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VOLUME III

SERVICE AND SUPPORT SYSTEMS

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TABLE OF CONTENTS
VOLUME III

TABLE OF CONTENTS (Continued)

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS (Continued)

LIST OF ILLUSTRATIONS (Contined)

LIST OF ILLUSTRATIONS (Continued)

LIST OF TABLES

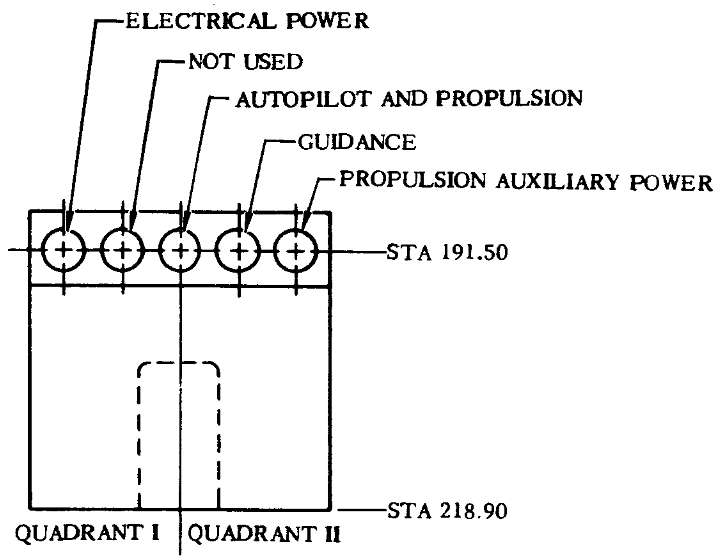
LIST OF TABLES (Continued)

SECTION XVIII

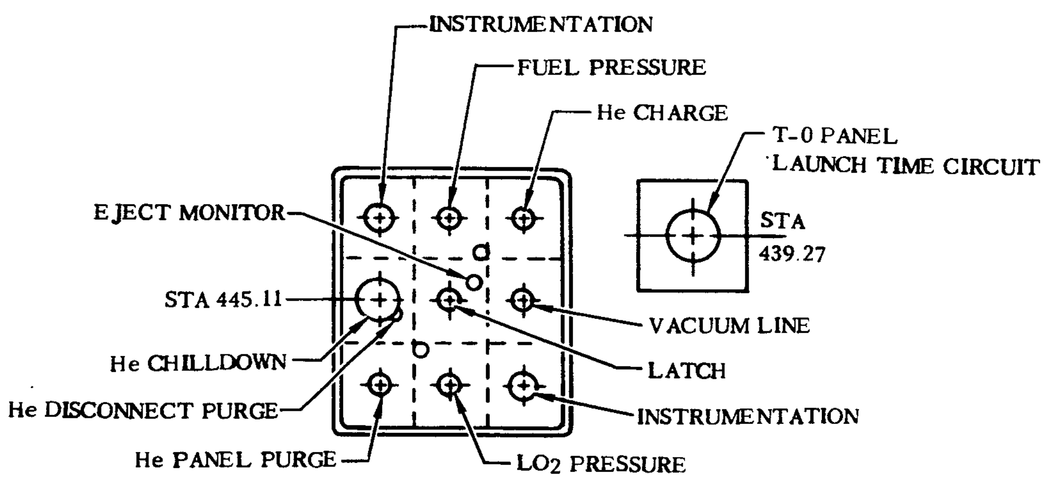
UMBILICAL SYSTEMS

18.1 INTRODUCTION

This section deals with the umbilicals only, and not with the retractable umbilical boom system. The latter is thoroughly described in General Dynamics/Convair (GD/C) Report Number GD/C63-1013, "Centaur Complex 36B: Umbilical Boom System Operation and Maintenance Manual," dated 1 April 1965. The forward and aft umbilical panels are shown in Figure 18.1-1.



a. Forward Umbilical Panel (Reference Figure 3.3-2 "Umbilical Island Cutout" in Volume I)



b. Aft Umbilical Panels T-4 and T-0 (Quad II) (Reference Items 7 and 8 of Figure 3.3-5 in Volume I)

Figure 18.1-1. Forward and Aft Umbilical Panels

The umbilical system provides retractable boom support for the service lines and electrical cables extending between the Centaur vehicle and the umbilical tower. Electrical and mechanical umbilicals are separately discussed in the following subsections. In the event that an abort occurs in the H_2O_2 system, the umbilical system includes a water spray to dilute the Hydrogen Peroxide (H_2O_2) issuing from the dump port on the side of the vehicle. The umbilical system provides the means for vehicle checkout, monitoring, and control, and is the primary system for linking together the Centaur Ground Support Equipment (GSE) and the Centaur vehicle.

18.2 ELECTRICAL UMBILICALS

There are presently eighteen electrical GSE umbilical cables. These cables supply power, monitoring, and control capabilities for the Centaur vehicle during checkout and countdown procedures. The umbilicals are the final link between GSE and Centaur.

The reference designators for the various plugs and receptacles are prefixed by the letters P, J, or U (such as B600P409, B600J401, and B600U402). The P designator stands for plug or running end of cable, J stands for receptace or standing end of cable, and U stands for a unit utilized for any number of receptacles or plugs. Receptacles and plugs can be either male or female, contrary to popular usage which has regarded receptacles as female and plugs as male.

18.2.1 UPPER UMBILICAL CABLES. The twelve forward umbilicals are supported by the upper umbilical boom. They are grouped into units composed of three cables each. Each unit of three cables plugs into an umbilical adapter (P/N 27-06172), which in turn plugs into the vehicle-mounted umbilical receptacle (see Figure 18.2-1). The adapter or plug designations, the systems which they supply, and number of conductors for each of the four plugs are shown in Table 18.2-1. The number of pins and their use with the conductors is established by design requirements and defined in "Upper Stage Airborne Systems Schematic Diagrams," a released drawing for each vehicle.

