperature (STA 2565)

FIGURE 3.6-5:
ORBITER LOWER SURFACE TEMPERATURE HISTORIES — ASCENT (X/L = .16)

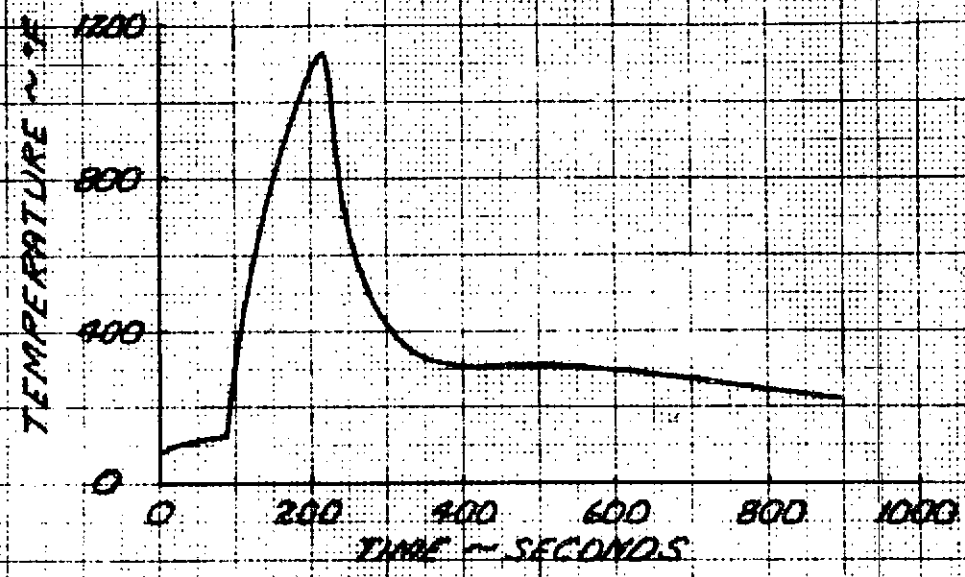


FIGURE 3.6-6:
ORBITER LOWER SURFACE TEMPERATURE HISTORIES - ASCENT ($X/L = .39$)

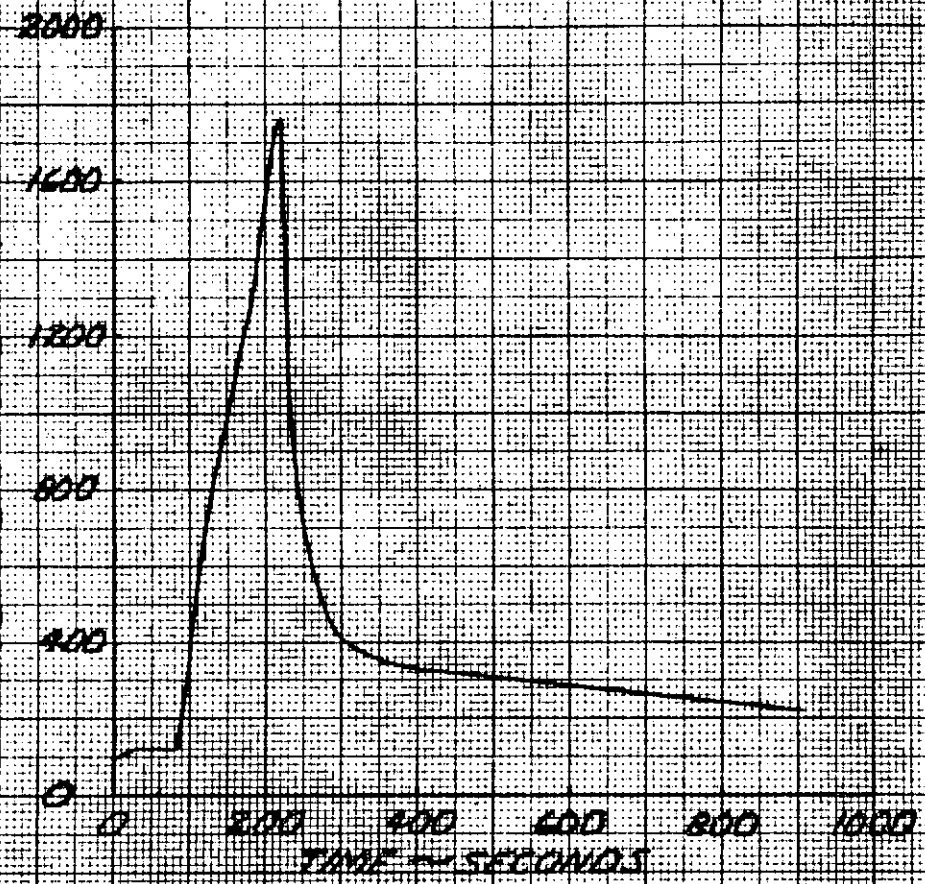


FIGURE 3.6-7:
ORBITER LOWER SURFACE TEMPERATURE HISTORIES - ASCENT (X/L = .46)

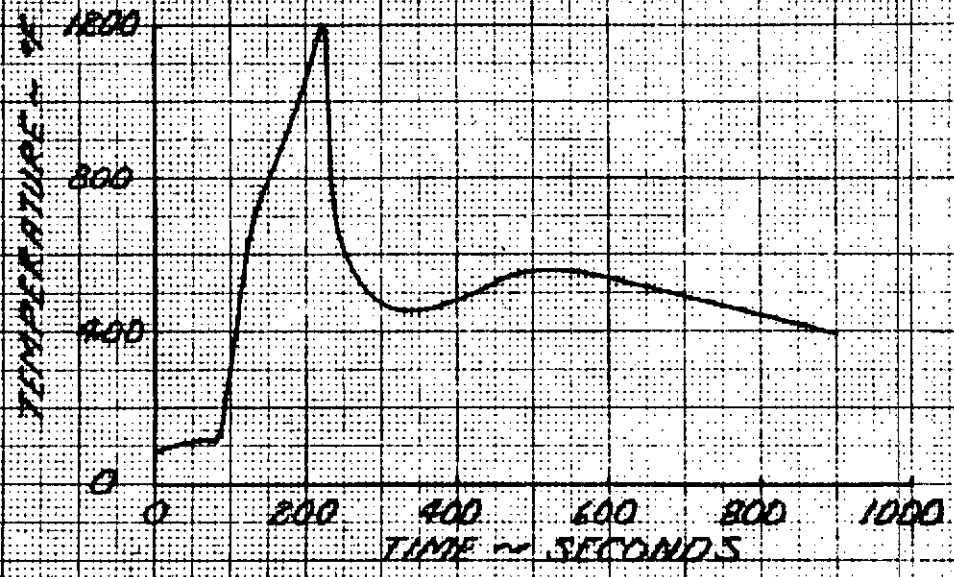
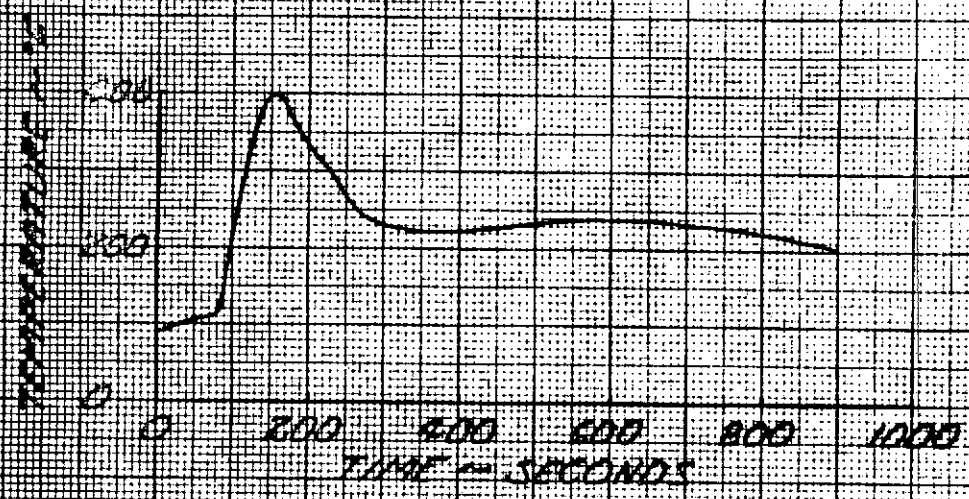


FIGURE 3.6-8:
ORBITER LOWER SURFACE TEMPERATURE HISTORIES - ASCENT (X/L = .8)



along an altered ascent trajectory until burnout, subsequent reorientation, reentry and flyback to the launch site or a designated alternate emergency landing site. This recovery requirement is void if the particular damage sustained (which may have necessitated abort separation) shall subsequently preclude vehicle recovery.

3.8 Flight Control

Mated Shuttle Vehicle flight control functions shall be performed primarily by the Booster main engine thrust vector control (TVC) and, possibly, the Booster aerodynamic surfaces. The aerodynamic surfaces of the Orbiter Vehicle shall be trimmed during boost to the minimum drag position unless needed to actively suppress integrated vehicle loads.

3.9 Separation Sequence and Maneuvers

3.9.1 Separation Sequence

Normal separation shall be accomplished to the timeline shown in Figure 3.9-1. ~~The normal separation sequence shall be as shown in~~ Figure 3.9-2. The separation sequence shall be adaptive to prevailing conditions at any point along the ascent trajectory where separation is to occur. The Orbiter Vehicle shall provide parallel-redundant separation commands to the Orbiter interface to provide all separation functions. As long as Booster-Orbiter communications are intact, the separation sequence shall be slaved to the Booster Vehicle as the master controller. In the event that Booster-Orbiter communications are lost, the sequence adaptation shall cease and the last sequence update shall be used by both vehicles. In the event of Booster incapacity, the Orbiter Vehicle shall assume the master controller function. The separation sequence controllers shall be in accordance with 76Z0548 Specification for Software, Airborne, Separation Sequences.

3.9.2 Post-Separation Maneuvers

The post-separation maneuvers of both vehicles shall prevent recontact. To provide for a desired Booster pitch up angle after separation and prior to the recovery maneuver, a 2 degree/second pitch up command shall be preprogrammed .50 seconds after initation of the separation sequence. For the condition with neither Orbiter engine operating, a larger Booster pitchup angle is required to provide sufficient clearance between the Orbiter and Booster tail. This shall be accomplished by programming an additional Booster pitch up command concurrently with the release of the vertical links.

In the event of abort separation, post-separation maneuvers shall have as an objective to maximize intervehicle separation distances. During

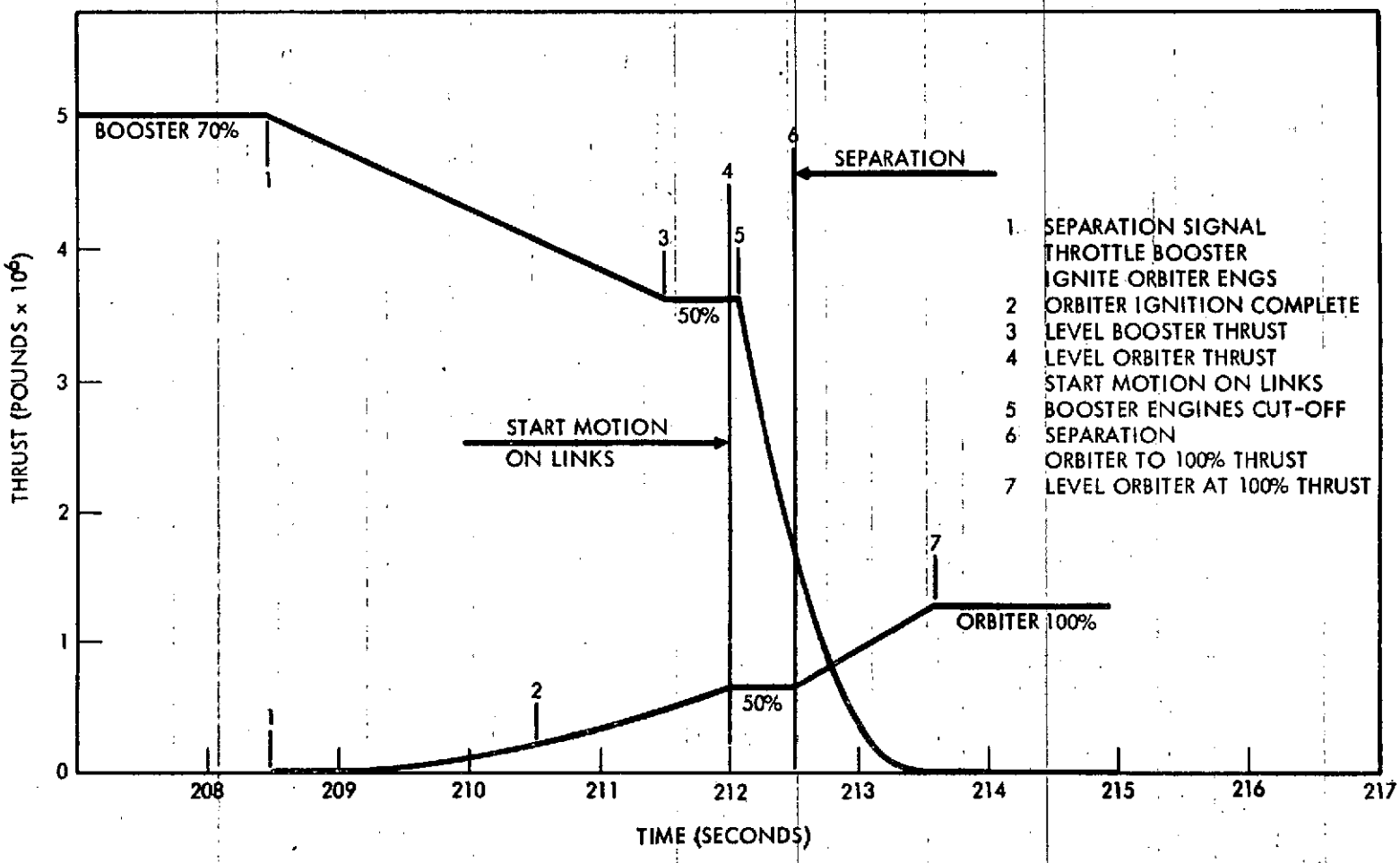
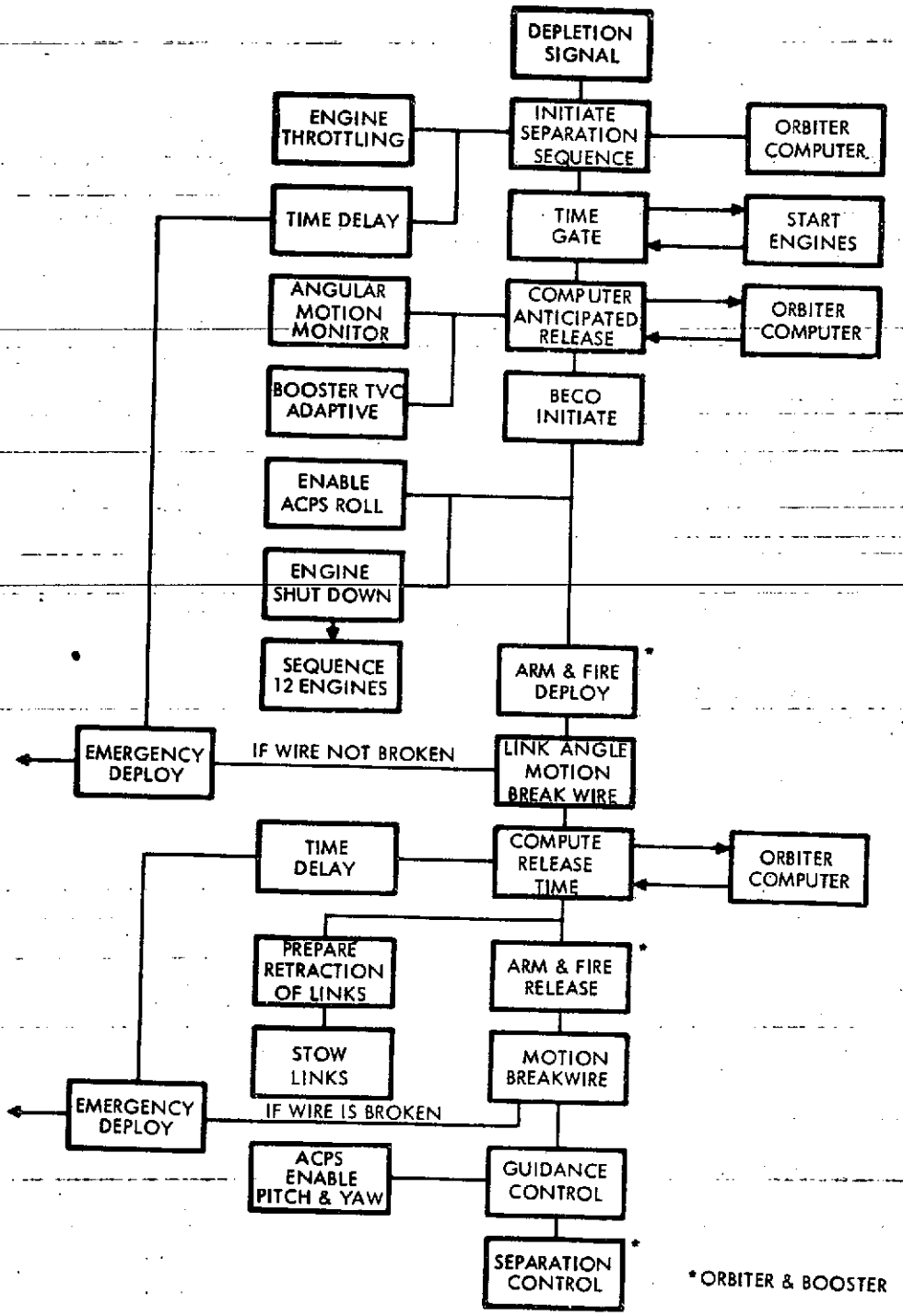

BOOSTER 70%
SEPARATION
START MOTION
ON LINKS
50%
50%
ORBITER 100%
1. SEPARATION SIGNAL
THROTTLE BOOSTER
IGNITE ORBITER ENGS
2 ORBITER IGNITION COMPLETE
3 LEVEL BOOSTER THRUST
4 LEVEL ORBITER THRUST
START MOTION ON LINKS
5 BOOSTER ENGINES CUT-OFF
6 SEPARATION
ORBITER TO 100% THRUST
7 LEVEL ORBITER AT 100% THRUST
THRUST (POUNDS x 10^6)
0
1
2
3
4
5
208
209
210
211
212
213
214
215
216
217
TIME (SECONDS)

Fig 3.9-1



*ORBITER & BOOSTER

Fig 3.9-2

post-liftoff abort Booster thrust shall be sequentially increased to 100% to provide required separation energy, reduced to 55% for tail clearance and increased back to 109% to provide for recovery. The Orbiter Vehicle shall be preprogrammed with a 2 degree attitude and a 4 degree/sec pitch rate at separation to ensure adequate separation distance.

For max-q abort Booster thrust scheduling shall be similar to post-lift except for timing and Booster thrust not exceeding normal power. To account for wind effects the Booster Vehicle shall be programmed to weather cock to maintain a β of 1/2 degree. The Orbiter engine gimbal controls shall provide for a 7-degree hardover command for 5 seconds after separation.

To prevent exceeding the 3-g limit on the Booster and/or Orbiter during abort 180 seconds after liftoff, four of the booster engines shall be shutoff and the remaining reduced to 50% thrust. To achieve required separation clearance 6-degree Booster and 10-degree Orbiter attitudes at a 2 deg/sec pitch rate shall be preprogrammed.

3.9.3 Electrical Power

Both vehicles shall redundantly to each other provide 28 V DC electrical power to fire sixteen deployment squibs. Both vehicles shall, over paths separate from the above, supply redundant 28 V DC electrical power to fire twelve release squibs. In addition, back-up of electrical power paths shall be provided to burst the separation/mating links in the event of a failure.

3.10 Communications

3.10.1 Hardline Communications

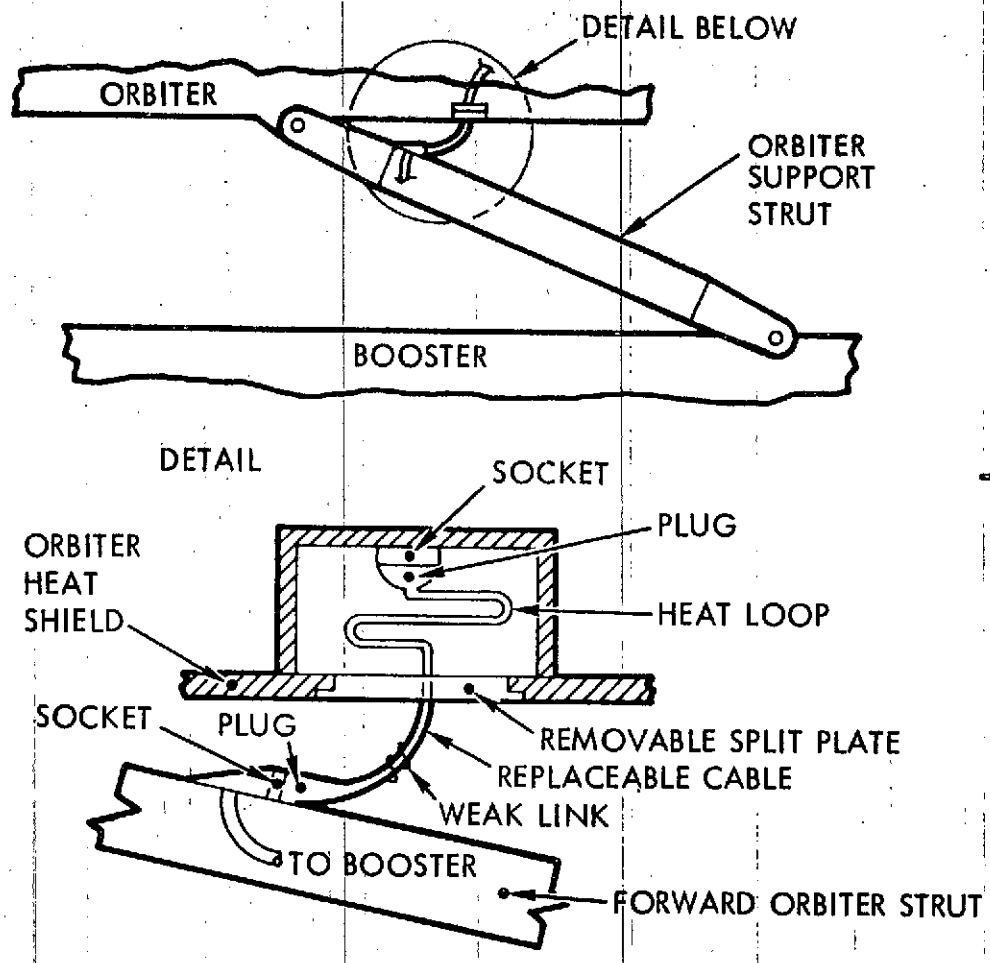
Three hardline communications links shall be provided between the two vehicles while mated, as defined in Figure 3.10-1. Each link shall be cabled and terminated separately from the others, and each shall consist of four twisted wire pairs, each pair being shielded. Two communications links shall be incorporated into one of the two front drag links of the Booster/Orbiter Mating/Separation Subsystem previously defined in Paragraph 3.2, and the third communications link shall be incorporated into the other of the two front drag links.

3.10.1.1 Data

Two of the four twisted pairs in each communications link shall be utilized to provide two-way simplex data interchange as specified in Table 3.10-1 (TBD). The data transfer in either direction shall be provided by the

FUNCTIONS

BI-DIRECTIONAL VOICE (2 CHANNELS EACH WAY)
BI-DIRECTIONAL VEHICLE STATUS DATA
FO FS OPERATION



ELECTRICAL DIAGRAM

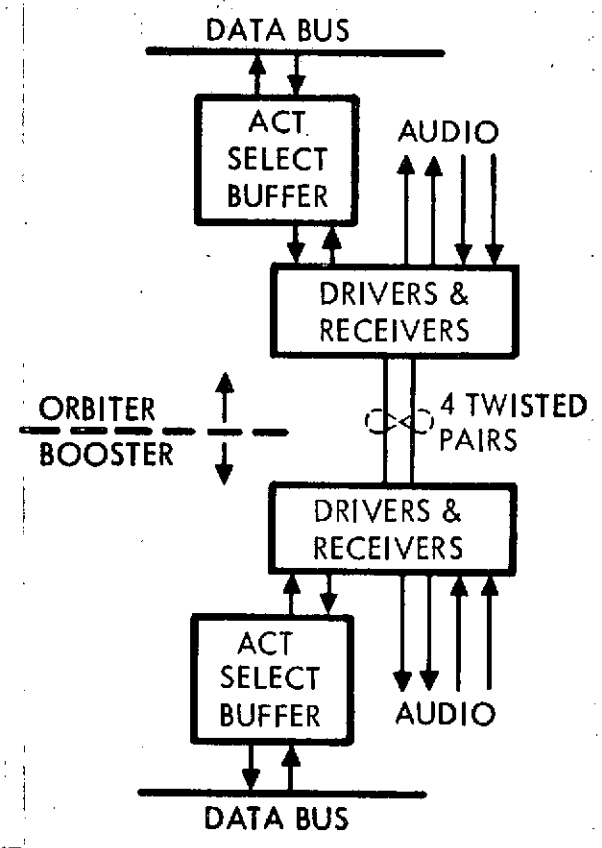


Fig 3.10-1

originating vehicle at a rate of 5 KB/second maximum. The format of the data to be transferred shall be established by the originating vehicle.

3.10.1.2 Voice

Two of the four twisted pairs in each communications link shall be utilized to provide two-way duplex voice as specified in Table 3.10-2.

TABLE 3.10-2 HARDLINE TWO-WAY DUPLEX VOICE

Input Impedance (Microphone)	Balanced 600 ± 60 ohms at 1 KHz
Frequency Response	300 Hz to 3 KHz , flat within 3 db
Isolation	(1) 52 db minimum between channels (2) 46 db minimum between microphone and earphone lines.
Attenuation	1 db maximum in the frequency range from 300 Hz to 3 KHz
Input Signal Level	(1) Microphone Line: from -30 dbm to + 15 dbm (2) Earphone Line: +20 ± 6 dbm nominally
Internal Noise	(1) -42 dbm maximum nominally and during max vibration levels shall not exceed -27 dbm (2) -27 dbm maximum under maximum vibration levels

3.10.2 RF Communications

3.10.2.1 Voice

RF communications between the Booster and Orbiter Vehicles shall be provided by UHF two-way simplex voice utilizing the following frequencies:

(a) Booster to Orbiter - TBD (225 - 400 MHz)

(b) Orbiter to Booster - TBD (225 - 400 MHz)

The equipment used shall be that used for communication with ground stations.

3.11 Vehicle Inter-Control

3.11.1 Control by Booster Vehicle

The Orbiter Vehicle shall be capable of receiving, and responding to, the following command and control signals transmitted from the Booster

Vehicle via the data interchange communications defined in Paragraph 3.10.1. No action by the Orbiter Vehicle crew shall be required to implement these commands and controls:

(a) Main engine ignition
(b) Thrust Vector Angles (each engine, open loop)
(c) Thrust Level Commands (each engine)
(d) Aerodynamic Surface Deflections
(e) Short Term Guidance Commands
(f) ACPS Commands

3.11.2 Control by Orbiter Vehicle

The Booster Vehicle shall be capable of receiving, and responding to, the following command and control signals transmitted from the Orbiter Vehicle via the data interchange communications defined in Paragraph 3.10.1. No action by the Booster Vehicle crew shall be required to implement these commands and controls:

(a) Main engine ignition
(b) Thurst vector angles (each engine, open loop)
(c) Thrust level commands (each engine)
(d) Aerodynamic surface deflections
(e) Short term guidance commands
(f) ACPS commands

3.12 Status and Performance Monitoring

3.12.1 Booster Vehicle

The Booster Vehicle shall be capable of monitoring the Orbiter status and performance data defined in Paragraph 3.14.2. Such data shall be made available to the Booster Vehicle via the hardline communications link defined in Paragraph 3.10.1.

3.12.2 Orbiter Vehicle

The Orbiter Vehicle shall be capable of monitoring the Booster status and performance data defined in Paragraph 3.14.1. Such data shall be made available to the Orbiter Vehicle via the hardline communications link defined in Paragraph 3.10.1.

3.13 Contingency Operations

3.13.1 Abort

Means shall be provided in both the Booster and Orbiter Vehicles for manual and automatic initiation of the automatic abort sequence(s) as determined by the abort criteria defined in Paragraph I.1.1 of Appendix I. Automatic abort sequencing shall be verified in both the Orbiter Vehicle and the Booster Vehicle. Manual override of the automatic abort sequence(s) by the flight crew of either vehicle shall be provided. This capability shall be limited such that the crew of either vehicle can only exercise manual override of the automatic abort sequence(s) initiated by the vehicle they occupy. The capability shall also be provided, on both the Booster Vehicle and the Orbiter Vehicle, to initiate the separation sequence automatically by the on-board computer or manually by members of the flight crew. The hardline data interchange link defined in Paragraph 3.10.1.1 shall be used for initiation of the separation sequence.

3.13.2 Emergency Detection

Identification of malfunctions, requiring abort, and the abort signal resulting from either manual or automatic abort initiation shall be transmitted from the vehicle initiating such abort to the other vehicle in a form suitable for simultaneous display in the cockpits of both the Booster and Orbiter Vehicles. These signals shall be transmitted via the 2-way data interchange link defined in Paragraph 3.10.1.

3.13.3 Caution and Warning Signals

Caution and warning signals shall be transmitted from the initiating vehicle to the other vehicle in a form suitable for simultaneous display in the cockpits of both the Booster and Orbiter Vehicles. These signals shall be transmitted via the 2-way data interchange link defined in Paragraph 3.10.1.

3.14 Data

3.14.1 Booster Vehicle

The Booster Vehicle shall provide, to the Orbiter Vehicle, the data specified in Table 3.14-1.

3.14.2 Orbiter Vehicle

The Orbiter Vehicle shall provide, to the Booster Vehicle, the data specified in Table 3.14-2.

3.15 Interstage Grounding

The Booster and Orbiter Vehicles each shall meet the grounding requirements of MIL-B-5087. The ground shall be carried through the communication link physical interface shown on Figure 3.2-1.

TABLE 3.14-1 DATA PROVIDED TO THE ORBITER VEHICLE BY BOOSTER VEHICLE

Data Items	OPERATIONAL MODE/PHASE				
	Via Hardline	Via R.F.	Pre-Launch and Launch	Lift-off and Mated Ascent	Post Separation
Emergency Detection					
Main Engine Status	X		X	X	
Control System Status	X		X	X	
Fire Detection	X	X	X	X	X
Major Propellant Leak	X	X	X	X	X
Explosion	X	X	X	X	X
Fail-Safe Level Static	X		X	X	
Caution & Warning					
Operational Data					
Air Data (α, β, q, Mach, $\dot{\alpha}$, $\dot{\beta}$, $\dot{q}$)	X			X	
Main Engine Thrust & TVC	X			X	
Control System Data	X			X	
Guidance Data (Altitude Attitude, Wind Data, Gust Data)	X			X	

TABLE 3.14-2 DATA PROVIDED TO THE BOOSTER VEHICLE BY ORBITER VEHICLE

Data Items	OPERATIONAL MODE/PHASE				
	Via Hardline	Via R.F.	Pre-Launch and Launch	Lift-off and Mated Ascent	Post Separation
Emergency Detection					
Main Engine Status	X		X	X	
Control System Status	X			X	
Fire Detection	X	X	X	X	X
Major Propellent Leak	X	X	X	X	X
Explosion	X	X	X	X	X
Fail -Safe Level Static	X		X	X	
Caution & Warning					
Operational Data					
Main Engine Thrust & TVC	X			X	
Control System Data	X			X	
ACPS Thrust	X			X	

4. INTERFACE DESIGN CRITERIA

4.1 Environmental Conditions

Design of the interface(s) between the Booster Vehicle and Orbiter Vehicle shall be based on the requirement that the two vehicles be capable of operation in the natural and induced environments specified in Paragraphs 3.2.7.1 and 3.2.7.2 of the "System Specification for a Space Shuttle System," except as specified in the following paragraphs of this section.

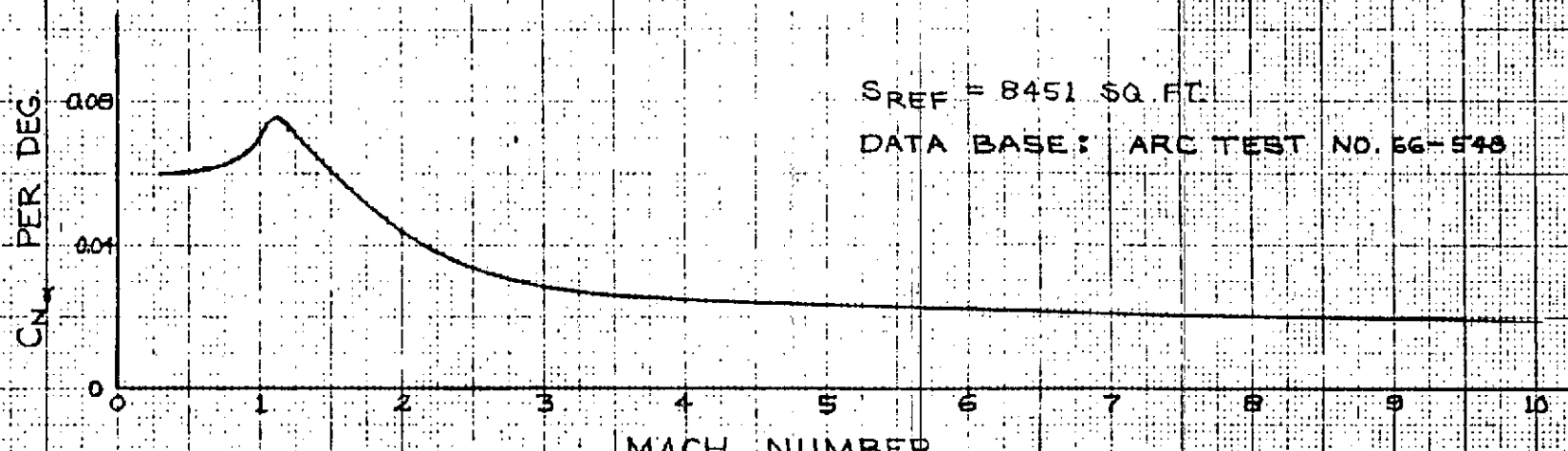
4.2 Ascent Flight Aerodynamics

The mated configuration aerodynamic characteristics with interference effects included, are given in Figures 4.2-1 through 4.2-8.

4.3 Timeline

The timeline for Mated Flight, Liftoff to Separation, shown in Table 4.3-1, shall be used as the baseline for ascent performance studies.

AERODYNAMIC DATA – INTEGRATED SYSTEM
BOOST CONFIGURATION (B-9U/161C)



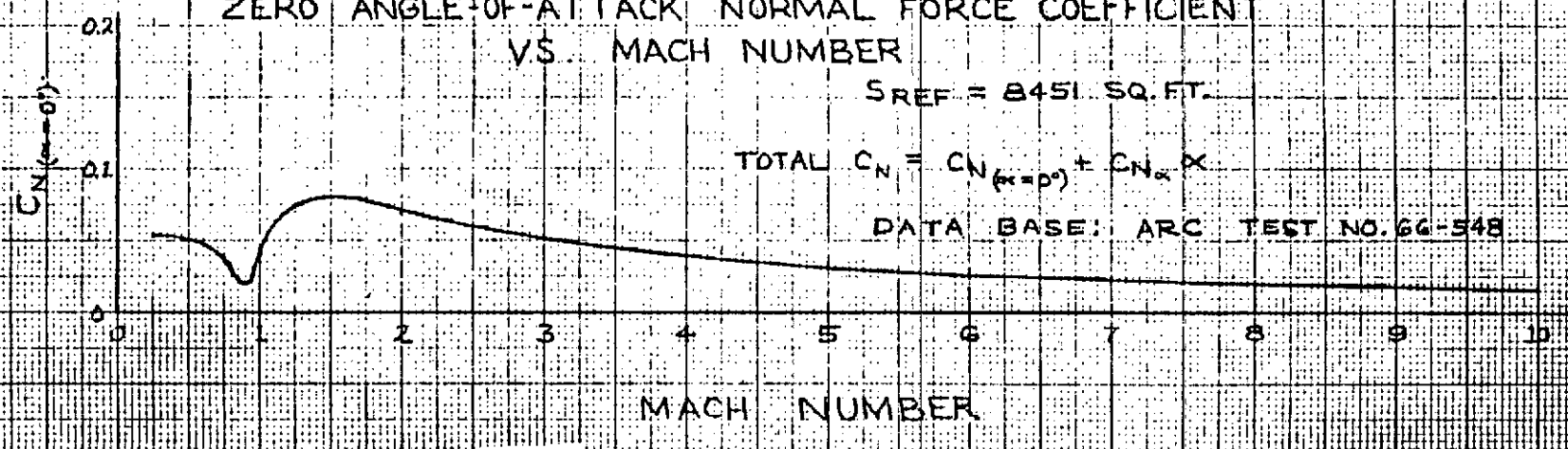


FIGURE 4.2-1 NORMAL FORCE CHARACTERISTICS

AERODYNAMIC DATA – INTEGRATED SYSTEM
BOOST CONFIGURATION (B-9U/161C)

FOREBODY AXIAL FORCE COEFFICIENT VS. MACH NUMBER

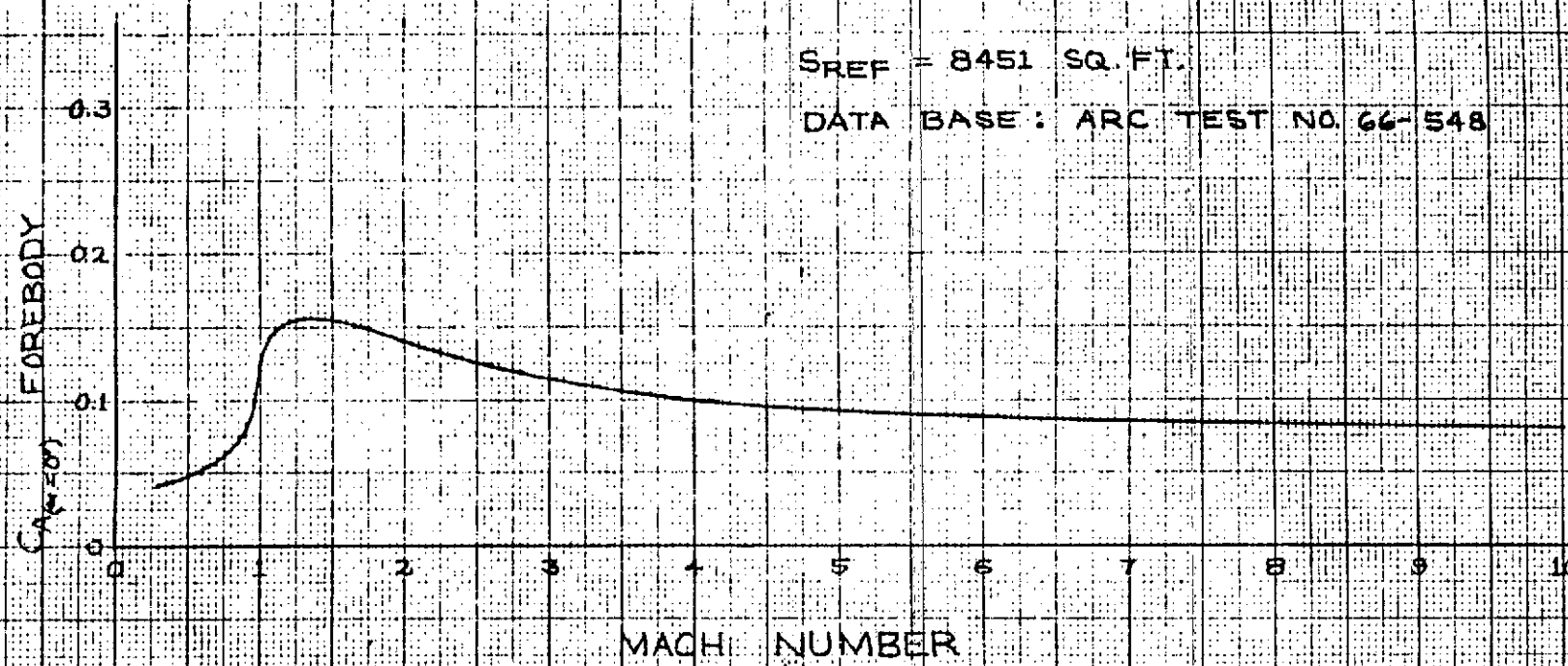


FIGURE 4.2-2 AXIAL FORCE CHARACTERISTICS

AERODYNAMIC DATA - INTEGRATED SYSTEM
BOOST CONFIGURATION (B-9U/161C)

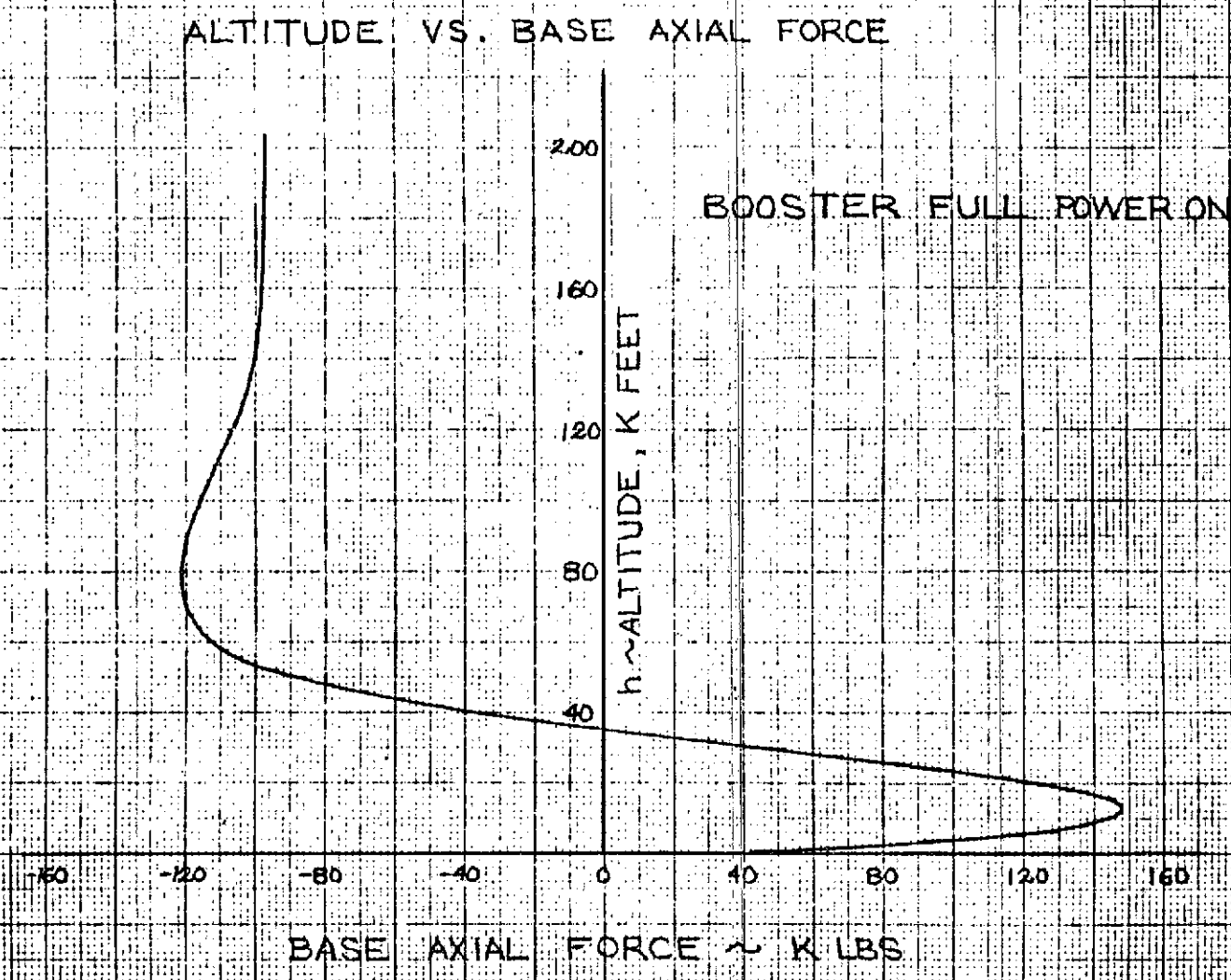
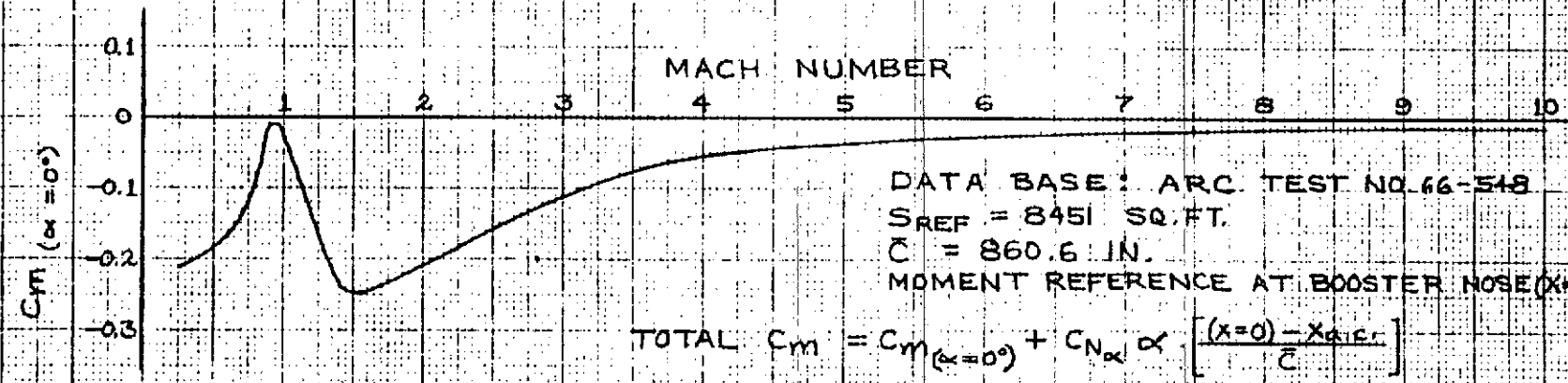


FIGURE 4.2-3 AXIAL FORCE CHARACTERISTICS

AERODYNAMIC DATA - INTEGRATED SYSTEM
BOOST CONFIGURATION (B-9U/161C)

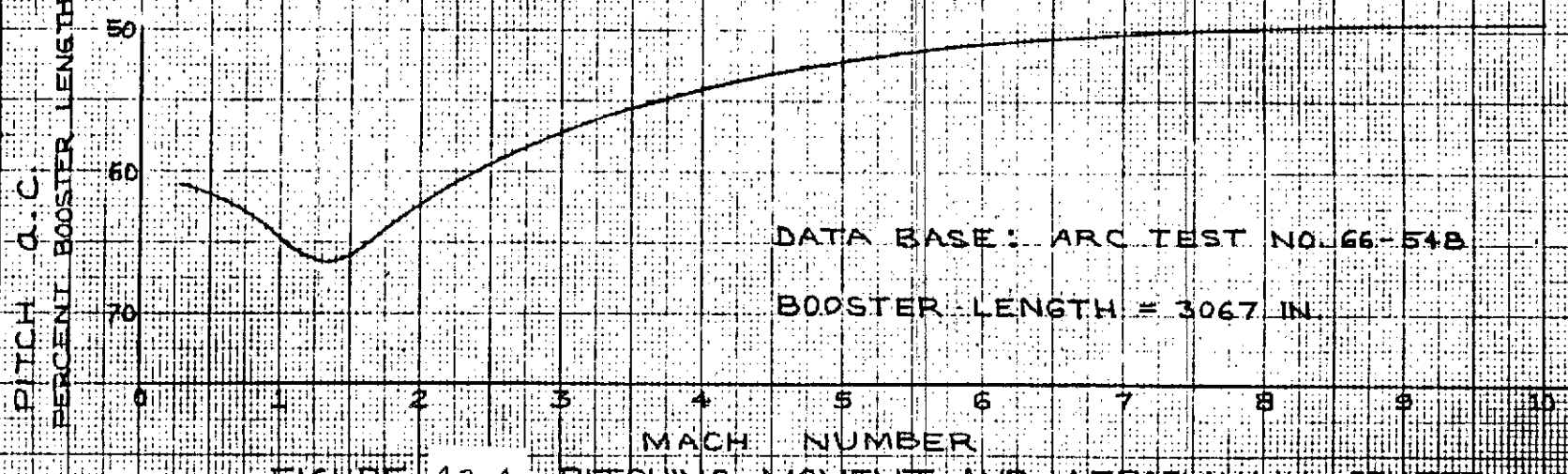
ZERO ANGLE-OF-ATTACK PITCHING MOMENT COEFFICIENT VS. MACH NUMBER



DATA BASE: ARC TEST NO. 66-548
S_{REF} = 8451 SQ. FT.
$\bar{C}$ = 860.6 IN.
MOMENT REFERENCE AT BOOSTER NOSE (X=0)

$$\text{TOTAL } C_m = C_{m_{(\alpha=0°)}} + C_{N_\alpha}\,\alpha\left[\frac{(X=0)-X_{a.c.}}{\bar{C}}\right]$$

PITCH AERODYNAMIC CENTER VS. MACH NUMBER



DATA BASE: ARC TEST NO. 66-548

BOOSTER LENGTH = 3067 IN.

FIGURE 4.2-4 PITCHING MOMENT AND AERODYNAMIC CENTER

AERODYNAMIC DATA – INTEGRATED SYSTEM
BOOST CONFIGURATION (B-8U/161C)

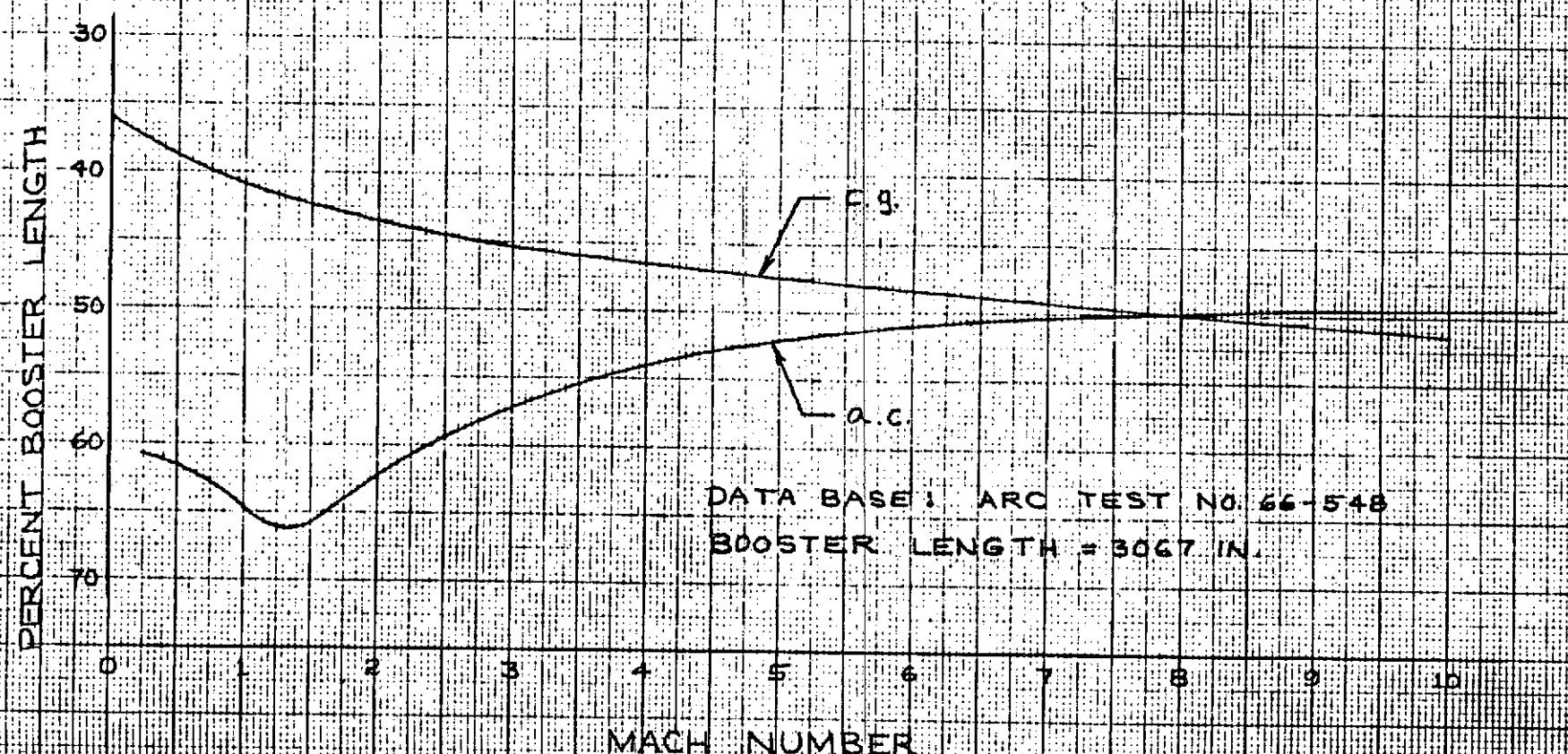


FIGURE 4.2-5 PITCH STABILITY CHARACTERISTICS

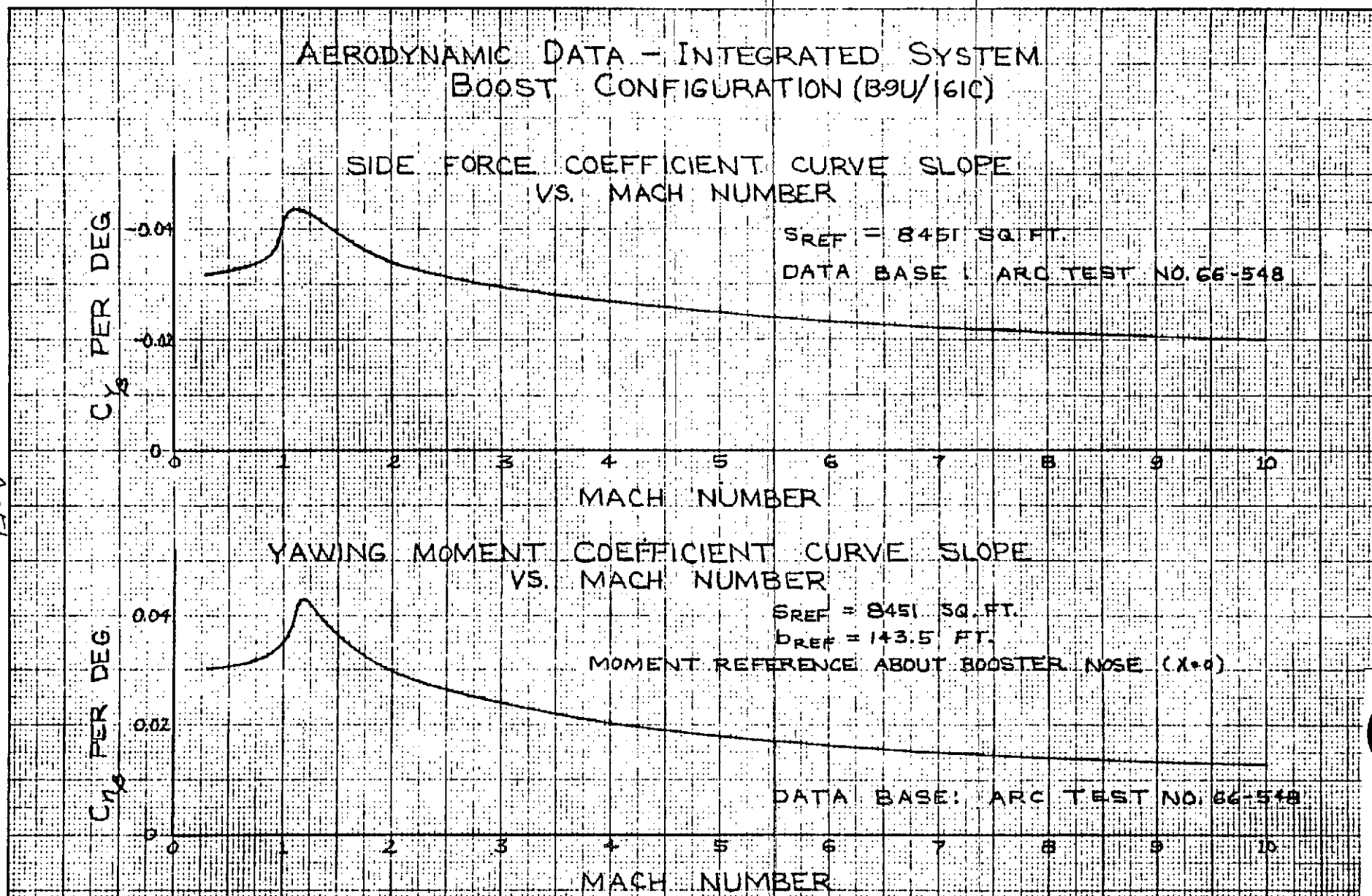


FIGURE 4.2-6 DIRECTIONAL CHARACTERISTICS

AERODYNAMIC DATA - INTEGRATED SYSTEM
BOOST CONFIGURATION (B-9U/161C)

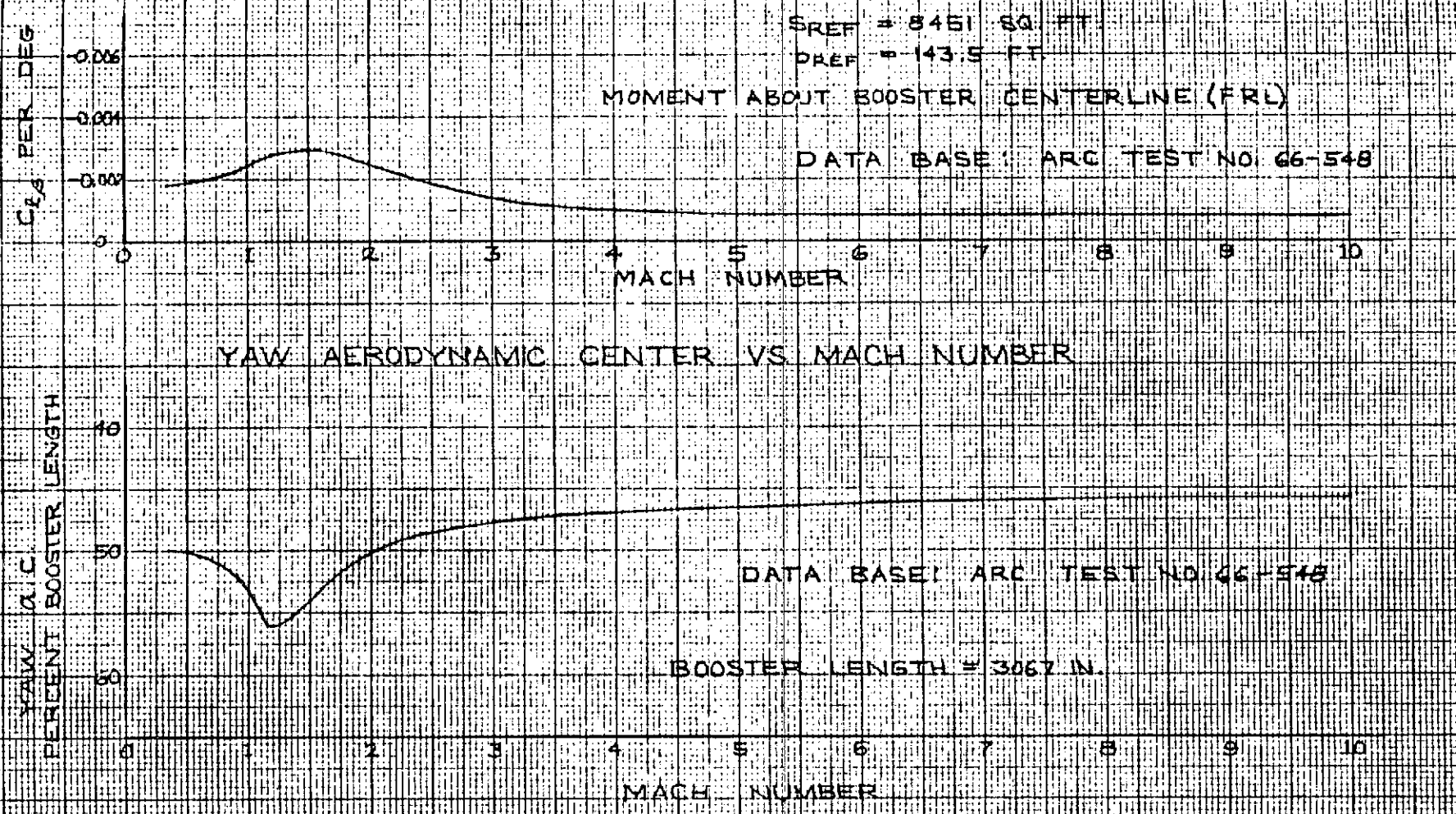


FIGURE 4.2-7 LATERAL AND DIRECTIONAL CHARACTERISTICS

K+E 10 X 10 TO THE CENTIMETER 18 X 25 CM. • ALBANENE® KEUFFEL & ESSER CO. 46 1817 MADE IN U.S.A.

AERODYNAMIC DATA – INTEGRATED SYSTEM
BOOST CONFIGURATION (B-9U/161C)

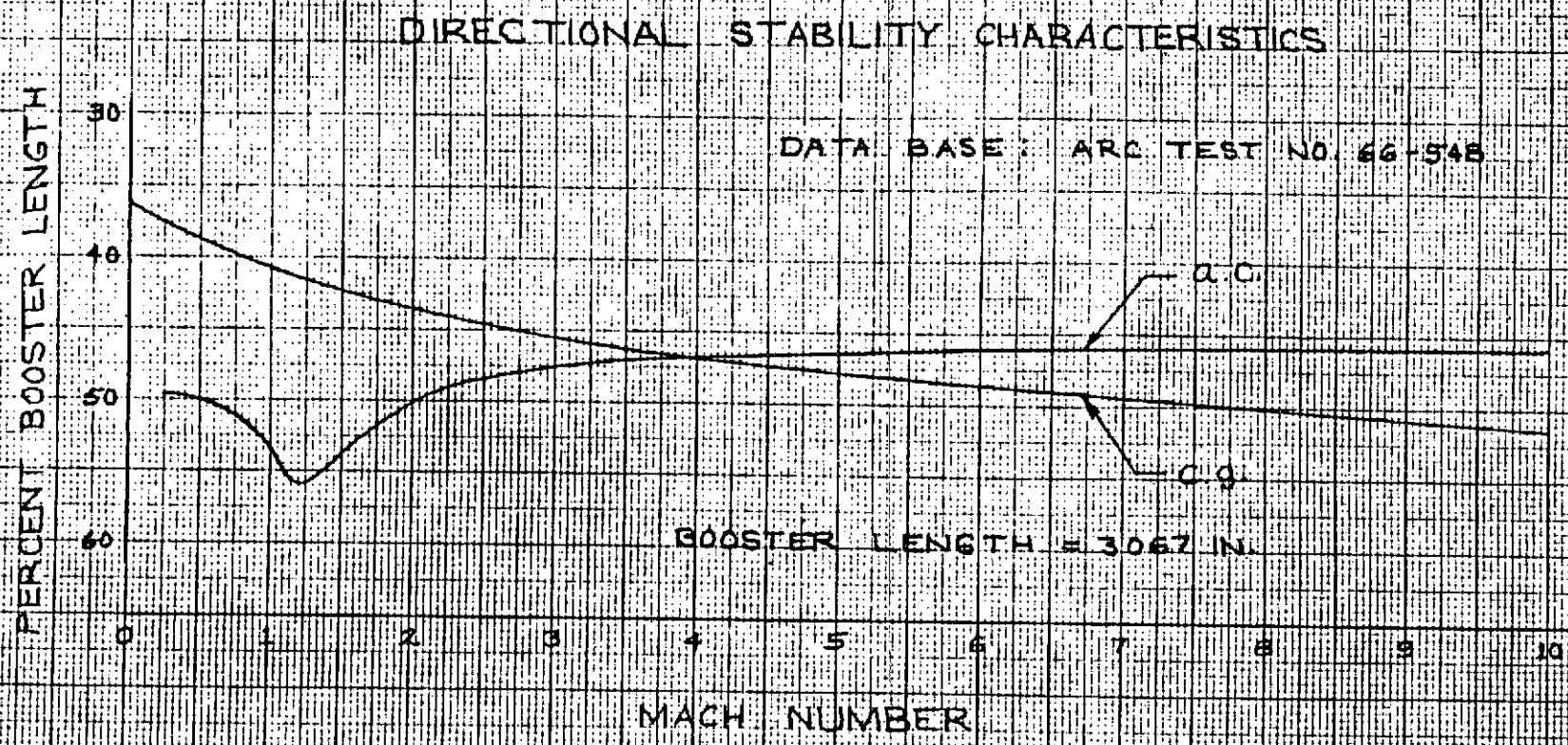


FIGURE 4.2-8 YAW STABILITY CHARACTERISTICS

Table 4.3-1 Mated Flight, Liftoff to Separation

Initiate				Complete				Duration				FUNCTION NUMBER	FUNCTION, SUBFUNCTION,
D	H	M	S	D	H	M	S	D	H	M	S	(FROM FFD)	OR EVENT TITLE
00	00	00	00	00	00	03	04	00	00	03	04	1.1	Perform mated ascent (starts with liftoff)
			00				05				05	1.1.1	Perform initial ascent maneuver
			-06								00		BV ignition (instant of)
			00								00		Liftoff (instant of)
			00								00		Full thrust achieved (instant of)
			00				05				05		Control vehicle to vertical
			05				17				12	1.1.2	Perform roll maneuver
			10				30				20	1.1.3	Perform pitch maneuver
			30			03	04			02	34	1.1.4	Maintain ascent profile
			30			03	04			02	34		Maintain gravity turn (pitch program)
		01	05								00		Max g (instant of)
		02	20								00		3-g max axial load (instant of)
		02	20			03	04				44		Maintain axial load 3 g
		03	04			03	08					1.2	Perform orbiter/booster staging
												1.2.1	Sense booster propellant depletion (instant of)
							(Details TBD)						Sense oxidizer depletion
													Sense fuel depletion
													Signal to DCM (data control and mgmt)
												1.2.2	Configure vehicles for staging
													Initiate staging sequence, booster and orbiter
													Booster maintains mated vehicle attitude
												1.2.3	Perform separation
													Release hold down link
													Perform physical separation (motion of link)

A-54

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APPENDIX I — ABORT INTERFACE REQUIREMENTS

1.1 Operational Abort

1.1.1 Voice and Data

The Booster computer shall be the command center for abort during mated ascent. The computer shall monitor Booster and Orbiter subsystem failures, generate automatic and manual abort signals, display abort conditions to Booster/Orbiter crews, and control automatic abort initiation commands. The Booster computer (with backup provided by the Orbiter computer) shall establish vehicle capabilities and the required abort separation timing to remain within these capabilities. Automatic abort initiation shall be provided for those failure situations in which manual response time is not adequate to provide a safe abort separation; the use of automatic abort initiation for separation is a function of the nature of the failure and the time from liftoff at which the failure occurs. Abort initiation shall be provided for the following conditions:

(a) Manual abort separation signal for loss of critical subsystem to fail-safe level, if time permits; otherwise, the computer shall provide an automatic (back-up) abort separation signal.

(b) Manual mission abort for incapacitated crew or passengers.

(c) Manual abort separation signal for leaks/fire/explosions in the (TBD) areas, if time permits; otherwise, the computer shall provide an automatic (back-up) abort separation signal.

1.1.2 Control

Following the separation sequence, the Booster and Orbiter control systems shall maintain control during an abort separation maneuver to prevent recontact of the Booster/Orbiter stages and to allow a safe recovery. The control system shall be capable of operating within the baseline design flight envelope for abort which is from the start of booster main engine ignition sequence through normal stage separation.

1.1.3 Loads

For abort conditions, the Booster and Orbiter design ultimate structural loads shall not be exceeded either during or subsequent to the separation maneuver as a result of the separation maneuver or sequencing.

1.1.4 Definition

Aborts during mated flight shall be categorized on the basis of whether the failure causing the abort is critical or noncritical.

(a) Critical failures are those functional failures for which continued mated flight to Booster propellant depletion is not advisable and the vehicles are required to separate early.

(b) Non-critical failures are those functional failures for which continued safe mated flight to Booster propellant depletion is advisable.

The abort performance requirements for critical failures are (TBD). For non-critical failures, separation shall be accomplished within the control and structural design capability for the baseline design.

1.2 Development Flight Tests Abort

1.2.1 Voice and Data

The Booster/Orbiter command pilots shall have a voice link during the mated development flight tests. The Booster computer shall be the command center for intact abort during ascent for critical and non-critical failures. The Booster command pilot shall initiate crew escape with ejection seats for catastrophic vehicle failures.

(a) Manual abort separation signal for explosions/fires/leaks in the (TBD) areas, if time permits; otherwise, the computer shall provide an automatic (back-up) abort separation signal.

1.2.2 Performance

The ejection seats shall be capable of providing crew safety from the mated configuration on the pad through Max q (approximately 60,000 ft. at 2000 FPS).

Appendix C
SD 71-127
(MSC 03305)

INTERFACE CONTROL DOCUMENT (ICD)

ORBITER VEHICLE TO SPACE STATION

(Deleted: See page 1 of Summary)

25 June 1971

SPACE DIVISION

NORTH AMERICAN ROCKWELL CORPORATION

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1. SCOPE

1.1 TECHNICAL INTERFACE

This Interface Control Document (ICD) specifies functional, physical and procedural requirements for the interface(s) between any Orbiter Vehicle and any Payload from cargo insertion (prior to launch) through cargo removal (subsequent to landing). It includes design criteria to be observed in design of the interfacing equipment in accordance with requirements specified in this ICD. For purposes of this ICD, the term "Payload" shall refer only to items within the Orbiter Vehicle's cargo bay at time of launch.

2. APPLICABLE DOCUMENTS

The following documents, of the issue in effect on date of original official release of this ICD, form a part of this ICD to the extent specified herein. In the event of conflict between documents referenced herein and the contents of this ICD, the contents of this ICD shall govern.

2.1 SPECIFICATIONS

a. Specification No. SS613M001: System Specification for a Space Shuttle System.

b. MIL-STD-461: Requirements for Electromagnetic Interference Characteristics.

c. MIL-STD-462: Measurement of Electromagnetic Interference Characteristics.

d. MIL-STD-704A: Characteristics and Utilization of Aircraft Electrical Power.

2.2 INTERFACE CONTROL DOCUMENTATION

a. ICD No. SR 2.4.4-11188: Orbiter Vehicle to Space Station.

2.3 DRAWINGS

(TBD)

3. INTERFACE REQUIREMENTS

3.1 OPERATIONAL PHASES

The operational phases included in this ICD shall be as defined in the following sub-paragraphs.

3.1.1 Assembly and Launch

This operational phase shall be defined as beginning with first physical contact as the Payload is being loaded into the Orbiter Vehicle, prior to launch, and terminating with Shuttle Vehicle liftoff.

3.1.2 Ascent and Rendezvous

This operational phase shall be defined as beginning with Shuttle Vehicle liftoff and terminating with achievement of the following conditions:

a. The Orbiter Vehicle is less than 1000 feet from the vehicle or satellite with which it plans to rendezvous.

b. The Orbiter Vehicle's relative velocity is less than 5 feet per second different from that of the target vehicle or satellite.

If there is no target vehicle or satellite, then such termination is defined as achieving a stable earth orbit which remains within 1000 feet of the desired orbit for one complete orbit of the earth.

3.1.3 On-Orbit Operations

This operational phase shall be defined as beginning with the achievement of rendezvous (per paragraph 3.1.2) and terminating with the engine ignition signal for deorbit.

3.1.4 Entry and Landing

This operational phase shall be defined as beginning with deorbit initiation and terminating with last physical contact as the Payload is being removed from the Orbiter Vehicle subsequent to rollout at the landing site.

3.2 PAYLOAD MASS PROPERTIES

Payload weight shall not exceed 65,000 pounds.

When the Payload is attached in the cargo bay, the Payload's center-of-gravity (cg) shall lie within the longitudinal cg envelope shown in Figure 3.2-1 (Air Breathing Engines removed).

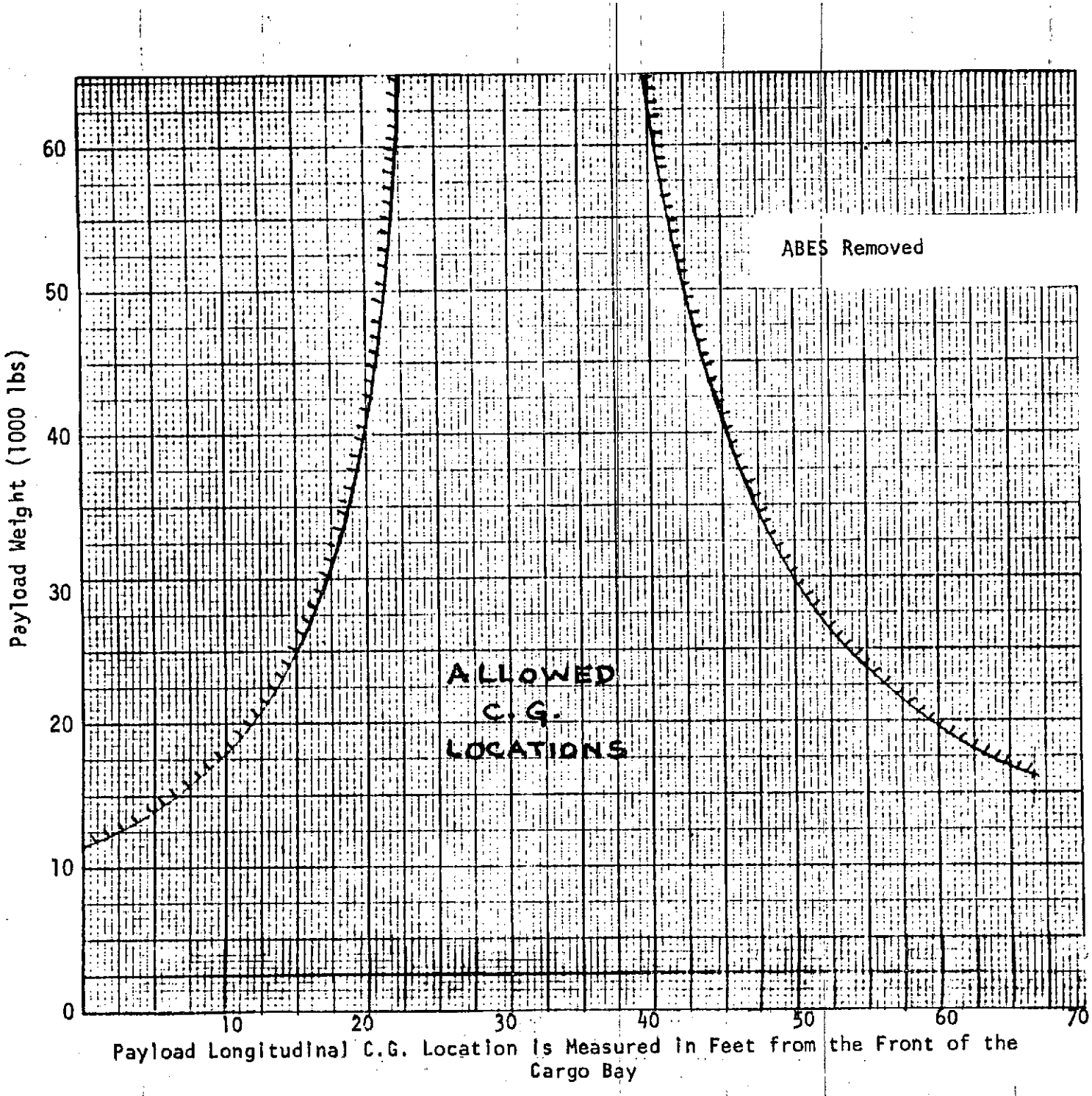


Figure 3.2-1. PAYLOAD CENTER-OF-GRAVITY ENVELOPE

3.3 PAYLOAD STOWAGE AND HANDLING

3.3.1 Payload and Cargo Bay Envelopes

Undistorted payload dimensions shall not exceed a cylindrical envelope 60 feet in length by 15 feet in diameter, with the exception of the payload retention fittings discussed in section 3.3.5.

The cargo bay shall provide a minimum clear volume of 15 feet in diameter by 60 feet length. Cargo bay dimensions and clearances shall be as shown in Figure 3.3-1.

3.3.2 Cargo Bay Doors

During the rendezvous and on-orbit mission phases, the cargo bay doors shall be retracted to allow a 180° lateral field of view as shown in Figure 3.3-1.

Prior to launch, the cargo bay doors shall be capable of opening under their own power when the Orbiter Vehicle is in the vertical (shielded from wind gusts by support equipment).

3.3.3 Payload Venting and Support Equipment Access

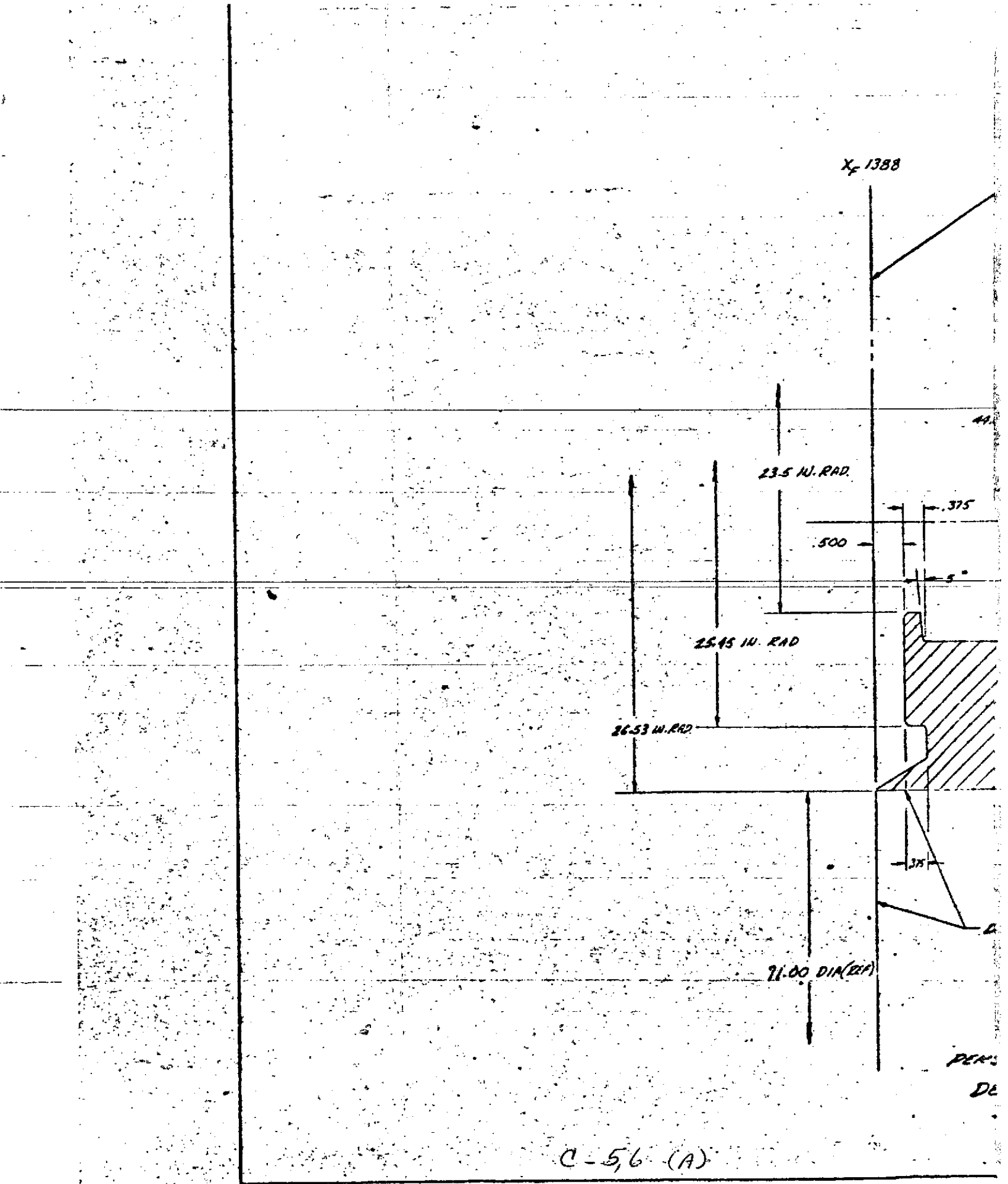
The Orbiter Vehicle shall accommodate payload venting and support equipment access when the Payload is in the cargo bay and the cargo bay doors are closed. This accommodation shall be through the payload umbilical panels shown in Figure 3.3-1. (These panels are nominally blanks; the weight differential between the blank panels and the payload-supplied, mission-peculiar panels is chargeable to payload weight.)

Between liftoff and landing, payload venting shall be non-propulsive and shall not impart disturbances greater than 10 lb nor impulses greater than 1000 lb-sec.

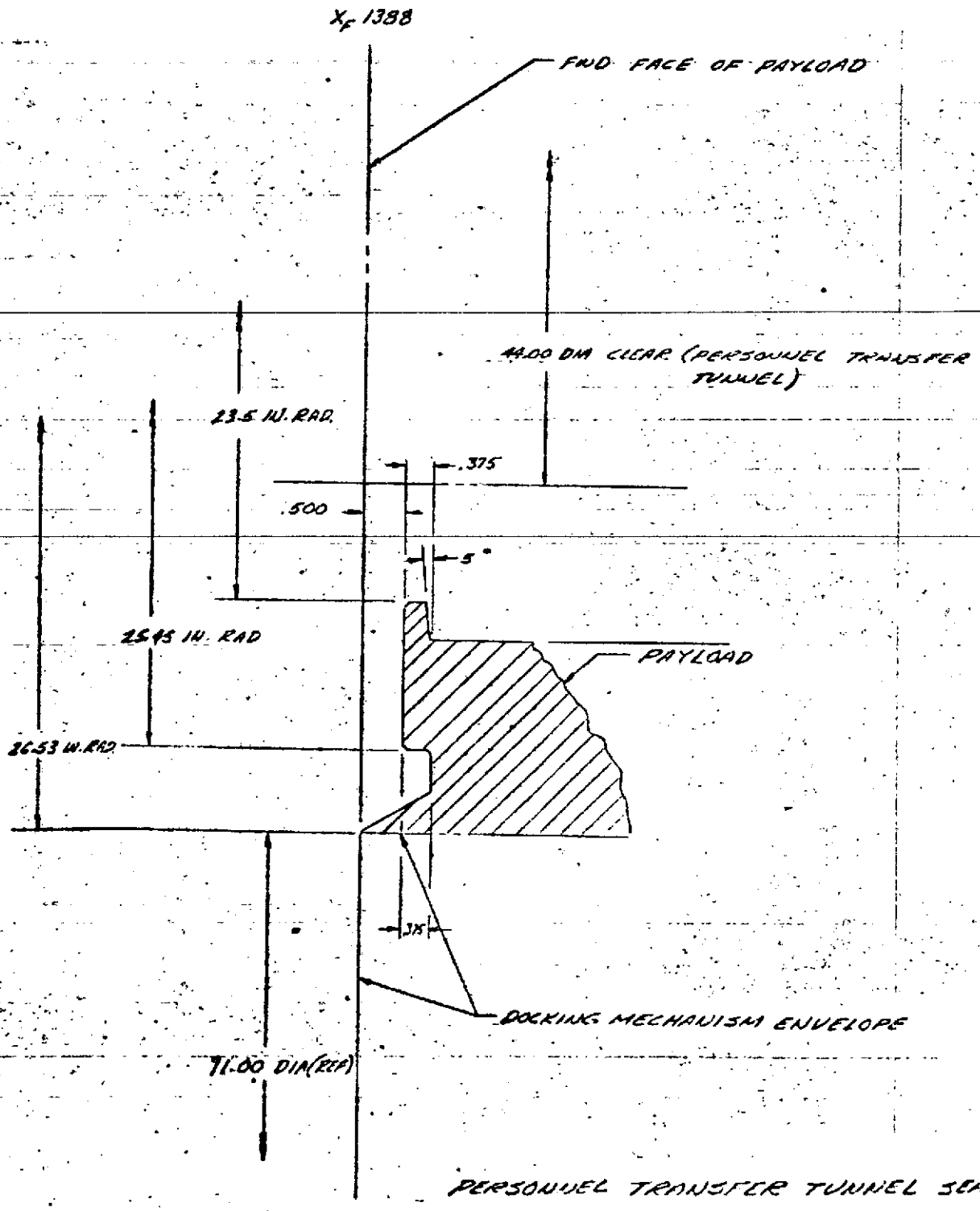
3.3.4 Personnel Transfer

The Orbiter Vehicle shall provide internal access from the personnel compartment via an internal airlock to either a pressurized payload module or the unpressurized cargo bay. Personnel shirtsleeve transfer shall be possible with a pressurized payload module either (a) attached within the cargo bay or (b) attached to the airlock docking port. All portions of the access route between the personnel compartment and a pressurized payload module shall be capable of being sealed so as to provide a completely shirtsleeve environment.

The Orbiter Vehicle shall provide a retractable personnel transfer port for access to a pressurized payload module in the cargo bay. The physical interface for the personnel transfer port shall be as shown in Figure 3.3-1.


X_F 1388
23.5 IN. RAD.
.375
.500
.5
25.45 IN. RAD
26.53 IN. RAD.
.375
91.00 DIA(REF)

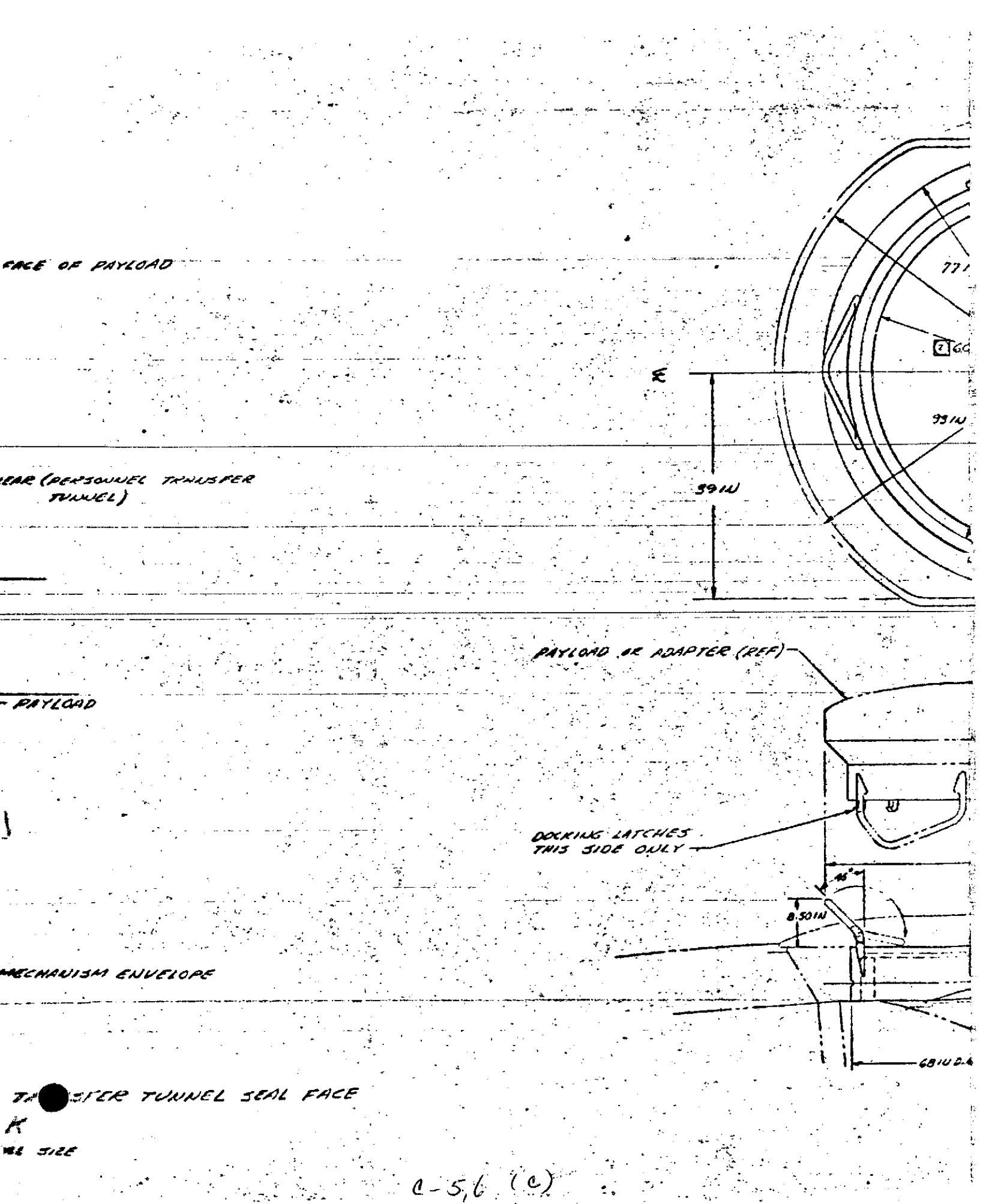
C-5,6 (A)



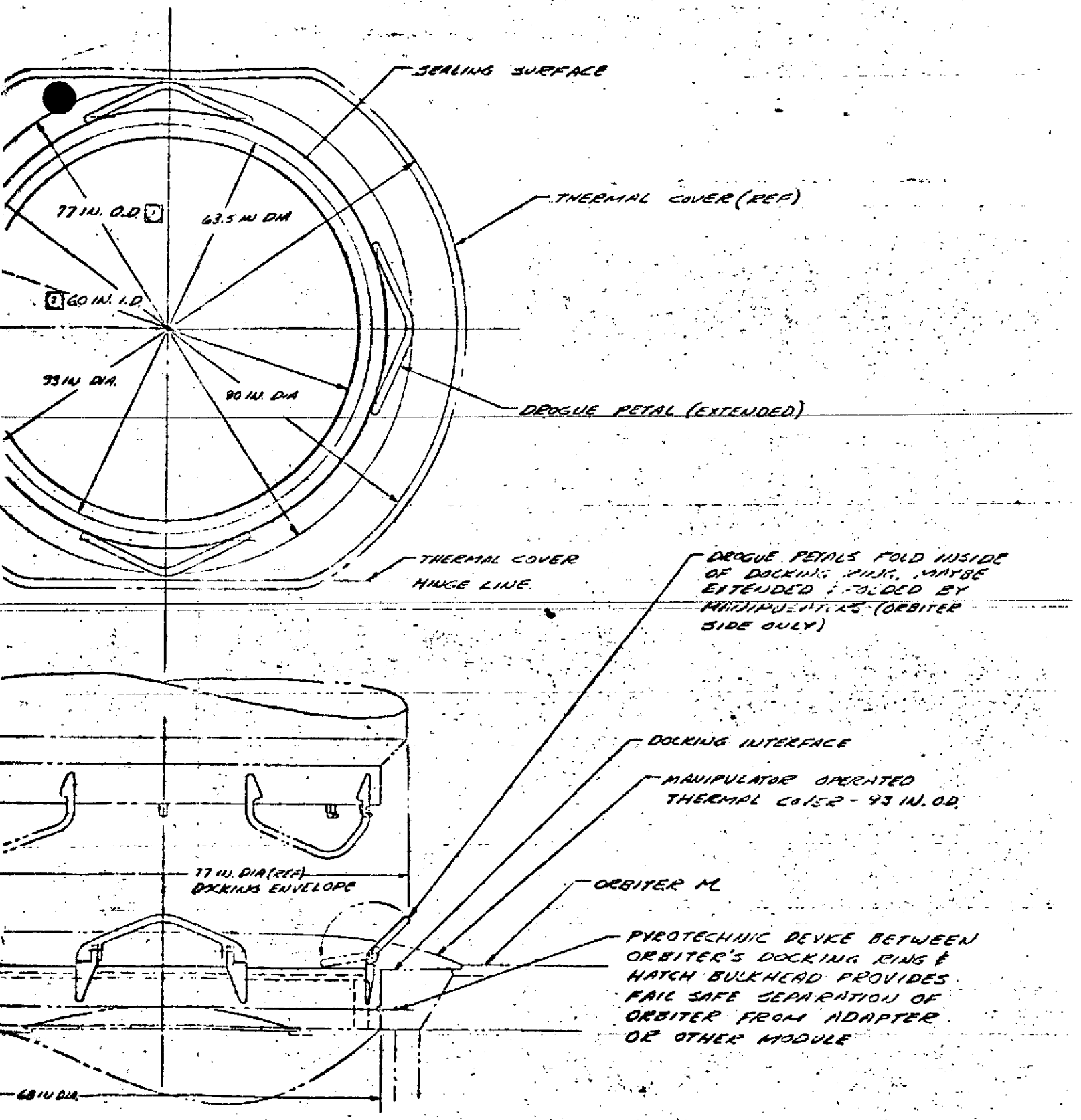
PERSONNEL TRANSFER TUNNEL SEAL

DETAIL K

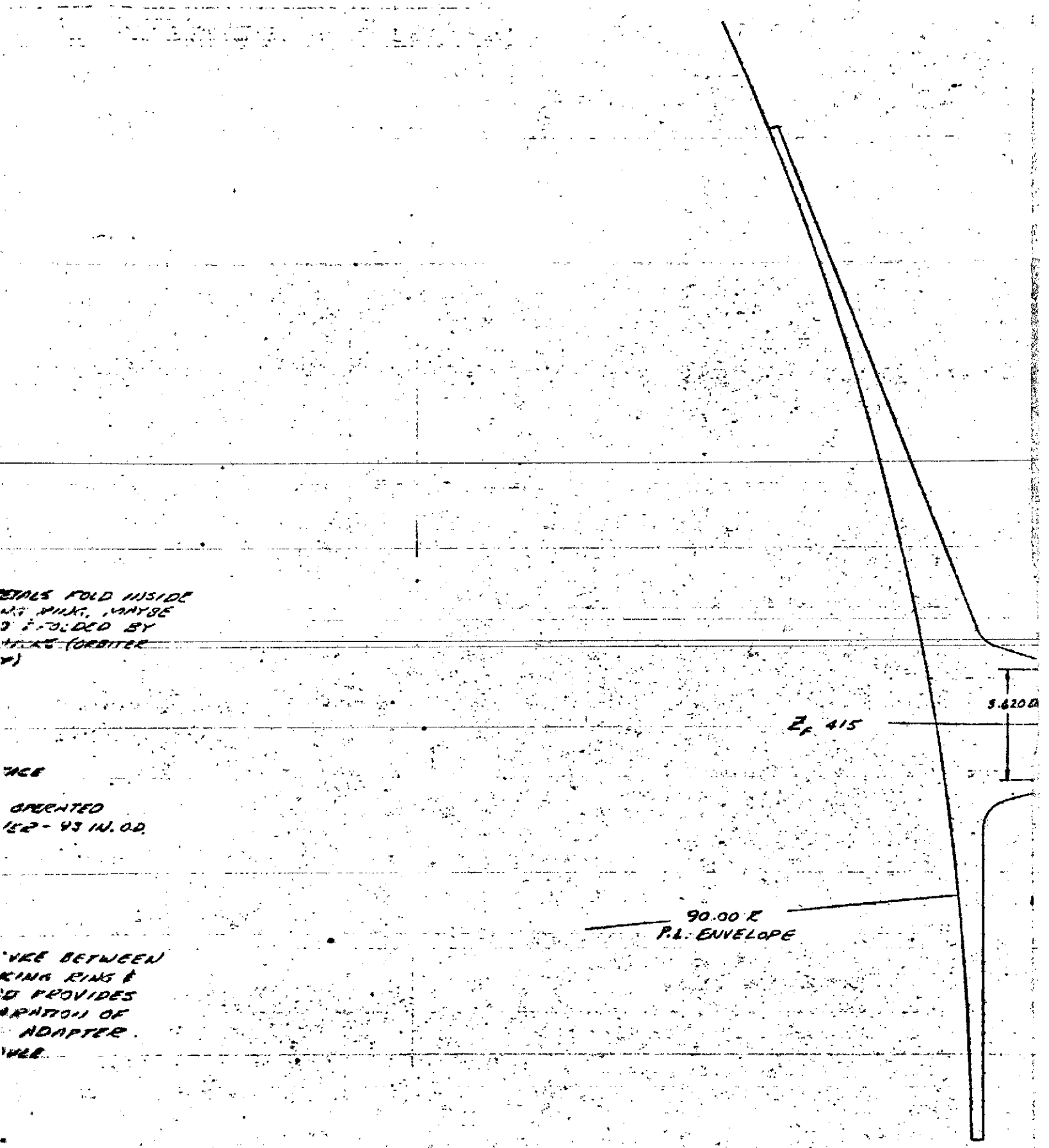
FULL SIZE


FACE OF PAYLOAD
EAR (PERSONNEL TRANSFER TUNNEL)
PAYLOAD
MECHANISM ENVELOPE
TA SFER TUNNEL SEAL FACE
K
SIZE
39 IN
93 IN
PAYLOAD OR ADAPTER (REF)
DOCKING LATCHES THIS SIDE ONLY
45°
8.50 IN
68 IN D.