TABLE 18.2-1. UPPER ELECTRICAL UMBILICAL PLUGS

Connector Reference Designation (Cable Part No.)	Total Conductors	Wire Data		Ejection	
		Number	Type (gauge)	Type	Time (sec)
FORWARD PANEL					
B600J401 Autopilot and Propulsion	140	↓	↓	Elect	T-3.1
B600U401P2 (55-55730)	47	45 1	16S 16TPS		

TABLE 18.2-1. UPPER ELECTRICAL UMBILICAL PLUGS (Continued)

Connector Reference Designation (Cable Part No.)	Total Conductors	Wire Data		Ejection	
		Number	Type (gauge)	Type	Time (sec)
FORWARD PANEL (Continued)					
B600U401P3	46	25	16S		
(55-55731)		7	12S		
		4	16TPS		
		2	16TTS		
B600U401P4	47	45	16S		
(55-55730)		1	16TPS		
B600J402 Propulsion Auxiliary Power	138	↓	↓	Elect	T-3.1
B600U402P2	46	25	16S		
(55-55731)		7	12S		
		4	16TPS		
		2	16TTS		
B600U402P3	46	24	16S		
(55-55732)		6	12S		
		8	16TPS		
B600U402P4	46	24	16S		
(55-55732)		6	12S		
		8	16TPS		
B600J403 Power	106	↓	↓	Elect	T-3.1
B600U403P2	13	6	4		
(55-55733)		7	8		
B600U403P3	46	25	16S		
(55-55731)		7	12S		
		4	16TPS		
		2	16TTS		
B600U403P4	47	45	16S		
(55-55730)		1	16TPS		
B600J404 Guidance	110	↓	↓	Elect	T-3.1
B600U404P2	8	4	RG71/U		
(55-55734)		2	16S		
		2	12		

TABLE 18.2-1. UPPER ELECTRICAL UMBILICAL PLUGS (Continued)

Connector Reference Designation (Cable Part No.)	Total Conductors	Wire Data		Ejection	
		Number	Type (gauge)	Type	Time (sec)
FORWARD PANEL (Continued)					
B600U404P3 (55-55735)	51	7	RG71/U		
		41	16S		
		1	16TTS		
B600U404P4 (55-55736)	51	40	16S		
		4	16TPS		
		1	16TTS		

CODE

S - Single shielded
TPS - Twisted pair shielded
TTS - Twisted triad shielded
SJ - Shielded jacketed
TPSJ - Twisted pair shielded jacketed
RG71/U - Coaxial cable

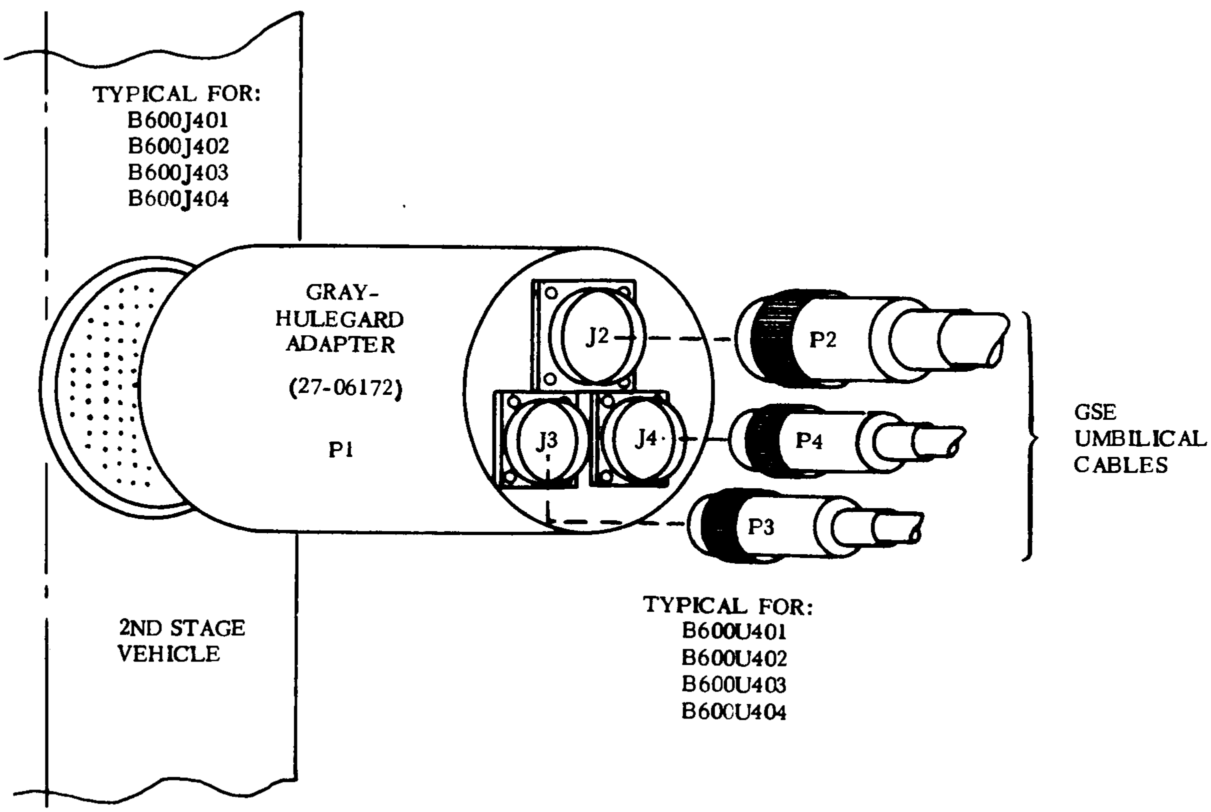


Figure 18.2-1. Umbilical Connections, Twelve Forward Umbilicals

18.2.2 LOWER UMBILICAL CABLES. Umbilicals which supply monitoring and instrumentation functions for the T-0 Panel, T-4 Aft Panel, Oxidizer Fill and Drain, and Fuel Fill and Drain are supported on the lower umbilical boom. Table 18.2-2 delineates the plug or receptacle designations, the systems which they supply, and the number of conductors for each cable.

TABLE 18.2-2. LOWER ELECTRICAL UMBILICAL PLUGS

Connector Reference Designation (Cable Part No.)	Total Conductors	Wire Data		Ejection	
		Number	Type (gauge)	Type	Time (sec)
T-0 PANEL (Reference Figure 18.1-1b)					
B600P409 (55-55737) Critical to Launch Time Circuits	88	74 14	20S 16	Elect	T-0
AFT PANEL (Reference Figure 18.1-1b)				Pneumatic Lanyard	T-4
B600P412 (55-65972) Aft Panel Eject Monitor	2	1	20TPS		
B105P9 (55-17257-7) Instrumentation	52	43 4 1 2	20SJ 16SJ 20TPSJ 20TPSJ		
B105P11 (55-17257-15) Instrumentation	53	43 4 2 1	20SJ 16SJ 20TPSJ 20TPSJ		
OXIDIZER FILL AND DRAIN (Reference Figure 3.3-5, Volume I)					
7502P1 LO_2 Valve Position	4	4	16TPSJ	Lanyard Static T-0 Cylinder	T-0
FUEL FILL AND DRAIN (Reference Figure 3.3-4, Volume I)					
7509P1 LH_2 Valve Position	4	4	16TPSJ	T-0 Cylinder Lanyard Static	T-0

18.3 MECHANICAL UMBILICALS

The mechanical umbilicals are located on both upper and lower Centaur umbilical booms. Their function is to supply the Centaur vehicle with all necessary gases and liquids. The mechanical umbilicals must provide vehicle air-conditioning, tank pressures, pneumatic supplies, propellants, purge functions, and actuation of various disconnect devices during the launch sequence. Table 18.3-1 lists the requirements of the upper mechanical umbilicals and Table 18.3-2 lists those of the lower mechanical umbilicals.