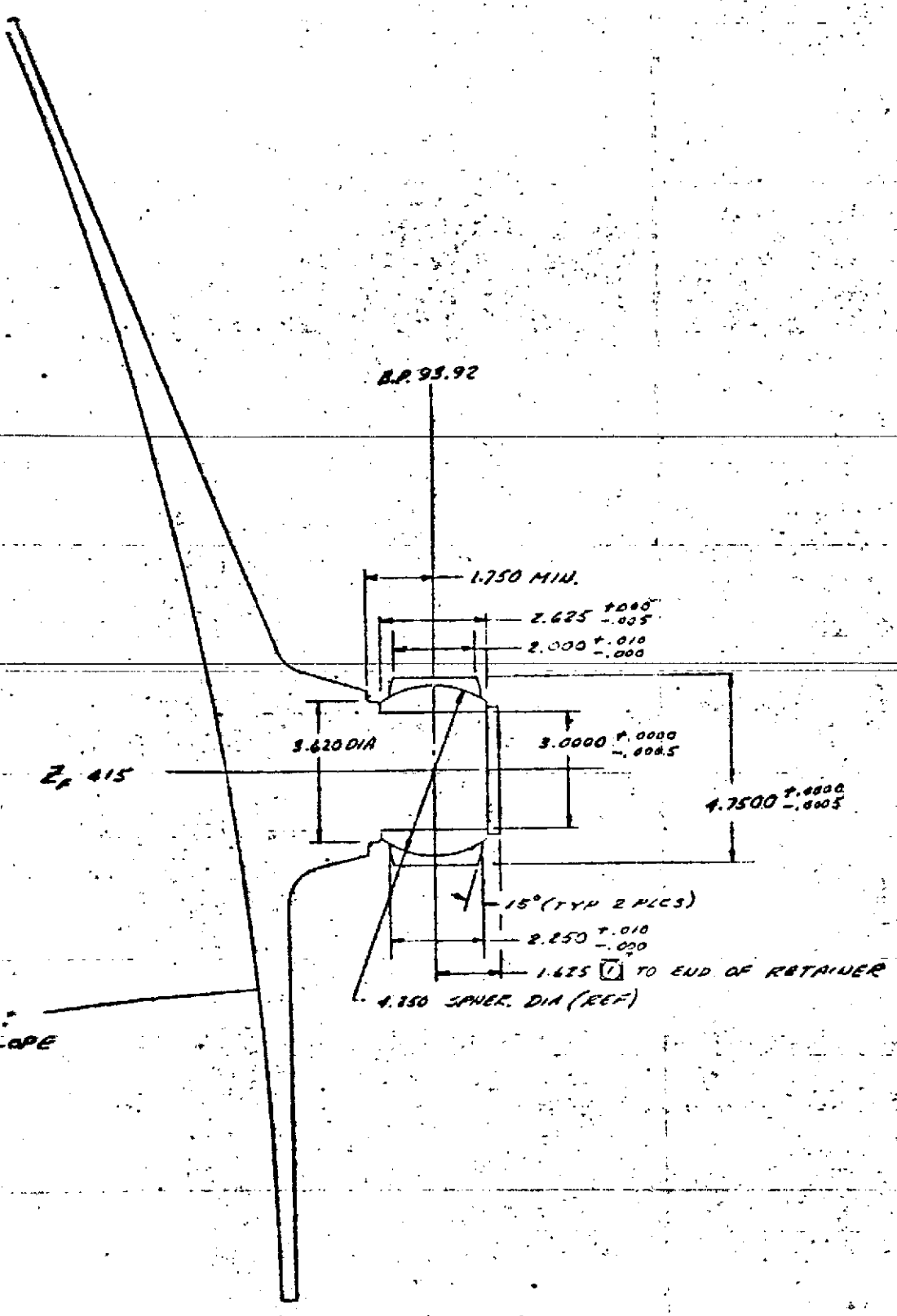
C-5,6 (c)



SECTION J-J
SCALE $\frac{1}{10}$



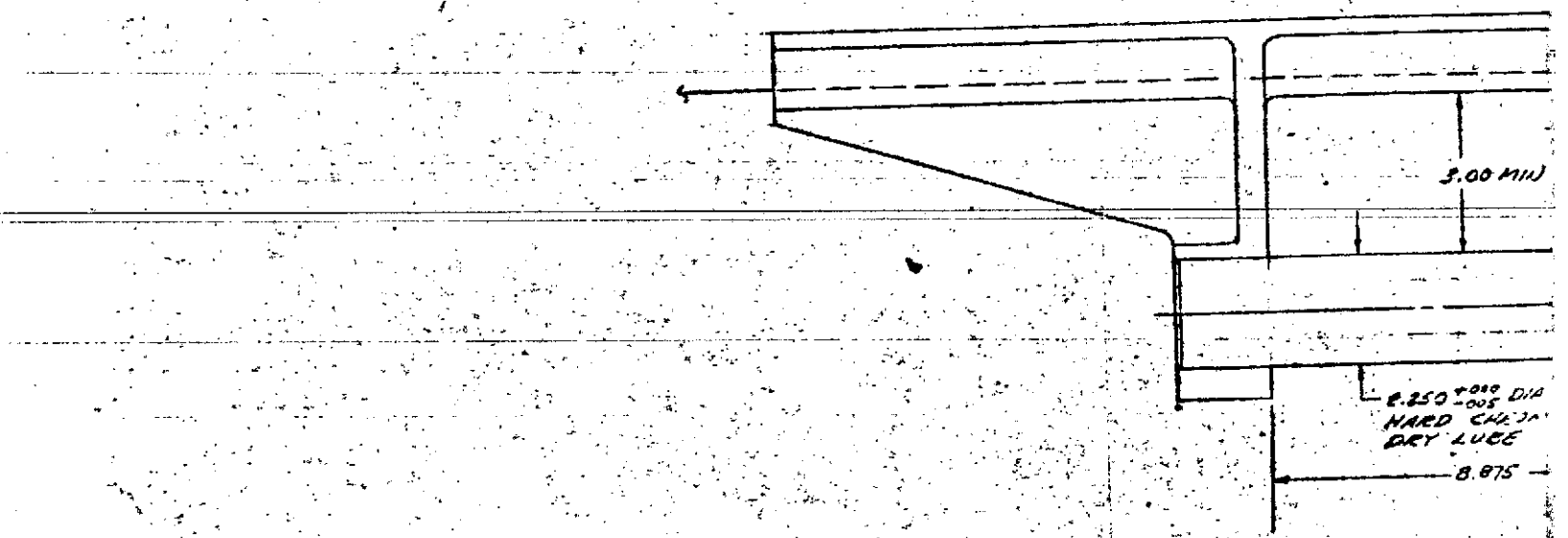
ETALS FOLD INSIDE
MAYBE
FOLDED BY
(ORBITER
ACE
OPERATED
IN. O.D.
VRE BETWEEN
KING RING &
PROVIDES
RATION OF
ADAPTER.
3.620 D
Z_F 415
90.00 R
P.L. ENVELOPE



VIEW E

½ SCALE

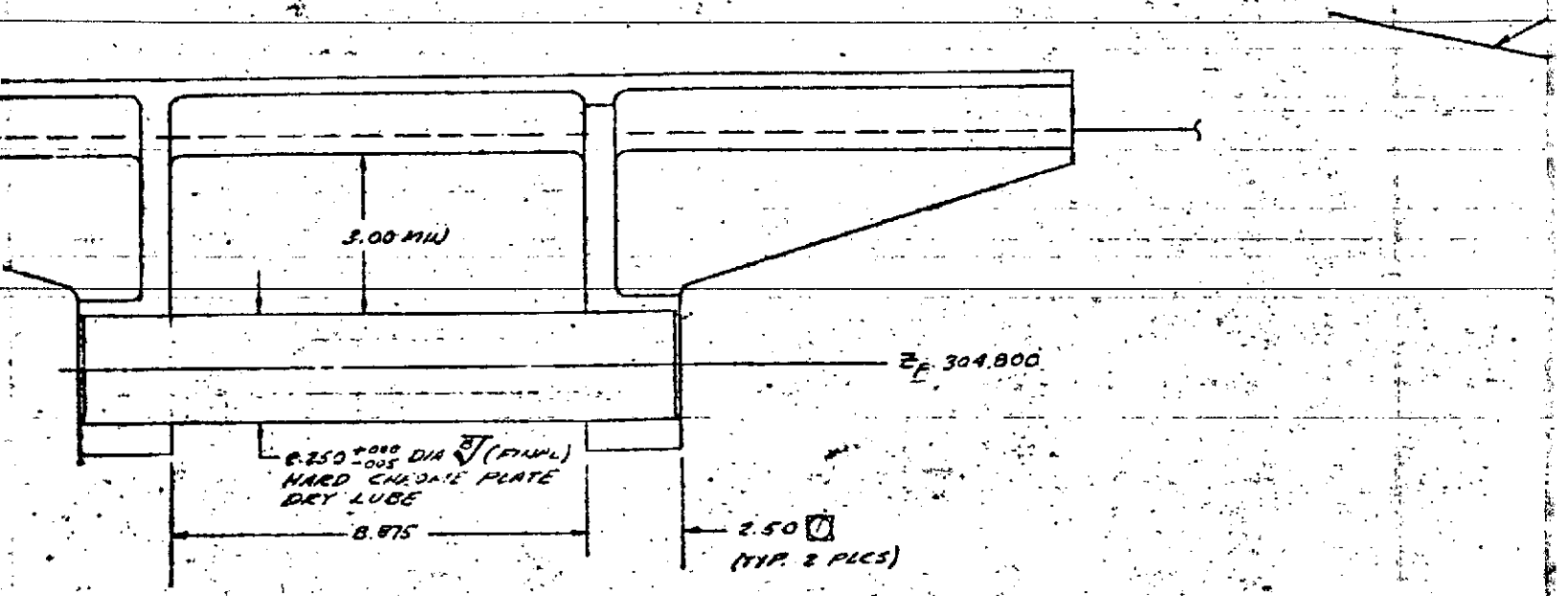
C-5,6 (F)



VIEW L

½ SCALE

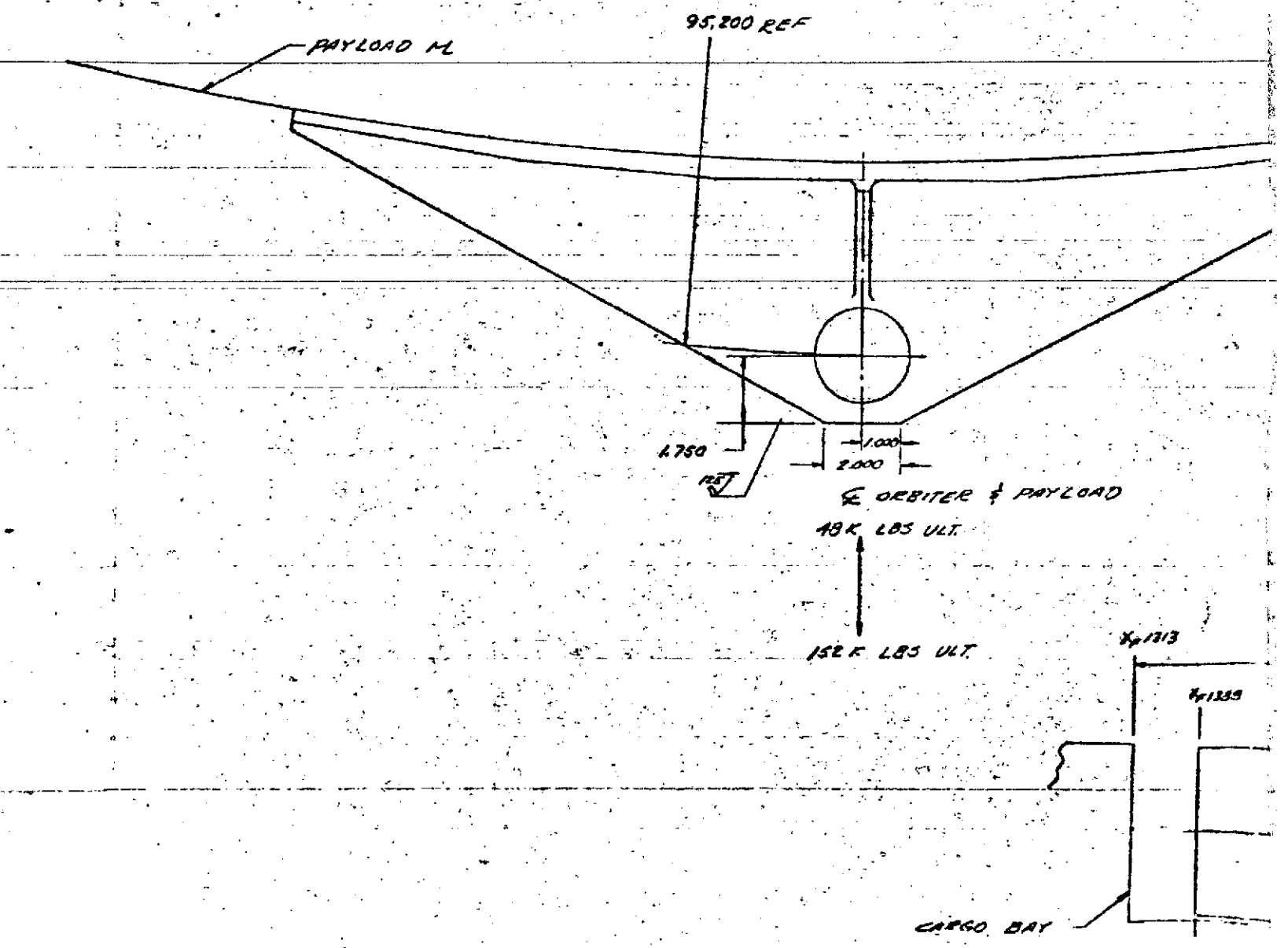
C-5,6 (G)



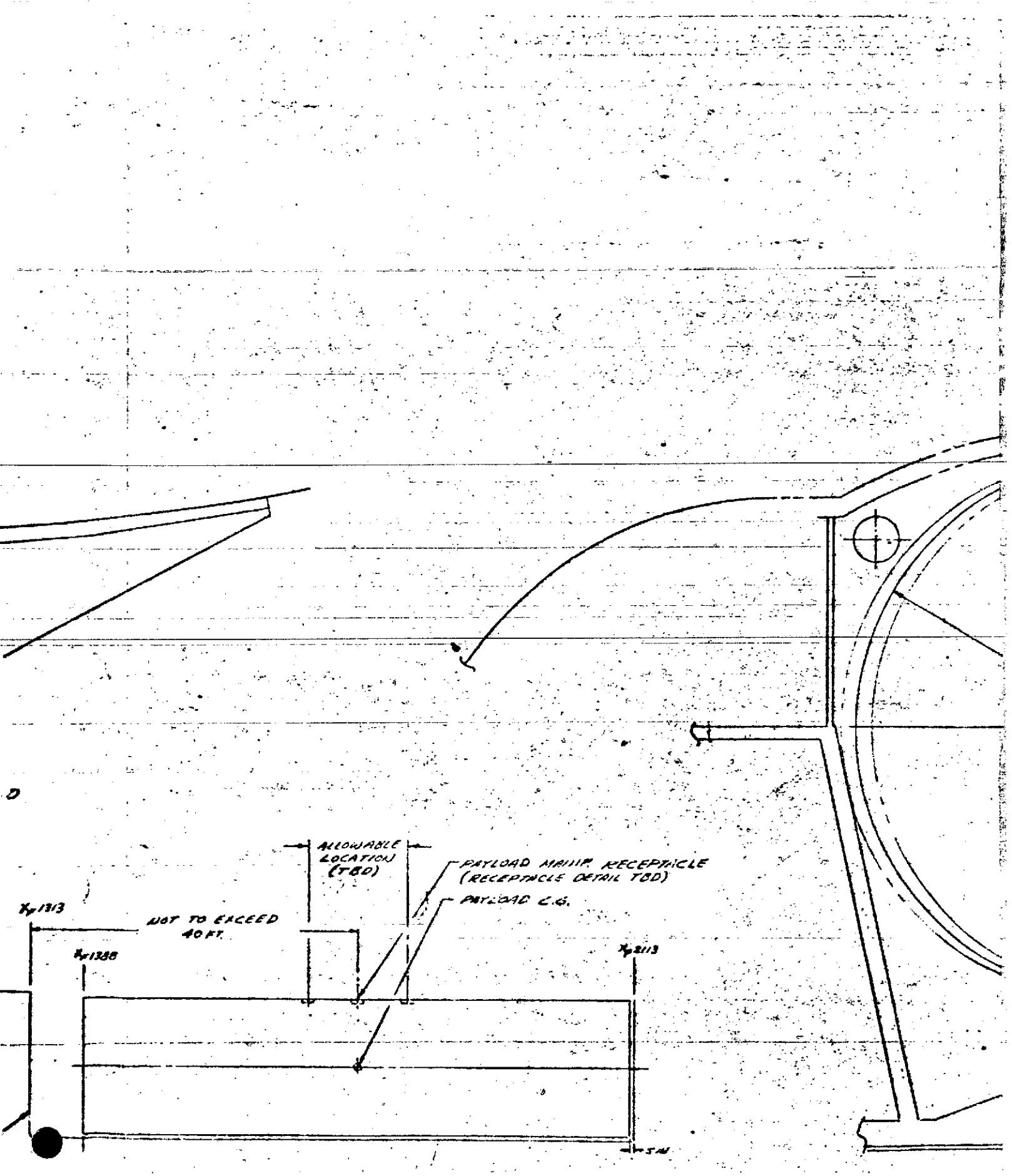
VIEW D

½ SCALE

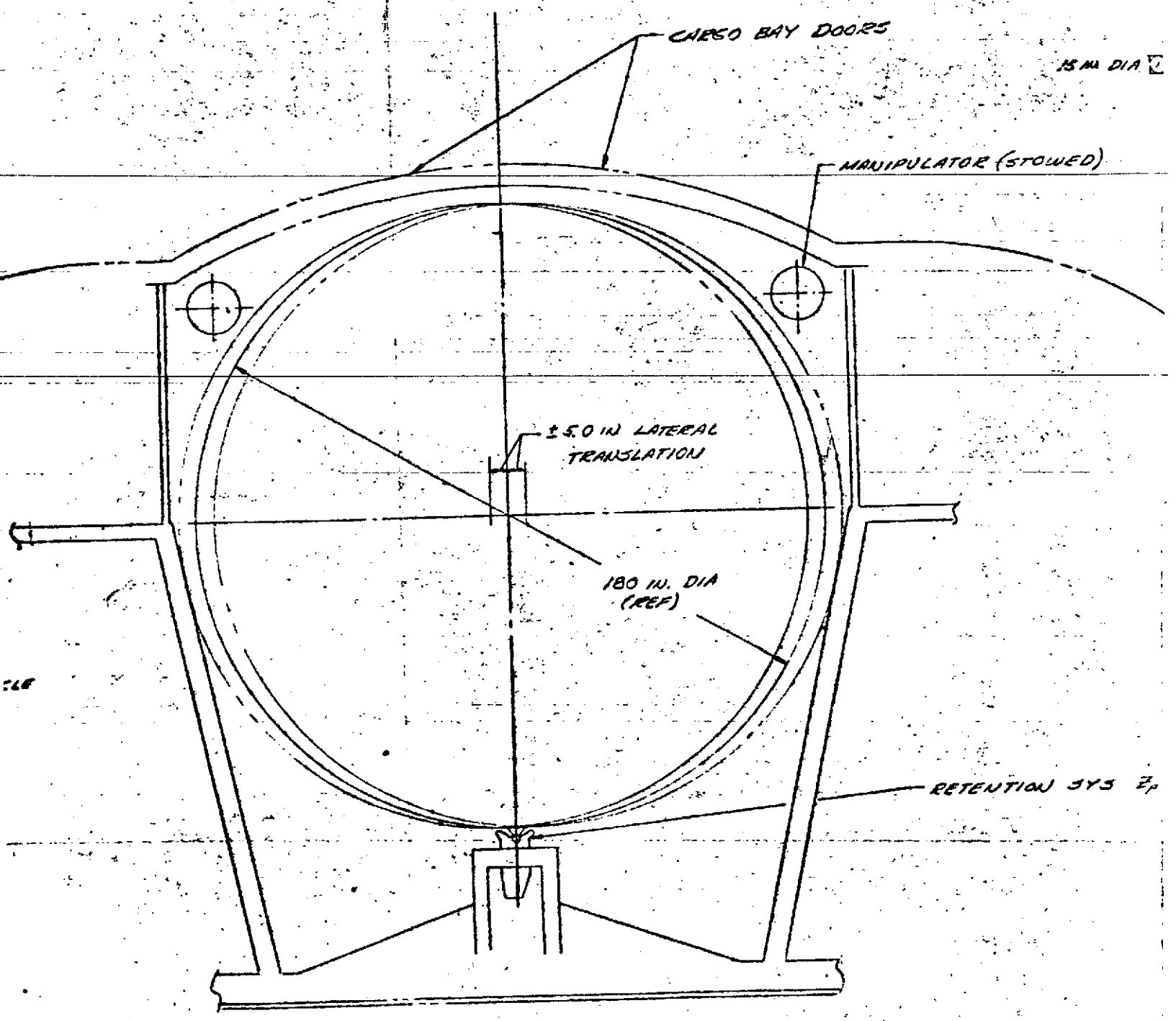
C-5,6 (H)



PAYLOAD ML
95,200 REF
1.750
1.000
2.000
℄ ORBITER & PAYLOAD
48K LBS ULT.
152K LBS ULT.
CARGO BAY



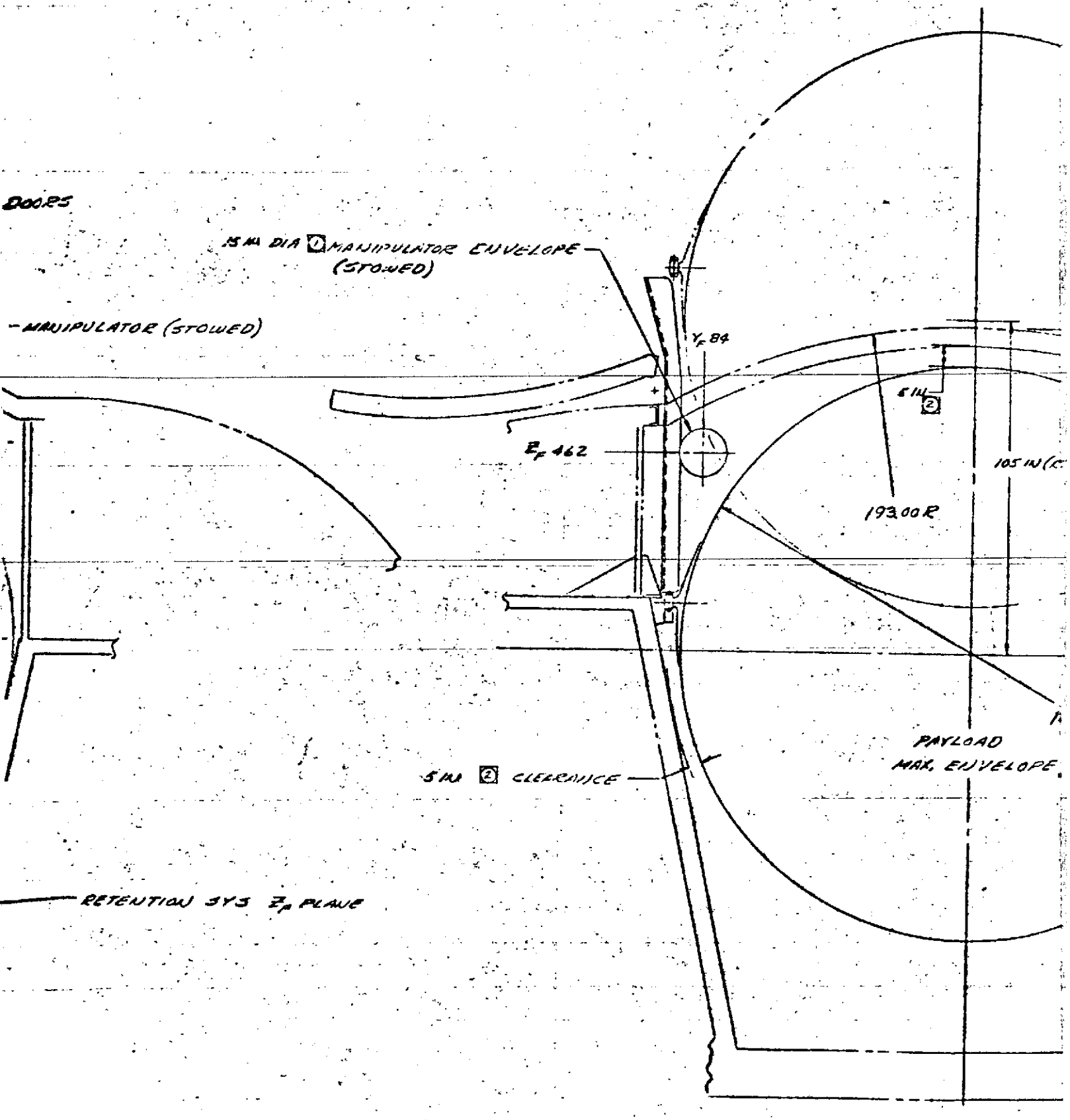
DETAIL H. $\frac{1}{80}$ SCALE

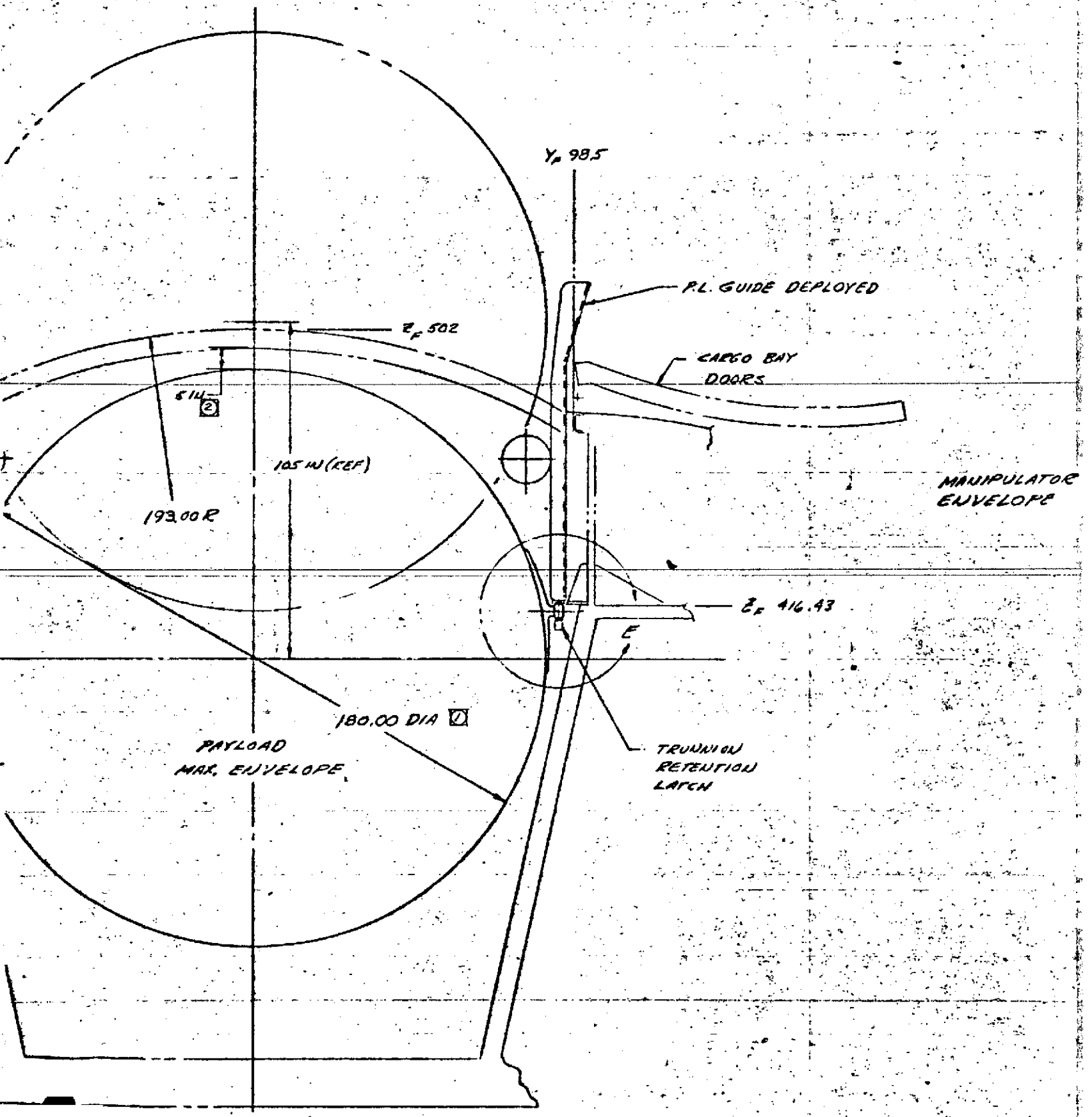


SECTION C-C

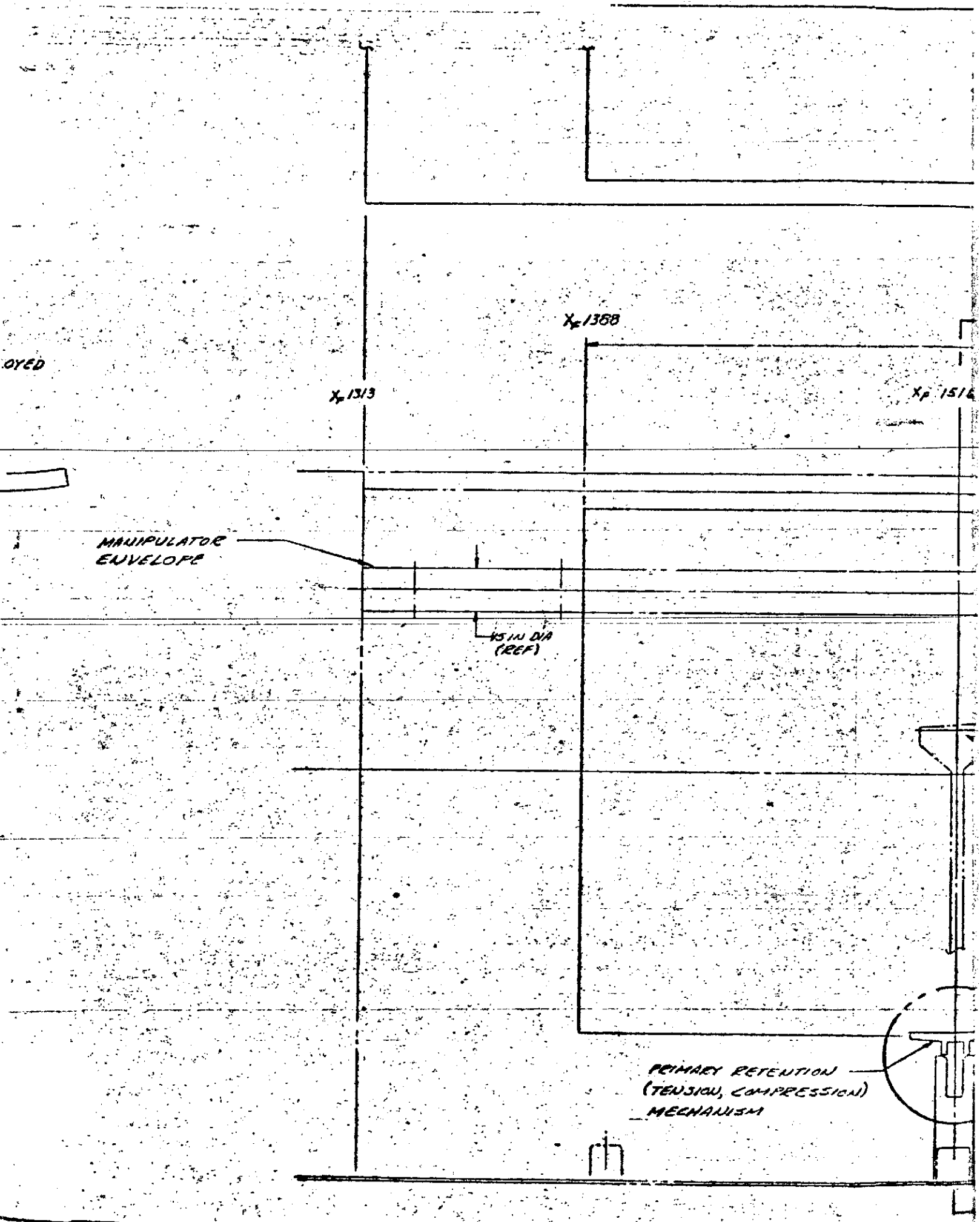
1/40 SCALE

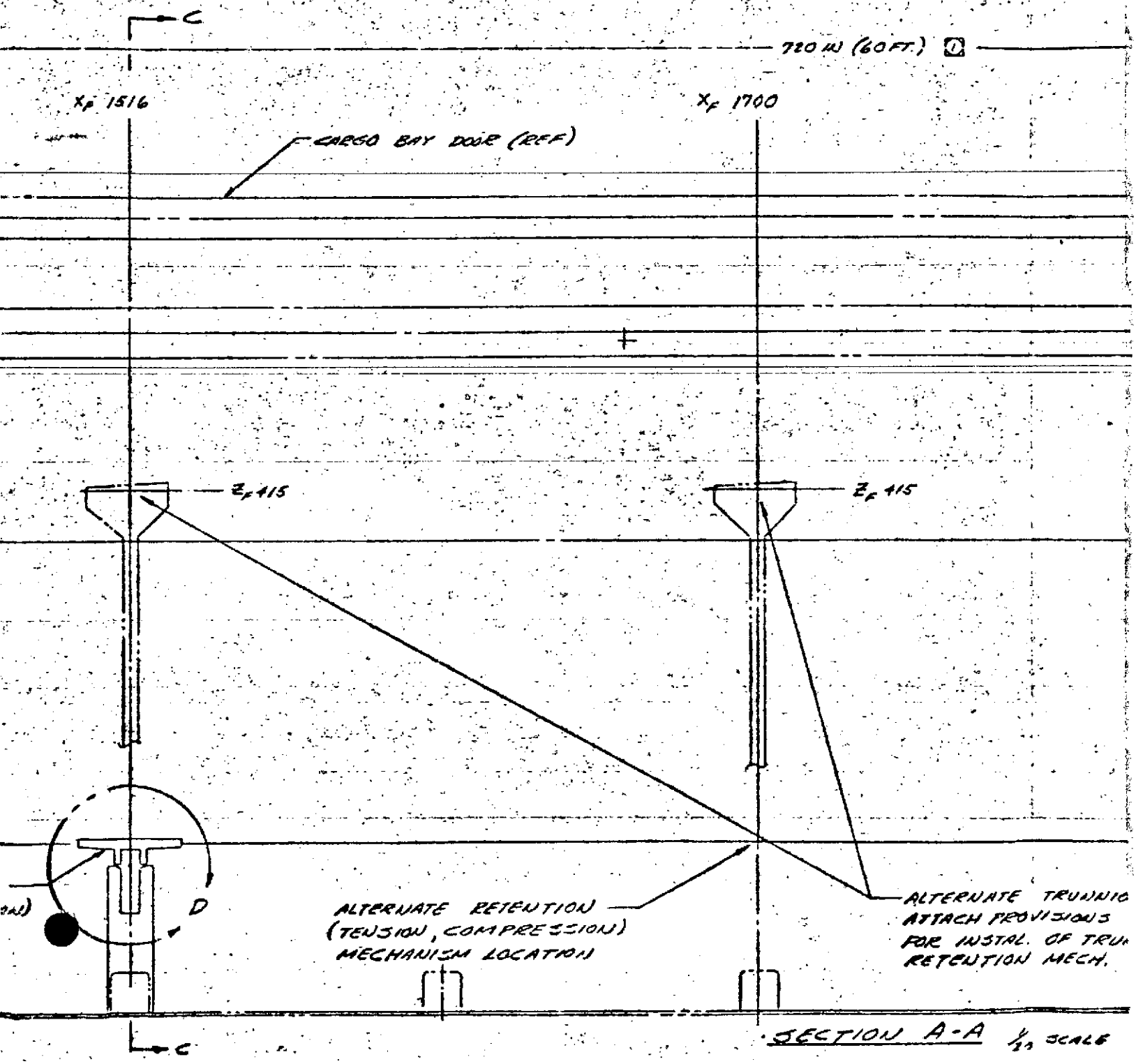
C-5,6 (K)


DOORS
15 IN DIA 1 MANIPULATOR ENVELOPE (STOWED)
MANIPULATOR (STOWED)
Y_F 84
6 IN 2
Z_F 462
105 IN (
193.00 R
PAYLOAD MAX. ENVELOPE
5 IN 2 CLEARANCE
RETENTION SYS Z_F PLANE
SECTION B-
1/20 SCALE



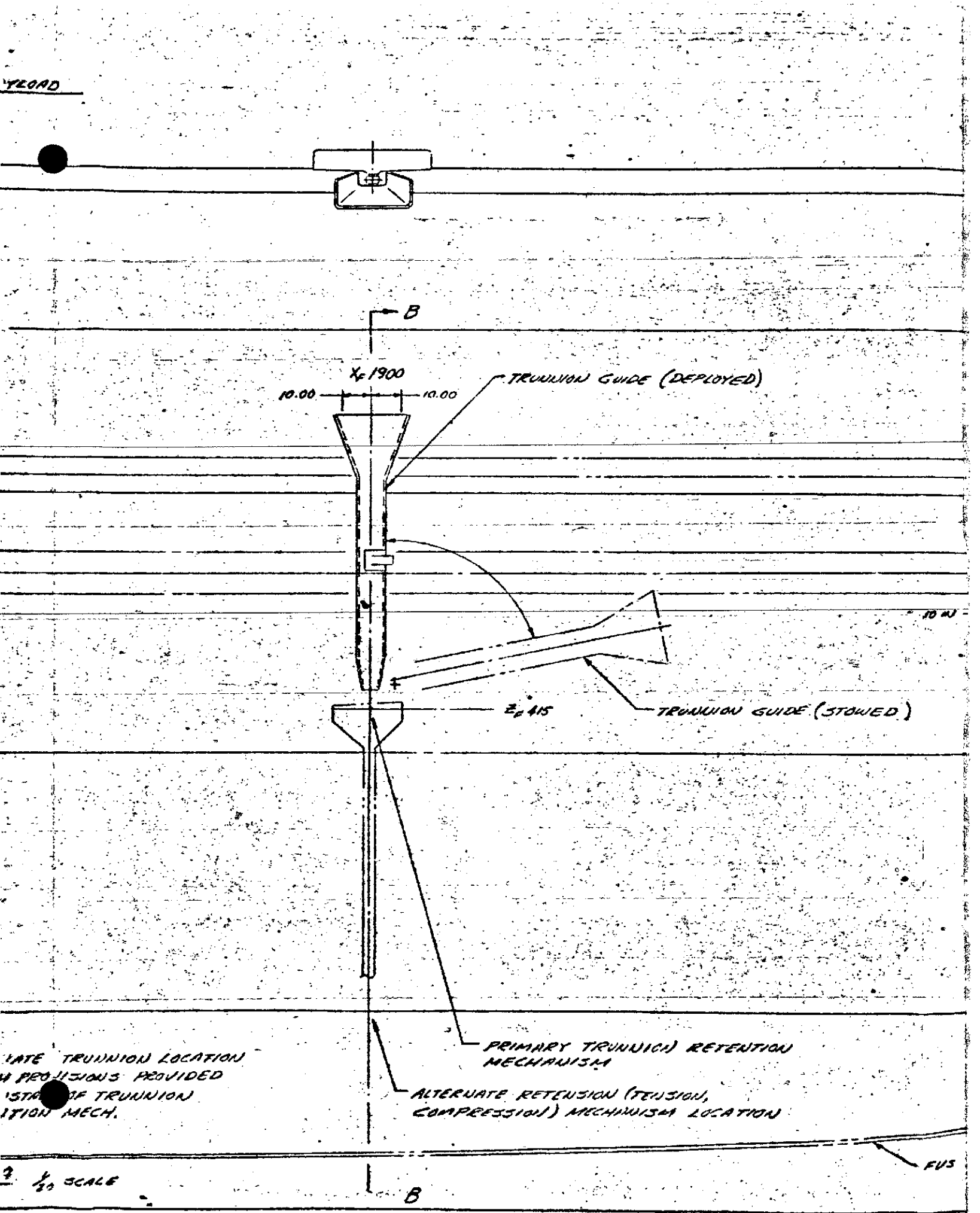
SECTION B-B
1/20 SCALE


OYED
X_F 1388
X_F 1313
X_F 1516
MANIPULATOR ENVELOPE
45 IN DIA (REF)
PRIMARY RETENTION (TENSION, COMPRESSION) MECHANISM



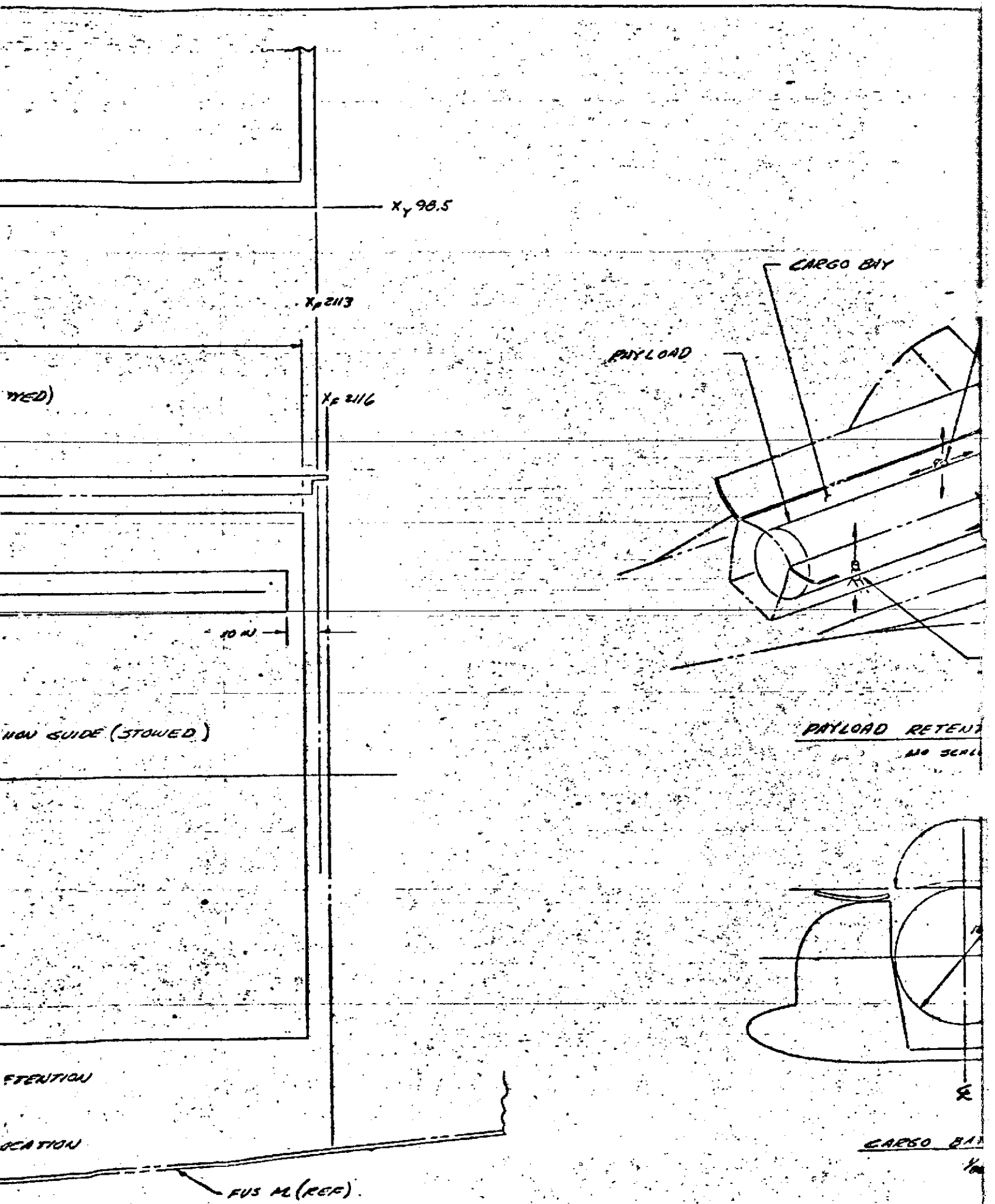
SECTION A-A 1/10 SCALE

YLOAD

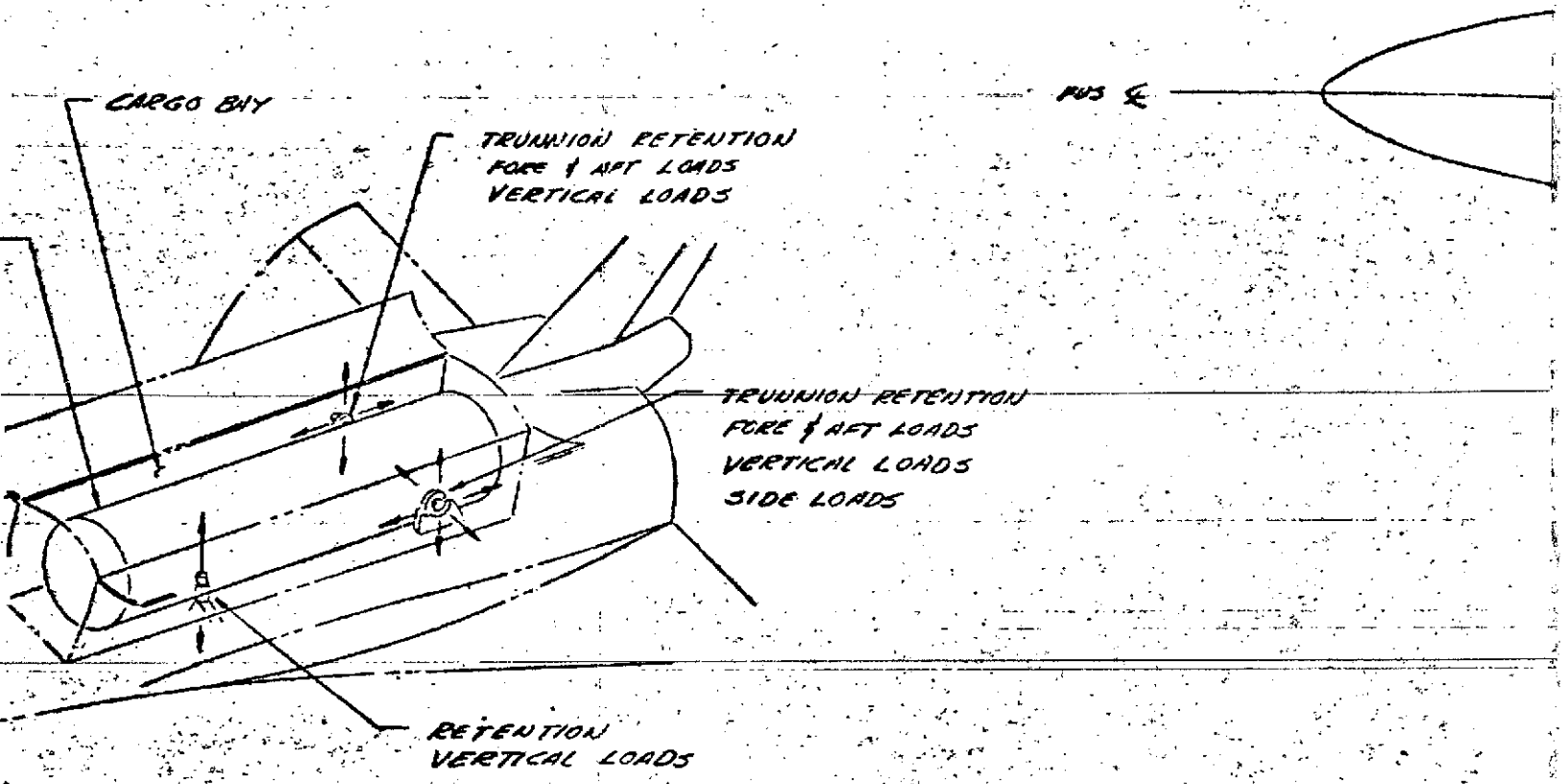


LATE TRUNNION LOCATION
H PROVISIONS PROVIDED
STA OF TRUNNION
ITION MECH.

2 1/10 SCALE

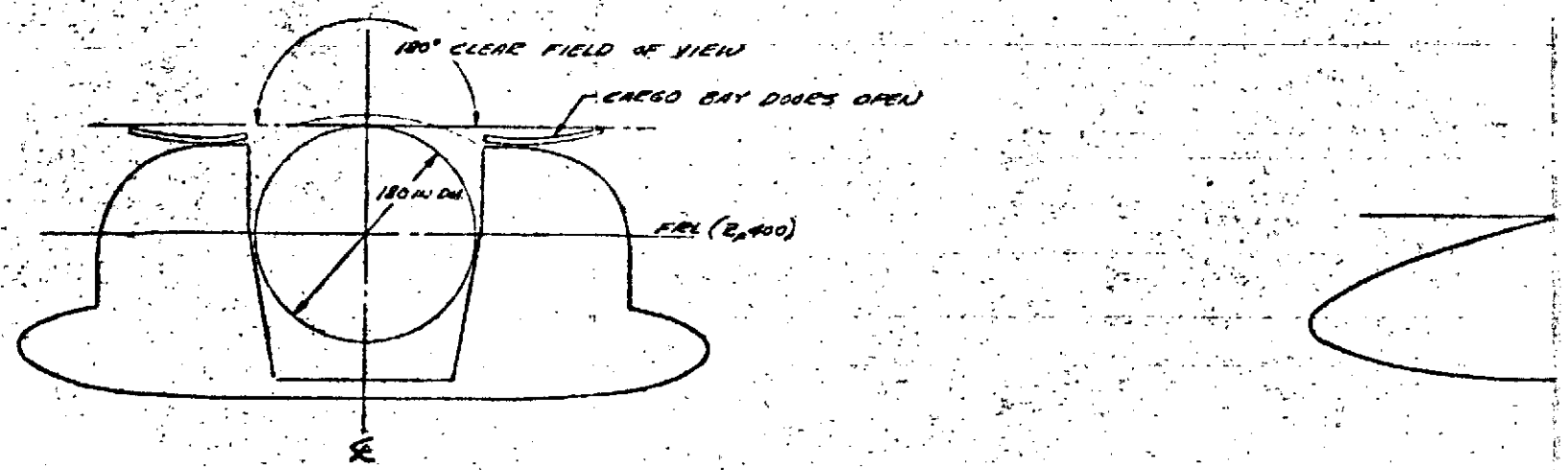


X_Y 98.5
X_F 2113
X_F 2116
CARGO BAY
PAYLOAD
10 IN
GUIDE (STOWED)
PAYLOAD RETENT
NO SCAL
ETENTION
OCATION
FUS ML (REF)
CARGO BA



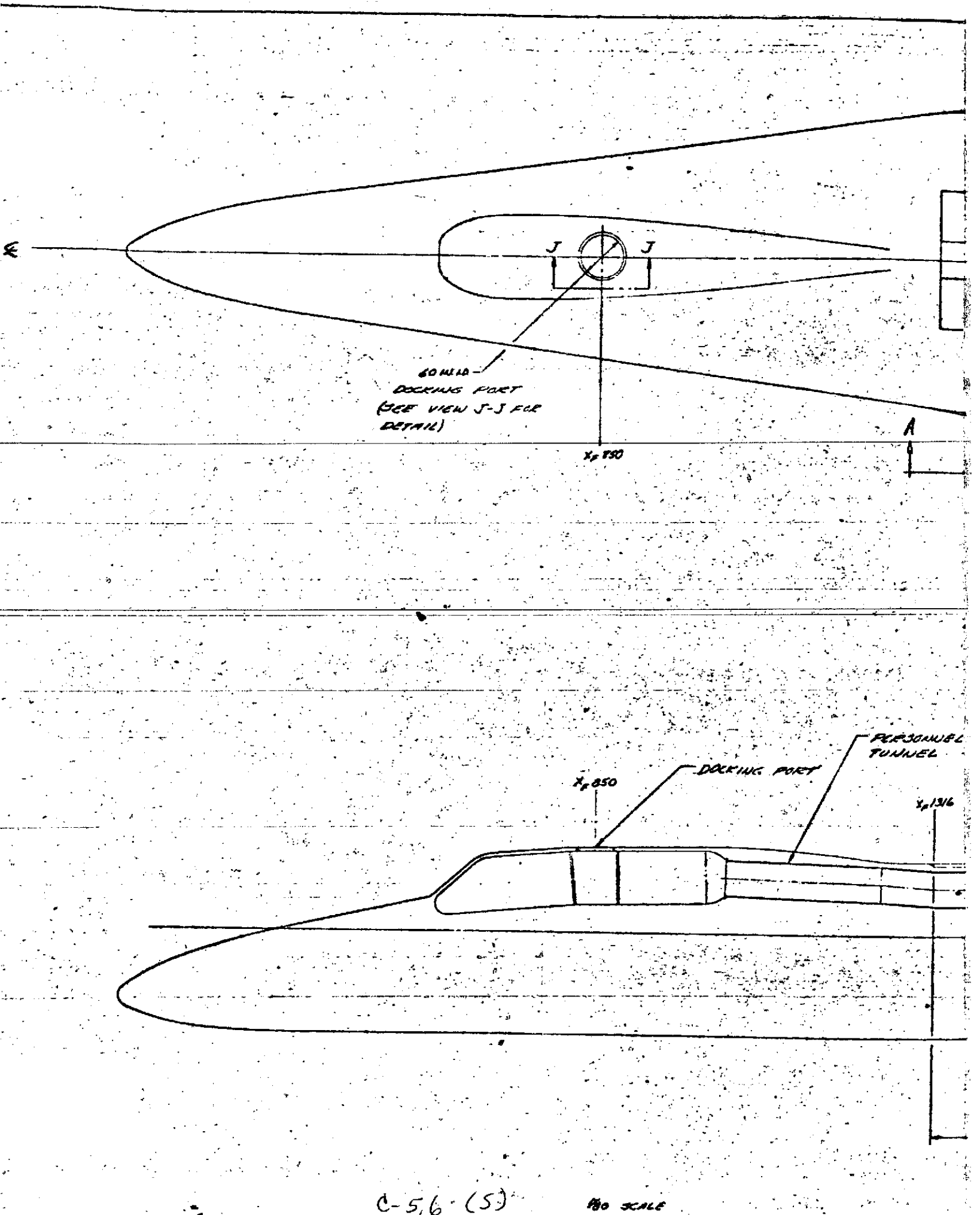
PAYLOAD RETENTION ASSEMBLY

NO SCALE



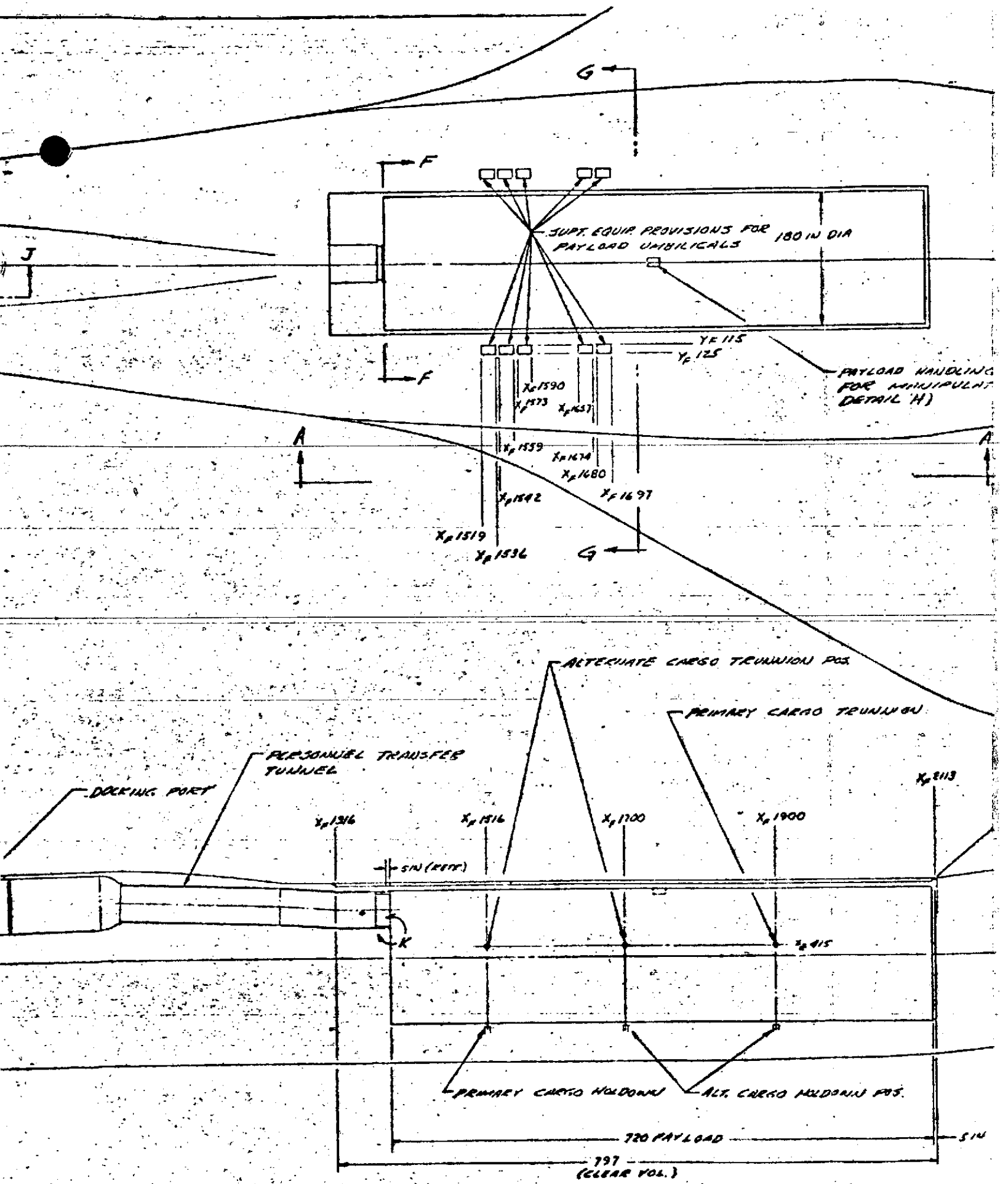
CARGO BAY DOOR CLEARANCE

1/60 SCALE

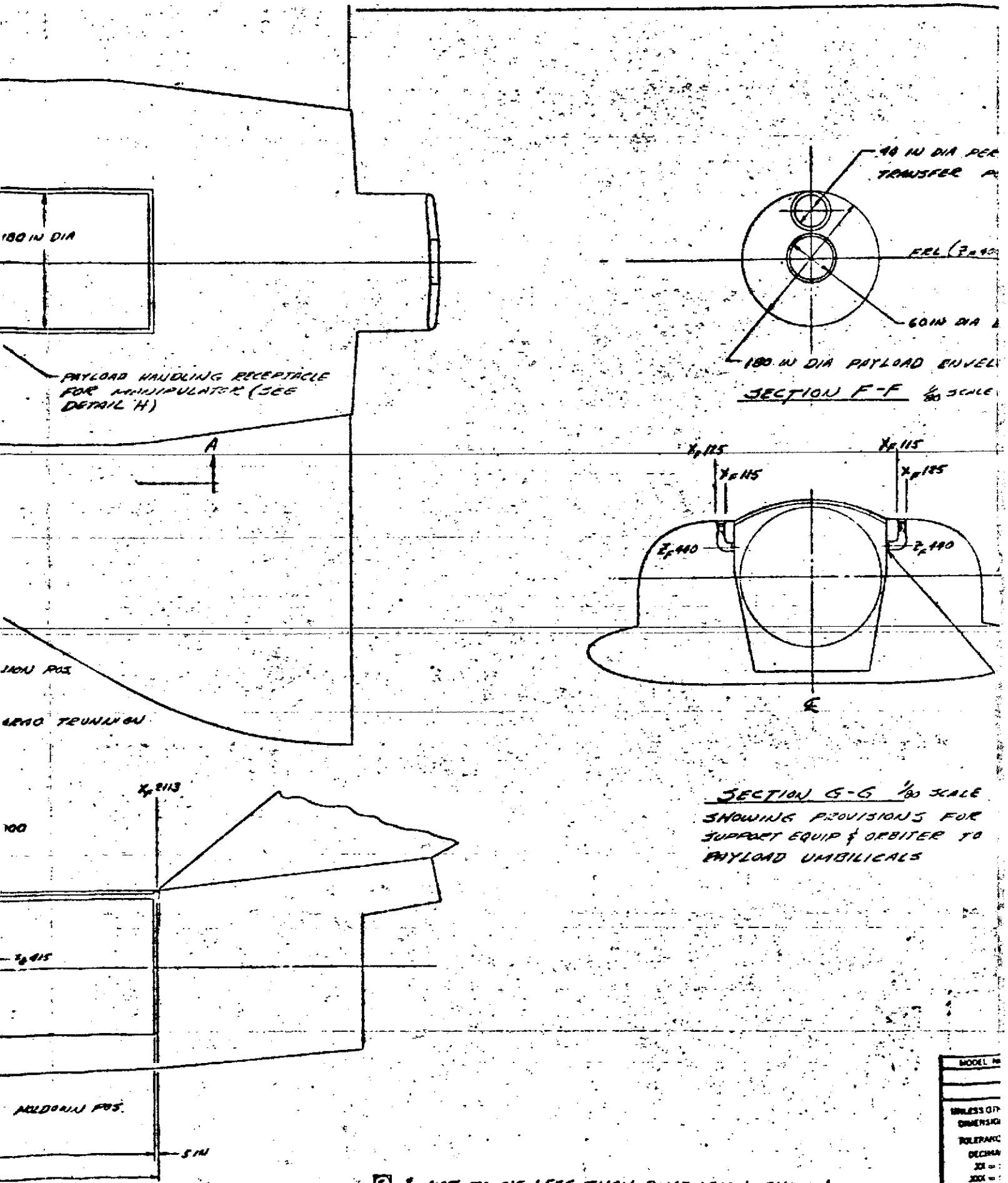


C-5,6 (5)

1/80 SCALE


G
F
SUPT. EQUIP. PROVISIONS FOR PAYLOAD UMBILICALS
180 IN DIA
J
YF 115
YF 125
PAYLOAD HANDLING FOR MANIPULAT DETAIL 'H)
XF 1590
XF 1573
XF 1657
A
XF 1559
XF 1674
XF 1680
XF 1697
XF 1542
XF 1519
XF 1536
ALTERNATE CARGO TRUNNION POS.
PRIMARY CARGO TRUNNION
PERSONNEL TRANSFER TUNNEL
DOCKING PORT
XF 2113
XF 1316
XF 1516
XF 1700
XF 1900
5 IN (RETR)
K
XF 415
PRIMARY CARGO HOLDOWN
ALT. CARGO HOLDOWN POS.
720 PAYLOAD
5 IN
797
(CLEAR VOL.)
SCALE

C-5,6 (T)



2. NOT TO BE LESS THAN DIMENSION SHOWN

1. NOT TO EXCEED DIMENSION SHOWN

NOTES: UNLESS OTHERWISE SPECIFIED

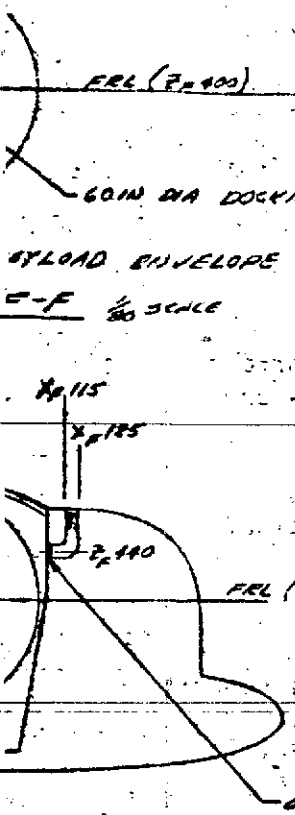


Figure 3.3-1. Structural and Mechanical Interfaces

MODEL NO	PART NO	DESCRIPTION	EFFECTIVITY	APPLICABLE SPECIFICATIONS

EFFECTIVITY AND SPECIFICATIONS

INTERFACE CONTROL DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES.

TOLERANCES ON:

DECIMALS	ANGLES
.XX = ± .03	± 0° 30'
.XXX = ± .010	

THIS DOCUMENT SPECIFIES TECHNICAL REQUIREMENTS AND NOTHING HEREIN CONTAINED SHALL BE DEEMED TO ALTER THE TERMS OF ANY CONTRACT OR PURCHASE ORDER BETWEEN ABL PARTIES AFFECTED.

DR BY [illegible] 6-8-71

CHK BY

AUTH SIGNATURE	REP	DATE

SPACE DIVISION
NORTH AMERICAN ROCKWELL
12214 LAKEWOOD BOULEVARD • DOWNEY, CALIFORNIA 90241

ORBITER TO PAYLOAD ICD

A

SIZE	CODE IDENT NO	DRAWING NO.
J	03953	9992-1353

SCALE NONE | SHEET

SD 71-127

C-5,6. (V)

2 1

3.3.5 Cargo Bay Payload Retention

The structural attachment loads between the Payload and the cargo bay shall be statically determinant. The payload retention fittings shall be as shown in Figure 3.3-1.

One-sigma mechanical alignment uncertainty between the Payload and the Orbiter Vehicle's reference frame shall not exceed the limits presented in Table 3.3-2 (TBD).

The payload retention assembly shall accommodate up to ±5 inches of lateral distortion of the Payload, as shown in Figure 3.3-1.

3.3.6 Manipulator Arms

The mechanisms used for deployment, retrieval, and docking of Payloads shall be two manipulator arms. The payload fitting where a manipulator arm attaches shall be as shown in Figure 3.3-1. The manipulator arms shall be stowed outside the payload volume, as shown in Figure 3.3-1.

3.3.7 Docking Provisions

The manipulator arms shall be used to dock detached Payloads to the Orbiter Vehicle's airlock docking port. The Payload shall have three options for the physical interface at the airlock docking port (shown in Figure 3.3-1):

(1) The Payload utilizes the Orbiter Vehicle's universal docking adapter, in which case the Payload has a passive docking ring identical to the Orbiter Vehicle's (with the possible exception of the retractable docking petals).

(2) The Payload is docked directly to the Orbiter Vehicle without an adapter, in which case the Payload has the same interface as the universal adapter with the airlock docking port.

(3) The Payload supplies a special-purpose adapter, one end of which looks like the universal adapter and the other end of which is uniquely tailored to the Payload.

3.3.8 Payload On-Orbit Handling

Deployment of the Payload to free space shall leave the payload with one-sigma position, velocity, attitude, and attitude rate errors that shall not exceed the limits specified in Table 3.3-3(TBD).

Retrieval of the Payload from free space shall require the Payload to be stabilized within the limits specified in Table 3.3-4 (TBD).

The Payload shall not perform any attitude control either prior to deployment release or subsequent to retrieval engagement.

3.3.8 Continued

Docking of the Payload to the airlock docking port shall occur with limits that do not exceed those specified in Table 3.3-5.

Table 3.3-5. Docking Impact Limits

PARAMETER	LIMIT AT IMPACT
Centerline Miss Distance	2 inches
Centerline Miss Angle	1 degree
Longitudinal Velocity	0.05 ft/sec
Lateral Velocity	0.05 ft/sec
Angular Velocity	0.1 deg/sec

3.4 ELECTRICAL POWER

3.4.1 Connectors Between the Orbiter and Payload

Standardized connectors shall be structurally mounted on the Orbiter Vehicle, at both the airlock docking port and within the cargo bay, to provide electrical power to the Payload.

The standardized connectors shall have the locations and characteristics shown in Figure 3.4-1 (TBD).

3.4.2 Availability

Power shall be available to the Payload following activation of the ground power system on the launch pad. Power from the Orbiter Vehicle's fuel cells shall be available following transfer from ground power to internal power(nominally occurring one hour and 45 minutes prior to liftoff). Power from the fuel cells shall cease after the connection of Orbiter Vehicle ground power following landing. Ground power shall be available to the Payload until the Orbiter Vehicle is moved from the safing area (nominally 12 hours following landing).

Power shall be available to the Payload at either the airlock docking port or within the cargo bay - but not at both locations simultaneously.

3.4.3 Total Energy

A maximum of 20 KWH of electrical energy shall be provided by the Orbiter Vehicle to the Payload from the Orbiter Vehicle's fuel cells.

3.4.4 Power Level

Power supplied to the Payload shall not exceed (1) an average of 500 watts in any period of (TBD) duration, and (2) a peak of 800 watts for as many as (TBD) seconds in any (TBD) second period.

3.4.5 Voltage Characteristics

DC power shall be supplied to the Payload with the characteristics shown in Figure 3.4-2. Nominal voltage is 28V, with a ripple of 4V peak-to-peak (MIL-STD-704A).

3.5 COMMUNICATIONS

3.5.1 Hardline Communications (Attached Payloads)

3.5.1.1 Connectors Between Orbiter and Payload

Standardized connectors shall be structurally mounted on the Orbiter Vehicle, at both the airlock docking port and within the cargo bay, to provide communications between the Orbiter Vehicle and the Payload. The standardized connectors shall have the locations and characteristics shown in Figure 3.5-1 (TBD). Connectors between the Payload and payload-supplied displays and controls (located in the Orbiter Vehicle's personnel compartment) are described in section 3.9.1.

The standardized connectors for Orbiter/Payload communications shall consist of three links. Each link shall be cabled separately from the others, and each shall consist of six twisted wire pairs (each pair being shielded), and one coax transmission line.

3.5.1.2 Availability

Hardline communications between the Orbiter Vehicle and the Payload shall be available during the period of electrical power availability, as specified in section 3.4.2. Each communication function shall be available to the Payload at either the airlock docking port or within the cargo bay - but not at both locations simultaneously.

3.5.1.3 Data and Commands

Two of the six twisted pairs in each communication link shall be utilized to provide two-way data and/or commands. Functions shall be as specified in section 3.6. Electrical characteristics of the data/command lines shall be as specified in Table 3.5-1 (TBD).

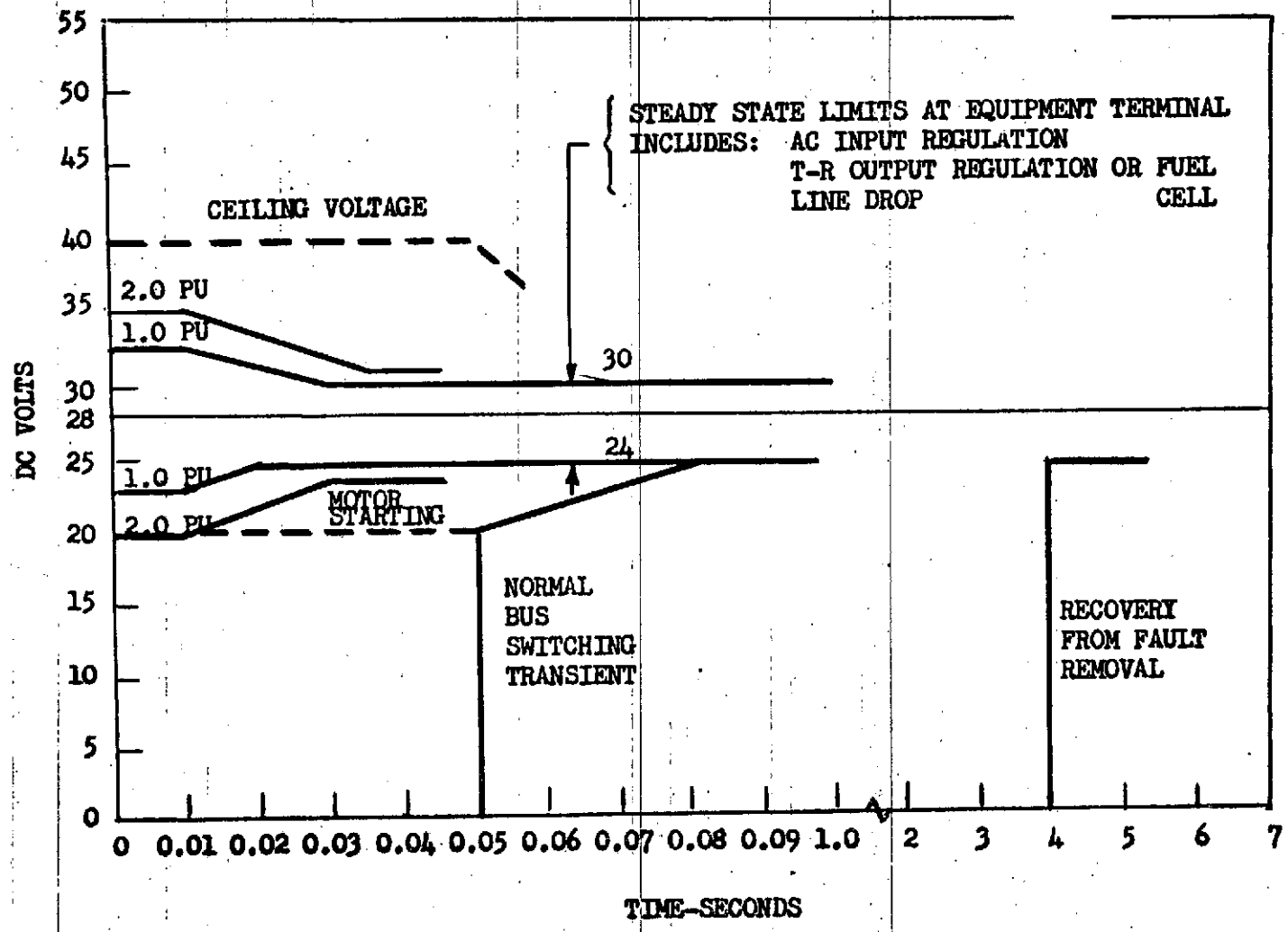


Figure 3.4-2. DC Transient and Steady State Voltage Limits

Appendix B
SD71-127
(MSC 03305)

FINAL SUBMITTAL

INTERFACE CONTROL DOCUMENT (ICD)

ORBITER VEHICLE TO PAYLOAD

(Also available separately as SR 2.4.4-11187)

25 June 1971

SPACE DIVISION
NORTH AMERICAN ROCKWELL

3.5.1.4 Voice

[illegible] Four of the six-twisted pairs in each communication link shall be [illegible] provide two-way duplex voice. Provision shall be made for use [illegible] communications system to enable communication over these voice lines between passengers in the Payload and the ground. Electrical characteristics of the voice lines shall be as specified in Table 3.5-2.

Table 3.5-2 Voice Line Characteristics

[illegible] Impedance (microphone) - Balanced 600 ±60 ohms at 1 Khz
[illegible] Response - 300 Hz to 3 Khz flat within 4 db
[illegible] each channel shall be 52 db [illegible] between the microphone and [illegible] shall be [illegible] db minimum.
[illegible] hardline link shall not [illegible] in the frequency range from 300 Hz to 3 Khz.
[illegible] Microphone line - from minus 30 db to plus 15 db [illegible]. Earphone line from +14 db to 26 db nominally.

3.5.1.5 [illegible] Transmission Line

[illegible] transmission line shall provide the Payload with access [illegible] Vehicle's S-band antenna subsystem. The signal characteristics [illegible] specified in Table 3.5-3.

Characteristic	Actual	Limits
Frequency	TBD	2 GHz to 2.3 GHz
RF Power	TBD	2 watts max. at the antenna.
Input Impedance	50 ohms nominally	See VSWR
VSWR	TBD	2:1 max.
Transmission Line Attenuation	TBD	TBD

Table 3.5-3. Coax Transmission Line Characteristics

3.5.2 [illegible] (Detached Payloads)

3.5.2.1 [illegible]

[illegible] between the Orbiter Vehicle and the detached [illegible] during rendezvous and the on-orbit mission phase. [illegible] information transfer between the Orbiter Vehicle and the detached [illegible] shall be [illegible] with the mission-specified communications [illegible] the Orbiter Vehicle and outside elements (e.g., Space Station and [illegible]).

3.5.2.2 Data, Commands, and Voice

For data, commands, and voice, the principal Orbiter/Payload RF link shall be specified in Table 3.5-4.

[illegible] Carrier Signal Characteristics

[illegible]	VALUE
[illegible]	2287.5 MHz
[illegible]	2106.4 MHz
[illegible]	10 w (min)
[illegible] Required [illegible]	(TBD)
[illegible]	0 db (min. 85% of 4π steradians)
[illegible]	Right Hand Circular

[illegible] on the principal Orbiter/Payload RF link shall be specified in [illegible] 3.5-5 (TBD). Data and commands shall be two-way simplex with [illegible] exceed 5 Kbps. Voice shall be two-way duplex.

Payload supplied command equipment shall have access to the principal Orbiter/Payload RF link. Mechanical, electrical, and functional characteristics of the interface are (TBD).

[illegible] the principal Orbiter/Payload RF link, the following [illegible] shall be available on a non-interference basis:

[illegible] Transmit and receive on any of 20 (min) [illegible] channels between [illegible] MHz and 400 MHz. [illegible] simplex voice. Normal service between [illegible] Booster Vehicles and between Orbiter [illegible] Air Traffic Control.

3.5.2.2 Continued

(2) VHF/FM. Transmit between 148 and 150 MHz, and receive between 136 and 138 MHz. One channel of two-way duplex voice or a maximum data/command rate of 2000 bps (functions can be time-shared). Normal service between Orbiter Vehicle and the Tracking and Data Relay Satellite (TDRS).

Additional details about these links are (TBD).

3.5.2.3 Tracking and Transponding

The Orbiter Vehicle shall transmit a tracking signal and receive a transponded turn-around signal from the Payload for range and range rate determination. The carrier signal shall be S-band, phase modulated, with tone or PRN ranging; details are (TBD). Accuracies shall be as specified in section 3.7.1.3.

The Orbiter Vehicle shall be capable of transponding a Payload-generated tracking signal. The tracking signal transmission and modulation (PRN) shall be compatible with the Orbiter's USBE. Carrier signal characteristics shall be as specified in Table 3.5-4.

3.6 INFORMATION MANAGEMENT

3.6.1 Relationships with the Orbiter Vehicle's Integrated Avionics

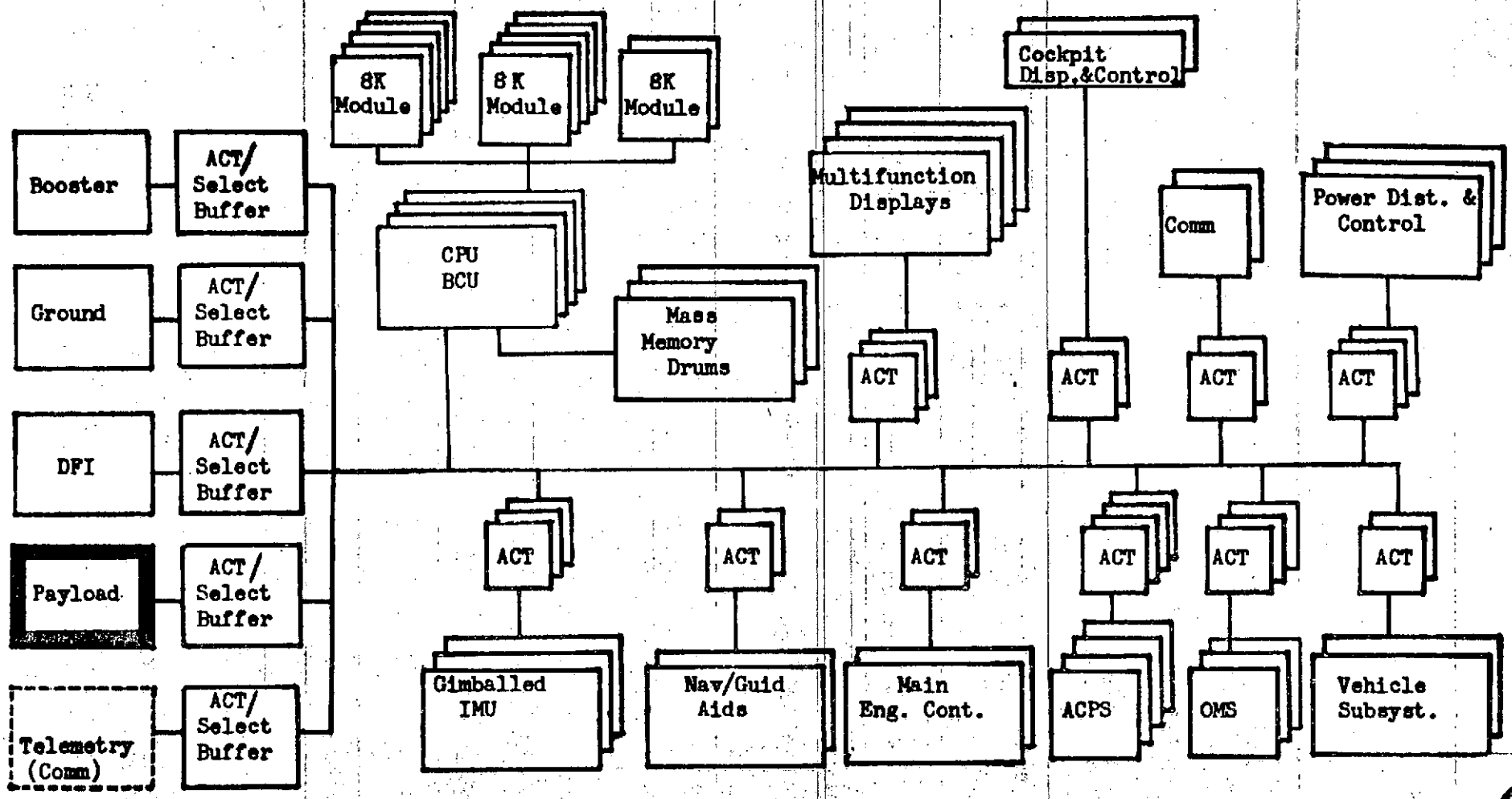
For attached Payloads, information management shall utilize the hardline data/command links described in section 3.5.1.3. The hardline data/command links shall interface with the Orbiter Vehicle's integrated avionics through an ACT/Select Buffer, as shown in Figure 3.6-1, thereby providing asynchronous Orbiter/Payload information management (i.e., each side of the interface shall be independent).

For detached Payloads, information management shall utilize the RF link described in section 3.5.2.2. This RF link shall interface with the Orbiter Vehicle's integrated avionics through the telemetry function of the communications system and an ACT/Select Buffer, as shown in Figure 3.6-1.

3.6.2 Capacities and Formats

The Orbiter Vehicle shall allocate 2000 words of mass memory for payload-supplied computer programs and data. Memory word size shall be 36 bits, which includes four data bytes of eight bits each. Nominal Orbiter Vehicle processing rate shall be 5000 operations/second. Maximum rate shall be 10,000 operations/second.

For attached Payloads, the bit rate between the Payload and the ACT/Select Buffer shall not exceed 5000 bps (simplex). For detached



ACT: Acquisition, Control and Test (Unit)
ACPS: Attitude Control Propulsion System
BCU: Bus Control Unit
CPU: Central Processing Unit
DFI: Development Flight Instrumentation
OMS: Orbit Maneuvering System

Figure 3.6-1. ORBITER VEHICLE DATA MANAGEMENT RELATIONSHIPS

3.6.2 Continued

Payloads, the bit rate between the Payload and the Orbiter Vehicle's communications system shall not exceed 5000 bps (simplex).

For both attached and detached Payloads, the bit stream shall consist of bits of 200 μsec duration. Bits shall be grouped in bytes of nine bits each (including one parity bit per byte). Additional bit stream characteristics shall be as specified in Table 3.6-1 (TBD).

3.6.3 Functions

Utilizing the computer program capacity described in section 3.6.2 and the general purpose displays and controls, the Orbiter Vehicle shall be capable of performing the information management functions described in sections 3.6.3.1 through 3.6.3.6.

3.6.3.1 Telemetry Routing

For attached Payloads, the Orbiter Vehicle shall be capable of routing the 5000 bps Payload bit stream to (or from) the Orbiter Vehicle's communications system. The communications system shall be capable of routing this bit stream to (or from) the ground.

3.6.3.2 Checkout of the Payload

The Orbiter Vehicle shall be capable of checking out the Payload (either attached or detached Payloads).

3.6.3.3 Payload Status and Performance Monitoring

The Orbiter Vehicle shall be capable of monitoring Payload status and performance data (either attached or detached Payloads).

3.6.3.4 Payload Data Display

The Orbiter Vehicle shall be capable of displaying Payload data on the general-purpose displays (either attached or detached Payloads).

3.6.3.5 Guidance and Navigation Data Exchange

For attached payloads, the Orbiter Vehicle shall be capable of exchanging guidance and navigation data with the Payload. Uncertainties in Orbiter Vehicle data shall be as specified in section 3.7.1.

3.6.3.6 Commands to the Payload

The Orbiter Vehicle shall be capable of commanding the Payload, and receiving command confirmation (either attached or detached Payloads).

3.7 ON-ORBIT GUIDANCE, NAVIGATION AND CONTROL

3.7.1 Guidance and Navigation

3.7.1.1 Position and Velocity Uncertainty

At the time of a state vector update, the one-sigma uncertainty in Orbiter Vehicle position and velocity shall not exceed the limits presented in Table 3.7-1.

Table 3.7-1. Position and Velocity Uncertainty

Parameter / Component	Position	Velocity
Altitude	±0.25 n mi	±1.5 ft/sec
In-track	±0.5 n mi	±0.6 ft/sec
Cross-track	±0.5 n mi	±3.0 ft/sec

3.7.1.2 Attitude and Attitude Rate Uncertainty

At the time of a stellar update, the one-sigma uncertainty in Orbiter Vehicle attitude shall not exceed $\pm 0.1^{\circ}$ about each axis (pitch, roll, yaw).

The one-sigma uncertainty in Orbiter Vehicle attitude rate shall not exceed $\pm 0.01^{\circ}$ /sec about each axis (pitch, roll, yaw).

3.7.1.3 Cooperative Target Tracking Uncertainty

When the Orbiter Vehicle is tracking a cooperative target as specified in Section 3.5.2.3, the one-sigma tracking uncertainties shall not exceed the limits presented in Table 3.7-2.

Table 3.7-2. Tracking Uncertainty

PARAMETER	UNCERTAINTY	
	At 30 n mi	At 500 ft
Range Range Rate	±0.1 n mi ±10 ft/sec	±5.0 ft ±0.1 ft/sec

In addition to range and range rate information, the Orbiter Vehicle shall be capable of optically determining the bearing angle to the target; the one-sigma bearing angle uncertainty shall not exceed $\pm 0.02^{\circ}$.

3.7.2 Control

3.7.2.1 Translation Control

Orbiter Vehicle translation control rates shall be as specified in Table 3.7-3.

Table 3.7-3. Translation Control Rates (Attitude Control Propulsion System Thrusters)

Orbiter Axis	Minimum Acceleration	Maximum Acceleration	Minimum Velocity Increment
X	0.26 ft/sec^2	0.78 ft/sec^2	0.026 ft/sec
Y	0.52 ft/sec^2	1.56 ft/sec^2	0.052 ft/sec
Z	0.26 ft/sec^2	0.78 ft/sec^2	0.026 ft/sec

3.7.2.2 Attitude Control

The Orbiter Vehicle shall be capable of pointing the Payload at the earth or any celestial object.

The Orbiter Vehicle shall have selectable attitude dead-bands of $\pm 0.5^{\circ}$, $\pm 10^{\circ}$, and $\pm 45^{\circ}$.

Orbiter Vehicle attitude control rates shall be as specified in Table 3.7-4.

Table 3.7-4. Attitude Control Rates

Orbiter Axis	Minimum Angular Acceleration	Maximum Angular Acceleration	Minimum Angular Velocity Increment
X (roll)	0.5°/sec^2	1.0°/sec^2	0.05°/sec
Y (pitch)	0.5°/sec^2	1.0°/sec^2	0.05°/sec
Z (yaw)	0.6°/sec^2	1.8°/sec^2	0.06°/sec

3.8 EXTERNAL ILLUMINATION

3.8.1 Orbiter Vehicle

External illumination on the Orbiter Vehicle shall be provided at the locations shown in Figure 3.8-1 (TBD). The characteristics of the illumination shall be as specified in Table 3.8-1 (TBD).

External illumination on the Orbiter Vehicle shall be available on request from the Payload, subject to (TBD) constraints.

3.8.2 Payload

External illumination on Payloads to be retrieved by the Orbiter Vehicle shall be provided as shown in Figure 3.8-2 (TBD). The characteristics of the illumination shall be as specified in Table 3.8-2.

External illumination on the Payload shall be available on request from the Orbiter Vehicle, subject to (TBD) constraints.

3.9 PAYLOAD-SUPPLIED DISPLAYS AND CONTROLS

3.9.1 Connectors Between Payload and Payload-Supplied Displays and Controls

Standardized connectors shall be structurally mounted on the Orbiter Vehicle, at both the airlock docking port and within the cargo bay, to provide hardline transmission between the Payload and payload-supplied displays and controls (mounted in the Orbiter Vehicle's personnel compartment, as specified in section 3.9.2). The standardized connectors shall have the locations and characteristics shown in Figure 3.9-1 (TBD).

3.9.2 Provisions in the Orbiter Vehicle's Personnel Compartment

Within the Orbiter Vehicle's personnel compartment, at the left-hand-side Cargo Specialist station, payload-supplied displays and controls shall be accommodated within 1.5 cubic feet and 560 square inches of panel area. Mounting connections and connectors with lines running to the payload shall be as specified in Figure 3.9-2 (TBD). Power for the payload-supplied displays and controls shall be provided by the Payload.

4. INTERFACE DESIGN CRITERIA

4.1 ENVIRONMENTAL CONDITIONS

Design of the interface(s) between the Orbiter Vehicle and Payload will be based on the requirement that the two elements be capable of operating in the natural and induced environments specified in Paragraphs 3.2.7.1 and 3.2.7.2 of the "System Specification for a Space Shuttle System," except as specified in the following paragraphs of this section.

4.2 CARGO BAY ENVIRONMENT

4.2.1 Purge and Vent

The cargo bay will be purged with dry gaseous nitrogen (GN_2) prior to liftoff. The GN_2 dew point will be -65°F; temperature will be 75 ± 5°F; pressure will be 17 ± 1 psia.

The cargo bay will be vented during launch and entry, and will be unpressurized during the orbital phase. The pressure differential between the cargo bay and the external environment will not exceed 2 psi.

4.2.2 Temperature

The internal wall temperatures for the cargo bay will lie within the limits presented in Table 4.2-1.

4.2.3 Flight Loads

Orbiter flight load factors will not exceed the limits presented in Table 4.2-2. (Load factors in Table 4.2-2 are quasi-steady state and are equal to the total externally applied load divided by the total vehicle weight; factors carry the signs of the externally applied loads.

The load factors were computed using rigid body analysis methods. In these preliminary studies estimated dynamic magnification factors were used to account for elastic body effects. These factors are summarized in Table 4.2-3. For design purposes, payload planners should use the product of the load factors in Table 4.2-2 and the magnification factors in Table 4.2-3.)

4.2.4 Acoustics

The noise level in the cargo bay will not exceed 153 db. The associated acoustic spectrum is presented in Figure 4.2-1. (For design purposes, payload planners should assume a duration of 30 seconds for the given spectrum, starting at Booster Vehicle engine ignition.)

Table 4.2-1. TEMPERATURE LIMITS FOR THE INTERNAL WALLS OF THE CARGO BAY

Payload External Surface Temperature (°F)	Cargo Bay Doors (°F)									
	Prelaunch *		Launch		On-Orbit (Doors Closed)		On-Orbit (Doors Open)		Entry	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
100	80	120	80	150	-100	150	N/A**	N/A**	-100	250
70	50	120	50	150	-100	150	N/A	N/A	-100	250
0	-20	120	-20	150	-100	150	N/A	N/A	-100	250
-300	-100	120	-100	150	-150	150	N/A	N/A	-150	250
-420	-100	120	-100	150	-150	150	N/A	N/A	-150	250

Payload External Surface Temperature (°F)	Other Cargo Bay Areas (Sides, Bottom, Ends) (°F)									
	Prelaunch *		Launch		On-Orbit (Doors Closed)		On-Orbit (Doors Open)		Entry	
	Min	Max	Min	Max	Min	Max	Min	Max	Min	Max
100	80	120	80	130	0	130	0	130	0	200
70	50	120	50	130	-25	130	-25	130	-25	180
0	-20	120	-20	130	-75	130	-75	130	-75	160
-300	-290	120	-290	130	-300	130	-300	130	-300	150
-420	-290	120	-290	130	-420	130	-420	130	-420	150

* Cargo Bay is purged with dry GN_2 for ground thermal conditioning. For bare LH_2 tanks, special provisions (e.g., He purging) will be required to prevent liquid air formation.

** The exposed surfaces of the payload will be subjected to the deep space environment which includes a black body radiation sink at 4°K and direct sun radiation.