TABLE 18.3-1. UPPER UMBILICAL BOOM DISCONNECT DATA, MECHANICAL (Reference Figure 3.3-2, Volume I)

Disconnecting Plug Nomenclature (Part Number)	Gas or Liquid	Line Size (in.)	Pressure (psig)	Flow (lb/min)	Temperature (°F)	Ejection Type Primary	Ejection Type Secondary	Ejection Time (sec)
Centaur forward compartment cooling duct (57-08301-41)	GN_2	6	20" H_2O	150	130 ± 5	Lanyard External	Lanyard Internal	T - 0
Payload air-conditioning umbilical duct (55-08311-5)	Air or GN_2	8	20" H_2O	75 ± 3.5	85 ± 5	Inflate Seal	Lanyard Internal	T - 0
Fuel Vent Disconnect (55-02012)	GH_2					Lanyard Static	Lanyard Static	T-0

TABLE 18.3-2. LOWER UMBILICAL BOOM DISCONNECT DATA, MECHANICAL

Disconnecting Plug Nomenclature (Part Number)	Gas or Liquid	Line Size (in.)	Pressure (psig)	Flow (lb/min)	Temperature (°F)	Ejection		
						Type		Time (sec)
						Primary	Secondary	
AFT PANEL (Reference Figure 18.1-1)						Pneumatic	Lanyard	T - 4
LH_2 Pressure (55-08111-29)	He	1	25	1/4	Amb	⊗		
LO_2 Pressure (55-08111-27)	He	1	10	1/4	Amb	⊗		
He Bottle Charge, Pneumatic (55-08111-25)	He	9/16 Aminco	3,000	1/4	Amb	⊗		
Ground Insulation Panel Purge (55-08111-31)	He	3/4	300	3	Amb	⊗		
Aft Panel Eject	GN_2	1/4	2,000	Neg	Amb	⊗		
Liquid He	LHe	1	75	2-11	-454	⊗		
LHe Disconnect Purge	He	1/4	100	25 scfm	Amb	⊗		
Vacuum		1	450 microns Hg	5 scfm	Amb	⊗		
He DISCONNECT								
He Bottle Charge, Inflight Purge (55-08111)	He	1/2	3,000	5	Amb	T-0 Cylinder	Lanyard Static	T-0
OXIDIZER FILL AND DRAIN (Figure 3.3-5, Volume I)						Lanyard Static	T-0 Cylinder	T-0

TABLE 18.3-2. LOWER UMBILICAL BOOM DISCONNECT DATA, MECHANICAL (Continued)

Disconnecting Plug Nomenclature (Part Number)	Gas or Liquid	Line Size (in.)	Pressure (psig)	Flow (lb/min)	Temperature (°F)	Ejection Type Primary	Ejection Type Secondary	Ejection Time (sec)
Valve Assembly - Propellant Fill/Drain Ground Half (55-23001-3)	LO_2	3	75	6-600	-297	▼		
LO_2 Fill/ Drain Valve Purge	He	3/8	100	0.3 scfm	Amb	▼		
LO_2 Fill/ Drain Valve Actuation	He	3/8	800	Neg	Amb	▼		
<u>FUEL</u> <u>FILL AND DRAIN</u> (Figure 3.3-4, Volume I)						T-0 Cylinder	Lanyard Static	T-0
Valve Assembly - Propellant Fill/Drain Ground Half (55-23001-1)	LH_2	3	75	2-11	-423	▼		
LH_2 Line Purge	He	1/2	45	100 scfm	Amb	▼		
LH_2 Fill/ Drain Valve Purge	He	3/8	100	0.3 scfm	Amb	▼		
LH_2 Fill/ Drain Valve Actuation	He	3/8	800	Neg	Amb	▼		

NOTE:

⊗ Connecting plug mounted on aft panel.

▼ Integral part of fill/drain valve assembly.

18.4 UMBILICAL WATER SYSTEM

The Umbilical Water System is used to spray water at the Centaur Hydrogen Peroxide (H_2O_2) dump port at the side of the vehicle to dilute the mixture and thus reduce harmful corrosive action.

18.4.1 CONFIGURATION. The system consists of a remotely controlled water nozzle mounted on the end of the lower umbilical boom. The nozzle is fed by a four-inch water line mounted on the umbilical tower. It delivers approximately 250 gpm of water at 85 psi at the nozzle. Remote control of the water flow is accomplished by means of a pilot-operated solenoid valve.

18.4.2 CONTROL. A three-position toggle switch, mounted on the Water Control Panel in the blockhouse, controls the solenoid valve. With the switch in the "test" position, a momentary contact is made which operates the valve as long as the switch is depressed. The "arm" position provides a maintained contact which allows the valve to be controlled by the Emergency Dump switch on the Attitude Engine Control Panel.

Figure 18.4-1 illustrates the nozzle and water spray showing its orientation relative to the Centaur vehicle. Figure 18.4-2 is a schematic diagram illustrating the electrical operation of the solenoid valve in the H_2O_2 Dilution System. Figure 18.4-3 is a systems block diagram which shows the positions and relationships of all major components.