Table 4.2-2. Orbiter Limit Load Factors

CONDITION	LOAD FACTOR (g's)		
	X	Y	Z
Liftoff	1.6	±0.5	-0.5
High Q Boost	1.9	±0.35	(+0.5 (-0.7
Booster End Burn	3.0	±0.1	-0.5
Orbiter End Burn	3.0	±0.1	-0.5
Entry	±0.25	±0.5	-2.5
Flyback	±0.25	±0.5	(+1.0 (-2.5
Landing & Braking	(+0.8 (-1.0	±0.5	-2.5 *

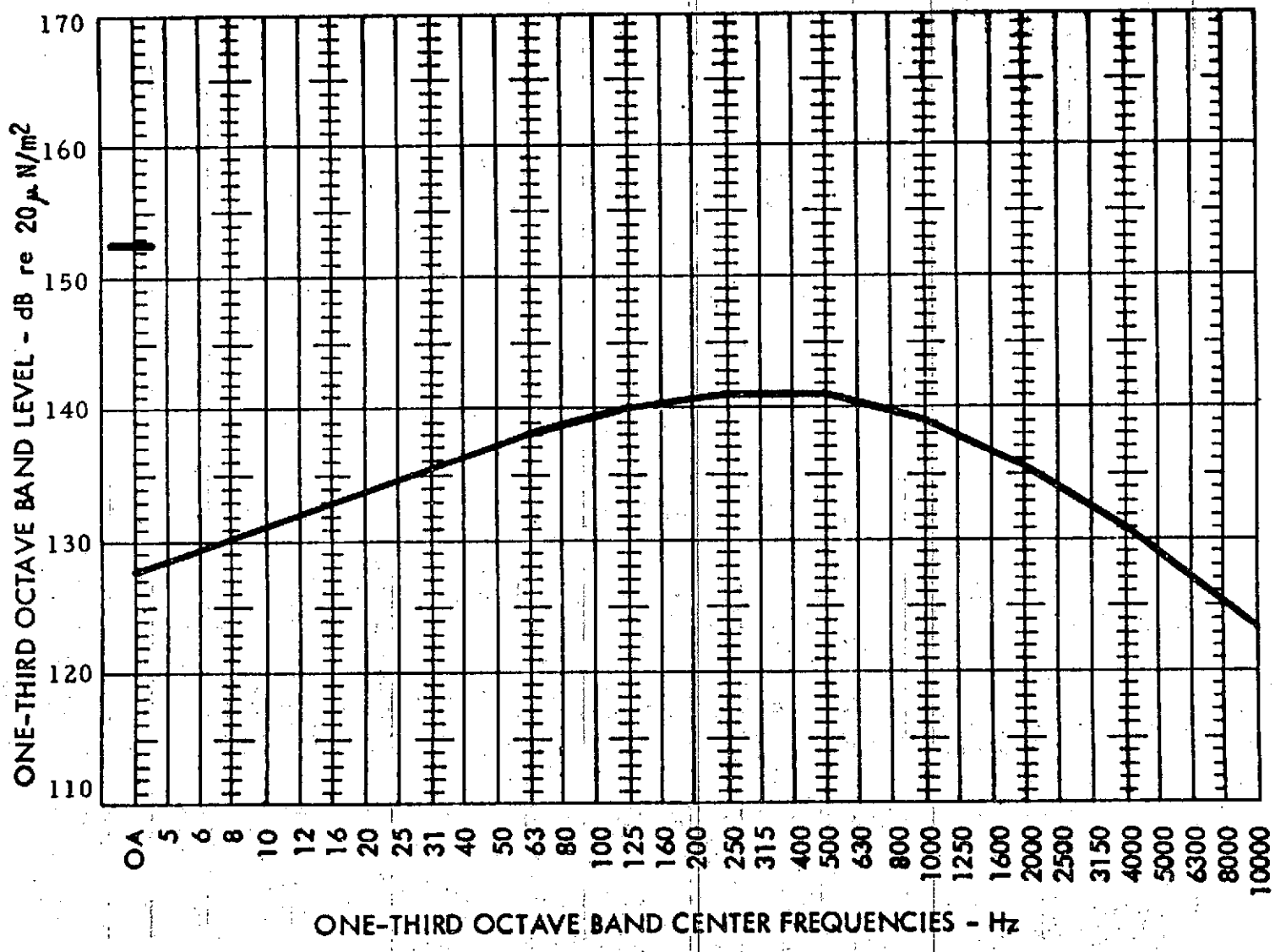
* Consists of 1.0 g of aerodynamic lift, plus 1.5 g's of landing impact loads. See Section 4.2.6 (Shock) for a time-history description of the landing impact loads.

Table 4.2-3. Dynamic Magnification Factors

CONDITION*	MAGNIFICATION FACTOR	
	X	Y,Z
High Q Boost	1.1	1.2
Booster End Burn	1.1	1.1
Orbiter End Burn	1.1	1.1
Landing	1.2	1.2

* For other conditions listed in Table 4.2-2, the dynamic magnification factors equal 1.0.

Figure 4.2-1. CARGO BAY ACOUSTIC SPECTRUM



4.2.5 Vibration

The vibration transmitted to the Payload in the cargo bay will not exceed TBD g-rms (65,000 pound payload, attached as discussed in Section 3.3.5). The associated vibration spectrum is presented in Figure 4.2-2(TBD). (For design purposes, payload planners should assume a duration of 120 seconds for the given spectrum, starting at Booster Vehicle engine ignition.)

4.2.6 Shock

Landing shock will not exceed 1.50 g's in the minus Z direction. The landing shock criterion is presented in Table 4.2-4 (rectangular pulses in the minus Z direction, with probability of occurrence per landing).

Table 4.2-4. Landing Shock

Acceleration	Duration	Probability
0.23 g peak	170 m sec	0.18
0.28	280	0.29
0.35	330	0.26
0.43	360	0.15
0.56	350	0.08
0.72	320	0.03
1.50	260	0.01

Other shock criteria are (TBD).

4.3 OUTGASSING AND EFFLUENTS

(TBD)

4.4 ELECTROMAGNETIC INTERFERENCE

The Payload will satisfy MIL-STD-461 and MIL-STD-462, such that interference and all applicable interface requirements do not exceed the limits of MIL-STD-461.

4.5 PAYLOAD SAFETY CRITERIA

(TBD)

APPENDIX D
SD71-127
(MSC 03305)

FINAL SUBMITTAL

INTERFACE DEFINITION DOCUMENT

RF COMMUNICATIONS NETWORK

(Also available separately as SR 2.4.4-11192)

25 June 1971

SPACE DIVISION

NORTH AMERICAN ROCKWELL CORPORATION

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1. SCOPE

This Interface Definition Document identifies and defines RF communications interfaces among elements of the Space Shuttle System, and between Space Shuttle elements and elements of other systems. It also allocates the interfaces to ICD's which will be required during Phase C-D to control these interfaces.

2. APPLICABLE DOCUMENTS

This Interface Definition Document is an interim document which summarizes the communications interfaces until such time as they can be stabilized and controlled in Specification No. SS613M001--System Specification for a Space Shuttle System. Consequently, this document shall comply with all applicable requirements of the System Specification.

3. INTERFACE DEFINITION

RF communications interfaces affecting the Shuttle System are depicted in the Schematic Block Diagram in Figure 3-1. Additional definition of the interfaces is included in Table 3-1. The following is a list of ICD's projected during Phase C-D to control these interfaces:

A. ICD - Booster Vehicle to Orbiter Vehicle
B. ICD - Booster Vehicle to Manned Space Flight Network (TBD)
C. ICD - Booster Vehicle to Air Traffic Control (TBD)
D. ICD - Orbiter Vehicle to Payload
E. ICD - Orbiter Vehicle to Space Station
F. ICD - Orbiter Vehicle to Manned Space Flight Network (TBD)
G. ICD - Orbiter Vehicle to Air Traffic Control (TBD)
H. ICD - Orbiter Vehicle to Tracking Data Relay Satellite (TBD)
I. ICD - Payload to Space Station (TBD)
J. ICD - Payload to Manned Space Flight Network (TBD)
K. ICD - Payload to Tracking Data Relay Satellite (TBD)
L. ICD - Booster Vehicle to Search and Rescue Vehicles (TBD)
M. ICD - Orbiter Vehicle to Search and Rescue Vehicles (TBD)
N. ICD - Booster Vehicle to Landing Sites
O. ICD - Orbiter Vehicle to Landing Sites

The letter preceding each ICD is also used to cross-correlate the interfaces and controlling ICD's in Figure 3-1 and Table 3-1. Correlation of individual interface functions with operational and/or flight test use is also indicated in Table 3-1.

Table 3-1. Space Shuttle RF Communications Interfaces

Transmission from	Communications Description	Frequency (MHz)	Reception By: Operational Phase	Flight Test Program	Booster Vehicle	Orbiter Vehicle	Payload	Space Station	MSFN	ATC	TDRS	Search/Rescue Vehs.	Landing Sites
Booster Vehicle	S-Band One-Way Data	TBD (2100-2300)		X					B				
	UHF Two-Way Simplex Voice	TBD (225-400)	X	X		A			B	C		L	N
	S-Band Interrogator (PRS)	TBD (2000-2100)	X	X						C			N
	L-Band Transponder	1090	X	X						C			
	Continuous-Signal Beacon	243	X	X								L	
Orbiter Vehicle	S-Band Data	2287.5	X				D	E	F				
	S-Band Data	2272.5		X				E	F				
	S-Band Voice	2287.5	X				D	E	F				
	S-Band Voice	2272.5		X				E	F				
	UHF Two-Way Simplex Voice	TBD (225-400)	X	X	A				F	G		M	O
	S-Band Interrogator (PRS)	TBD (2000-2100)	X	X			D	E		G			O
	L-Band Transponder	1090	X	X						G			
	VHF/FM Two-Way Duplex Voice or Data	TBD (136-152)	X	X							H		
	Continuous-Signal Beacon	243	X	X								M	
Payload	S-Band Data	TBD	X			D		I	J		K		
	S-Band Transponder (PRS)	TBD (2000-2100)	X	X		D							
Space Station	S-Band Data	TBD	X			E	I						
	S-Band Voice	TBD	X			E							
	S-Band Transponder (PRS)	TBD (2000-2100)	X	X		O							
MSFN (Manned Space Flt Net)	S-Band Two-Way Data	2106.4	X	X		F	J						
	S-Band Two-Way Duplex Voice	2106.4	X	X		F							
	S-Band Tracking (PRN)	2106.4	X	X		F	J						
ATC (Air Traffic Control)	UHF Two-Way Simplex Voice	TBD(225-400)	X	X	C	G							
	S-Band Ground Transponder	TBD (2000-2100)	X	X	C	G							
	L-Band Interrogator	1030	X	X	C	G							
TDRS (Tracking Data Relay Sat)	VHF/FM Two-Way Duplex Voice or Data	TBD (136-152)	X	X		H							
	S-Band Two-Way Simplex Data	TBD					K						
Landing Sites	Precision Ranging Transponder	TBD(2000-2100)	X	X	O	P							

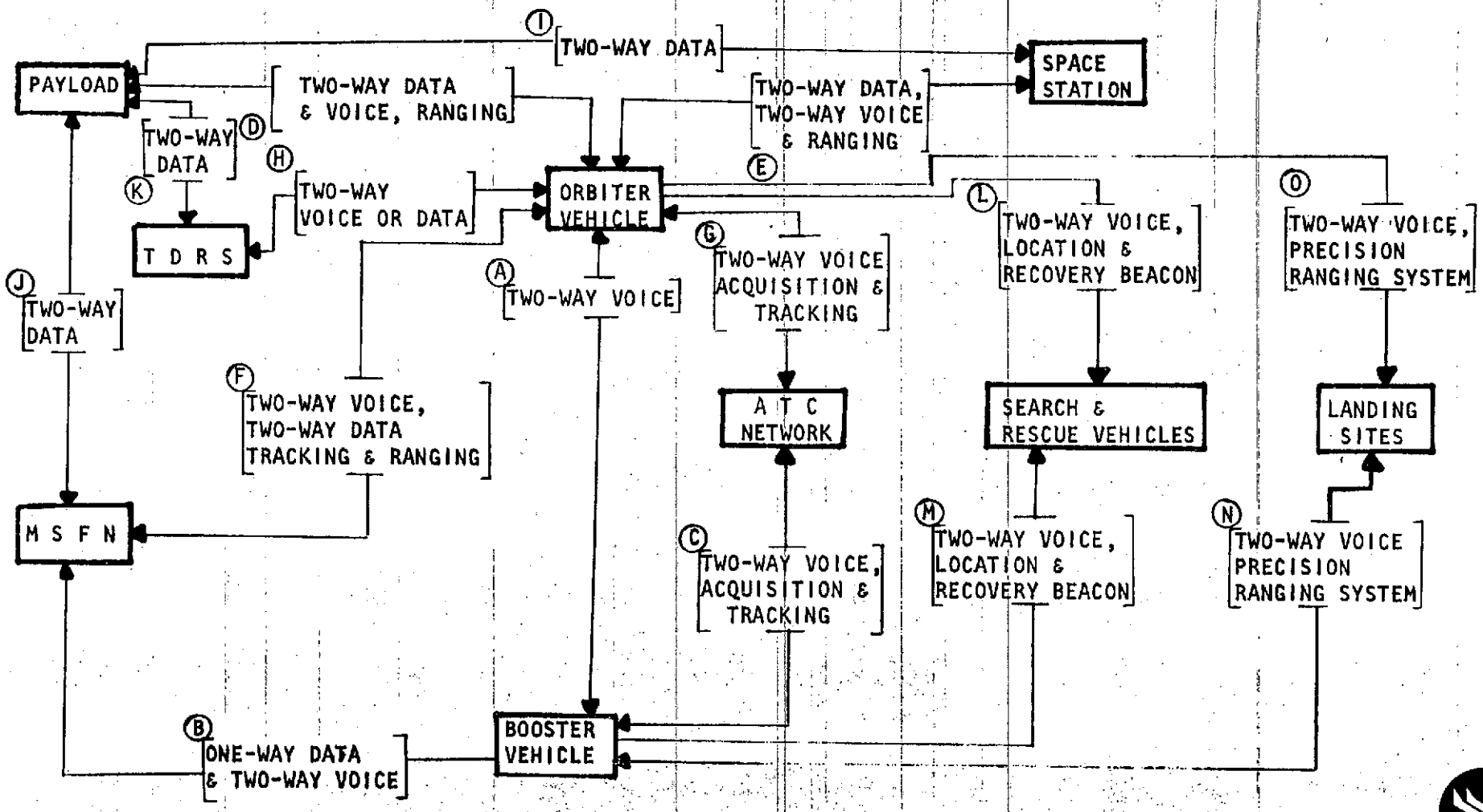

Figure 3-1. Schematic Block Diagram - Space Shuttle RF Communications

APPENDIX E
SE71-127
(MSC 03305)

FINAL SUBMITTAL

INTERFACE DEFINITION DOCUMENT

LAUNCH OPERATIONS COMPLEX

(Also available separately as SR 2.4.4-11190)

25 June 1971

Space Division

North American Rockwell

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1. SCOPE

This Interface Definition Document identifies and defines Launch Operations Complex interfaces between the Space Shuttle System Flight Vehicles (Booster, Orbiter and Payload), the Support Equipment, and the Facilities. It is in preliminary form, defining vehicle to support equipment and support equipment to facilities interfaces in gross terms.

2. APPLICABLE DOCUMENTS

This document complies with all applicable requirements of the following documents.

(a) Space Shuttle System Specification, SS613M0001

(b) Space Shuttle Ground System Specification, 76Z0501

(c) Space Shuttle Booster Specification, 76Z0500

(d) Space Shuttle Orbiter Specification, CP613M0002

3. INTERFACE DEFINITION

Launch Operations Complex functional interfaces for major mechanical, fluid, electrical and avionic subsystems are depicted in Figure 3-1. Physical interfaces between the launch complex and the air vehicles are shown in Figure 3-2. Interface data is defined in Interface Tables 3-1 and 3-2 for the booster and orbiter respectively to GSE and in Table 3-3 for GSE to facilities.

All vehicle ground interface and GSE to facilities interface requirements shall be categorized as follows:

(a) Category I — those ground interfaces required to launch, safe, or maintain the vehicle in a safe condition, on the launch pad up to first vehicle motion. These ground connections are designated Rise-off Disconnects (coded BA for booster and OA for orbiter).

(b) Category II — those ground service interfaces required to service the vehicle at the launch pad; however, the service can be terminated prior to, or concurrent with, personnel ingress/egress access swing arm

retrieval. These ground service interfaces are designated Swing-Arm Umbilicals (coded BB for booster and OB for orbiter).

(c) Category III — those external ground service interfaces required for scheduled vehicle servicing in the M&R area in preparation for launch. These services are designated External Service Disconnects (coded BC for booster and OC for orbiter).

(d) Category IV — those internal ground connections required for unscheduled vehicle servicing in the M&R area. These services are designated Internal Service Disconnects (coded BD for booster and OD for orbiter).

(e) Category V — those ground services interfaces betweeen the booster and orbiter common or dedicated GSE to launch pad, M&R and landing sites facilities. These services are designated GSE - Facility disconnects (coded LE for the launch pad, LR for the M&R area and LS for the landing sites).

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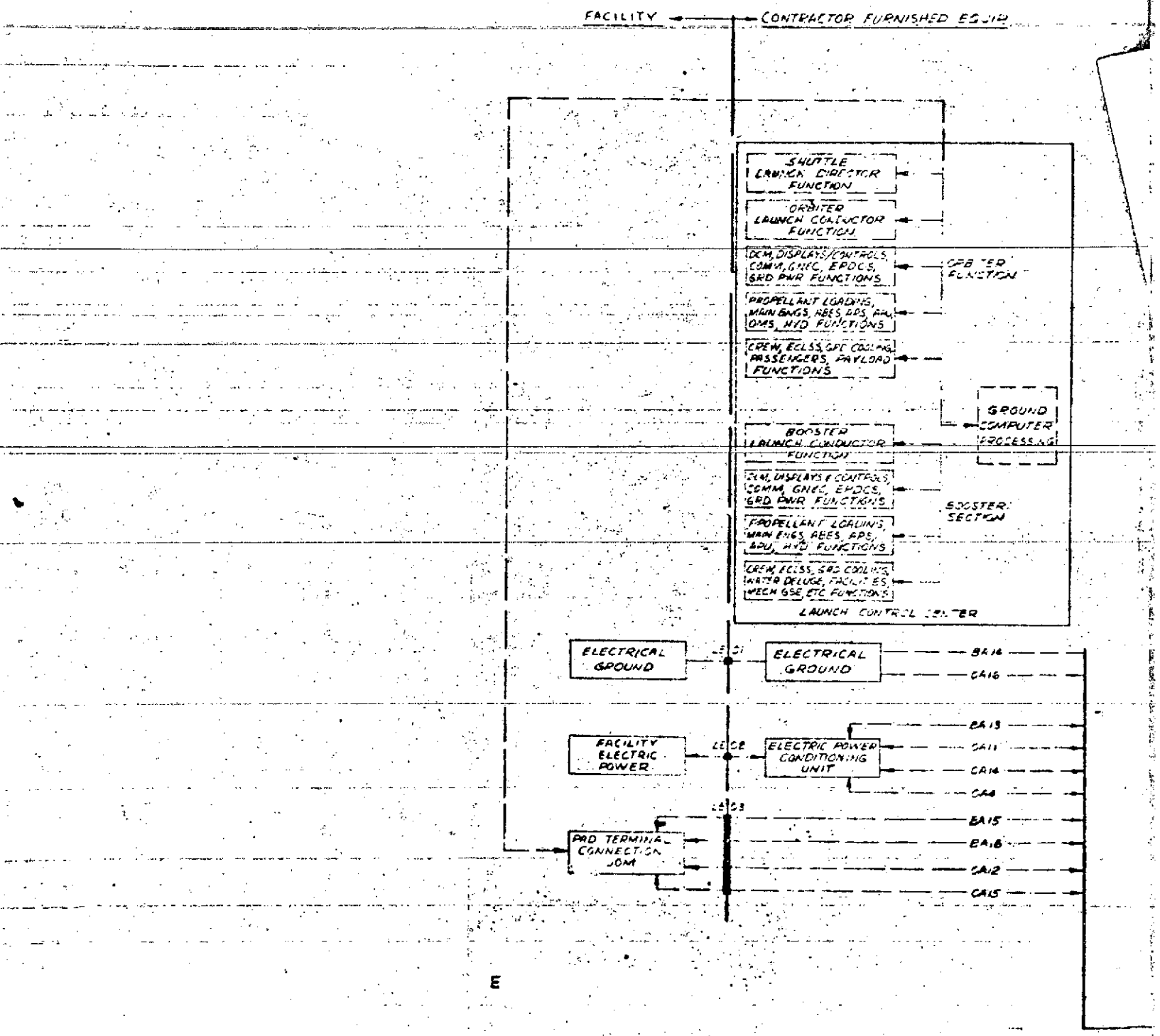

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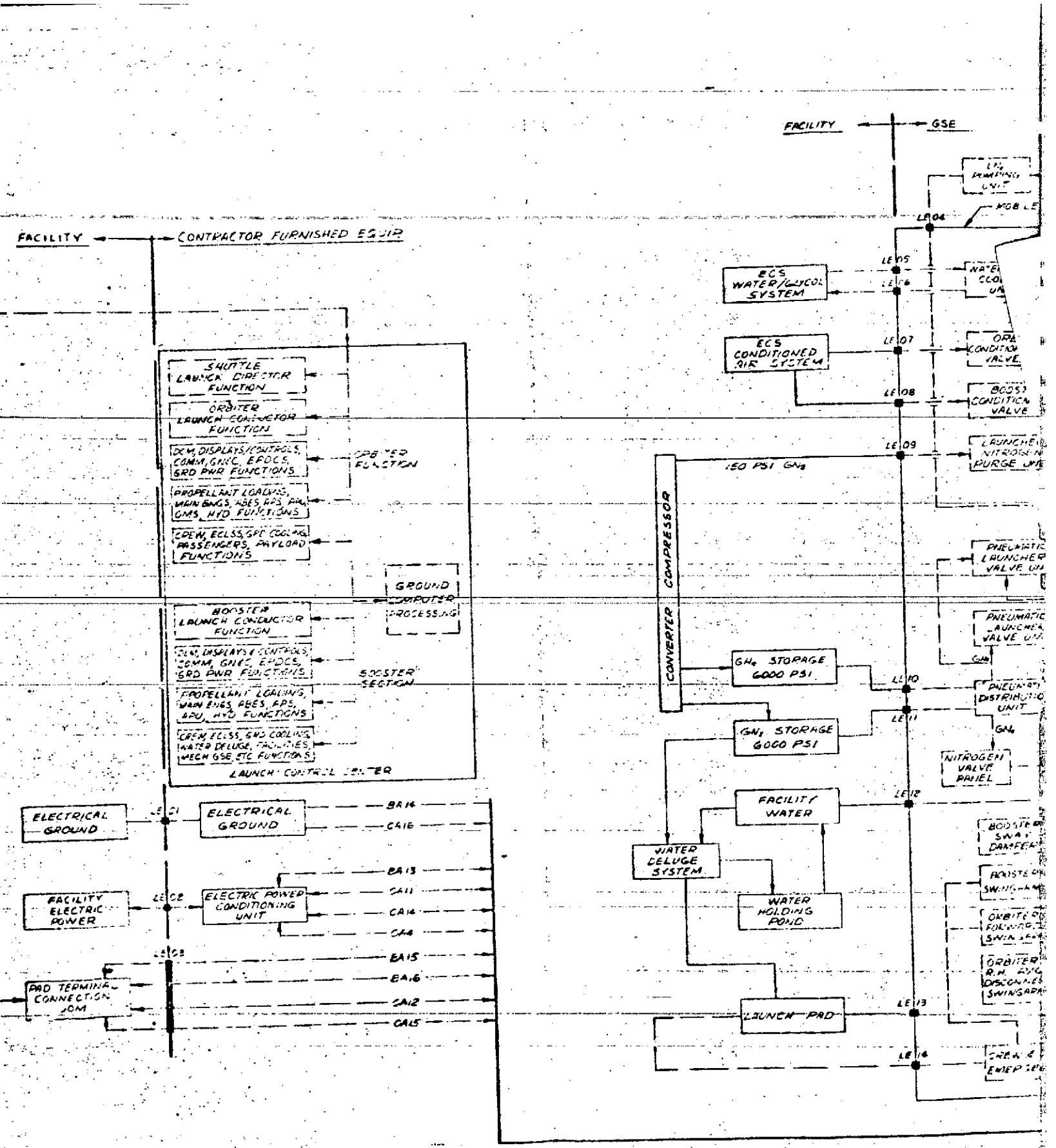
FACILITY
GSE
FACILITY
CONTRACTOR FURNISHED EQUIP
SHUTTLE LAUNCH DIRECTOR FUNCTION
ORBITER LAUNCH CONDUCTOR FUNCTION
DCM, DISPLAYS/CONTROLS, COMM, GNEC, EPDCS, GRD PWR FUNCTIONS
ORBITER FUNCTION
PROPELLANT LOADING, MAIN ENGS, ABES, RPS, APU, OMS, HYD FUNCTIONS
CREW, ECLSS, GRD COOLING, PASSENGERS, PAYLOAD FUNCTIONS
GROUND COMPUTER PROCESSING
BOOSTER LAUNCH CONDUCTOR FUNCTION
DCM, DISPLAYS & CONTROLS, COMM, GNEC, EPDCS, GRD PWR FUNCTIONS
BOOSTER SECTION
PROPELLANT LOADING, MAIN ENGS, ABES, RPS, APU, HYD FUNCTIONS
CREW, ECLSS, GRD COOLING, WATER DELUGE, FACILITIES, MECH GSE, ETC FUNCTIONS
LAUNCH CONTROL CENTER
ELECTRICAL GROUND
ELECTRICAL GROUND
BA14
CA16
FACILITY ELECTRIC POWER
ELECTRIC POWER CONDITIONING UNIT
BA13
CA11
CA14
CA4
BA15
BA16
CA12
CA15
PAD TERMINAL CONNECTION ROM
ECS WATER/GLYCOL SYSTEM
ECS CONDITIONED AIR SYSTEM
LE04
LE05
LE06
LE07
LE08
LE09
LE10
LE11
LE12
LE13
LE14
160 PSI GH2
COMPRESSOR
CONVERTER
GH2 STORAGE 6000 PSI
GN2 STORAGE 6000 PSI
FACILITY WATER
WATER DELUGE SYSTEM
WATER HOLDING POND
LAUNCH PAD
NITROGEN VALVE PANEL
GH2
GN2

E-3, 4 (B)

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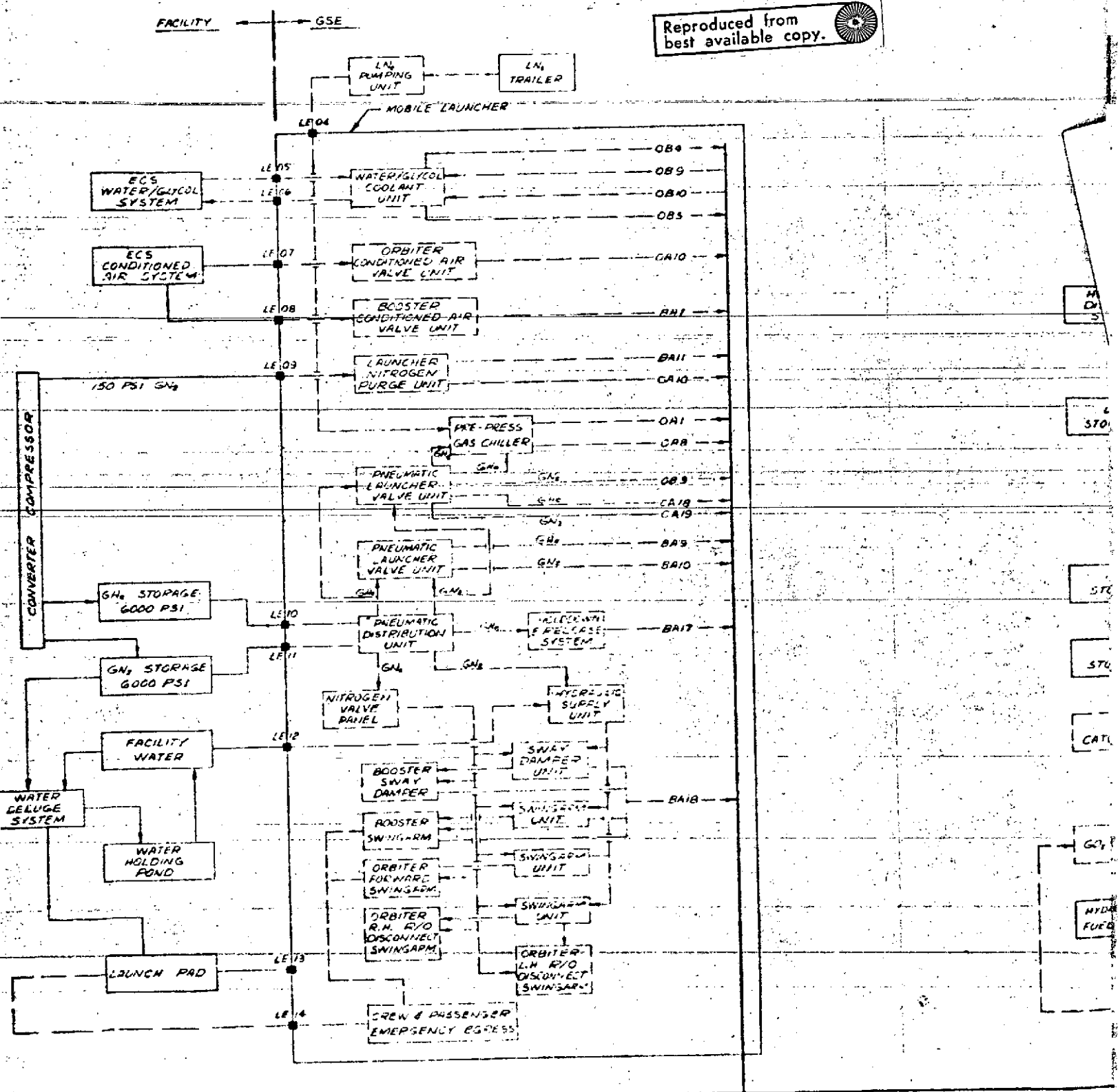

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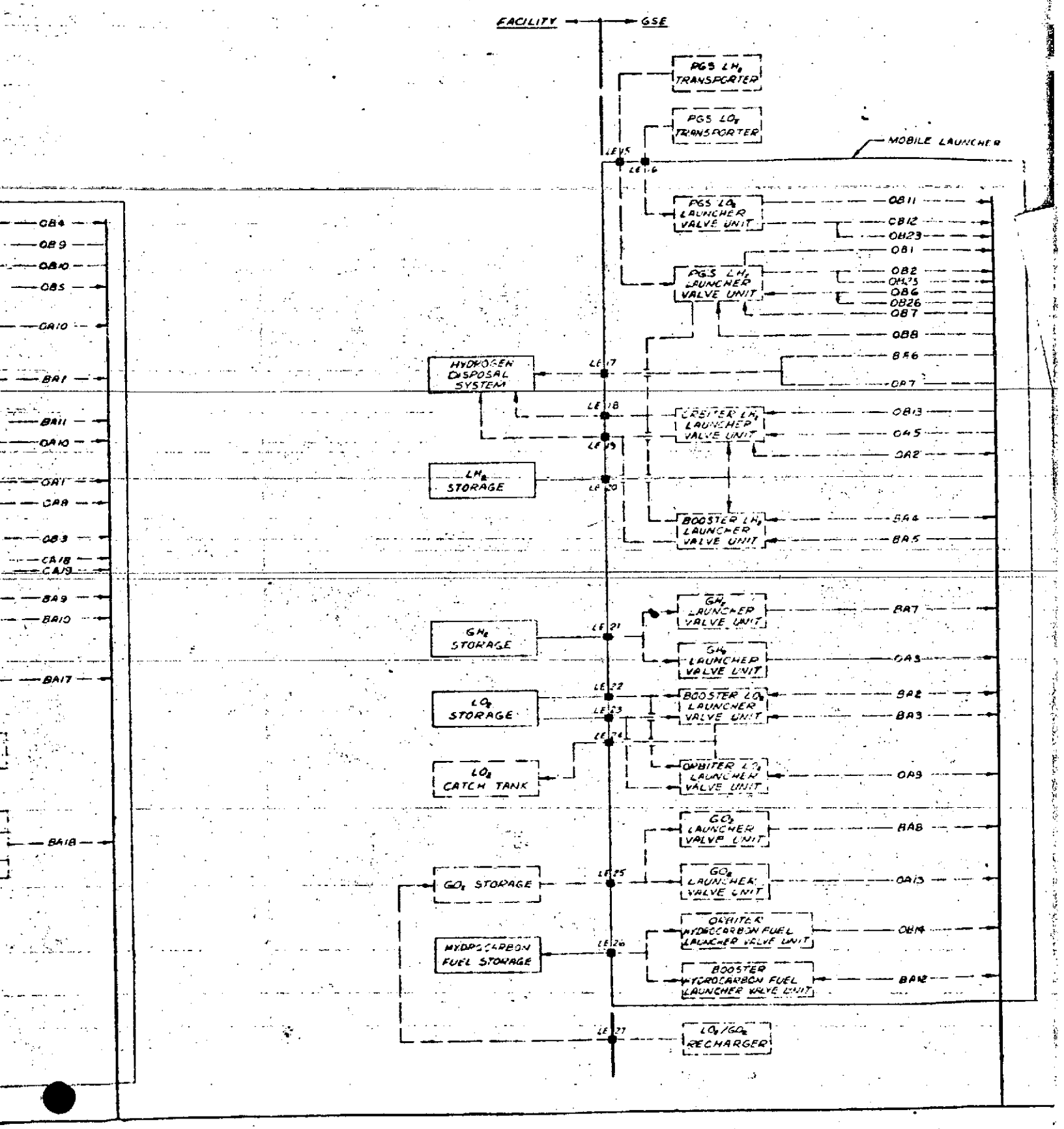
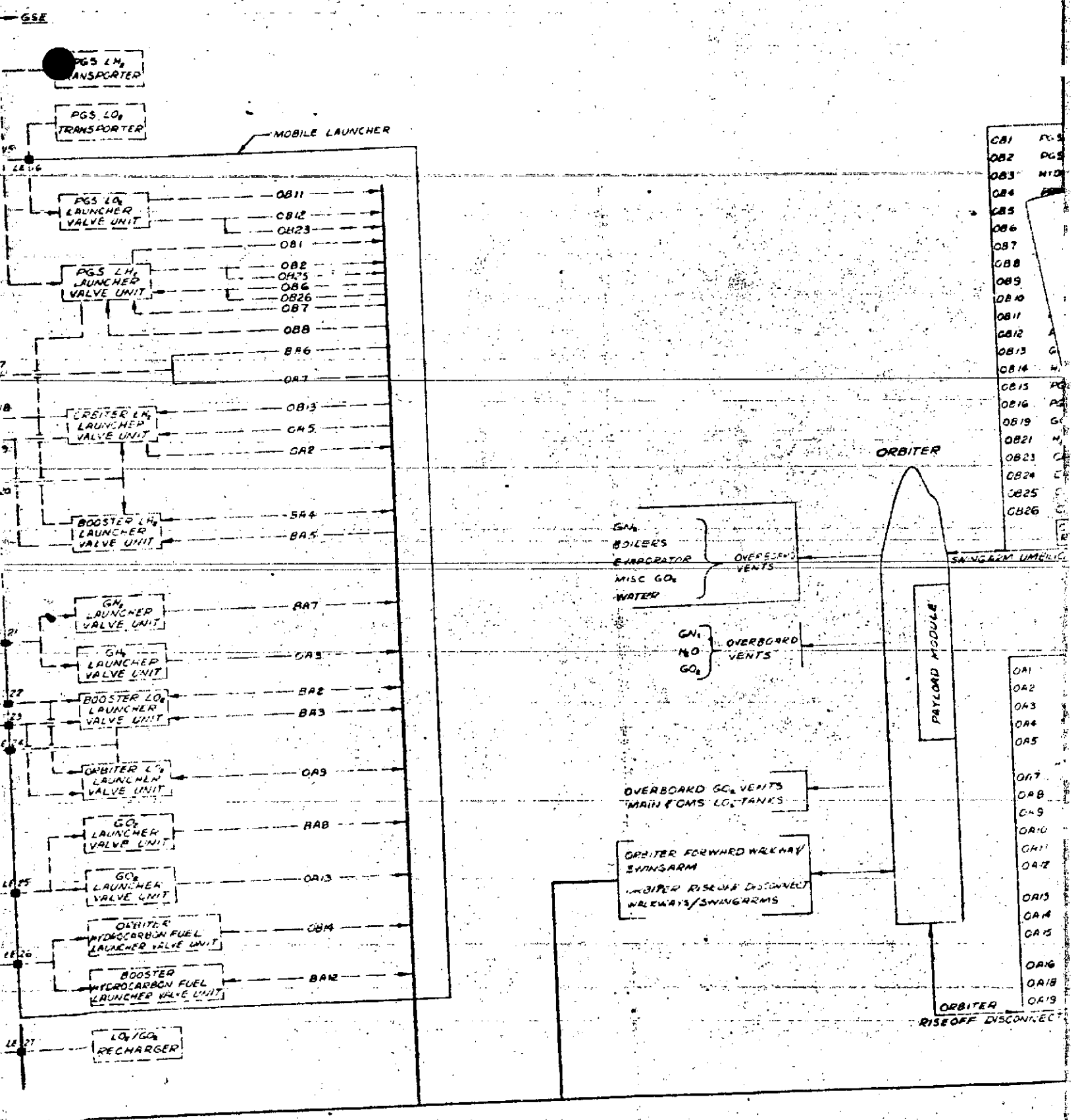
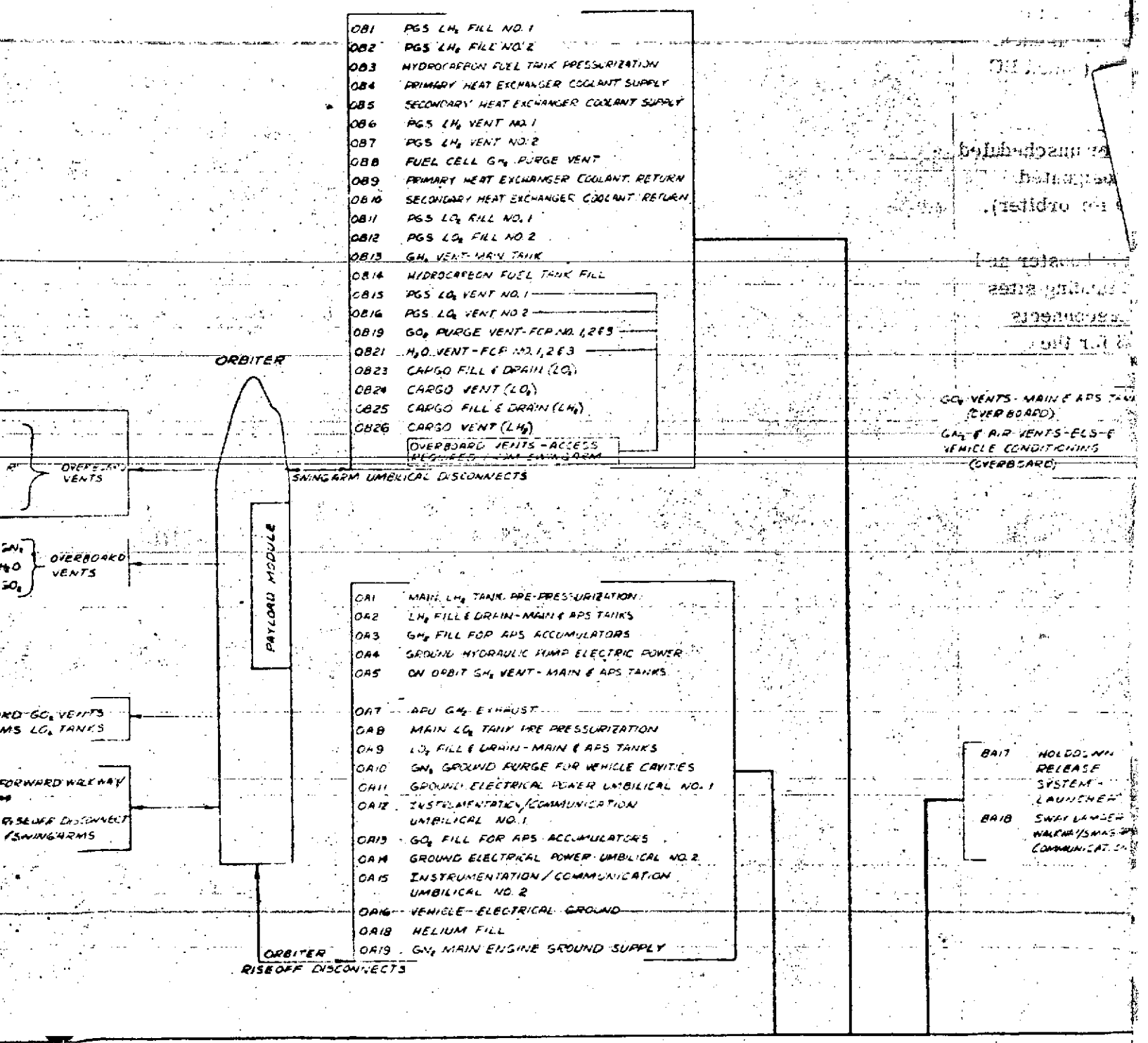

FACILITY
GSE
PGS LH2 TRANSPORTER
PGS LO2 TRANSPORTER
MOBILE LAUNCHER
LE15
LE16
PGS LO2 LAUNCHER VALVE UNIT
PGS LH2 LAUNCHER VALVE UNIT
OB11
OB12
OB23
OB1
OB2
OB25
OB6
OB26
OB7
OB8
BA6
OB7
HYDROGEN DISPOSAL SYSTEM
LE17
LE18
ORBITER LH2 LAUNCHER VALVE UNIT
OB13
OA5
OA2
LE19
LH2 STORAGE
LE20
BOOSTER LH2 LAUNCHER VALVE UNIT
BA4
BA5
GH2 LAUNCHER VALVE UNIT
BA7
GH2 STORAGE
LE21
GH2 LAUNCHER VALVE UNIT
OA3
LE22
LO2 STORAGE
BOOSTER LO2 LAUNCHER VALVE UNIT
BA2
LE23
BA3
LE24
LO2 CATCH TANK
ORBITER LO2 LAUNCHER VALVE UNIT
OA9
GO2 LAUNCHER VALVE UNIT
BA8
GO2 STORAGE
LE25
GO2 LAUNCHER VALVE UNIT
OA13
ORBITER HYDROCARBON FUEL LAUNCHER VALVE UNIT
OB14
HYDROCARBON FUEL STORAGE
LE26
BOOSTER HYDROCARBON FUEL LAUNCHER VALVE UNIT
BA12
LE27
LO2/GO2 RECHARGER
OB4
OB9
OB10
OB5
OA10
BA1
BA11
OA10
OA1
OA8
OB3
OA18
OA19
BA9
BA10
BA17
BA18

E-3,4 (D)


GSE
PGS LH2 TRANSPORTER
PGS LO2 TRANSPORTER
MOBILE LAUNCHER
PGS LO2 LAUNCHER VALVE UNIT
PGS LH2 LAUNCHER VALVE UNIT
ORBITER LH2 LAUNCHER VALVE UNIT
BOOSTER LH2 LAUNCHER VALVE UNIT
GN2 LAUNCHER VALVE UNIT
GH2 LAUNCHER VALVE UNIT
BOOSTER LO2 LAUNCHER VALVE UNIT
ORBITER LO2 LAUNCHER VALVE UNIT
GO2 LAUNCHER VALVE UNIT
GO2 LAUNCHER VALVE UNIT
ORBITER HYDROCARBON FUEL LAUNCHER VALVE UNIT
BOOSTER HYDROCARBON FUEL LAUNCHER VALVE UNIT
LO2/GO2 RECHARGER
OB11
OB12
OB23
OB1
OB2
OB25
OB6
OB26
OB7
OB8
BA6
OA7
OB13
OA5
OA2
SA4
BA5
BA7
OA3
BA2
BA3
OA9
BA8
OA13
OB4
BA12
GN2
BOILERS
EVAPORATOR
MISC GO2
WATER
OVERBOARD VENTS
GN2
N2O
GO2
OVERBOARD VENTS
OVERBOARD GO2 VENTS
MAIN & OMS LO2 TANKS
ORBITER FORWARD WALKWAY SWINGARM
ORBITER RISEOFF DISCONNECT WALKWAYS/SWINGARMS
ORBITER
PAYLOAD MODULE
SWINGARM UMBILICAL
ORBITER RISEOFF DISCONNECT
OB1
OB2
OB3
OB4
OB5
OB6
OB7
OB8
OB9
OB10
OB11
OB12
OB13
OB14
OB15
OB16
OB19
OB21
OB23
OB24
OB25
OB26
OA1
OA2
OA3
OA4
OA5
OA7
OA8
OA9
OA10
OA11
OA12
OA13
OA14
OA15
OA16
OA18
OA19

E-3, 4 (E)

Reproduced from best available copy.



Figu

E-3, 4 (F)

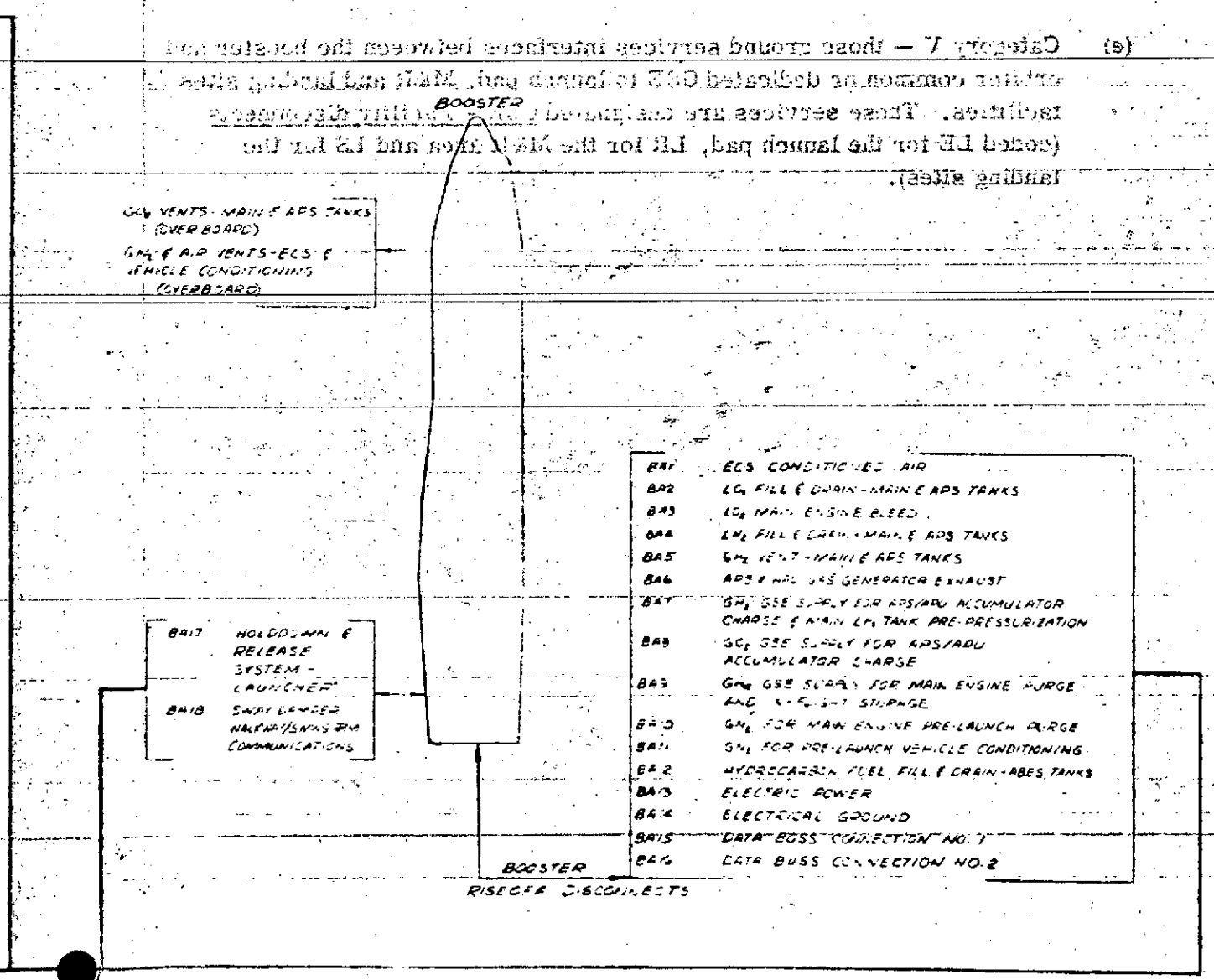
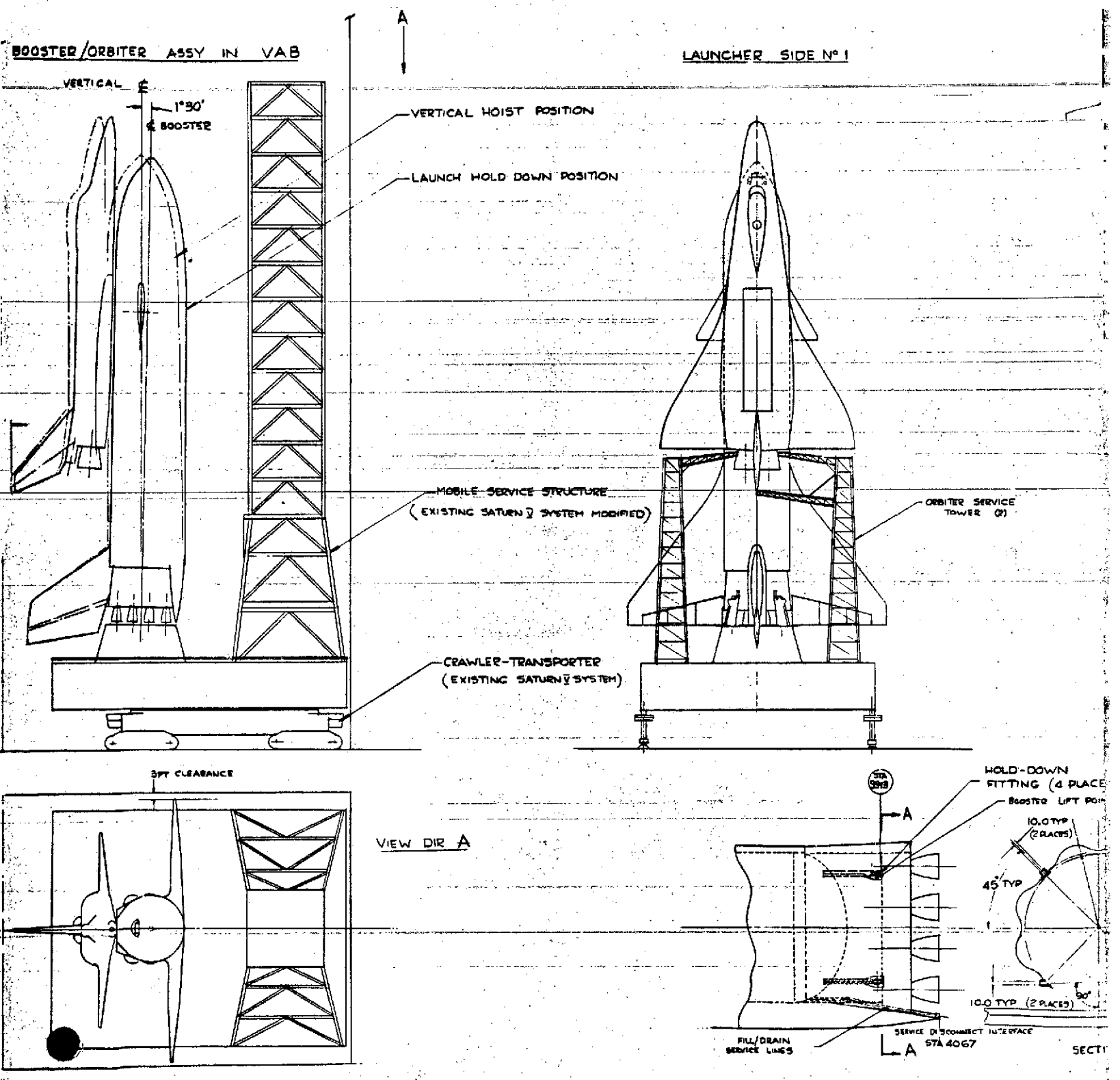
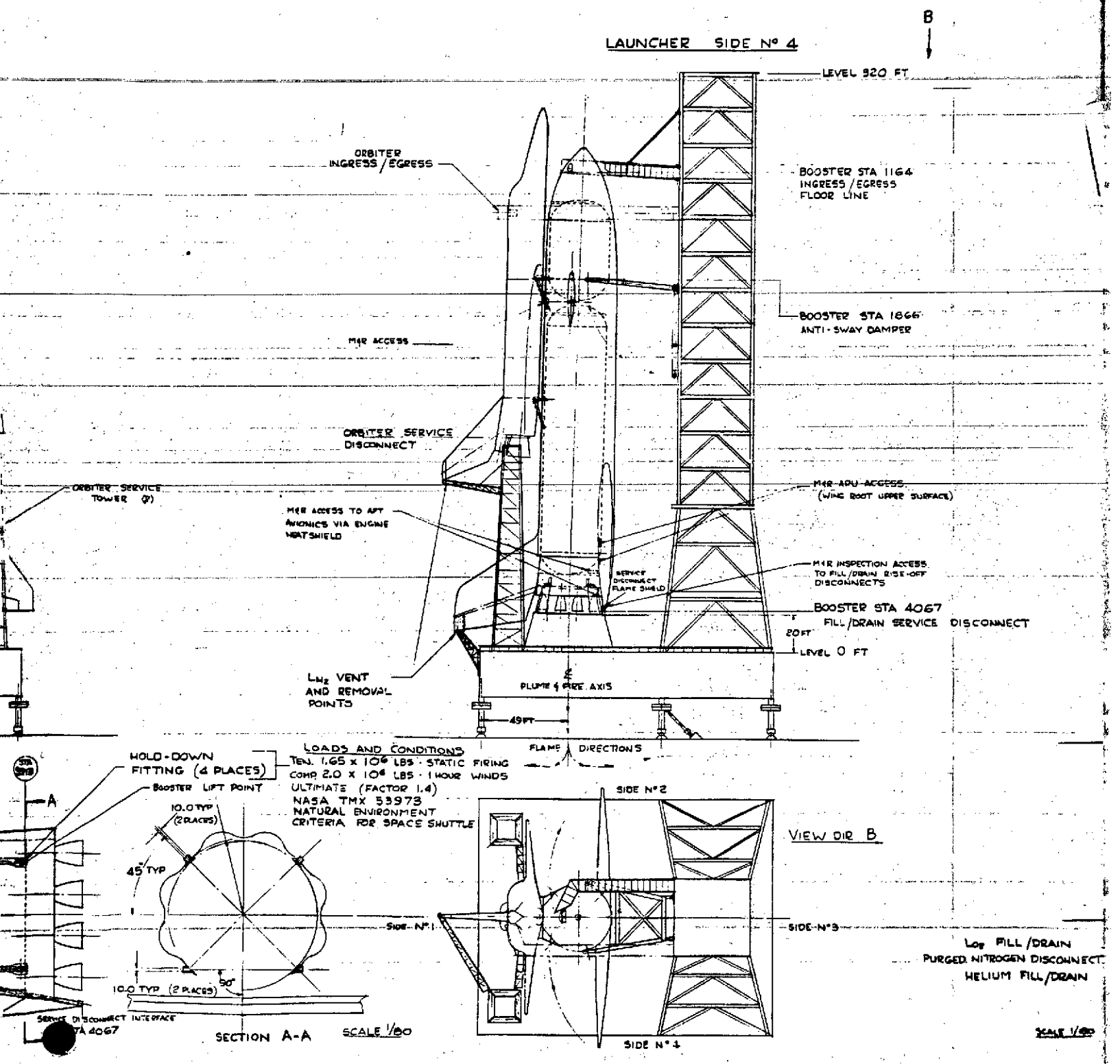


Figure 3-1. Launch Pad Functional Interface Diagram


BOOSTER/ORBITER ASSY IN VAB
LAUNCHER SIDE Nº 1
A
VERTICAL ℄
1°30'
℄ BOOSTER
VERTICAL HOIST POSITION
LAUNCH HOLD DOWN POSITION
MOBILE SERVICE STRUCTURE
(EXISTING SATURN V SYSTEM MODIFIED)
ORBITER SERVICE TOWER (2)
CRAWLER-TRANSPORTER
(EXISTING SATURN V SYSTEM)
3FT CLEARANCE
VIEW DIR A
HOLD-DOWN FITTING (4 PLACE
BOOSTER LIFT POI
10.0 TYP (2 PLACES)
45° TYP
10.0 TYP (2 PLACES)
90°
FILL/DRAIN SERVICE LINES
SERVICE DISCONNECT INTERFACE STA 4067
SECTI

E-5, 6 (A)


LAUNCHER SIDE Nº 4
B
LEVEL 920 FT
ORBITER INGRESS / EGRESS
BOOSTER STA 1164 INGRESS / EGRESS FLOOR LINE
BOOSTER STA 1866 ANTI-SWAY DAMPER
M&R ACCESS
ORBITER SERVICE DISCONNECT
ORBITER SERVICE TOWER (?)
M&R APU ACCESS (WING ROOT UPPER SURFACE)
M&R ACCESS TO AFT AVIONICS VIA ENGINE HEATSHIELD
SERVICE DISCONNECT FLAME SHIELD
M&R INSPECTION ACCESS TO FILL/DRAIN RISE-OFF DISCONNECTS
BOOSTER STA 4067 FILL/DRAIN SERVICE DISCONNECT
20 FT
LEVEL 0 FT
LH2 VENT AND REMOVAL POINTS
PLUME & FIRE AXIS
49 FT
FLAME DIRECTIONS
LOADS AND CONDITIONS
TEN. 1.65 x 10^6 LBS · STATIC FIRING
COMP 2.0 x 10^6 LBS · 1 HOUR WINDS
ULTIMATE (FACTOR 1.4)
NASA TMX 53973
NATURAL ENVIRONMENT
CRITERIA FOR SPACE SHUTTLE
HOLD-DOWN FITTING (4 PLACES)
BOOSTER LIFT POINT
A
10.0 TYP (2 PLACES)
45° TYP
90°
10.0 TYP (2 PLACES)
SERVICE DISCONNECT INTERFACE STA 4067
SECTION A-A
SCALE 1/80
SIDE Nº 2
SIDE Nº 1
SIDE Nº 3
SIDE Nº 4
VIEW DIR B
LOX FILL/DRAIN
PURGED NITROGEN DISCONNECT
HELIUM FILL/DRAIN
SCALE 1/80

E - 5, 6 (B)

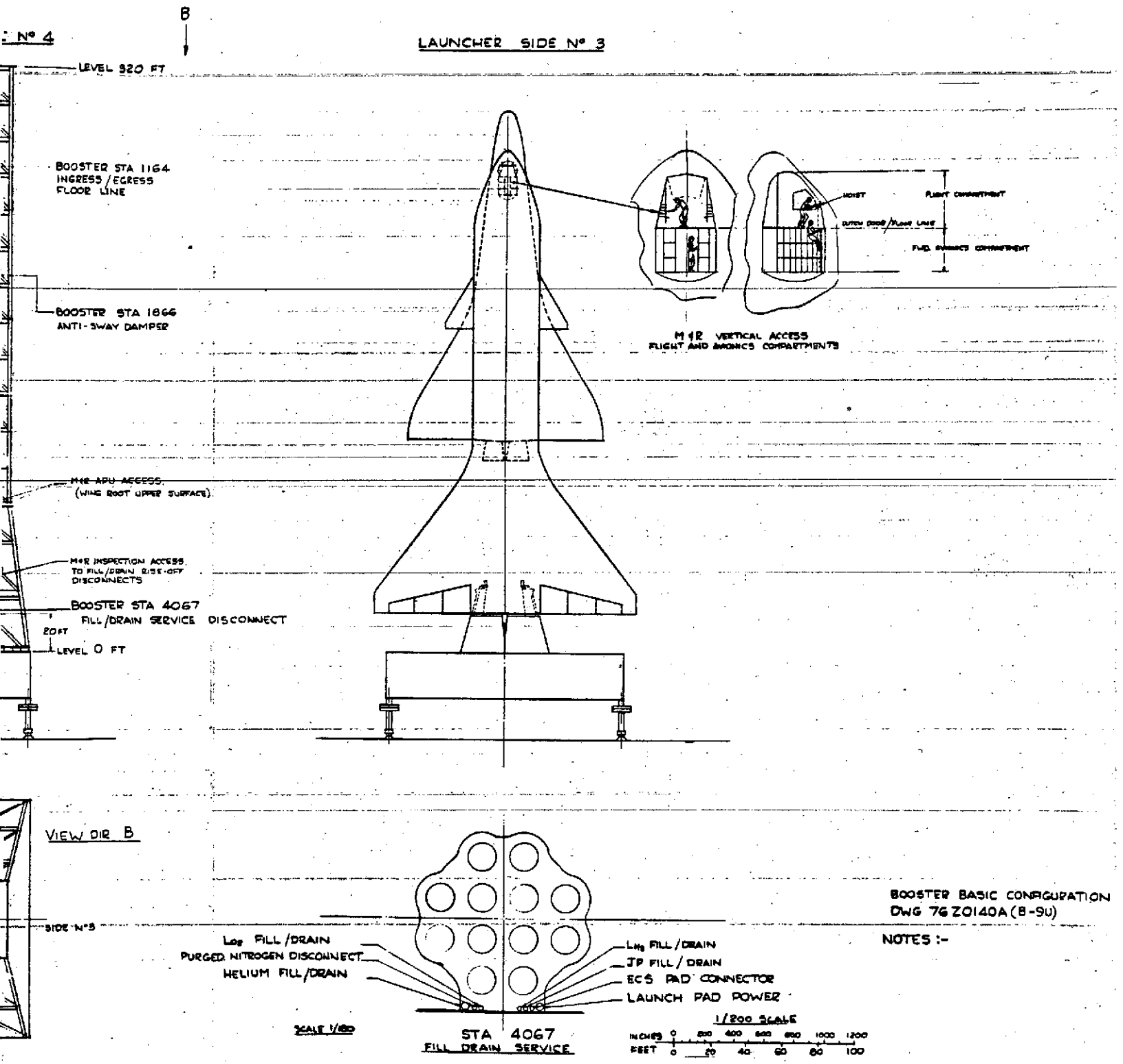


Figure 3-2. Booster/Orbiter Launcher Interfaces

BOOSTER

TO

LAUNCH OPERATIONS COMPLEX

INTERFACES

TABLE 3-1. LAUNCH OPERATIONS COMPLEX - BOOSTER INTERFACES

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
BA 1	ECS Air Conditioning	Cabin & equipment cooling until life off	Thrust Section	Fig. 3-1	3" line 34 lbs/min @ 5 PSIG 40°F
BA 2	LO_2 Fill and Drain	Supplies LO_2 to Main and ACPS Tanks. Allows Gravity Drain to Ground Supply	Thrust Section	Fig. 3-1	10" line 8500 GPM
BA 3	LO_2 Main Engine Bleed	Provides MPS LO_2 Conditioning and Recirculation	Thrust Section	Fig. 3-1	2" line 305 GPM
BA 4	LH_2 Fill and Drain	Supplies LH_2 to Main and ACPS tanks. Allows Gravity Drain to Ground Supply	Thrust Section	Fig. 3-1	10" line 9600 GPM
BA 5	GH_2 Vent	Provides Venting of GH_2 from Main & ACPS Tanks to Burn Pond	Vertical Stabilzer	Fig. 3-1	10" line Chill Boil 11-0 7.0 #/Sec 17.7 15.0 PSIA 530-50 40 °R
BA 6	ACPS & APU Gas Generator Exhaust	Provisions for ACPS & APU Exhaust to Burn Pond	Vertical Stabilizer	Fig. 3-1	10" Line 0.5(Avg) – 15 (Max) #/sec 20 PSIA , 800 °R 50% H_2 50% H_2O

TABLE 3-1. LAUNCH OPERATIONS COMPLEX - BOOSTER INTERFACES

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
BA 7	GH_2 GSE Supply	GH_2 Supply for ACPS/APU Accumulator Charge and Main LH_2 Pre-Press	Thrust Section	Fig. 3-1	1" line 1.0 #/Sec (Avg) 530 ^oR 1000 PSIA
BA 8	GO_2 GSE Supply	GO_2 Supply to ACPS/APU Accumulator Charge	Thrust Section	Fig. 3-1	1" line 1.0 #/Sec (Avg) 530 ^oR 1000 PSIA
BA 9	GHe GSE Supply	GHe Supply for Main Engine Purge and Engine Controls In-Flight Storage	Thrust Section	Fig. 3-1	1" line 1.0 #/Sec 530 ^oR 3700 PSIA
BA 10	GN_2 for Main Engine Purge	GN_2 Supply for Main Engine Purge	Thrust Section	Fig. 3-1	1.5" line 6.0 #/Sec 530 ^oR 725 PSIA
BA 11	GN_2 for Vehicle Conditioning	Supplies GN_2 to Airframe Compartments to Provide Inert Atmosphere and to Prevent Ice Accumulation on TPS near LO_2 Tank	Thrust Section	Fig. 3-1	4" line 28 #/Sec 160 ^oF 150 PSIA

TABLE 3-1. LAUNCH OPERATIONS COMPLEX - BOOSTER INTERFACES

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
BA 12	Hydrocarbon Fuel Fill & Drain	Supplies JP Fuel to the ABES Tanks	Thrust Section	Fig. 3-1	4" line 3600 #/Min 530°R 120 PSIA
BA 13	Ground Electrical Power	Provides Ground Electrical Power for Vehicle Systems to Lift-Off	Thrust Section	Fig. 3-1	115V 400 Hz 20-30 KVA 3 Ø (Clean)
BA 14	Electrical Ground	Provides Airframe Ground Connection	Thrust Section	Fig. 3-1	Low Resistance
BA 15	Data Bus #1 Connection	Provides Data Path	Thrust Section	Fig. 3-1	1 MHz
BA 16	Data Bus #2 Connection	Provides Data Path	Thrust Section	Fig. 3-1	1 MHz
BA 17	Launch Hold-Down and Release	Four Holddown Arms for Static Firing, Launch and Wind Resistance on Launch Pedestal	Thrust Structure	Fig. 3-1 Fig. 3-2	
BA 18	Sway Damping	Damping Device Between the LUT and Booster for Pre-Launch Tie-Down	Nose Gear Support Structure	Fig. 3-1 Fig. 3-2	

TABLE 3-1. LAUNCH OPERATIONS COMPLEX - BOOSTER INTERFACES

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
BA 19	LH_2 Recirculation Pump Ground Power Supply	Provides Power to Electric Motors Driving the Low Pressure Turbopumps on the MPS Engines to Provide LH_2 Conditioning Bleed Flow	Thrust Structure	Fig. 3-1	115V 400 Hz 3 Ø 120 KVA (Facility Power)
BA 20	Voice Intercommunications	Provides Hardwire Voice Communications Between Ground Crew and Vehicle Crew	Thrust Structure	Fig. 3-1	20 KHz

ORBITER

TO

LAUNCH OPERATIONS COMPLEX

INTERFACES

TABLE 3-2. LAUNCH OPERATIONS COMPLEX - ORBITER INTERFACES

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
OA1	LH_2 Tank Pre-Press	Chilled GH_e Supply to Main LH_2 Tank Pre-Press	Aft	Fig. 3-1	1500 psig 100 lb/min -250°F
OA2	LH_2 Fill and Drain	Provide LH_2 for Main and OMS Tanks - Provide Drain and Purge Capability	Aft	Fig. 3-1 Fig. 3-3	5922 lb/min (max) (10,000 gpm) 25 psig -423°F
OA3	ACPS GH_2 Fill	Provides Ambient GH_2 to ACPS Accumulator	Aft	Fig. 3-1 Fig. 3-3	1250 psig Ambient
OA4	Hydraulic Pump Ground Electric Power	Provides power for driving hydraulic pumps during pre-launch	Aft	Fig. 3-1 Fig. 3-3	
OA5	On-Orbit GH_2 Vent	Provides Secondary Vent for Main and OMS LH_2 Tanks to Safe Disposal	Vertical Stabilizer	Fig. 3-1 Fig. 3-3	
OA7	GH_2 Hot Gas Exhaust	Directs Hot GH_2 from GG and APU to Safe Disposal	Vertical Stabilizer	Fig. 3-1 Fig. 3-3	60 lbs/min GH_2/H_2O 20 psia 350°F

TABLE 3-2. LAUNCH OPERATIONS COMPLEX - ORBITER INTERFACES

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
OA8	LO_2 Tank Pre-Press	Provide Chilled GH_e to Pre-Press LO_2 Tank	Aft	Fig. 3-1 Fig. 3-3	1500 psig 100 lb/min -250°F
OA9	LO_2 Fill and Drain	Provide LO_2 for Main and OMS Tanks - Provide Drain and Purge Capability	Aft	Fig. 3-1 Fig. 3-3	50 psig 47,320 lbs/min (5000 gpm) max -297°F
OA10	Vehicle Purge	GN_2 for Purging Vehicle - Non-Pressurized Volumes	Aft	Fig. 3-1 Fig. 3-3	
OA11	Ground Electrical Power No. 1	Provides Ground Electrical Power	Aft	Fig. 3-1 Fig. 3-3	400 Hz 120/208 Vac
OA12	Instrumentation/ Communication No. 1	Provides Data & Communication Path to Vehic	Aft	Fig. 3-1 Fig. 3-3	
OA13	ACPS GO_2 Fill	Provides Ambient GO_2 to ACPS Accumulator	Aft	Fig. 3-1 Fig. 3-3	1250 psig
OA14	Ground Electrial Power No. 2	Provides Ground Electrical Power	Aft	Fig. 3-1 Fig. 3-3	400 Hz 120/208 Vac
OA15	Instrumentation Communication No. 2	Provides Data & Communication Path to Vehicle	Aft	Fig. 3-1 Fig. 3-3	

TABLE 3-2. LAUNCH OPERATIONS COMPLEX - ORBITER INTERFACES

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
OA16	Vehicle Ground	Provides Single Point Ground	Aft	Fig. 3-1 Fig. 3-3	
OA17	Helium Fill	Provide GH_e Pressurant	Aft	Fig. 3-1 Fig. 3-3	
OA18	N_2 Main Engine Ground Supply		Aft	Fig. 3-1 Fig. 3-3	

TABLE 3-2. LAUNCH OPERATIONS COMPLEX - ORBITER INTERFACE

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
OB1	PGS LH_2 Fill No. 1	Fill/Drain PGS LH_2 Super Critical Storage #1	Mid body	Fig. 3-1 Fig. 3-3	
OB2	PGS LH_2 Fill No. 2	Fill/Drain PGS LH_2 Super Critical Storage #2	Mid body	Fig. 3-1 Fig. 3-3	
OB3	Hydrocarbon Fuel Tank Press		Mid body	Fig. 3-1 Fig. 3-3	
OB4	Primary Hx Coolant Supply	Provide Ground Coolant to Vehicle Primary Hx	Mid body	Fig. 3-1 Fig. 3-3	
OB5	Secondary Hx Coolant Supply	Provide Ground Coolant to Vehicle Secondary Hx	Mid body	Fig. 3-1 Fig. 3-3	
OB6	PGS LH_2 Vent #1	Vent PGS LH_2 Super Critical Tank #1 During Filling and Purge	Mid body	Fig. 3-1 Fig. 3-3	
OB7	PGS LH_2 Vent #2	Vent PGS LH_2 Super Critical Tank #2 During Filling and Purge	Mid body	Fig. 3-1 Fig. 3-3	
OB8	Fuel Cell GH_2 Purge	Direct Fuel Cell Hydrogen Gas to Safe Disposal	Mid body	Fig. 3-1 Fig. 3-3	
OB9	Primary Hx Coolant Return	Provide Return for Ground Coolant to Vehicle Primary Hx	Mid body	Fig. 3-1 Fig. 3-3	

TABLE 3-2. LAUNCH OPERATIONS COMPLEX - ORBITER INTERFACES

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
OB10	Secondary Hx Coolant Return	Provide Return for Ground Coolant to Vehicle Secondary Hx	Mid body	Fig. 3-1 Fig. 3-3	
OB11	PGS LO_2 Fill #1	Fill/Drain PGS LO_2 Super Critical Storage #1	Mid body	Fig. 3-1 Fig. 3-3	
OB12	PGS LO_2 Fill #2	Fill/Drain PGS LO_2 Super Critical Storage #2	Mid body	Fig. 3-1 Fig. 3-3	
OB13	GH_2 Vent	Provide GH_2 Vent for Main Tanks	Mid body	Fig. 3-1 Fig. 3-3	
OB14	Hydrocarbon Fuel Fill	Fill and Drain Hydrocarbon Fuel Tank	Mid body	Fig. 3-1 Fig. 3-3	
OB15	PGS LO_2 Vent #1	Vent PGS LO_2 Super Critical Tank #1 During Filling and Purge	Mid body	Fig. 3-1 Fig. 3-3	
OB16	PGS LO_2 Vent #2	Vent PGS LO_2 Super Critical Tank #2 During Filling and Purge	Mid body	Fig. 3-1 Fig. 3-3	
OB19	GO Purge Vent			Fig. 3-1 Fig. 3-3	
OB21	H_2O Vent		Mid body	Fig. 3-1 Fig. 3-3	

TABLE 3-2. LAUNCH OPERATIONS COMPLEX - ORBITER INTERFACES

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
OB23	Cargo Fill and Drain (LO_2)		Mid body	Fig. 3-1 Fig. 3-3	
OB24	Cargo Vent (LO_2)		Mid body	Fig. 3-1 Fig. 3-3	
OB25	Cargo Fill and Drain (LH_2)		Mid body	Fig. 3-1 Fig. 3-3	
OB26	Cargo Vent (LH_2)		Mid body	Fig. 3-1 Fig. 3-3	

LAUNCH OPERATIONS COMPLEX

GROUND SUPPORT EQUIPMENT (GSE)

TO

FACILITIES

INTERFACES

TABLE 3-3. LAUNCH OPERATIONS COMPLEX - GSE/FACILITY INTERFACES

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
LE-01	Electrical Ground	Provides pre-launch common ground for Booster and Orbiter			
LE-02	Electrical Power	Interconnects launch site facility power to booster/orbiter electrical power conditioning GSE.			
LE-03	Data bus	Interconnects booster/orbiter Data busses #1 and #2 to LCC launch and checkout functions through the Pad Terminal Connection Room.			
LE-04	LN_2 Supply	Interconnects LN_2 pumping unit to the mobile launcher pre-press gas chiller.			
LE-05	ECS Water/Glycol Supply	Interconnects facility ECS water/glycol supply to mobile launcher water/glycol coolant unit (orbiter only).			

E-20

TABLE 3-3. LAUNCH OPERATIONS COMPLEX - GSE/FACILITY INTERFACES

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
LE-06	ECS Water/Glycol Return	Interconnects facility ECS water/glycol return to mobile launcher with/glycol coolant unit (orbiter only)			
LE-07	ECS Conditioned Air	Interconnects facility ECS system to orbiter Conditioned Air Valve Unit on mobile launcher.			
LE-08	ECS Conditioned Air	Interconnects facility ECS system to booster Conditioned Air Valve Unit on mobile launcher.			
LE-09	GN_2 Purge Supply	Interconnects facility converter compressor to Mobile Launcher Nitrogen Purge Unit.			
LE-10	GHe Supply	Interconnects facility GHe storage to mobile launcher Pneumatic Distribution Unit			

TABLE 3-3. LAUNCH OPERATIONS COMPLEX - GSE/FACILITY INTERFACES

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
LE-11	GN_2 Supply	Interconnects facility GN_2 storage to mobile launcher pneumatic distribution unit.			
LE-12	Mobile Launcher Hydraulic Supply	Interconnects facility water supply to mobile launcher hydraulic supply unit.			
LE-13	Mobile Launcher	Provide mobile launcher fixed supports to the launch pad.			
LE-14	Emergency Escape Provisions	Interconnects crew and passenger emergency escape provisions on the mobile launcher to the launch pad blast protection area.			
LE-15	PGS LH_2 Supply	Interconnects PGS LH_2 transporter to the mobile launcher PGS LH_2 valve unit (Orbiter only)			
LE-16	PGS LO_2 Supply	Interconnects PGS LO_2 transporter to the mobile launcher PGS LO_2 valve unit (Orbiter only).			

TABLE 3-3. LAUNCH OPERATIONS COMPLEX - GSE/FACILITY INTERFACES

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
LE-17	Hydrogen Disposal	Interconnects the booster APS & APU gas generator exhaust ducting on the mobile launcher to the facility hydrogen disposal system. Also provides orbiter APU GN_2 exhaust interconnect.			
LE-18	LH_2 Vent (Orbiter)	Interconnects the facility hydrogen disposal system to the mobile launcher orbiter LH_2 valve unit.			
LE-19	LH_2 Vent (Booster)	Interconnects the facility hydrogen disposal system to the mobile launcher booster and orbiter LH_2 valve units.			
LE-20	LH_2 Storage Vent	Interconnects the LH_2 storage facility to the booster and orbiter mobile launcher LH_2 valve units.			
LE-21	GH_2 Supply	Interconnects the GH_2 storage facility to the mobile launcher booster and orbiter GH_2 valve units.			

TABLE 3-3. LAUNCH OPERATIONS COMPLEX - GSE/FACILITY INTERFACES

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
LE-22	LO_2 Supply - Rapid Fill	Interconnects the LO_2 storage facility to the mobile launcher booster and orbiter LO_2 valve units.			
LE-23	LO_2 Supply - Fine Fill	Interconnects the LO_2 storage facility to the mobile launcher booster and orbiter LO_2 valve unit.			
LE-24	LO_2 Disposal	Interconnects the facility LO_2 catch tank to the mobile launcher booster and orbiter LO_2 valve units.			
LE-25	GO_2 Supply	Interconnects the GO_2 storage facility to the mobile launcher booster and orbiter GO_2 valve unit.			
LE-26	Hydrocarbon Fuel Supply	Interconnects the hydrocarbon fuel storage facility to the mobile launcher booster and orbiter hydrocarbon fuel valve units.			

TABLE 3-3. LAUNCH OPERATIONS COMPLEX - GSE/FACILITY INTERFACES

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
LE-27	LO_2/GO_2 Recharge	Interconnects the LO_2-GO_2 recharger to the GO_2 storage facility.			

APPENDIX F
SD71-127
(MSC 03305)

FINAL SUBMITTAL

INTERFACE DEFINITION DOCUMENT

M&R OPERATIONS COMPLEX

(Also available separately SR 2.4.4-11189)

25 June 1971

Space Division

North American Rockwell

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2.	APPLICABLE DOCUMENTS	1
3.	INTERFACE DEFINITION	1

1. SCOPE

This Interface Definition Document identifies and defines M&R Operations Complex interfaces between the Space Shuttle Flight Vehicles (Booster, Orbiter and Payload), the Support Equipment, and the Facilities. It is in preliminary form defining vehicle to support equipment and support equipment to facilities interfaces in gross terms.

2. APPLICABLE DOCUMENTS

This document complies with all applicable requirements of the following documents:

(a) Space Shuttle System Specification, SS613M0001

(b) Space Shuttle Ground System Specification, 76Z0501

(c) Space Shuttle Booster Specification, 76Z0500

(d) Space Shuttle Orbiter Specification, CP613M0002

3. INTERFACE DEFINITION

M&R Operations Complex functional interfaces for major mechanical, fluid, electrical and avionic subsystems are depicted in Figures 3-1 and 3-2. Physical interfaces between the M&R Complex and the air vehicles are shown in Figure 3-3. Interface data is defined on Interface Tables 3-1 and 3-2 for the booster and orbiter respectively to GSE and in Tables 3-3 and 3-4 for GSE to facilities.

All vehicle ground interface and GSE to facilities interface requirements shall be categorized as follows:

(a) Category I — those ground interfaces required to launch, safe, or maintain the vehicle in a safe condition, on the launch pad up to first vehicle motion. These ground connections are designated Rise-off Disconnects (coded BA for booster and OA for orbiter).

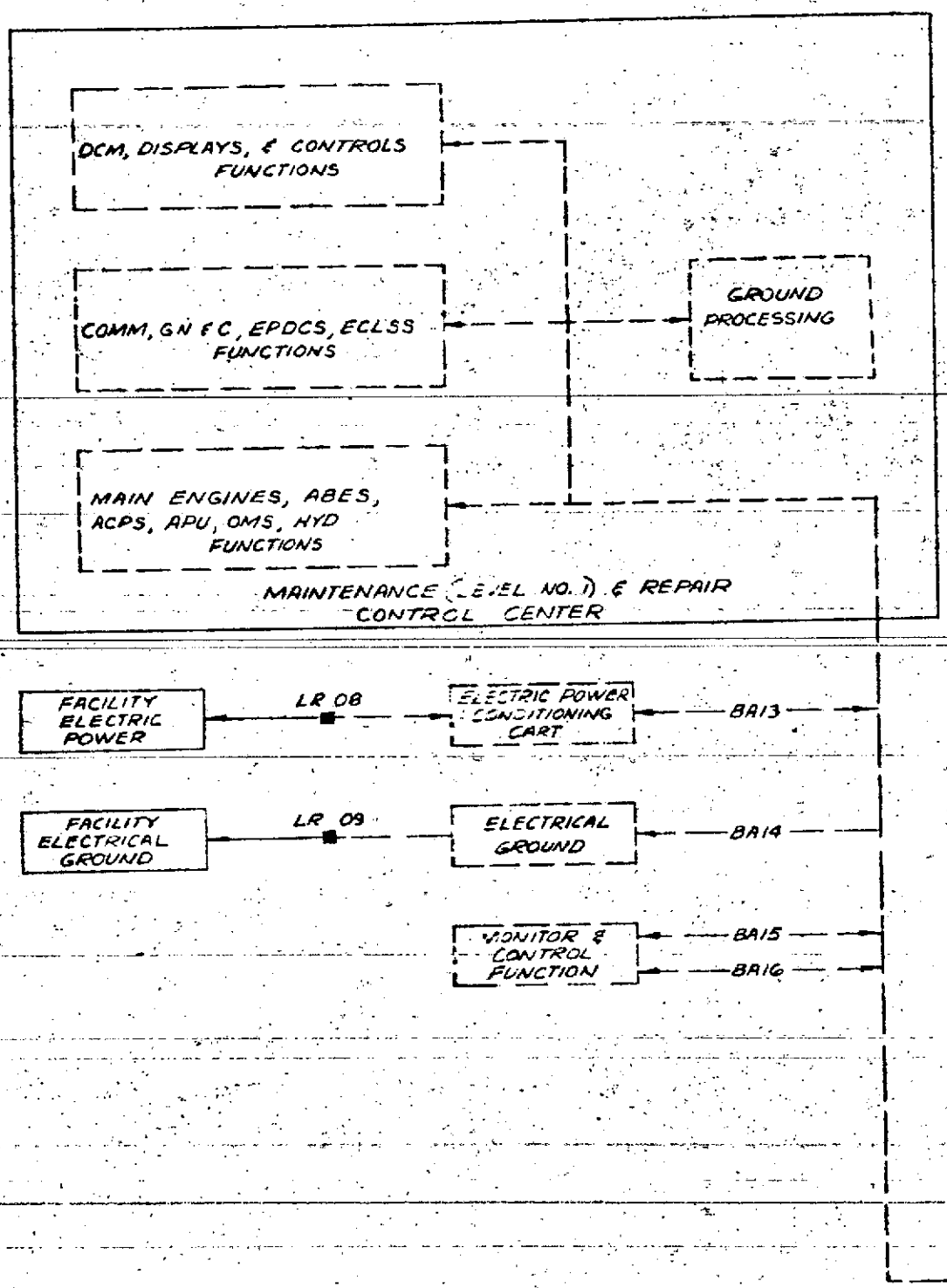
(b) Category II — those ground service interfaces required to service the vehicle at the launch pad; however, the service can be terminated prior to, or concurrent with, personnel ingress/egress access swing arm

retrieval. These ground service interfaces are designated Swing-Arm Umbilicals (coded BB for booster and OB for orbiter).

(c) Category III — those external ground service interfaces required for scheduled vehicle servicing in the M&R area in preparation for launch. These services are designated External Service Disconnects (coded BC for booster and OC for orbiter).

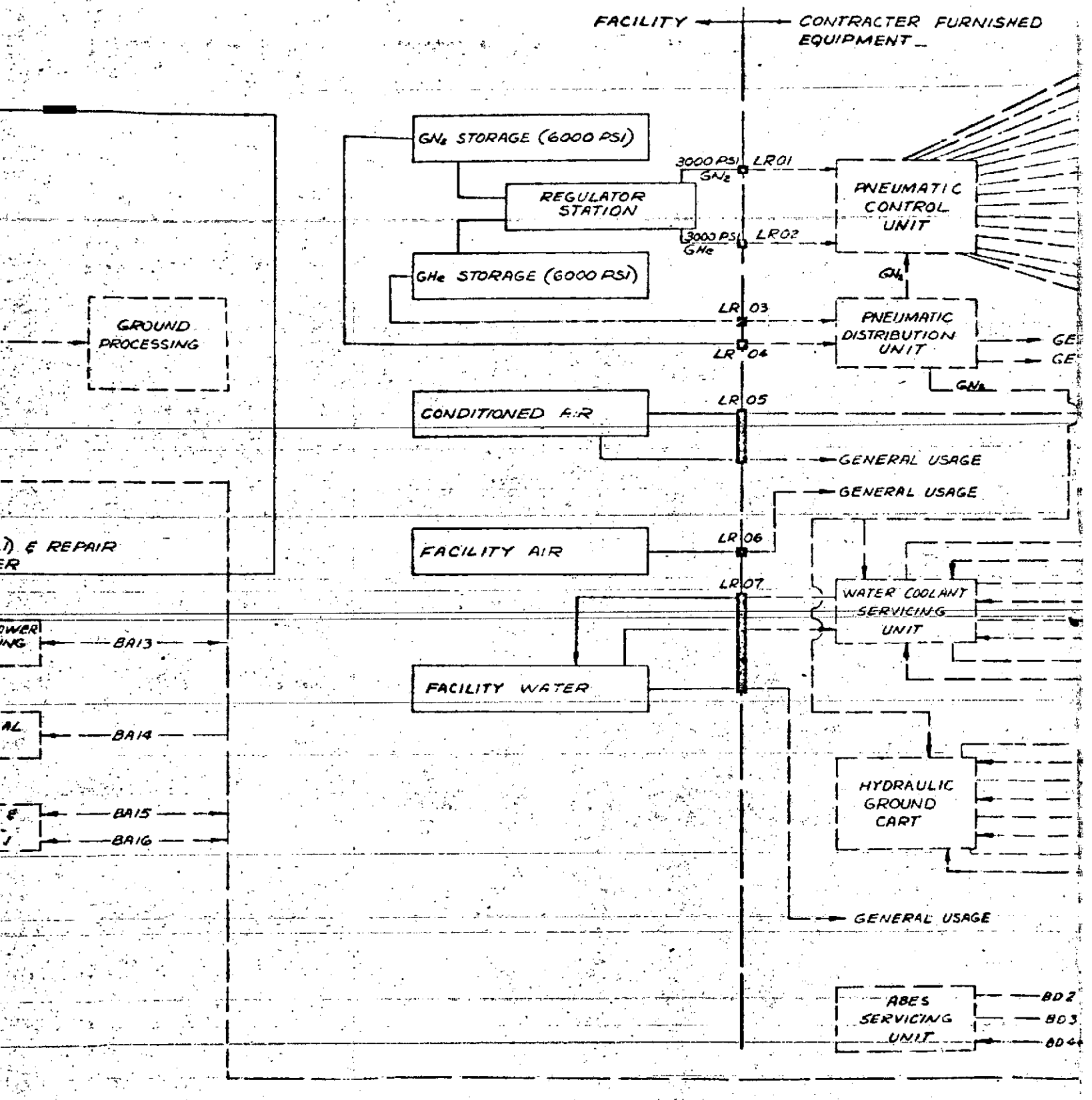
(d) Category IV — those internal ground connections required for unscheduled vehicle servicing in the M&R area. These services are designated Internal Service Disconnects (coded BD for booster and OD for orbiter).

(e) Category V — those ground services interfaces between the booster and orbiter common or dedicated GSE to launch pad, M&R and landing sites facilities. These services are designated GSE - Facility Disconnects (coded LE for the launch pad, LR for the M&R area and LS for the landing sites).

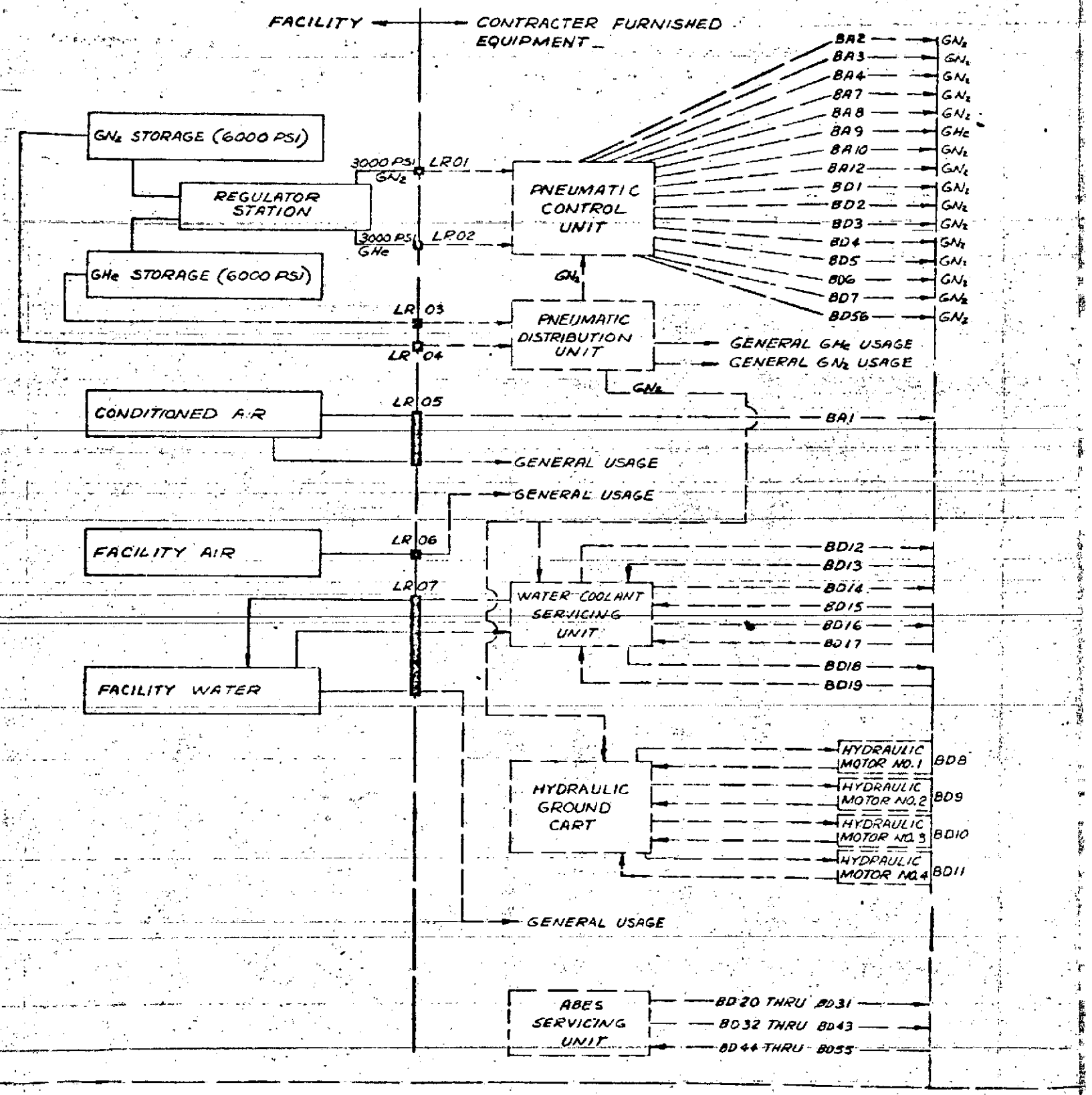

DCM, DISPLAYS, & CONTROLS FUNCTIONS
COMM, GN & C, EPDCS, ECLSS FUNCTIONS
GROUND PROCESSING
MAIN ENGINES, ABES, ACPS, APU, OMS, HYD FUNCTIONS
MAINTENANCE (LEVEL NO. 1) & REPAIR CONTROL CENTER
FACILITY ELECTRIC POWER
LR 08
ELECTRIC POWER CONDITIONING CART
BA13
FACILITY ELECTRICAL GROUND
LR 09
ELECTRICAL GROUND
BA14
MONITOR & CONTROL FUNCTION
BA15
BA16

F

F-3, 4 (A)


FACILITY
CONTRACTER FURNISHED EQUIPMENT
GN2 STORAGE (6000 PSI)
REGULATOR STATION
GHe STORAGE (6000 PSI)
3000 PSI GN2
LR01
3000 PSI GHe
LR02
PNEUMATIC CONTROL UNIT
GN2
LR 03
LR 04
PNEUMATIC DISTRIBUTION UNIT
GE
GE
GN2
GROUND PROCESSING
CONDITIONED AIR
LR 05
GENERAL USAGE
GENERAL USAGE
FACILITY AIR
LR 06
LR 07
WATER COOLANT SERVICING UNIT
BA13
BA14
BA15
BA16
FACILITY WATER
HYDRAULIC GROUND CART
GENERAL USAGE
ABES SERVICING UNIT
BD2
BD3
BD4

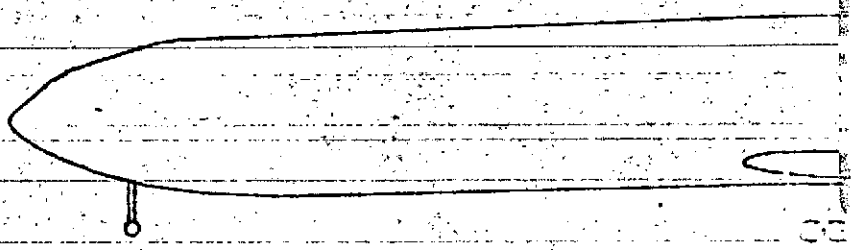
F-3, 4 (B)


FACILITY
CONTRACTER FURNISHED EQUIPMENT
GN2 STORAGE (6000 PSI)
REGULATOR STATION
GHe STORAGE (6000 PSI)
3000 PSI GN2
LR01
3000 PSI GHe
LR02
PNEUMATIC CONTROL UNIT
BA2
BA3
BA4
BA7
BA8
BA9
BA10
BA12
BD1
BD2
BD3
BD4
BD5
BD6
BD7
BD56
GN2
GHe
LR 03
LR 04
PNEUMATIC DISTRIBUTION UNIT
GENERAL GHe USAGE
GENERAL GN2 USAGE
CONDITIONED AIR
LR 05
BA1
GENERAL USAGE
GENERAL USAGE
FACILITY AIR
LR 06
BD12
BD13
BD14
BD15
BD16
BD17
BD18
BD19
LR 07
WATER COOLANT SERVICING UNIT
FACILITY WATER
HYDRAULIC GROUND CART
HYDRAULIC MOTOR NO.1
HYDRAULIC MOTOR NO.2
HYDRAULIC MOTOR NO.3
HYDRAULIC MOTOR NO.4
BD8
BD9
BD10
BD11
GENERAL USAGE
ABES SERVICING UNIT
BD20 THRU BD31
BD32 THRU BD43
BD44 THRU BD55

F-3, 4 (c)

GN_2
GN_2
GN_2
GN_2
GHe
GN_2
GN_2
GN_2
GN_2
GN_2
GN_2
GN_2
GN_2
GN_2
GN_2
GE
GE

BOOSTER

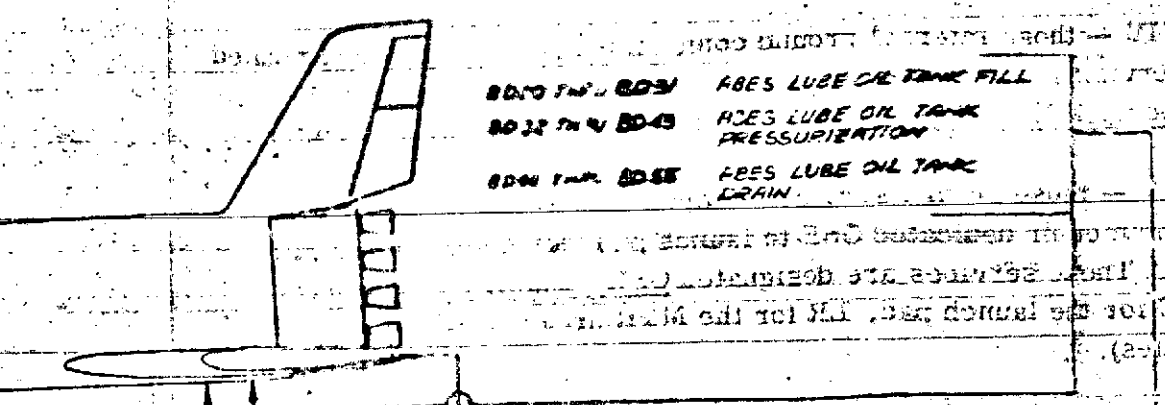


BD1	LH_2 HORIZONTAL FILL & DRAIN
BD2	LO_2 HORIZONTAL FILL & DRAIN
BD3	JP TANK HORIZONTAL FILL
BD4	HYDRAULIC GN_2 FLASK NO. 1 CHARGE
BD5	HYDRAULIC GN_2 FLASK NO. 2 CHARGE
BD6	HYDRAULIC GN_2 FLASK NO. 3 CHARGE
BD7	HYDRAULIC GN_2 FLASK NO. 4 CHARGE
BD8	DRIVE PAD FOR HYDRAULIC MOTOR NO. 1
BD9	DRIVE PAD FOR HYDRAULIC MOTOR NO. 2
BD10	DRIVE PAD FOR HYDRAULIC MOTOR NO. 3
BD11	DRIVE PAD FOR HYDRAULIC MOTOR NO. 4
BD12	HYDRAULIC COOLER NO. 1 WATER SUPPLY
BD13	HYDRAULIC COOLER NO. 1 WATER RETURN
BD14	HYDRAULIC COOLER NO. 2 WATER SUPPLY
BD15	HYDRAULIC COOLER NO. 2 WATER RETURN
BD16	HYDRAULIC COOLER NO. 3 WATER SUPPLY
BD17	HYDRAULIC COOLER NO. 3 WATER RETURN
BD18	HYDRAULIC COOLER NO. 4 WATER SUPPLY
BD19	HYDRAULIC COOLER NO. 4 WATER RETURN
BD56	JP FUEL TANK HORIZONTAL DRAIN