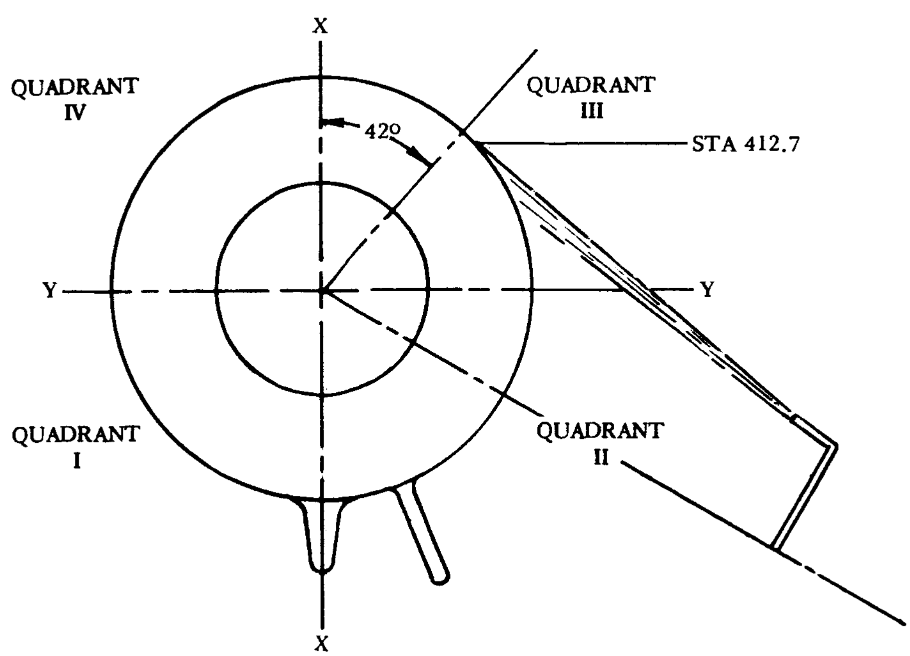


Figure 18.4-1. Umbilical Water System Nozzle and Spray

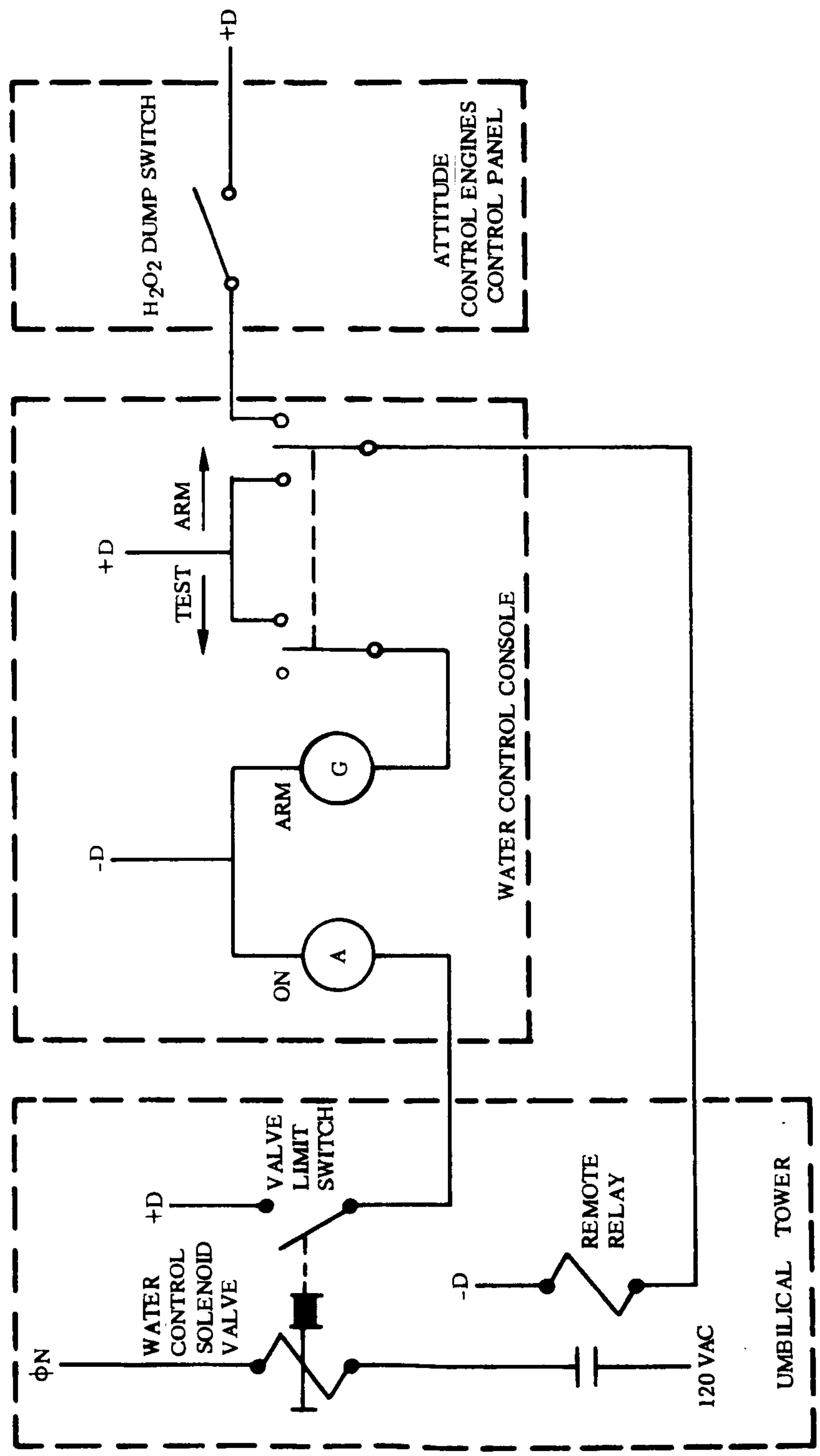


Figure 18. 4-2. Umbilical Water System, Electrical Control of Hydrogen Peroxide Dilution

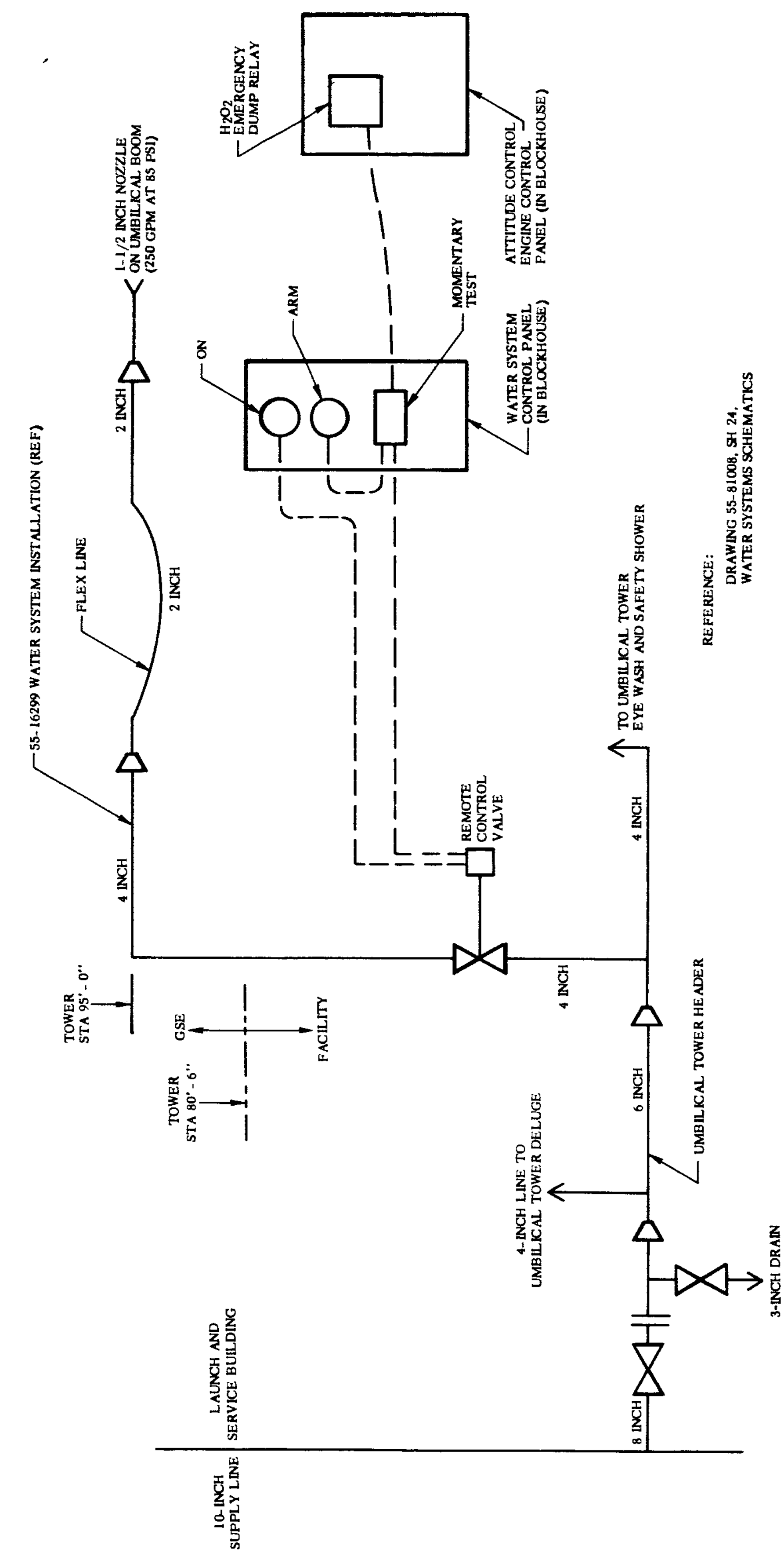


Figure 18. 4-3. Umbilical Water System, Hydrogen Peroxide Dilution, Block Diagram

18.5 UMBILICAL CIRCUIT AND PLUG CHECKOUT - ACCESS TEST BOXES

18.5.1 GENERAL. The Centaur umbilical cables, plugs, and circuits must be verified with respect to their accuracy, compatability, and integrity prior to mating the umbilical plugs to the vehicle umbilical receptacles. Two types of test accessory boxes are used to facilitate umbilical circuit checkout:

a. Umbilical Access Test Boxes (see Subsection 18.5).

b. Umbilical Circuits Load Bank (see Subsection 18.6).

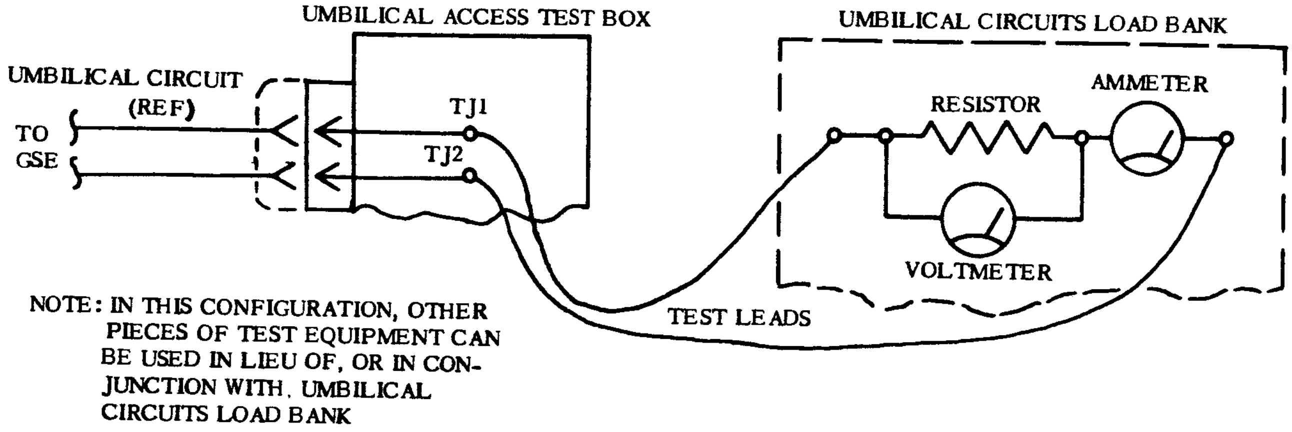
Accessory "a" (above) is used to provide access to the umbilical wiring, or the vehicle wiring; or it can be inserted in series with the umbilicals and vehicle. The faces of the Umbilical Access Test Boxes have test jacks for each umbilical wire. Accessory "b" (above) is used, in conjunction with accessory "a" to simulate electrical loads at the ends of the umbilical connectors. The Umbilical Circuits Load Bank is used in lieu of the vehicle components to assure that acceptable voltage levels will be maintained at the umbilical interface under simulated vehicle loads.

Figure 18.5-1 illustrates three typical arrangements used in umbilical circuit validation. Figure 18.5-1 further illustrates the potential use of other test equipment in conjunction with the Umbilical Access Test Boxes and Umbilical Circuits Load Bank to facilitate circuit evaluation.

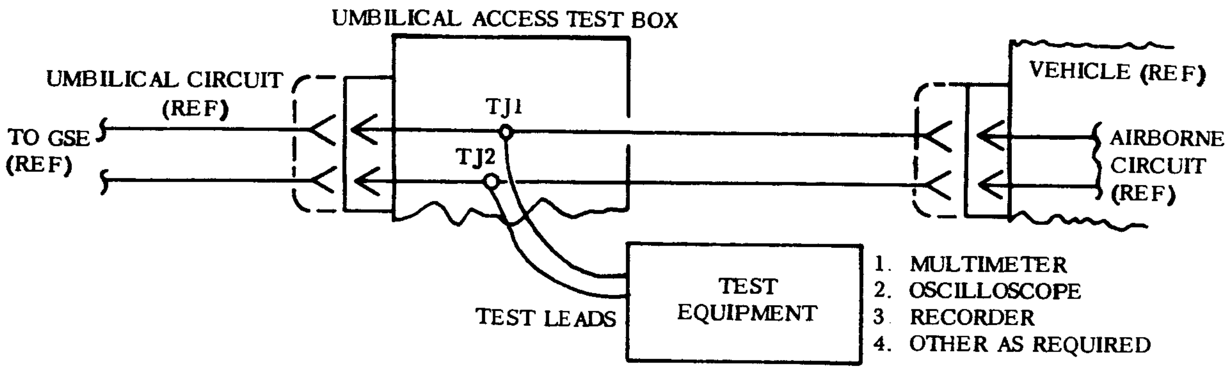
18.5.2 UMBILICAL ACCESS TEST BOXES. This equipment consists of several test boxes as identified in Table 18.5.-1.