BA1	ECS
BA2	LO_2 FILL
BA3	LO_2 M
BA4	LH_2 FILL
BA7	GH_2 GSE ACCUM. LH_2 TA
BA8	GO_2 GSE ACCUM
BA9	GH_2 GSE ENGINE
BA10	GN_2 FO PRELA
BA12	HYDROG DRAIN
BA13	ELECT
BA14	ELECT
BA15	DATA
BA16	DATA

ILIC NO. 1 BD8
ULIC NO. 2 BD9
ULIC NO. 3 BD10
ILIC NO. 4 BD11

F-3, 4 (D)



BD10 THRU BD31 ABES LUBE OIL TANK FILL

BD32 THRU BD43 ABES LUBE OIL TANK PRESSURIZATION

BD44 THRU BD55 ABES LUBE OIL TANK DRAIN

BA1 ECS CONDITIONED AIR

BA2 LO_2 FILL & DRAIN-MAIN & APS TANKS

BA3 LO_2 MAIN ENGINE BLEED

BA4 LH_2 FILL & DRAIN-MAIN & APS TANKS

BA7 GH_2 GSE SUPPLY FOR APS/APU ACCUMULATOR CHARGE & MAIN LH_2 TANK PRE-PRESSURIZATION

BA8 GO_2 GSE SUPPLY FOR APS/APU ACCUMULATOR CHARGE

BA9 GH_2 GSE SUPPLY FOR MAIN ENGINE PURGE

BA10 GH_2 FOR MAIN ENGINE PRELAUNCH PURGE

BA12 HYDROCARBON FUEL FILL & DRAIN-ABES TANKS

BA13 ELECTRIC POWER

BA14 ELECTRICAL GROUND

BA15 DATA BUSS CONNECTION NO. 1

BA16 DATA BUSS CONNECTION NO. 2

LEGEND:

——— EXISTING

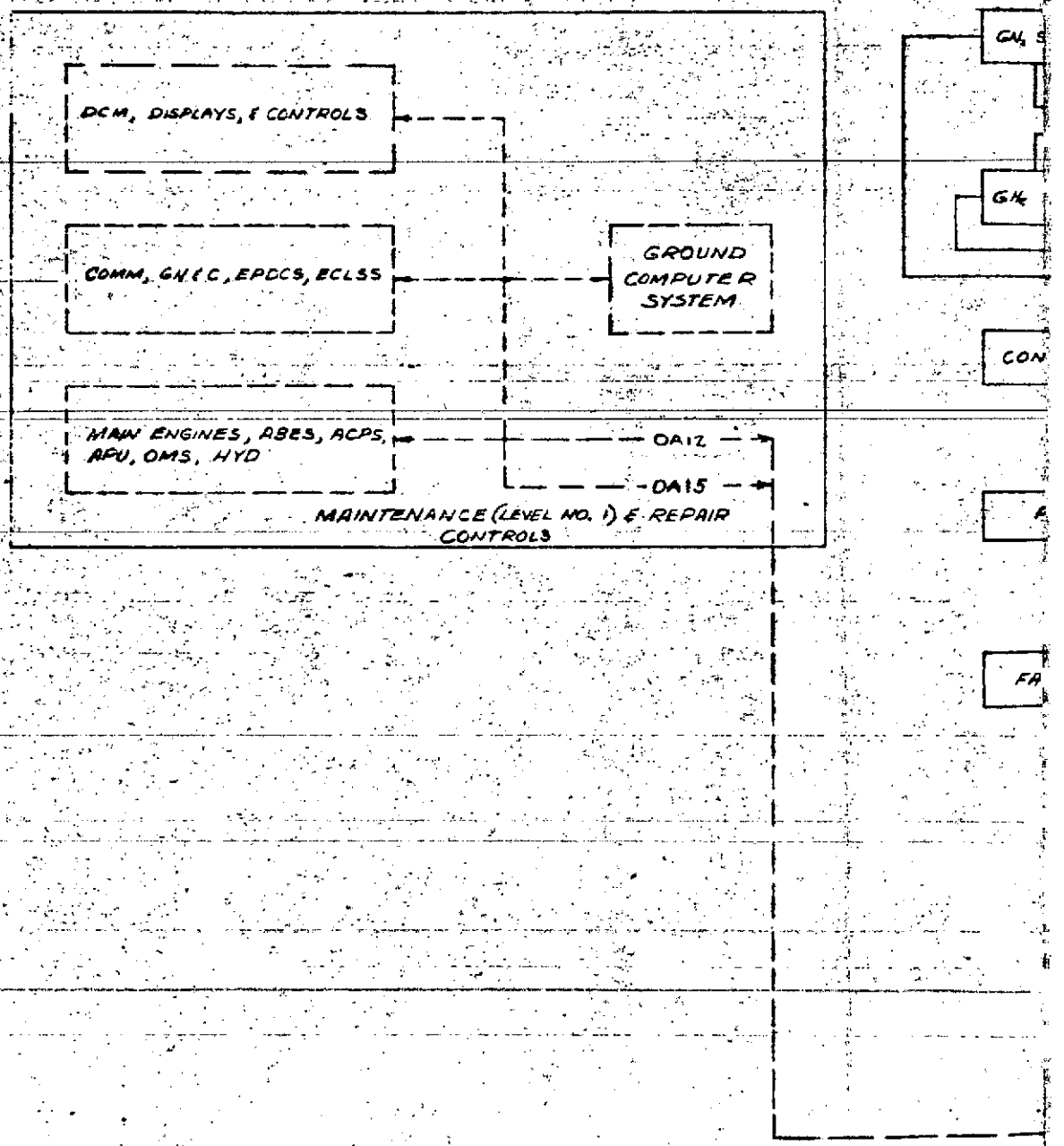
- - - NEW

BA RISEOFF DISCONNECTS (CATEGORY I)

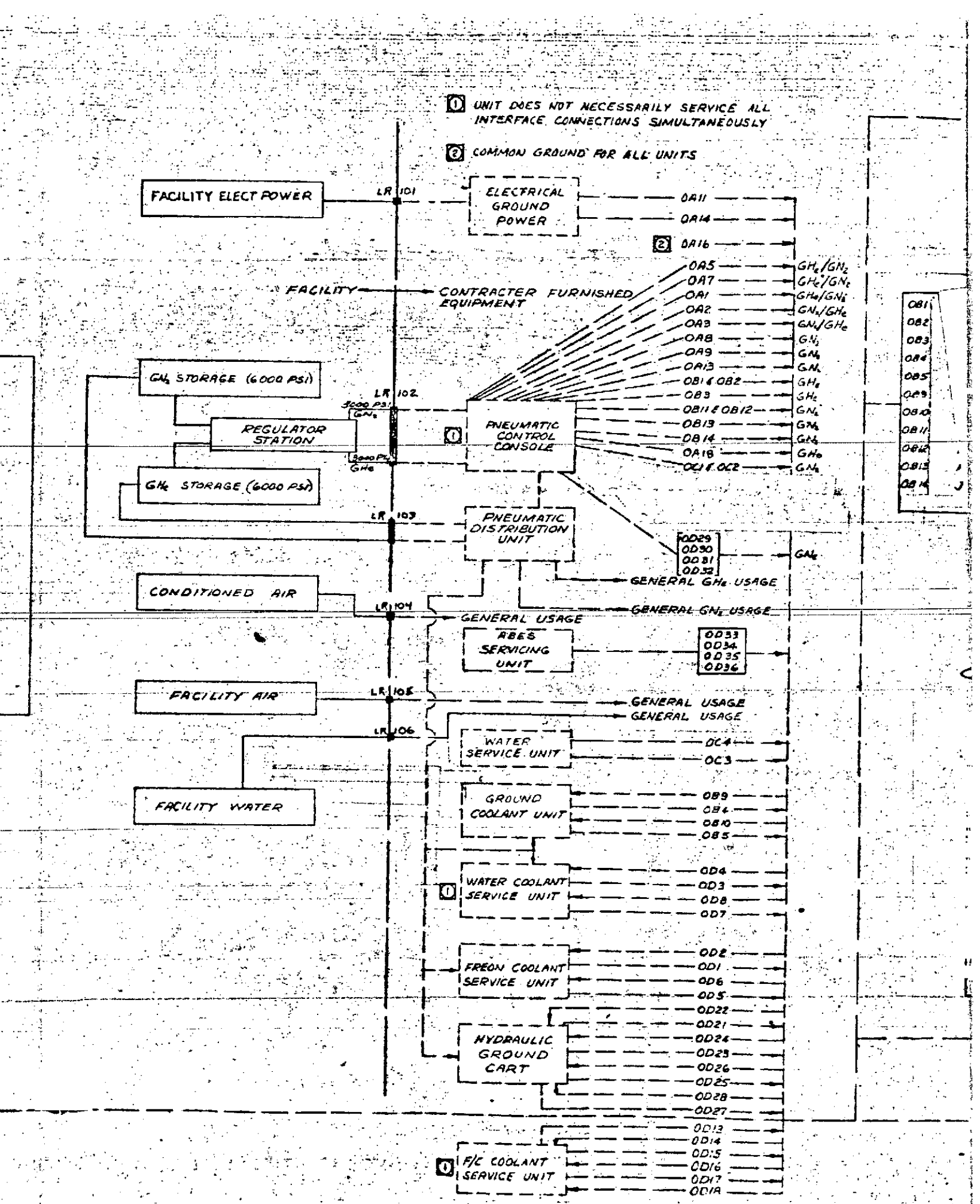
BD INTERNAL CONNECTONS (CATEGORY II)

LR GSE TO FACILITY INTERFACES (CATEGORY V)

Figure 3-1. Booster M&R Functional Interface Diagram


DCM, DISPLAYS, & CONTROLS
COMM, GN&C, EPDCS, ECLSS
GROUND COMPUTER SYSTEM
MAIN ENGINES, ABES, ACPS, APU, OMS, HYD
OA12
OA15
MAINTENANCE (LEVEL NO. 1) & REPAIR CONTROLS

F-5, 6 (A)

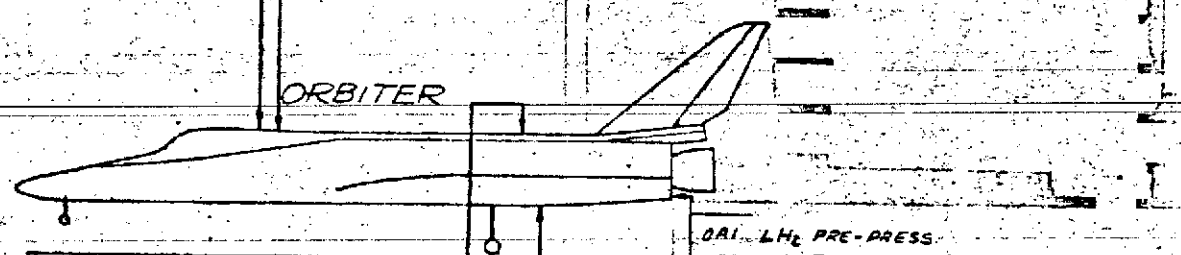

1 UNIT DOES NOT NECESSARILY SERVICE ALL INTERFACE CONNECTIONS SIMULTANEOUSLY
2 COMMON GROUND FOR ALL UNITS
FACILITY ELECT POWER
LR 101
ELECTRICAL GROUND POWER
OA11
OA14
2 OA16
OA5
OA7
OA1
OA2
OA3
OA8
OA9
OA13
OB1 & OB2
OB3
OB11 & OB12
OB13
OB14
OA18
OC1 & OC2
FACILITY
CONTRACTER FURNISHED EQUIPMENT
GN2 STORAGE (6000 PSI)
LR 102
3000 PSI GN2
REGULATOR STATION
3000 PSI GHe
GHe STORAGE (6000 PSI)
1
PNEUMATIC CONTROL CONSOLE
LR 103
PNEUMATIC DISTRIBUTION UNIT
OD29
OD30
OD31
OD32
GHe
GENERAL GHe USAGE
CONDITIONED AIR
LR 104
GENERAL USAGE
GENERAL GN2 USAGE
ABES SERVICING UNIT
OD33
OD34
OD35
OD36
FACILITY AIR
LR 105
GENERAL USAGE
GENERAL USAGE
LR 106
WATER SERVICE UNIT
OC4
OC3
FACILITY WATER
GROUND COOLANT UNIT
OB9
OB4
OB10
OB5
1 WATER COOLANT SERVICE UNIT
OD4
OD3
OD8
OD7
FREON COOLANT SERVICE UNIT
OD2
OD1
OD6
OD5
HYDRAULIC GROUND CART
OD22
OD21
OD24
OD23
OD26
OD25
OD28
OD27
4 F/C COOLANT SERVICE UNIT
OD13
OD14
OD15
OD16
OD17
OD18

F-5,6 (B)

OD13 COOLANT SUPPLY F/C NO. 1
OD14 COOLANT RETURN F/C NO. 1
OD15 COOLANT SUPPLY F/C NO. 2
OD16 COOLANT RETURN F/C NO. 2
OD17 COOLANT SUPPLY F/C NO. 3
OD18 COOLANT RETURN F/C NO. 3

OB1 P.G.S. LH_2 FILL NO. 1
OB2 P.G.S. LH_2 FILL NO. 2
OB3 P.G.S. GH_2 SUPPLY
OB4 PRIMARY HX COOLANT SUPPLY
OB5 SECONDARY HX COOLANT SUPPLY
OB9 PRIMARY HX COOLANT RETURN
OB10 SECONDARY HX COOLANT RETURN
OB11 P.G.S. LO_2 FILL NO. 1
OB12 P.G.S. LO_2 FILL NO. 2
OB13 P.G.S. GO_2 SUPPLY
OB14 JP FILL

OD1 PRIMARY FREON SUPPLY
OD2 PRIMARY FREON RETURN
OD3 PRIMARY WATER SUPPLY
OD4 PRIMARY WATER RETURN
OD5 SECONDARY FREON SUPPLY
OD6 SECONDARY FREON RETURN
OD7 SECONDARY WATER SUPPLY
OD8 SECONDARY WATER RETURN
OC1 GN_2 FILL NO. 1
OC2 GN_2 FILL NO. 2
OC3 POTABLE WATER FILL
OC4 WASTE WATER FILL



OD29 HYDRAULIC GN_2 PRESS. NO. 1
OD30 HYDRAULIC GN_2 PRESS. NO. 2
OD31 HYDRAULIC GN_2 PRESS. NO. 3
OD32 HYDRAULIC GN_2 PRESS. NO. 4
OD21 HYDRAULIC GND SUPPLY NO. 1
OD22 HYDRAULIC GND RETURN NO. 1
OD23 HYDRAULIC GND SUPPLY NO. 2
OD24 HYDRAULIC GND RETURN NO. 2
OD25 HYDRAULIC GND SUPPLY NO. 3
OD26 HYDRAULIC GND RETURN NO. 3
OD27 HYDRAULIC GND SUPPLY NO. 4
OD28 HYDRAULIC GND RETURN NO. 4

OD33 FILL FOR ABES OIL TANK NO. 1
OD34 FILL FOR ABES OIL TANK NO. 2
OD35 FILL FOR ABES OIL TANK NO. 3
OD36 FILL FOR ABES OIL TANK NO. 4

OA1 LH_2 PRE-PRESS
OA2 LH_2 TANK FILL & DRAIN
OA3 ACPS GH_2 FILL
OA8 LO_2 TANK PRE-PRESS.
OA9 LO_2 TANK FILL & DRAIN
OA11 GROUND ELECTRICAL POWER NO. 1
OA12 INSTRUMENTATION/COMMUNICATIONS NO. 1
OA13 ACPS GO_2 FILL
OA14 GROUND ELECTRICAL POWER NO. 2
OA15 INSTRUMENTATION/COMMUNICATIONS NO. 2
OA16 VEHICLE GROUND
OA5 ON-ORBIT GH_2 VENT
OA7 GN_2 HOT GAS EXHAUST
OA18 HELIUM FILL

LEGEND:

———	EXISTING
- - - -	NEW
LR	GSE TO FACILITY INTERFACES
OA	CATEGORY I (RISEOFF) DISCONNECTS
OB	CATEGORY II (SWING ARM) DISCONNECTS
OC	CATEGORY III (EXTERNAL SERVICE) DISCONNECTS
OD	CATEGORY IV (INTERNAL SERVICE DISCONNECTS)

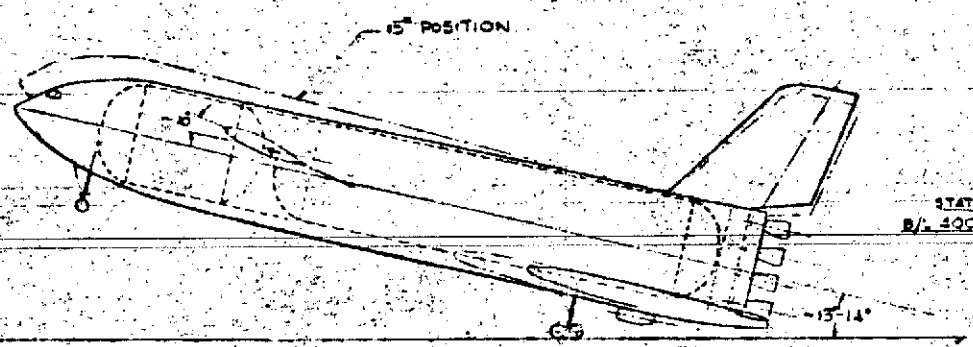
FUNCTIONAL INTERFACE DIAGRAM
FOR: KSC COMPLEX 39 VAB
MAINTENANCE OPERATIONS
LEVEL NO. 1
SPACE SHUTTLE ORBITER

FIGURE 3-2

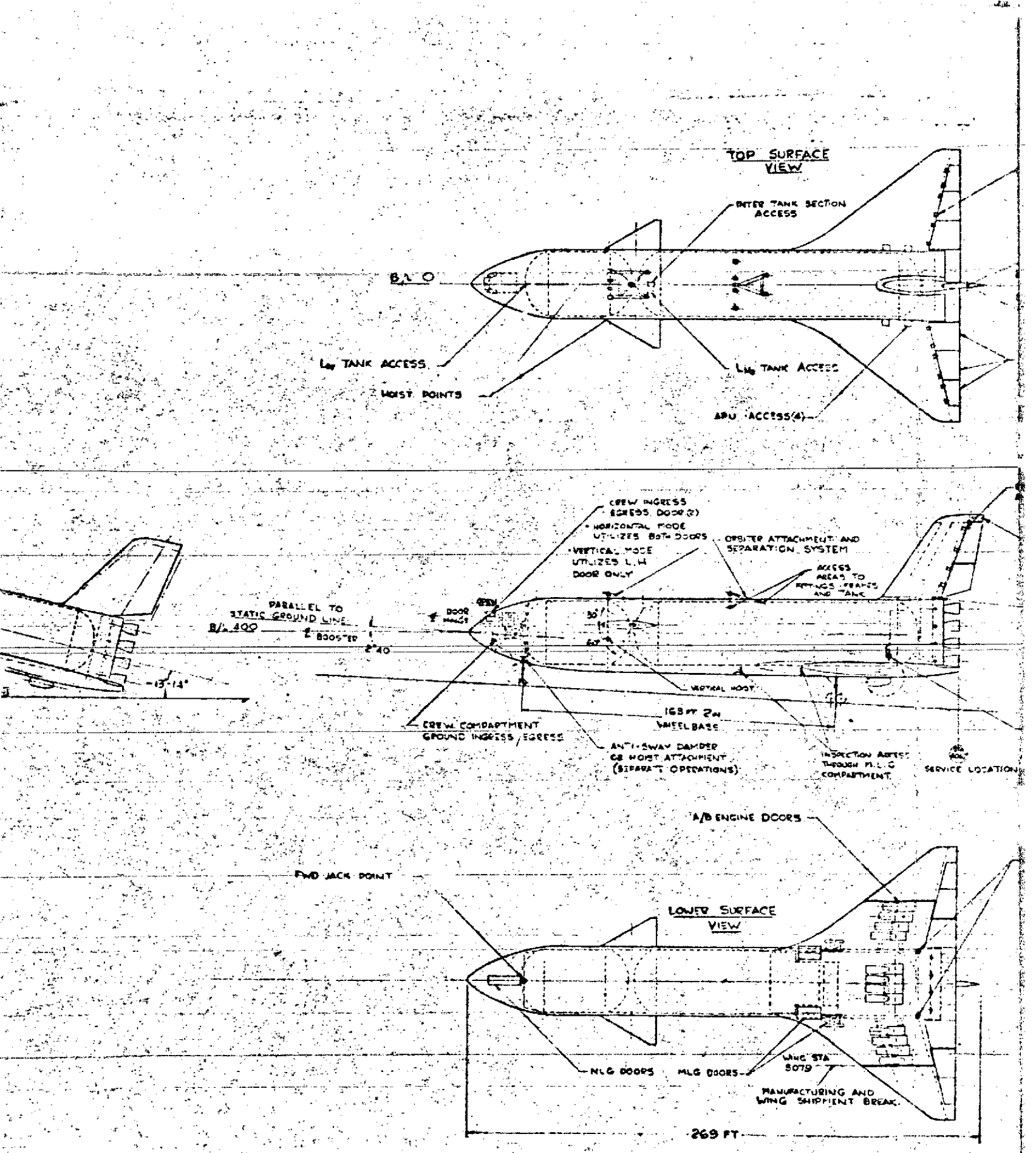
R.M. COLVIN 5-8-71

GENERAL REVISION R. COLVIN 5-12-71
J. SHADLEY 6-12-71

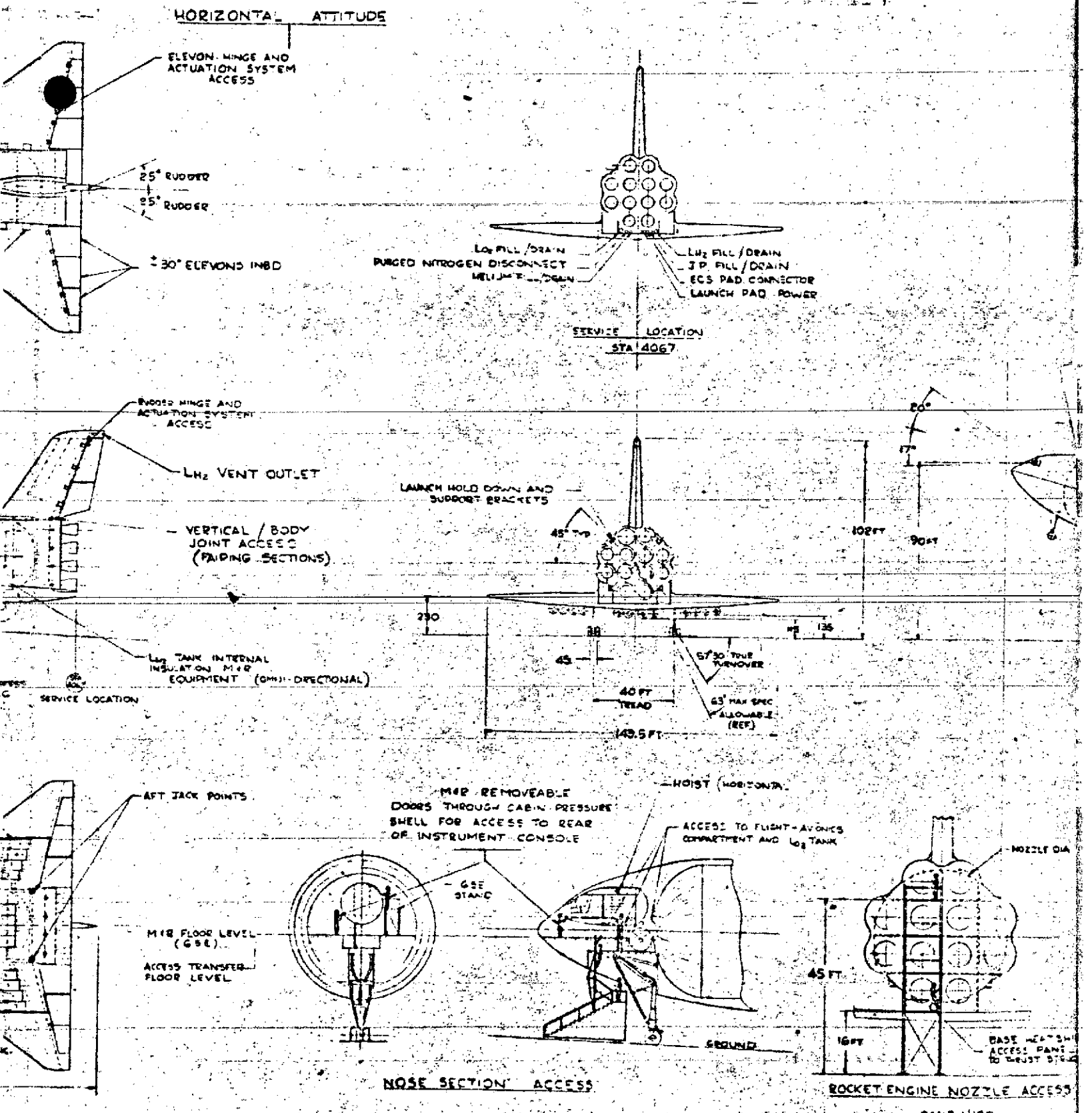
TAKE OFF ATTITUDE



F-7,8 (A)


TOP SURFACE VIEW
INTER TANK SECTION ACCESS
B/L 0
L_{OF} TANK ACCESS
HOIST POINTS
L_{H_2} TANK ACCESS
APU ACCESS(4)
CREW INGRESS EGRESS DOOR(2)
HORIZONTAL MODE UTILIZES BOTH DOORS
VERTICAL MODE UTILIZES L.H DOOR ONLY
ORBITER ATTACHMENT AND SEPARATION SYSTEM
ACCESS AREAS TO FITTINGS, FRAMES AND TANK
PARALLEL TO STATIC GROUND LINE
B/L 400
BOOSTER
DOOR HINGE
2°40'
13'-14"
VERTICAL HOIST
163 FT 2 IN WHEELBASE
CREW COMPARTMENT GROUND INGRESS/EGRESS
ANTI-SWAY DAMPER OR HOIST ATTACHMENT (SEPARATE OPERATIONS)
INSPECTION ACCESS THROUGH M.L.G COMPARTMENT
SERVICE LOCATION
A/B ENGINE DOORS
FWD JACK POINT
LOWER SURFACE VIEW
NLG DOORS
MLG DOORS
WING STA 5079
MANUFACTURING AND WING SHIPMENT BREAK
269 FT

F-7,8 (B)


HORIZONTAL ATTITUDE
ELEVON HINGE AND ACTUATION SYSTEM ACCESS
25° RUDDER
25° RUDDER
± 30° ELEVONS INBD
LO2 FILL / DRAIN
PURGED NITROGEN DISCONNECT
HELIUM FILL / DRAIN
LH2 FILL / DRAIN
J.P. FILL / DRAIN
ECS PAD CONNECTOR
LAUNCH PAD POWER
SERVICE LOCATION
STA 4067
RUDDER HINGE AND ACTUATION SYSTEM ACCESS
LH2 VENT OUTLET
VERTICAL / BODY JOINT ACCESS (FAIRING SECTIONS)
LH2 TANK INTERNAL INSULATION M&R EQUIPMENT (OMNI-DIRECTIONAL)
SERVICE LOCATION
LAUNCH HOLD DOWN AND SUPPORT BRACKETS
45° TYP
102 FT
90 FT
20°
17°
230
135
45
57°30' TRUE TURNOVER
40 FT TREAD
63° MAX SPEC ALLOWABLE (REF)
143.5 FT
AFT JACK POINTS
M&R REMOVEABLE DOORS THROUGH CABIN PRESSURE SHELL FOR ACCESS TO REAR OF INSTRUMENT CONSOLE
HOIST (HORIZONTAL)
ACCESS TO FLIGHT-AVIONICS COMPARTMENT AND LO2 TANK
GSE STAND
M&R FLOOR LEVEL (GSE)
ACCESS TRANSFER FLOOR LEVEL
GROUND
NOSE SECTION ACCESS
NOZZLE DIA
45 FT
16 FT
BASE HEATSHIELD ACCESS PANEL TO THRUST STRUCT
ROCKET ENGINE NOZZLE ACCESS
SCALE 1/100

F-7,8 (C)

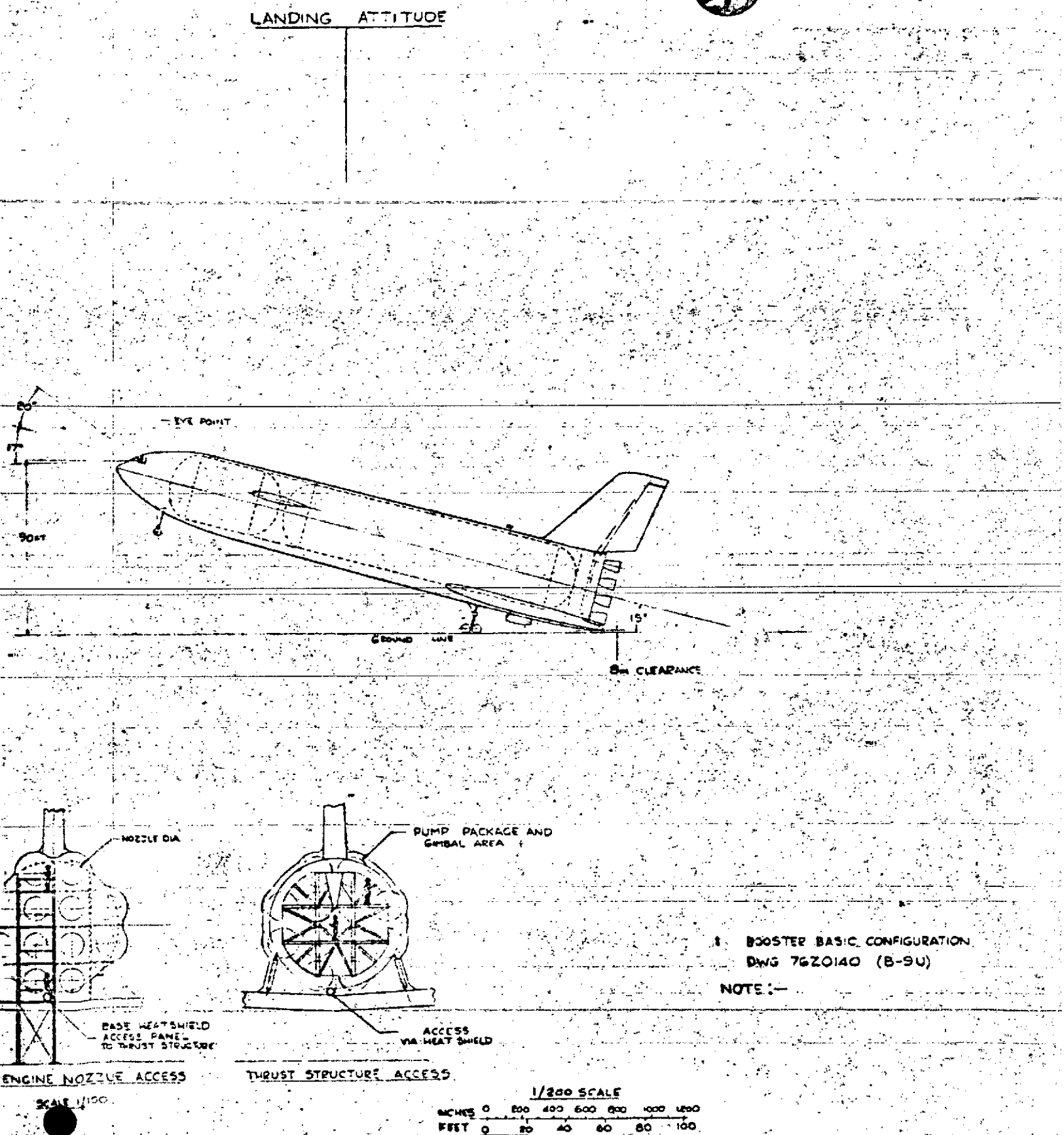


Figure 3-3. Booster M&R Interfaces

BOOSTER

TO

M&R OPERATIONS COMPLEX

INTERFACES

TABLE 3-1. M&R OPERATIONS COMPLEX - BOOSTER INTERFACES

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
BA 1	ECS Conditioned Air	Ground Cooling for Cabin and Equipment Areas	Thrust Section	Fig. 3-1	25 lbs/min. $40^{o}F$
BA 2	LO_2 Fill and Drain	LO_2 System Pressurization and Checkout	Thrust Section	Fig. 3-1	
BA 3	LO_2 Main Engine Bleed	Main Engine Bleed System Checkout	Thrust Section	Fig. 3-1	
BA 4	LH_2 Fill and Drain	LH_2 System Pressurization and Checkout	Thrust Section	Fig. 3-1	
BA 7	ACPS Accumulator GH_2 Charge and Main LH_2 Tank Pre-Press	ACPS System and Main LH_2 Tank pre-press System Checkout	Thrust Section	Fig. 3-1	
BA 8	ACPS Accumulator GO_2 Charge	ACPS Accumulator GO_2 System Checkout	Thrust Section	Fig. 3-1	
BA 9	Helium Storage and Main Engine Purge	GHe Pressurization for System Checkout	Thrust Section	Fig. 3-1	
BA 10	GN_2 Main Engine Ground Purge	Main Engine System Checkout	Thrust Section	Fig. 3-1	

TABLE 3-1. M&R OPERATIONS COMPLEX - BOOSTER INTERFACES

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
BA 12	JP Fuel Tank Fill and Drain	JP Fuel System Checkout	Thrust Section	Fig. 3-1	
BA 13	Electrical Ground Power Umbilical	Ground Electrical Power for Systems Operation and Checkout	Thrust Section	Fig. 3-1	
BA 14	Electrical Ground	Vehicle to Ground Connection During Checkout	Thrust Section	Fig. 3-1	
BA 15	Data Bus #1 Umbilical	Ground Data Path to Vehicle DCM System	Thrust Section	Fig. 3-1	
BA 16	Data Bus #2 Umbilical	Ground Data Path to Vehicle DCM System	Thrust Section	Fig. 3-1	
BA 20	Booster Vertical Erection	Provisions for Lifting Booster to Vertical Mate Position	Forward Support System	Fig. 3-3	
BA 21	Booster Vertical Erection	Provisions for Lifting Booster to Vertical Mate Position	Thrust Structure	Fig. 3-3	
BA 22	Vehicle Jacking	Provisions for Raising Booster for Landing Gear Ground Operations	Nose Gear Structure Attachment	Fig. 3-3	

TABLE 3-1. M&R OPERATIONS COMPLEX - BOOSTER INTERFACES

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
BA 23	Vehicle Jacking	Provisions for Raising Booster for Landing Gear Ground Operation	Thrust Structure Support	Fig. 3-3	
BD 1	LH_2 Horizontal Fill and Drain	LH_2 System Checkout		Fig. 3-1	
BD 2	LO_2 Horizontal Fill and Drain	LO_2 System Checkout		Fig. 3-1	
BD 3	JP Tank Horizontal Fill	JP Fuel System Checkout		Fig. 3-1	
BD 4	Hyd. Storage Bottle #1 GN_2 Charge	Pressurize Hyd. System for Ground Checkout		Fig. 3-1	
BD 5	Hyd. Storage Bottle #2 GN_2 Charge	Pressurize Hyd. System for Ground Checkout		Fig. 3-1	
BD 6	Hyd. Storage Bottle #3 GN_2 Charge	Pressurize Hyd. System for Ground Checkout		Fig. 3-1	
BD 7	Hyd. Storage Bottle #4 GN_2 Charge	Pressurize Hyd. System for Ground Checkout		Fig. 3-1	

TABLE 3-1. M&R OPERATIONS COMPLEX - BOOSTER INTERFACES

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
BD 8	Hyd. Motor #1 Drive	Hook up for GSE Hyd. Motor for Booster Hydraulic System Ground Operation		Fig. 3-1	
BD 9	Hyd. Motor #2 Drive	Hook up for GSE Hyd. Motor for Booster Hydraulic System Ground Operation		Fig. 3-1	
BD 10	Hyd. Motor #3 Drive	Hook up for GSE Hyd. Motor for Booster Hydraulic System Ground Operation		Fig. 3-1	
BD 11	Hyd. Motor #4 Drive	Hook up for GSE Hyd. Motor for Booster Hydraulic System Ground Operation		Fig. 3-1	
BD 12	Hyd. Cooler #1 Water Supply	Hook up for Cooling Booster Hydraulic System during Ground Operation		Fig. 3-1	
BD 13	Hyd. Cooler #1 Water Return	Hook up for Cooling Booster Hydraulic System during Ground Operation		Fig. 3-1	
BD 14	Hyd. Cooler #2 Water Supply	Hook up for Cooling Booster Hydraulic System During Ground Operation		Fig. 3-1	

TABLE 3-1. M&R OPERATIONS COMPLEX - BOOSTER INTERFACE

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
BD 15	Hyd. Cooler #2 Water Return	Hook up for Cooling Booster Hydraulic System During Ground Operation		Fig. 3-1	
BD 16	Hyd. Cooler #3 Water Supply	Hook up for Cooling Booster Hydraulic System During Ground Operation		Fig. 3-1	
BD 17	Hyd. Cooler #3 Water Return	Hook up for Cooling Booster Hydraulic System During Ground Operation		Fig. 3-1	
BD 18	Hyd. Cooler #4 Water Supply	Hook up for Cooling Booster Hydraulic System during Ground Operation		Fig. 3-1	
BD 19	Hyd. Cooler # 4 Water Return	Hook up for Cooling Booster Hydraulic System During Ground Operation		Fig. 3-1	
BD 20 thru BD 31	ABES Lubrication Oil Pressurized Tank Fill	Fill Pressurized Oil Tank for Vertical Launch		Fig. 3-1	

TABLE 3-1. M&R OPERATIONS COMPLEX - BOOSTER INTERFACES

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
BD 32 thru BD 43	ABES Lubrication Oil Tank Pressurization	Pressurize BD 20 thru BD 31 Tanks for Vertical Launch		Fig. 3-1	
BD 44 thru BD 55	ABES Lubrication Oil Main Tank Drain	Drain Main Oil Tank Before Vertical Erection		Fig. 3-1	
BD 56	Hydrocarbon Fuel Tank Horizontal Drain	Drain Residual Fuel and Maintaining Blanket Pressure in the Tanks		Fig. 3-1	

ORBITER

TO

M&R OPERATIONS COMPLEX

INTERFACES

TABLE 3-2. M&R OPERATIONS COMPLEX - ORBITER INTERFACES

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
OA1	LH_2 Tank Pre-Press	Standby blanket pressure	Thrust section	Fig. 3-2	
OA2	LH_2 Fill & Drain	Leak and Functional Checkout	Thrust Section	Fig. 3-2	
OA3	ACPS GH_2 Fill	Leak and Functional Checkout	Thrust Section	Fig. 3-2	
OA5	On Orbit GH_2 Vent	Leak and Functional Checkout	Thrust Section	Fig. 3-2	
OA7	GH_2 Hot Exhaust		Thrust Section	Fig. 3-2	
OA8	LO_2 Tank Pre-Press	Standby Blanket Pressure	Thrust Section	Figure 3-2	
OA9	LO_2 Fill & Drain	Leak and Functional Checkout	Thrust Section	Fig. 3-2	
OA11	Ground Electrical Power No. 1	Vehicle Ground Servicing Power	Thrust Section	Fig. 3-2	
OA12	Instrumentation/ Communication No. 1	Vehicle Control When Flight	Thrust Section	Fig. 3-2	
OA13	ACPS GO_2 Fill	Leak and Functional Check	Thrust Section	Fig. 3-2	
OA14	Ground Electrical Power No. 2	Vehicle Ground Servicing Power	Thrust Section	Fig. 3-2	
OA15	Instrumentation/ Communication No. 2	Vehicle Control When Flight Deck is Unmanned	Thrust Section	Fig. 3-2	
OA18	Helium Fill	Leak and Functional Checkout	Thrust Section	Fig. 3-2	
OA16	Vehicle-Ground	Ground Vehicle	Thrust Section	Fig. 3-2	
OB1	PGS LH_2 Fill #1	Leak and Functional Check	Mid Body	Fig. 3-2	
OB2	PGS LH_2 Fill #2	Leak and Functional Check	Mid Body	Fig. 3-2	
OB3	PGS GH_2 GSE Supply	Leak and Functional Check	Mid Body	Fig. 3-2	

TABLE 3-2. M&R OPERATIONS COMPLEX - ORBITER INTERFACES

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
OB4	Primary HX Coolant Supply	Hookup to ground supply for system operation and checkout	Mid Body	Fig. 3-2	
OB5	Secondary HX Coolant Supply	Hookup to ground supply for system operation and checkout	Mid Body	Fig. 3-2	
OB9	Primary HX Coolant Return	Hookup to ground supply for system operation and checkout	Mid Body	Fig. 3-2	
OB10	Secondary HX Return	Hookup to ground supply for system operation and checkout	Mid Body	Fig. 3-2	
OB11	PGS LO_2 Fill #1	Leak and Functional Checkout	Mid Body	Fig. 3-2	
OB12	PGS LO_2 Fill #2	Leak and Functional Checkout	Mid Body	Fig. 3-2	
OB13	PGS GO_2 Supply	Leak and Functional Checkout	Mid Body	Fig. 3-2	
OB14	JP Fill	Leak and Functional Checkout	Mid Body	Fig. 3-2	
OC1	GN_2 Fill #1	Leak and Functional Checkout	Forward Body	Fig. 3-2	
OC2	GN_2 Fill #2	Leak and Functional Checkout	Forward Body	Fig. 3-2	
OC3	Potable Water Fill	System checkout and launch preparation fill	Forward Body	Fig. 3-2	
OC4	Waste Water Fill	System checkout and launch preparation fill	Forward Body	Fig. 3-2	

TABLE 3-2. M&R OPERATIONS COMPLEX - ORBITER INTERFACES

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
OD1	Primary Freon Supply	System checkout and launch preparation fill	Forward Body	Fig. 3-2	
OD2	Primary Freon Return	System checkout and launch preparation fill	Forward Body	Fig. 3-2	
OD3	Primary Water Supply	System checkout and launch preparation fill	Forward Body	Fig. 3-2	
OD4	Primary Water Return	System checkout and launch preparation fill	Forward Body	Fig. 3-2	
OD5	Secondary Freon Supply	System checkout and launch preparation fill	Forward Body	Fig. 3-2	
OD6	Secondary Freon Return	System checkout and launch preparation	Forward Body	Fig. 3-2	
OD7	Secondary Water Supply	System checkout and launch preparation fill	Forward Body	Fig. 3-2	
OD8	Secondary Water Return	System checkout and launch preparation fill	Forward Body	Fig. 3-2	
OD13	Coolant Supply FC#1	PGS Fill for FCP #1 Coolant	Forward Body	Fig. 3-2	

TABLE 3-2. M&R OPERATIONS COMPLEX - ORBITER INTERFACES

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
OD14	Coolant Return FC #1	PGS Return for FCP #1 Coolant Loop	Forward Body	Fig. 3-2	
OD15	Coolant Supply FC #2	PGS Fill for FCP #1 Coolant Loop	Forward Body	Fig. 3-2	
OD16	Coolant Return FC #2	PGS Return for FCP #2 Coolant Loop	Forward Body	Fig. 3-2	
OD17	Coolant Supply FC #3	PGS Fill for FCP #3 Coolant Loop	Forward Body	Fig. 3-2	
OD18	Coolant Return FC #3	PGS Return for FCP #3 Coolant Loop	Forward Body	Fig. 3-2	
OD21	Hydraulic Ground Supply #1	Fill Hydraulic System #1	Aft Body	Fig. 3-2	
OD22	Hydraulic Ground Return #1	Return Hydraulic System #1	Aft Body	Fig. 3-2	
OD23	Hydraulic Ground Supply #2	Fill Hydraulic System #2	Aft Body	Fig. 3-2	
OD24	Hydraulic Ground Return #2	Return Hydraulic System #2	Aft Body	Fig. 3-2	

TABLE 3-2. M&R OPERATIONS COMPLEX - ORBITER INTERFACES

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
OD25	Hydraulic Ground Supply #3	Fill Hydraulic System #2	Aft Body	Fig. 3-2	
OD26	Hydraulic Ground Return #3	Return Hydraulic System #3	Aft Body	Fig. 3-2	
OD27	Hydraulic Ground Supply #4	Fill Hydraulic System #4	Aft Body	Fig. 3-2	
OD28	Hydraulic Ground Return #4	Return Hydraulic System #4	Aft Body	Fig. 3-2	
OD29	Hyd. GN_2 Press #1	Hydraulic GN_2 Fill Storage Bottle No. 1		Fig. 3-2	
OD30	Hyd. GN_2 Press #2	Hydraulic GN_2 Fill Storage Bottle No. 2		Fig. 3-2	
OD31	Hyd. GN_2 Press #3	Hydraulic GN_2 Fill Storage Bottle No. 3		Fig. 3-2	
OD32	Hyd. GN_2 Press #4	Hydraulic GN_2 Fill Storage Bottle No. 4		Fig. 3-2	
OD33	ABES Oil Fill #1	ABES Oil Fill No. 1	Forward Engine LH	Fig. 3-2	
OD34	ABES Oil Fill #2	ABES Oil Fill No. 2	Aft Engine RH	Fig. 3-2	
OD35	ABES Oil Fill #3	ABES Oil Fill No. 3	Forward Engine LH	Fig. 3-2	
OD36	ABES Oil Fill #4	ABES Oil Fill No. 4	Aft Engine RH	Fig. 3-2	

M&R OPERATIONS COMPLEX

BOOSTER GROUND SUPPORT EQUIPMENT (GSE)

TO

FACILITIES

INTERFACES

TABLE 3-3. M&R OPERATIONS COMPLEX - BOOSTER GSE TO FACILITIES INTERFACES

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
LR01	GN_2 Supply	Interconnects Facility GN_2 Regulator Station to GSE Pneumatic Control Unit		Fig. 3-1	3000 psi
LR02	GHe Supply	Interconnects Facility GHe Regulator Station to GSE Pneumatic Control Unit		Fig. 3-1	3000 psi
LR03	GHe Supply	Interconnects Facility GHe Storage to GSE Pneumatic Distribution Unit		Fig. 3-1	
LR04	GN_2 Supply	Interconnects Facility GN_2 Storage to GSE Pneumatic Distribution Unit		Fig. 3-1	
LR05	Conditioned Air Supply	Interconnects Facility Air Conditioning System to GSE Disconnect for Vehicle Conditioning		Fig. 3-1	
LR06	Air Supply	Interconnects Facility Air Supply to General Useage Air GSE		Fig. 3-1	
LR07	Water Supply	Interconnects Facility Water Supply to Water Coolant Servicing Unit and General Useage Water GSE		Fig. 3-1	

TABLE 3-3. M&R OPERATIONS COMPLEX - BOOSTER GSE TO FACILITIES INTERFACES

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
LR08	Ground Electrical Power	Interconnects Facility Electrical Power to GSE Electrical Power Conditioning Cart		Fig. 3-1	
LR09	Electrical Ground	Interconnects Facility Electrical Ground to GSE Disconnect for Vehicle Ground		Fig. 3-1	

M&R OPERATIONS COMPLEX

ORBITER GROUND SUPPORT EQUIPMENT (GSE)

TO

FACILITIES

INTERFACES

TABLE 3-4. M&R OPERATIONS COMPLEX - ORBITER GSE TO FACILITIES INTERFACES

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
LR101	Facility Electrical	Procide Electrical Power to the	VAB	Fig. 3-2	
LR102	GN_2, H_e Supply	Provide GN_2 and H_e to the Pneumatic Control Unit and Gas Distribution Unit	VAB	Fig. 3-2	
LR103	GN_2, H_e Supply	Provide GN_2 and H_e to the Pneumatic Distribution Unit	VAB	Fig. 3-2	
LR104	Conditioned Air	Provide Ventilation for Interior Vehicle Work Areas	VAB	Fig. 3-2	
LR104	Facility Air Supply	Provide Facility Air for General Usage	VAB	Fig. 3-2	
LR106	Facility Water Supply	Provide Facility Water to the Conditioned Air Unit	VAB	Fig. 3-2	

APPENDIX G
SD71-127
(MSC 03305)

FINAL SUBMITTAL

INTERFACE DEFINITION DOCUMENT

LANDING SITES

(Also available separately as SR 2.4.4-11191)

25 June 1971

Space Division

North American Rockwell

TABLE OF CONTENTS

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1.	SCOPE	1
2.	APPLICABLE DOCUMENTS	1
3.	INTERFACE DEFINITION	1

1. SCOPE

This Interface Definition Document identifies and defines Landing Sites interfaces between the Space Shuttle System Flight Vehicles (Booster, Orbiter and Payload), the support Equipment, and the Facilities. It is in preliminary form, defining vehicle to support equipment and support equipment to facilities interfaces in gross terms.