TABLE 18.5-1. UMBILICAL CIRCUITS TEST KIT AND BOXES

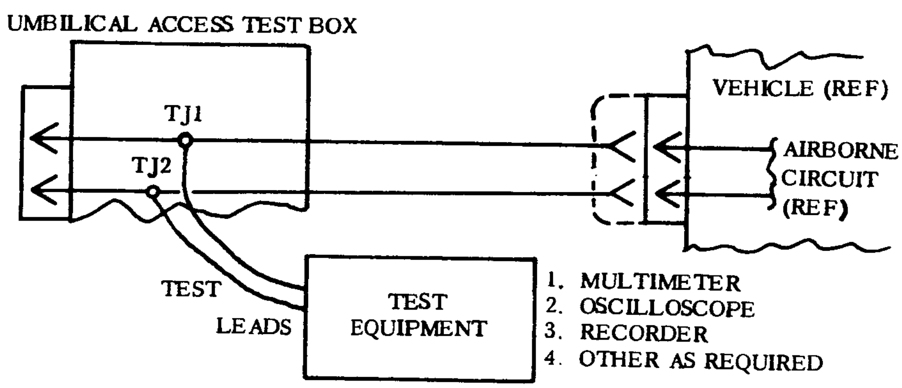
Part Number	Item	System
55-53117-1	Kit	Centaur (EID 55-4510-1)
55-54550-5	Box	Centaur Landlines, P9
55-54551-5	Box	Centaur Landlines, P11
55-54552-1	Box	Centaur Autopilot and Propulsion
55-54553-1	Box	Centaur Auxiliary Propulsion
55-54554-3	Box	Centaur Power
55-54555-1	Box	Centaur Guidance
55-54556-3	Box	Centaur Aft Prelaunch



a. With Load Bank and Umbilical Circuit Connections



b. With Vehicle and Umbilical Circuit Connections



c. With Vehicle and without Umbilical Circuit Connections

Figure 18.5-1. Typical Umbilical Circuit and Plug Checkout Configurations

18.5.2.1 Purpose. During GSE system validation, it is necessary to check circuit continuity to the ends of the umbilical cables or to perform tests requiring connection of test equipment to the umbilical circuits. During GSE systems/vehicle checkout, it is often necessary to connect test equipment to the umbilical circuits at the umbilical connector. It may also be required to connect test equipment to the vehicle circuits with the umbilical connector removed. The Umbilical Circuits Access Test Boxes are designed to be installed between the ends of the umbilical cables and the respective vehicle umbilical receptacles. These boxes provide access to the umbilical circuits for test purposes while maintaining uninterrupted circuits from the umbilical cables to the vehicle. The test boxes may also be used in two other configurations:

a. Connected to the umbilical cables with the vehicle side disconnected, or

b. Connected to the vehicle with the umbilical cable side disconnected.

In these installed configurations, the test jacks on the test box panels provide access to the umbilical circuits in accordance with the requirements described above.

18.5.2.2 Description. The test boxes are of two kinds as typified by Figures 18.5-2 and 18.5-3 and described in the following paragraphs. The boxes are portable, are painted yellow, and vary in size up to approximately 15" x 16" x 22", weighing up to 100 pounds including cables. Each test box is designed for use at a particular umbilical connector.

Figure 18.5-2 illustrates a typical test box with an attached cable approximately five feet in length. The end of the cable carries an umbilical type connector plug intended for mating with the vehicle-installed umbilical connector receptacle. The test panel within the box carries an umbilical type connector receptacle intended for mating with the connector plug on the end of the umbilical cable.

Figure 18.5-3 illustrates a typical test box with from one to three separate cables of approximately 9 feet in length. One end of each cable carries an electrical connector plug for mating with one of the connector receptacles on the back (umbilical cable side) of the Gray-Hulegard umbilical adapter connector plug. The other end of each of these cables carries a connector plug for mating with a connector receptacle on the test panel of the test box. The test panel carries from one to three receptacles to mate with the connector on the end of the respective umbilical cable. The cable normally connects with one of the receptacles on the back of the Gray-Hulegard umbilical adaptor.

18.5.3 FUNCTIONAL PROCEDURES. Both of the test box configurations just described provide continuous circuits from each umbilical cable through the test box to the vehicle umbilical receptacle with a test jack on the test panel for every umbilical cable lead. Each of the test jacks has a 30 ampere current rating and is suitable for connection to any of several common test lead tips. Figures 18.5-2 and 18.5-3 show a typical circuit through the test box and cable.

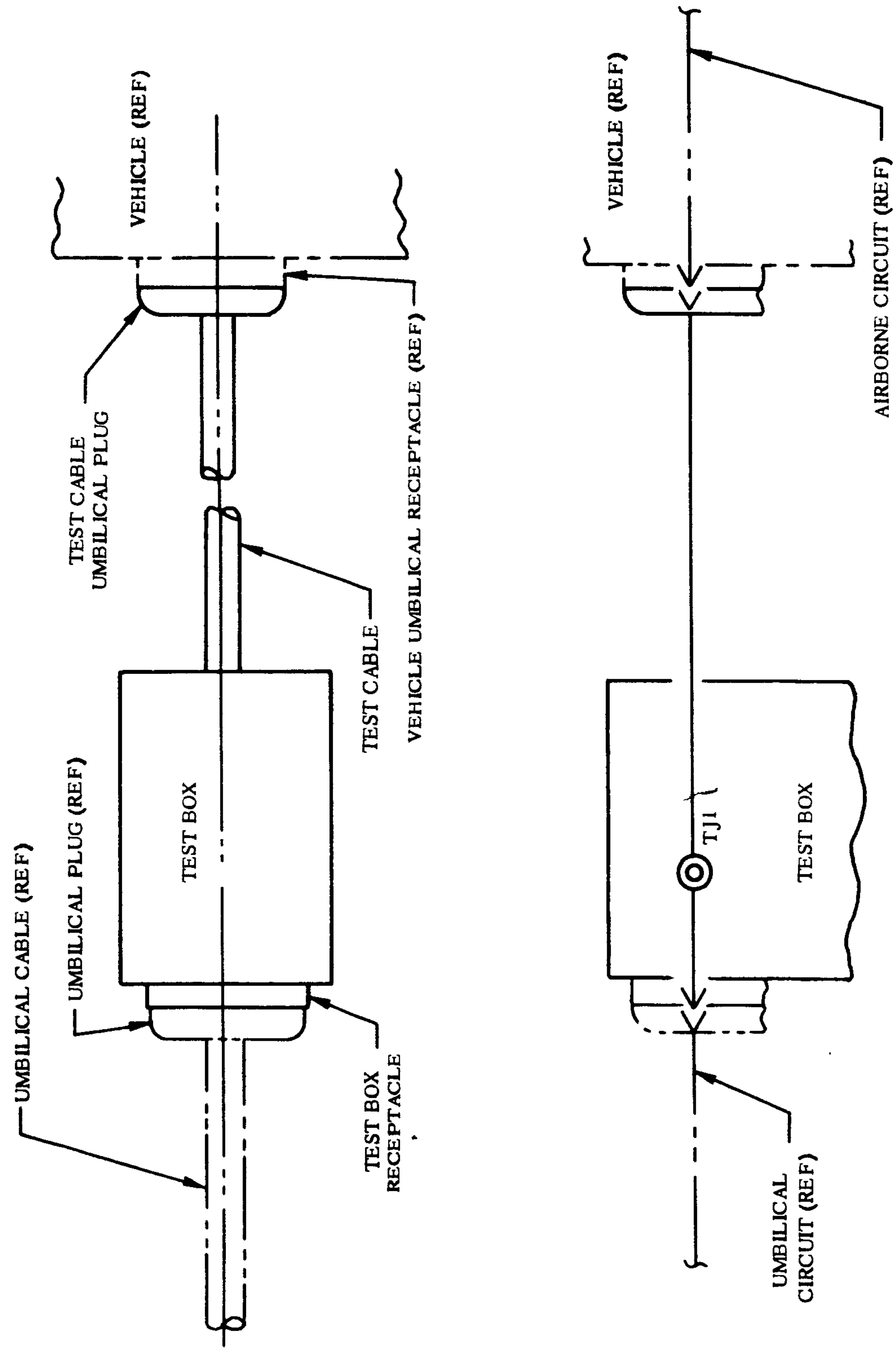


Figure 18. 5-2. Typical Umbilical Access Test Box Installation and Circuit - Attached Test Cables

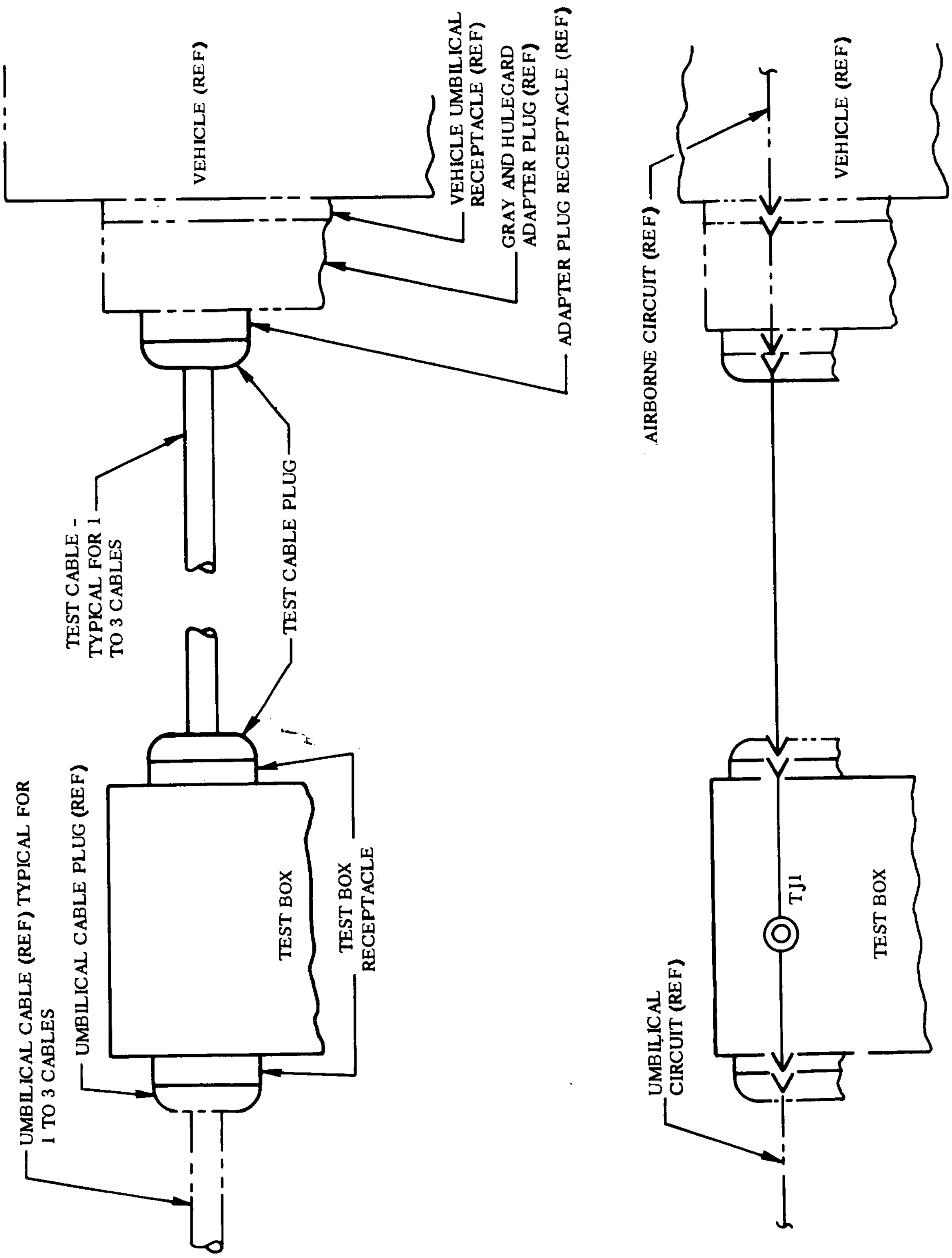


Figure 18. 5-3. Typical Umbilical Access Test Box Installation and Circuit - Separate Test Cables

Typical operations which may be performed using the test boxes include:

a. Monitoring the presence of a signal by means of an indicator light or voltmeter.

b. Verifying continuity of a circuit by means of a volt-ohmmeter.

c. Measuring circuit voltages under load by means of the Umbilical Circuits Load Bank unit (see Subsection 18.6).

18.5.3.1 Checkout Procedure. Since there are no functioning devices or circuits in the test boxes, checkout consists of a continuity test of each circuit, a test for improper connections or short circuits within the box or cables, and a measurement of insulation resistance. These tests are performed as follows:

a. If separate cables are provided (as in the test boxes of Figure 18.5-3), attach them to the test panel receptacles.

b. Provide a test lead circuit as shown in Figure 18.5-4 and connect to the facility 115 vac, 60 cycle power outlet. Connect the case of the test box to earth ground through the lead provided. Connect the 115 volt "hot" lead to test jack No. 1. The indicator light shall not illuminate. Touch the 115 volt return (ground potential) lead in turn to the panel connector receptacle contact and to the cable connector plug contact which correspond to test jack No. 1. The light shall illuminate in each case. Touch the 115 volt return lead in turn to each of the remaining higher numbered test jacks on the panel. The light shall not illuminate in any case. Use the wiring diagram in the box assembly drawing as a guide in performing this test.

c. Repeat the test per (b) above on each of the remaining test jacks on the panel.