2. APPLICABLE DOCUMENTS

This document complies with all applicable requirements of the following documents:

(a) Space Shuttle System Specification, SS613M0001

(b) Space Shuttle Ground System Specification, 76Z0501

(c) Space Shuttle Booster Specification, 76Z0500

(d) Space Shuttle Orbiter Specification, CP613M0002

3. INTERFACE DEFINITION

Landing Sites functional interfaces for major mechanical, fluid, electrical and avionic subsystems are depicted in Figures 3-1 and 3-2. Interface data is defined on Interface Tables 3-1 and 3-2 for the booster and orbiter respectively. to GSE and Tables 3-3 and 3-4 for GSE to facilities.

All vehicle ground interface and GSE to facilities interface requirements shall be categorized as follows:

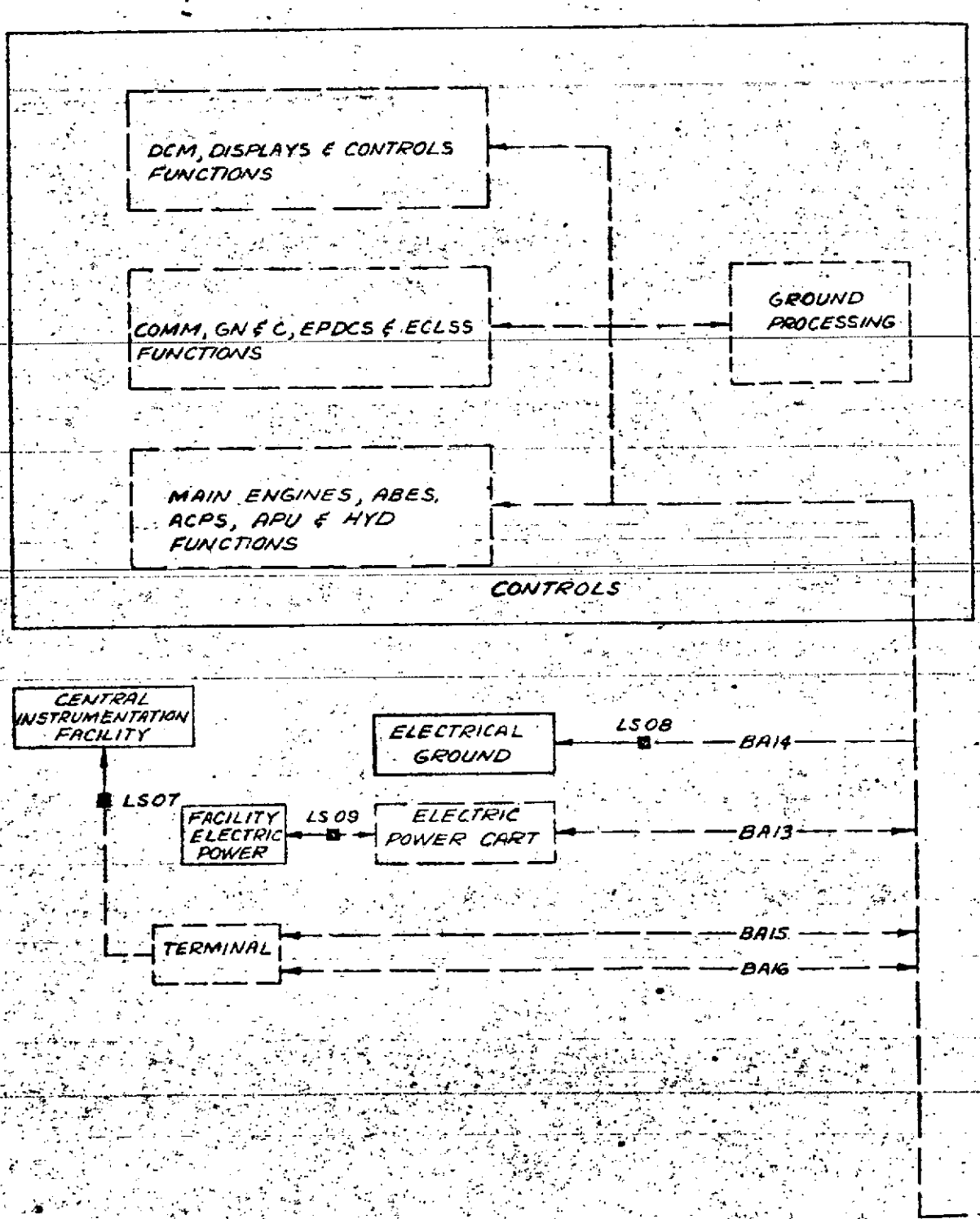
(a) Category I — those ground interfaces required to launch, safe, or maintain the vehicle in a safe condition on the launch pad up to first vehicle motion. These ground connections are designated Rise-off Disconnects (coded BA for booster and OA for orbiter).

(b) Category II — those ground service interfaces required to service the vehicle at the launch pad; however, the service can be terminated prior to, or concurrent with, personnel ingress/egress access swing arm retrieval. These ground service interfaces are designated Swing-Arm Umbilicals (coded BB for booster and OB for orbiter).

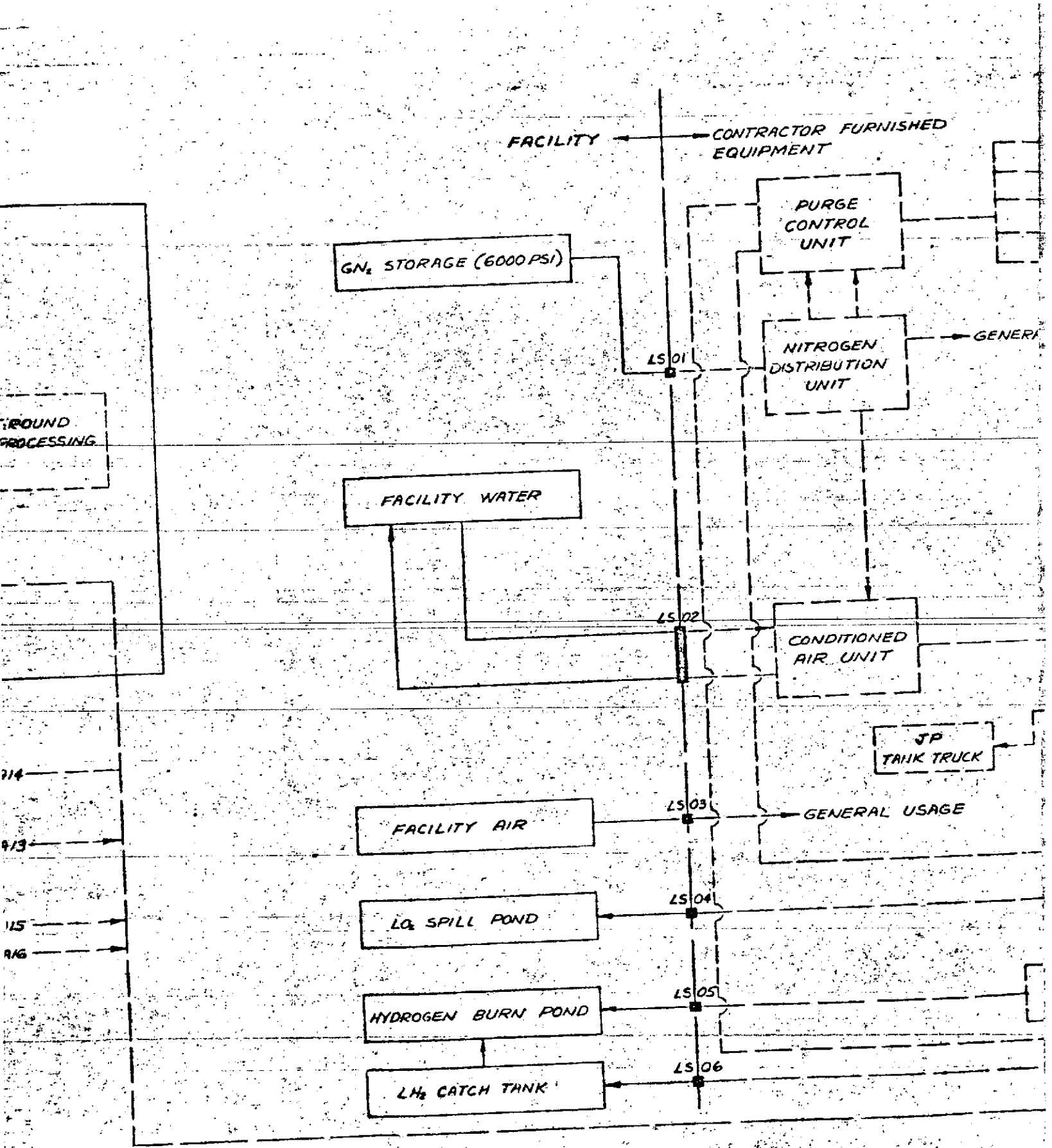
(c) Category III — those external ground service interfaces required for scheduled vehicle servicing in the M&R area in preparation for launch. These services are designated External Service Disconnects (coded BC for booster and OC for orbiter).

(d) Category IV — those internal ground connections required for unscheduled vehicle servicing in the M&R area. These services are designated Internal Service Disconnects (coded BD for booster and OD for orbiter).

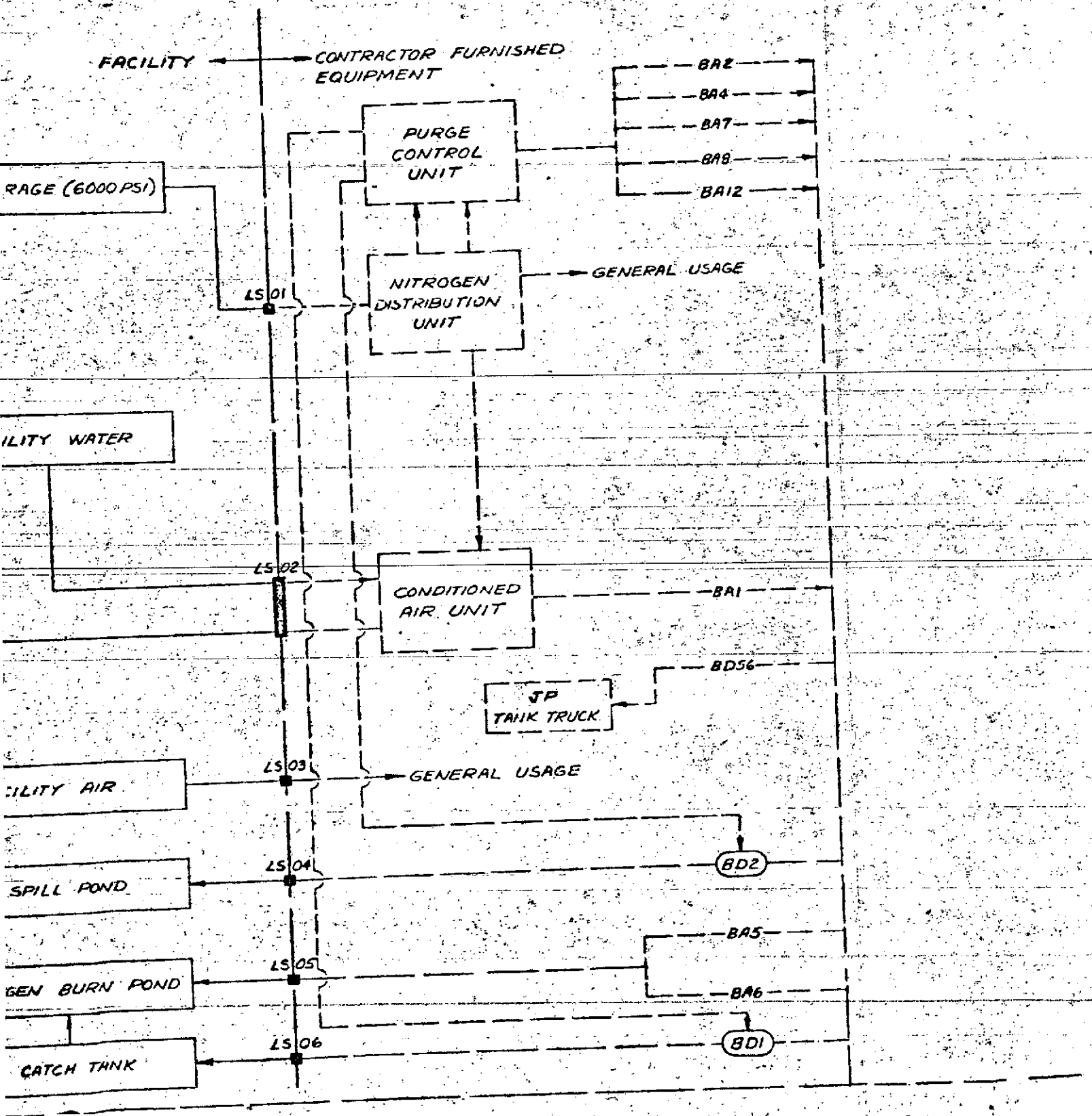
(e) Category V — those ground services interfaces between the booster and orbiter common or didicated GSE to launch pad, M&R and landing sites facilities. These services are designated GSE - Facility Disconnects (coded LE for the launch pad, LR for the M&R area and LS for the landing sites).


DCM, DISPLAYS & CONTROLS FUNCTIONS
COMM, GN & C, EPDCS & ECLSS FUNCTIONS
GROUND PROCESSING
MAIN ENGINES, ABES, ACPS, APU & HYD FUNCTIONS
CONTROLS
CENTRAL INSTRUMENTATION FACILITY
ELECTRICAL GROUND
LS08
BA14
LS07
FACILITY ELECTRIC POWER
LS09
ELECTRIC POWER CART
BA13
TERMINAL
BA15
BA16

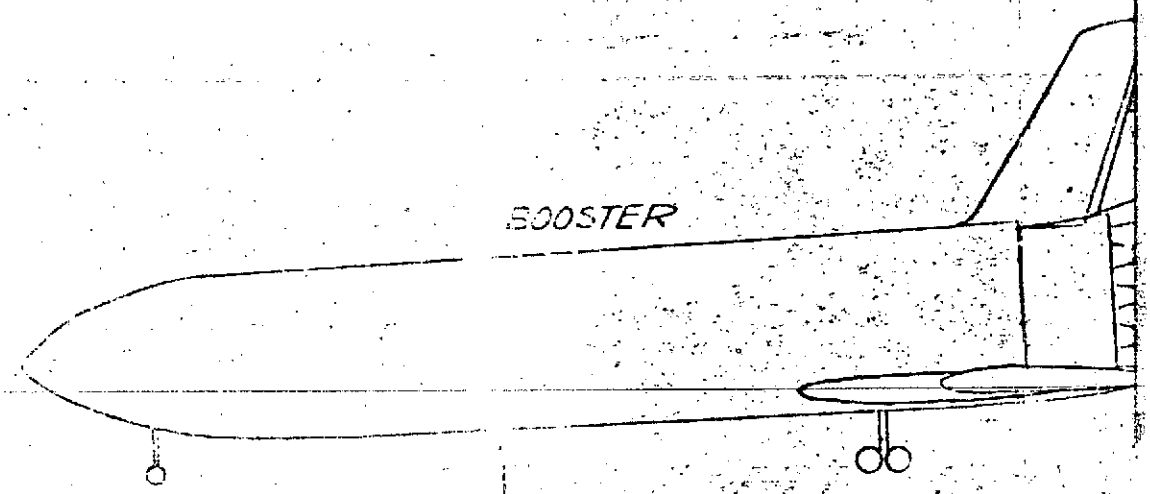
G


FACILITY
CONTRACTOR FURNISHED EQUIPMENT
PURGE CONTROL UNIT
GN_2 STORAGE (6000 PSI)
NITROGEN DISTRIBUTION UNIT
GENERA
LS 01
ROUND
ROCESSING
FACILITY WATER
LS 02
CONDITIONED AIR UNIT
JP TANK TRUCK
214
FACILITY AIR
LS 03
GENERAL USAGE
213
LS 04
LO_2 SPILL POND
115
216
LS 05
HYDROGEN BURN POND
LS 06
LH_2 CATCH TANK

G-3,4 (B)


FACILITY
CONTRACTOR FURNISHED EQUIPMENT
BA2
BA4
BA7
BA8
BA12
PURGE CONTROL UNIT
RAGE (6000 PSI)
NITROGEN DISTRIBUTION UNIT
GENERAL USAGE
LS 01
ILITY WATER
LS 02
CONDITIONED AIR UNIT
BA1
BD56
JP TANK TRUCK
LS 03
GENERAL USAGE
ILITY AIR
LS 04
BD2
SPILL POND
BA5
LS 05
GEN BURN POND
BA6
LS 06
BD1
CATCH TANK

G-3, 4 (c)



FD1 LH_2 HORIZONTAL FILL & DRAIN

FD2 LO_2 HORIZONTAL FILL & DRAIN

FD3 CP FUEL TANK HORIZONTAL DRAIN

BA1 ECS CONDITIONED AIR

BA2 LO_2 FILL & DRAIN-MAIN & APS

BA4 LH_2 FILL & DRAIN-MAIN & APS

BA5 GH_2 VENT-MAIN & APS TANK

BA6 APS & APU GAS GENERATO EXHAUST

BA7 GH_2 GSE SUPPLY FOR APS/APU ACCUMULATOR CHARGE & MA TANK PREPRESSURIZATION

BA8 GO_2 GSE SUPPLY FOR APS/APU ACCUMULATOR CHARGE

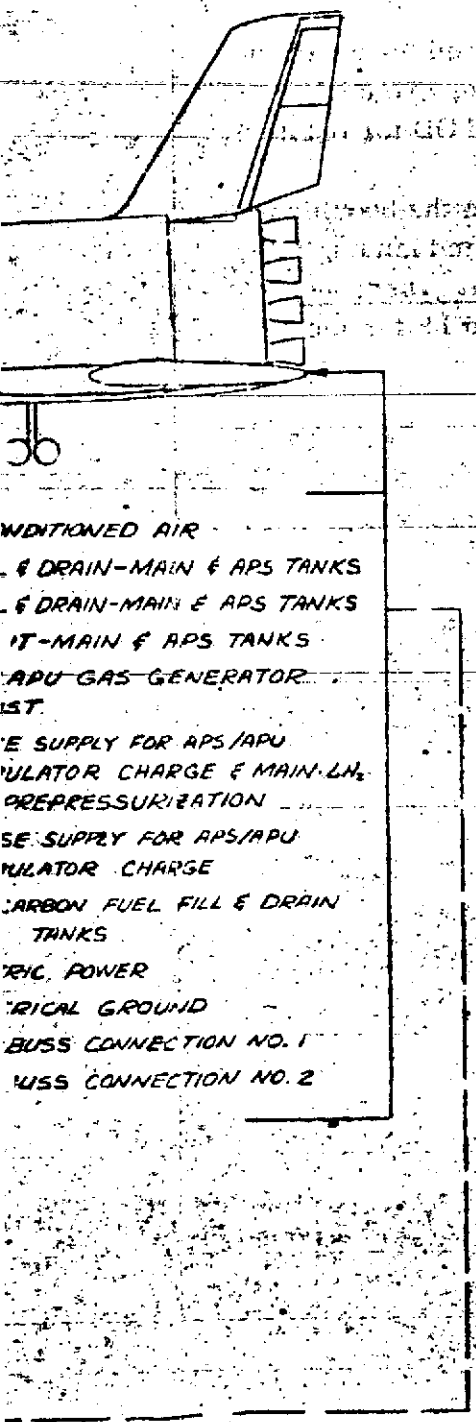
BA12 HYDROCARBON FUEL FILL & D —ABES TANKS

BA13 ELECTRIC POWER

BA14 ELECTRICAL GROUND

BA15 DATA BUSS CONNECTION NO

BA16 DATA BUSS CONNECTION NO



LEGEND:

——— FACILITY

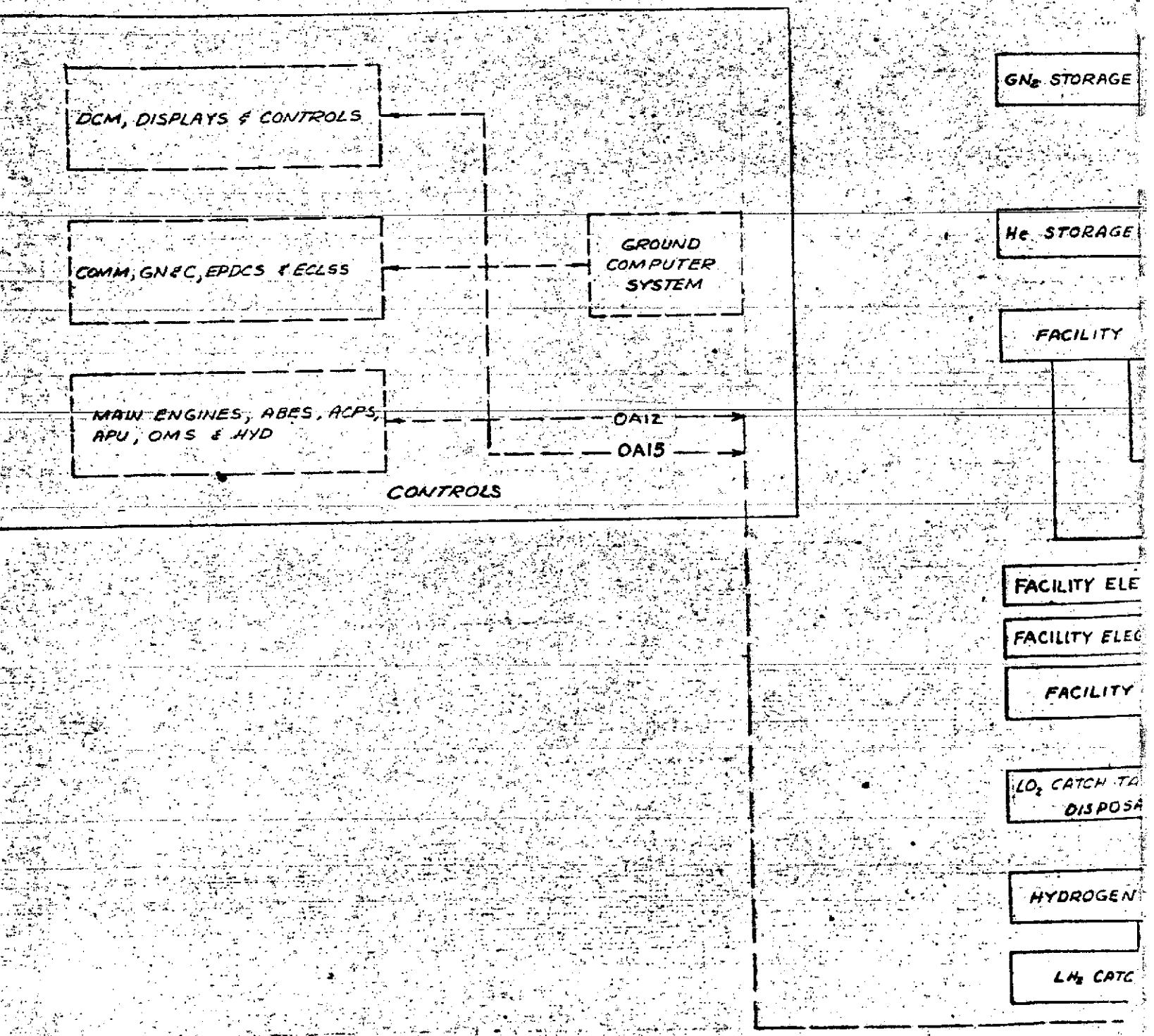
– – – – CONTRACTOR FURNISHED

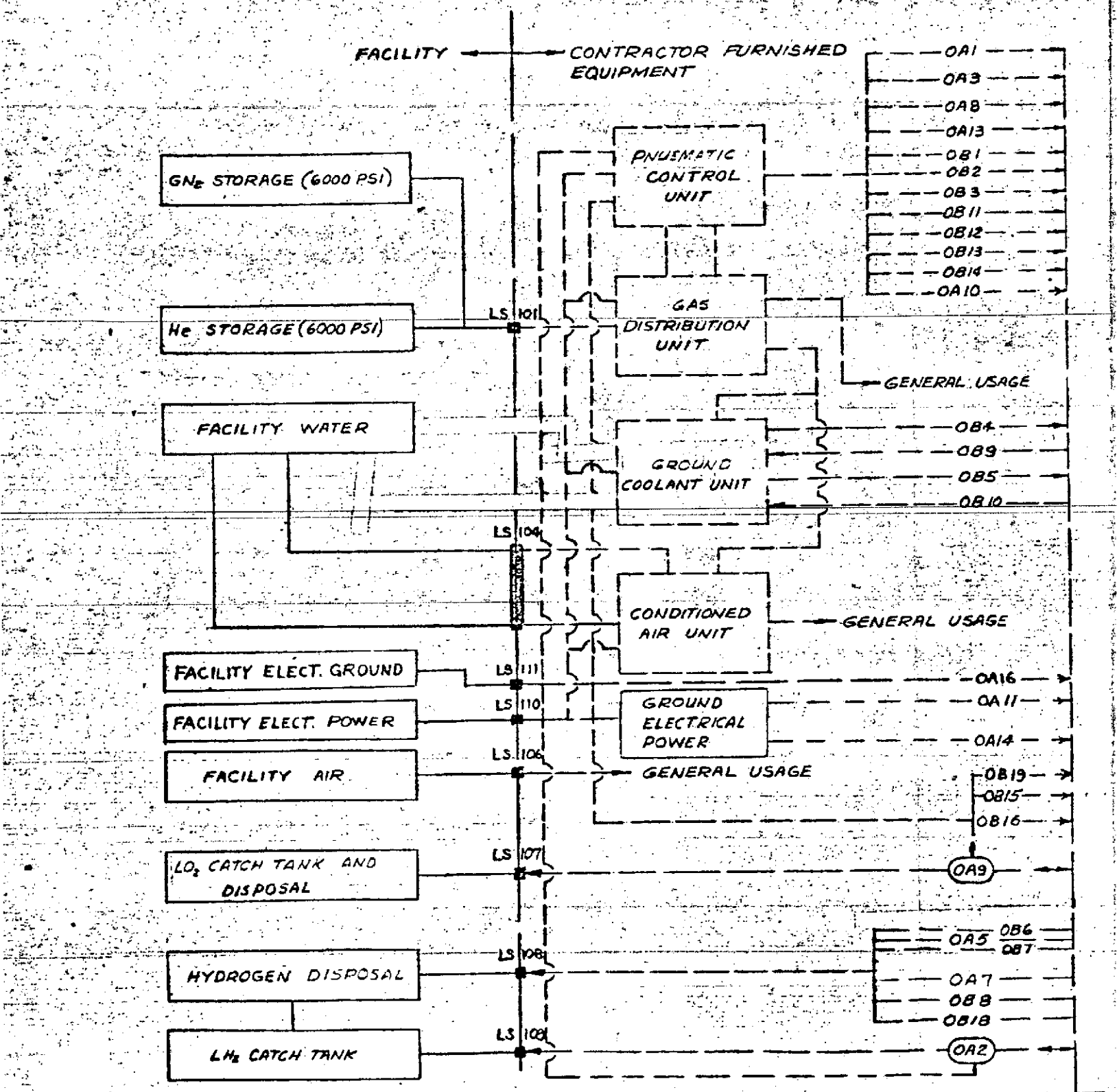
BA RISEOFF DISCONNECTS (CATEGORY I)

BD INTERNAL CONNECTIONS (CATEGORY II)

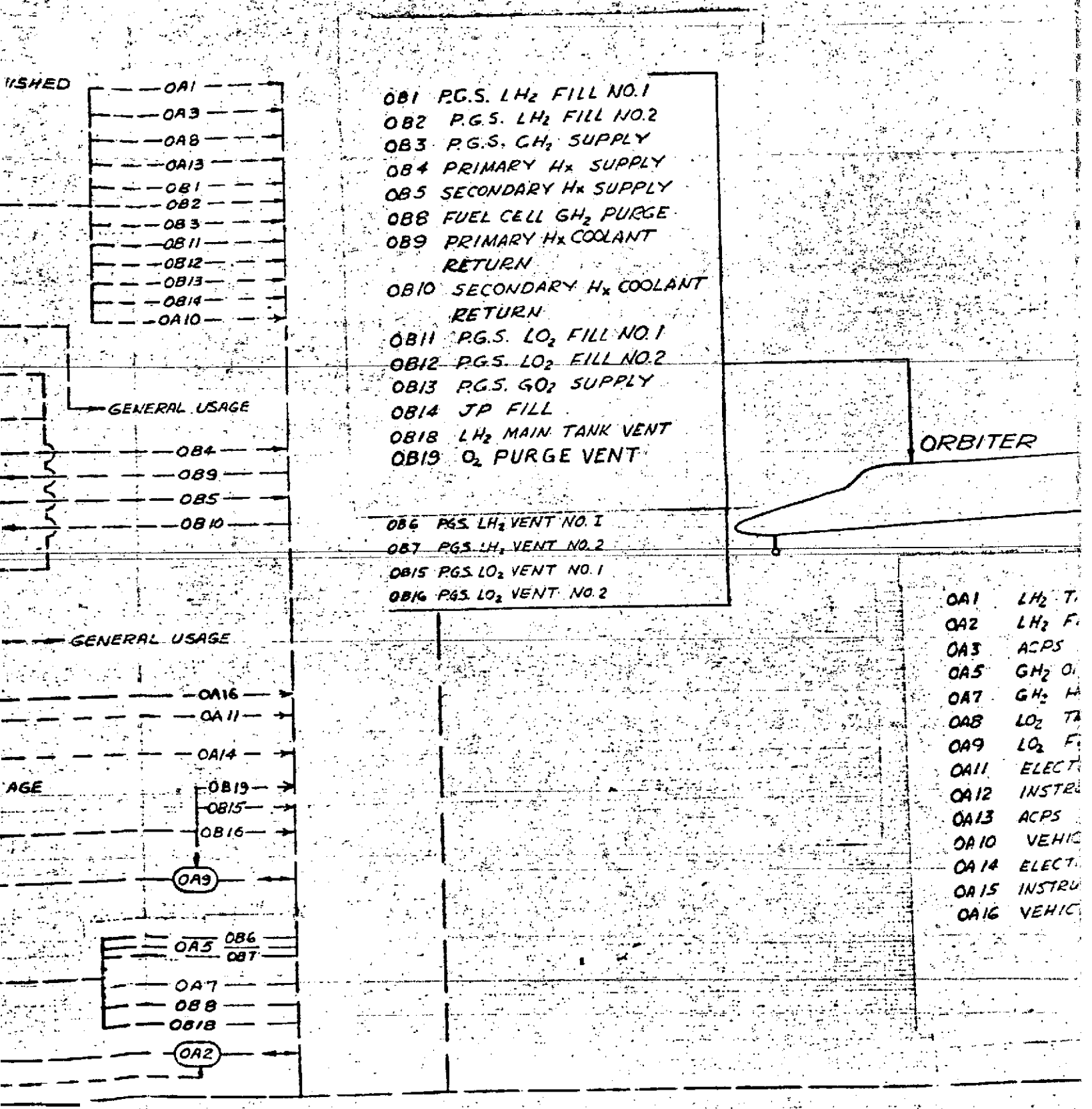
LS GSE TO FACILITY INTERFACES (CATEGORY I)

Figure 3-1. Booster Safing Site Functional Interface Diagram


DCM, DISPLAYS & CONTROLS
COMM, GN&C, EPDCS & ECLSS
GROUND COMPUTER SYSTEM
MAIN ENGINES, ABES, ACPS, APU, OMS & HYD
OA12
OA15
CONTROLS
GN2 STORAGE
He STORAGE
FACILITY
FACILITY ELE
FACILITY ELEC
FACILITY
LO2 CATCH TA
DISPOSA
HYDROGEN
LH2 CATC


FACILITY
CONTRACTOR FURNISHED EQUIPMENT
OA1
OA3
OA8
OA13
OB1
OB2
OB3
OB11
OB12
OB13
OB14
OA10
GN2 STORAGE (6000 PSI)
PNUEMATIC CONTROL UNIT
He STORAGE (6000 PSI)
LS 101
GAS DISTRIBUTION UNIT
GENERAL USAGE
FACILITY WATER
OB4
OB9
OB5
OB10
GROUND COOLANT UNIT
LS 104
CONDITIONED AIR UNIT
GENERAL USAGE
FACILITY ELECT. GROUND
LS 111
OA16
FACILITY ELECT. POWER
LS 110
GROUND ELECTRICAL POWER
OA11
OA14
FACILITY AIR
LS 106
GENERAL USAGE
OB19
OB15
OB16
LO2 CATCH TANK AND DISPOSAL
LS 107
OA9
OA5
OB6
OB7
HYDROGEN DISPOSAL
LS 108
OA7
OB8
OB18
LH2 CATCH TANK
LS 109
OA2

G-5,6 (B)


ISHED
OA1
OA3
OA8
OA13
OB1
OB2
OB3
OB11
OB12
OB13
OB14
OA10
GENERAL USAGE
OB4
OB9
OB5
OB10
GENERAL USAGE
OA16
OA11
OA14
AGE
OB19
OB15
OB16
OA9
OA5
OB6
OB7
OA7
OB8
OB18
OA2
OB1 P.G.S. LH2 FILL NO.1
OB2 P.G.S. LH2 FILL NO.2
OB3 P.G.S. GH2 SUPPLY
OB4 PRIMARY Hx SUPPLY
OB5 SECONDARY Hx SUPPLY
OB8 FUEL CELL GH2 PURGE
OB9 PRIMARY Hx COOLANT RETURN
OB10 SECONDARY Hx COOLANT RETURN
OB11 P.G.S. LO2 FILL NO.1
OB12 P.G.S. LO2 FILL NO.2
OB13 P.G.S. GO2 SUPPLY
OB14 JP FILL
OB18 LH2 MAIN TANK VENT
OB19 O2 PURGE VENT
OB6 P.G.S. LH2 VENT NO.1
OB7 P.G.S. LH2 VENT NO.2
OB15 P.G.S. LO2 VENT NO.1
OB16 P.G.S. LO2 VENT NO.2
ORBITER
OA1 LH2 T
OA2 LH2 F
OA3 ACPS
OA5 GH2 O
OA7 GH2 H
OA8 LO2 T
OA9 LO2 F
OA11 ELECT
OA12 INSTR
OA13 ACPS
OA10 VEHIC
OA14 ELECT
OA15 INSTRU
OA16 VEHIC

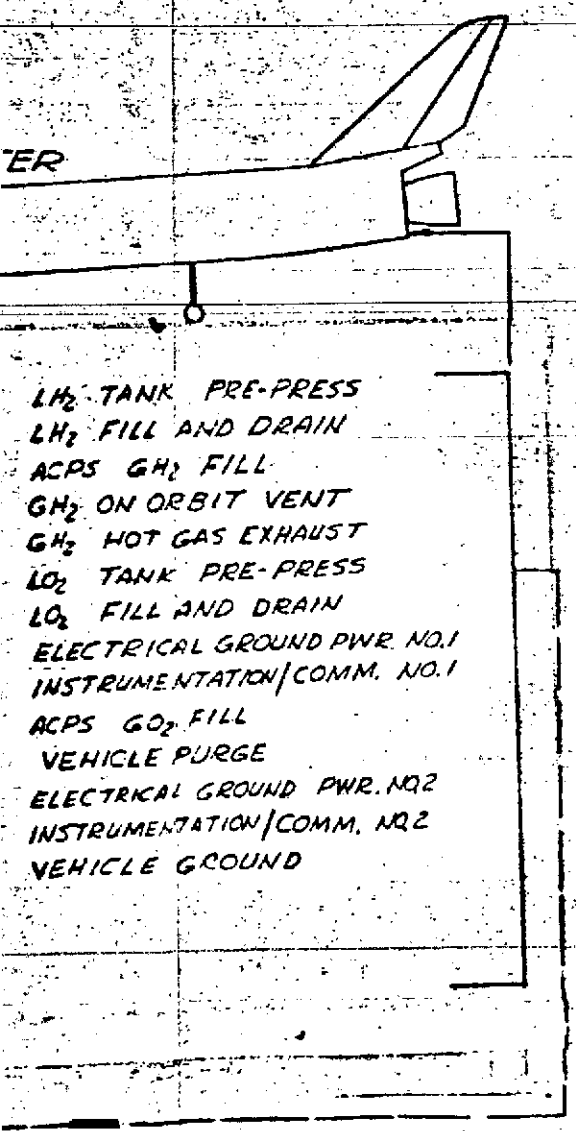


FIGURE 3-2

FUNCTIONAL INTERFACE DIAGRAM
SAFING FACILITY
WITH ORBITER VEHICLE

——— FACILITY
— — — CONTRACTOR FURNISHED

OA	VEHICLE RISEOFF CONNECTIONS
OB	VEHICLE SWINGARM CONNECTIONS
LS	GSE TO FACILITY INTERFACES

A. COLVIN 3-12-71

GENERAL REVISION
A. COLVIN 3-12-71
J. SHELLEY 6-10-71

BOOSTER

TO

LANDING SITES

INTERFACES

TABLE 3-1. LANDING SITES - BOOSTER INTERFACES

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
BA 1	ECLSS Conditioned Air	Ground Cooling for Cabin and Equipment Bays	Thrust Section	Fig. 3-1	25 lbs/min. $40^{o}F$
BA 2	LO_2 Fill and Drain	Post-Landing LO_2 System and Tank GN_2 Purge	Thrust Section	Fig. 3-1	13" line
BA 4	LH_2 Fill and Drain	Post-Landing LH_2 System and Tanks GN_2 Purge	Thrust Section	Fig. 3-1	13" line
BA 5	GH_2 Vent	LH_2 Systems Vent Provisions to Burn Pond	Vertical Stabilizer	Fig. 3-1	10" line
BA 6	Hot Gas Exhaust	APU Ground Run Exhaust Vent to Disposal	Vertical	Fig. 3-1	
BA 7	ACPS Accumulator GH_2 Charge and Main LH_2 Tank Pre-Press	Post-Landing GN_2 Purge Provisions	Thrust Section	Fig. 3-1	2.75" line
BA 8	ACPS Accumulator GO_2 Charge	Post-Landing GN_2 Purge Provisions	Thrust Section	Fig. 3-1	3" line
BA 12	Hydrocarbon Fuel Tank Fill and Drain	Post-Landing GN_2 Purge Provisions	Thrust Section	Fig. 3-1	

TABLE 3-1. LANDING SITES - BOOSTER INTERFACES

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
BA 13	Electrical Ground Power Umbilical	Vehicle Systems Power when APU's Shut Down	Thrust Section	Fig. 3-1	
BA 14	Electrical Ground	Vehicle Ground during Safing Operations	Thrust Section	Fig. 3-1	
BA 15	Data Bus #1	Ground Data Path to Vehicle DCM System	Thrust Section	Fig. 3-1	
BA 16	Data Bus #2	Ground Data Path to Vehicle DCM System	Thrust Section	Fig. 3-1	
BD 1	LH_2 Horizontal Fill and Drain	Post-Landing Drain Provisions to LH_2 Catch Tank		Fig. 3-1	
BD 2	LO_2 Horizontal Fill and Drain	Post-Landing Drain Provisions LO_2 Spill Pond		Fig. 3-1	
BD 56	Hydrocarbon Fuel Tank Horizontal Drain	Post-Landing Drain Provisions to Hydrocarbon Fuel Facility Tank		Fig. 3-1	

ORBITER

TO

LANDING SITES

INTERFACES

TABLE 3-2. LANDING SITES - ORBITER INTERFACES

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
OA1	LH_2 Tank Pre-Press	Post-Landing GN_2 Purge of Pre-Press Line	Thrust Section	Fig. 3-2	1" Line
OA2	LH_2 Fill & Drain	Post-Landing LH_2 System GN_2 Purge and LH_2 drain to catch tank	Thrust Section	Fig. 3-2	8" Line
OA3	ACPS GH_2 Fill	Post-Landing GN_2 Purge	Thrust Section	Fig. 3-2	1" Line
OA5	GH_2 On-Orbit Vent	Post-Landing Vent to Safe Disposal	Vertical Stabilizer	Fig. 3-2	3" Line
OA7	GH_2 Hot Gas Exhaust	Post-Landing Vent to Safe Disposal	Vertical Stabilizer	Fig. 3-2	10" Line
OA8	LO_2 Tank Pre-Press	Post-Landing GN_2 Purge of the Pre-Press Line	Thrust Section	Fig. 3-2	1" Line
OA9	LO_2 Fill & Drain	Post-Landing LO_2 System GN_2 Purge and LO_2 Drain to Catch Tank	Thrust Section	Fig. 3-2	8" Line
OA10	Vehicle Purge	Dry Air or GN_2	Thrust Section		12" Line
OA11	Electrical Ground Power #1	Vehicle Systems Power when APU's Shutdown	Thrust Section	Fig. 3-2	
OA12	Instrumentation/ Communications #1	Vehicle Control when Flight Deck is Unmanned	Thrust Section	Fig. 3-2	
OA13	ACPS GO_2 Fill	Post-Landing GN_2 Purge	Thrust Section	Fig. 3-2	1" Line

TABLE 3-2. LANDING SITES - ORBITER INTERFACES

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
OA14	Electrical Ground Power #2	Vehicle Systems Power when APU's Shutdown	Thrust Section	Fig. 3-2	
OA15	Instrumentation/ Communications #2	Vehicle Control when Flight Deck is unmanned	Thrust Section	Fig. 3-2	
OA16	Vehicle Ground				
OB1	PGS LH_2 Fill #1	Post-Landing GN_2 Purge	Mid Body	Fig. 3-2	
OB2	PGS LH_2 Fill #2	Post-Landing GN_2 Purge	Mid Body	Fig. 3-2	
OB3	PGS GH_2 Supply	Post-Landing GN_2 Purge	Mid Body	Fig. 3-2	
OB4	Primary HX Supply	Primary Heat Exchanger Ground Supply	Mid Body	Fig. 3-2	
OB5	Secondary HX Supply	Secondary Heat Exchanger Ground Supply	Mid Body	Fig. 3-2	
OB6	PGS LH_2 Vent #1	Post-Landing Purge & Drain	Mid Body	Fig. 3-2	
OB7	PGS LH_2 Vent #2	Post-Landing Purge & Drain	Mid Body	Fig. 3-2	
OB8	Fuel Cell GH_2 Purge	Post-Landing Vent to Burn Pond	Mid Body	Fig. 3-2	
OB9	Primary Coolant Return	Heat Exchanger Fluid Ground Return	Mid Body	Fig. 3-2	
OB10	Secondary Return	Heat Exchanger Fluid Ground Return	Mid Body	Fig. 3-2	

TABLE 3-2. LANDING SITES - ORBITER INTERFACE

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
OB11	PGS LO_2 Fill #1	Post-Landing GN_2 Purge	Mid Body	Fig. 3-2	
OB12	PGS LO_2 Tank #2 Fill	Post-Landing GN_2 Purge	Mid Body	Fig. 3-2	
OB13	PGS GO_2 Supply	Post-Landing GN_2 Purge	Mid Body	Fig. 3-2	
OB14	JP Fill	Post-Landing GN_2 Purge	Mid Body	Fig. 3-2	
OB15	PGS LO_2 Vent #1	Post-Landing Purge and Drain	Mid Body	Fig. 3-2	
OB16	PGS LO_2 Vent #2	Post-Landing Purge and Drain	Mid Body	Fig. 3-2	
OB18	LH_2 Main Tank Vent	Post-Landing Vent to Burn Pond	Mid Body	Fig. 3-2	
OB19	O_2 Purge Vent	Post-Landing Vent to Atmosphere	Mid Body	Fig. 3-2	

LANDING SITES

BOOSTER GROUND SUPPORT EQUIPMENT (GSE)

TO

FACILITIES

INTERFACES

TABLE 3-3. LANDING SITES — BOOSTER GSE TO FACILITIES INTERFACES

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
LS-01	GN_2 Supply	Interconnects Facility GN_2 Storage Supply to GSE Nitrogen Distribution Unit		Fig. 3-1	
LS-02	Water Supply	Interconnects Facility Water Supply and Return to GSE Conditionined Air Unit		Fig. 3-1	
LS-03	Air Supply	Interconnects Facility Air Supply to General Useage GSE		Fig. 3-1	
LS-04	LO_2 Disposal	Interconnects LO_2 Horizontal Fill and Drain GSE to LO_2 Spill Pond		Fig. 3-1	
LS-05	GH_2 and Gas Generator Exhaust Disposal	Interconnects GSE Used for Main and APS Tanks GH_2 Vents, and APS and APU Gas Generator Exhaust to Facility Burn Pond		Fig. 3-1	
LS-06	LH_2 Drain	Interconnects GSE Used for Horizontal LH_2 Drain to the Facility LH_2 Catch Tank		Fig. 3-1	
LS-07	Data Retrieval	Interconnects GSE Data Terminal Unit to the Central Instrumentation Facility		Fig. 3-1	

TABLE 3-3. LANDING SITES – BOOSTER GSE TO FACILITIES INTERFACES

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
LS-08	Electrical Ground	Interconnects Booster Vehicle Ground to the Facility Ground		Fig. 3-1	

LANDING SITES

ORBITER GROUND SUPPORT EQUIPMENT (GSE)

TO

FACILITIES

INTERFACES

TABLE 3-4. LANDING SITES - ORBITER GSE TO FACILITY INTERFACES

I/F CODE	FUNCTION	DESCRIPTION	I/F LOCATION	DWG/FIG	PARAMETER
LS101	GN_2, H_e Supply	Provide GN_2 and H_e to the Pneumatic Control Unit and Gas Distribution Unit	Safing Area	Fig. 3-2	
LS104	Facility Water Supply	Provide Facility Water to the Conditioned Air Unit	Safing Area	Fig. 3-2	
LS106	Facility Air Supply	Provide Facility Air for General Usage	Safing Area	Fig. 3-2	
LS107	Disposal of LO_2	Provide Catch Tank for Disposal of Residual LO_2	Safing Area	Fig. 3-2	
LS108	Burn Hydrogen Gas	Burnstack for GH_2 Vents and Exhaust	Safing Area	Fig. 3-2	
LS109	Disposal of LH_2	Provide Catch Tank for Disposal of Residual LH_2	Safing Area	Fig. 3-2	
LS110	Facility Electrical Power Supply	Provide Electrical Power to the Support Equipment and Orbiter	Safing Area	Fig. 3-2	
LS111	Electrical Ground	Provide an Electrical Ground for the Orbiter	Safing Area	Fig. 3-2	