CAUTION

The 115 vac used in this test can be dangerous if improperly handled and may be lethal. Provide properly insulated test leads and test prods for the safety of the operator.

d. Connect all test jacks together. Using a "megger," measure the insulation resistance between the test jacks and the case of the box. The insulation resistance shall not be less than 500 megohms.

18.5.3.2 Operating Procedure. The following procedure is typical for any of the several test boxes. Any number (or all) of the test boxes may be used simultaneously.

On test boxes with separate test cables, connect the cables to the receptacles on the test panel of the box. As required by the test to be performed, connect the umbilical cable to the connector receptacle on the test panel, and/or connect the umbilical

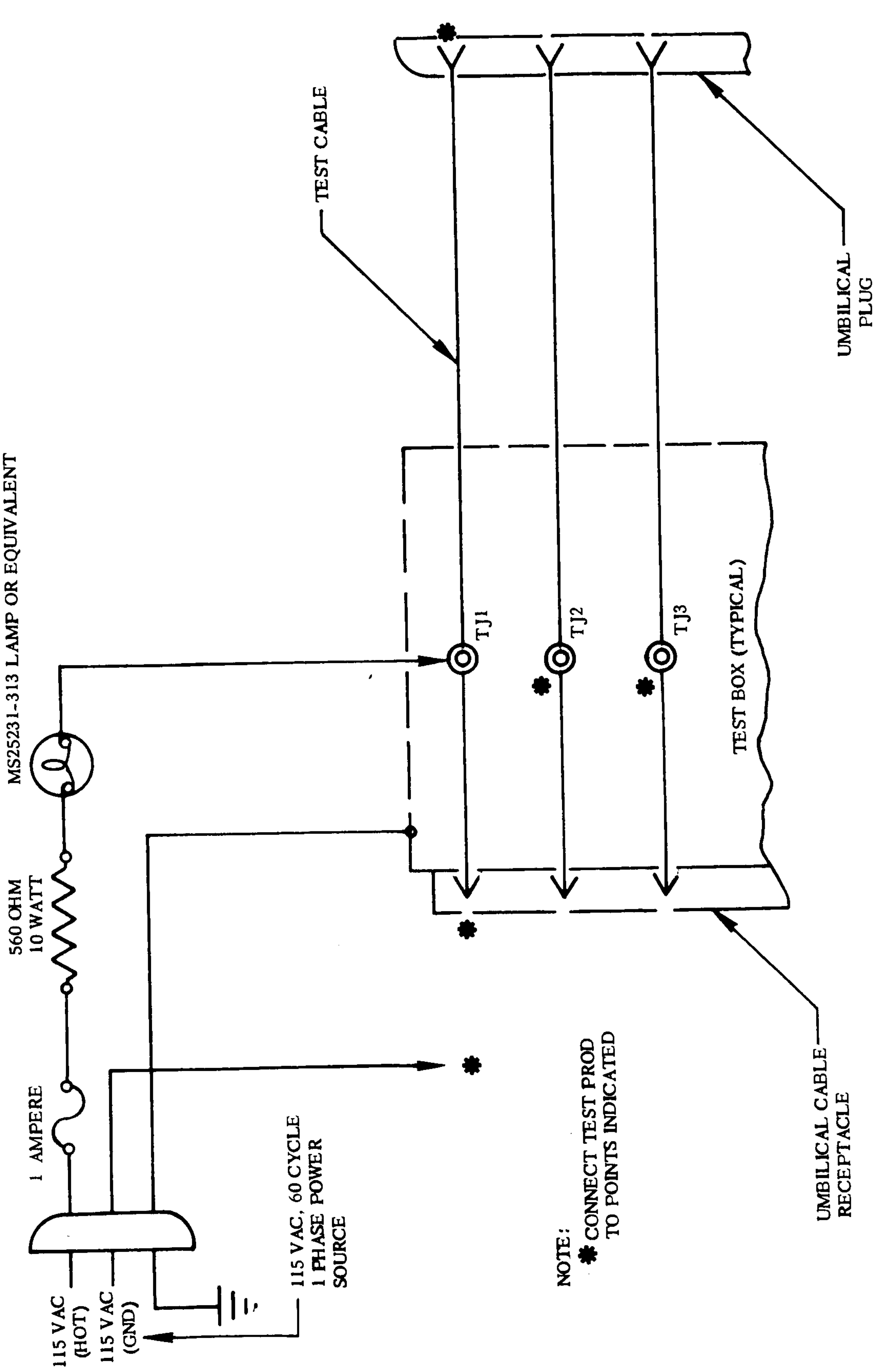


Figure 18. 5-4. Umbilical Access Test Box Checkout Test Circuit

connector end of the test cable to the vehicle umbilical receptacle or to the receptacle on the back of the Gray-Hulegard umbilical adapter plug, as appropriate. Attach test leads to the test jacks on the box panel and to appropriate test equipment in order to test or monitor the particular circuits of interest.

CAUTION

The umbilical circuits carry voltages as high as 115 vac, which are dangerous if improperly handled and may be lethal. Provide properly insulated test leads and take appropriate precautions for personnel safety.

18.6 UMBILICAL CIRCUIT AND PLUG CHECKOUT - CIRCUITS LOAD BANK

The unit described herein is identified as follows:

Part Number: 55-53119-1

Part Name: Load Bank - Umbilical Circuits

EID: 55-4512-1

Unit Number: U9003
(Reference Designator)

18.6.1 PURPOSE. Validation of the site electrical GSE systems includes a ring-out test to verify continuity of the GSE/vehicle interface circuits to the proper contacts in the umbilical connectors, and a circuit functional test to verify the proper voltage and current signals. The Umbilical Circuits Load Bank is provided so that particular circuits may be electrically loaded to detect improper circuit resistance or incipient circuit failure.

18.6.2 DESCRIPTION. The Umbilical Circuits Load Bank is contained in a yellow weather-resistant carrying case approximately 10" x 16" x 22" and weighs approximately 35 pounds. Removal of the cover exposes the control panel. Test leads furnished with the unit are stowed in the cover. The control panel contains the following components:

a. 0-30 volt d-c voltmeter

b. 0-30 ampere d-c ammeter

c. 0-5 ampere d-c ammeter

d. "Ready for Test" toggle switch

e. "Load" toggle switch

f. 0-25 ampere load selector switch

g. 0-4 ampere load selector switch

h. 0-1 ampere load selector switch

i. Input current jacks.

The panel layout is shown in Figure 18.6-1. Beneath the panel the following items are located:

a. Load bank resistors

b. Cooling air blower

c. Control relays.

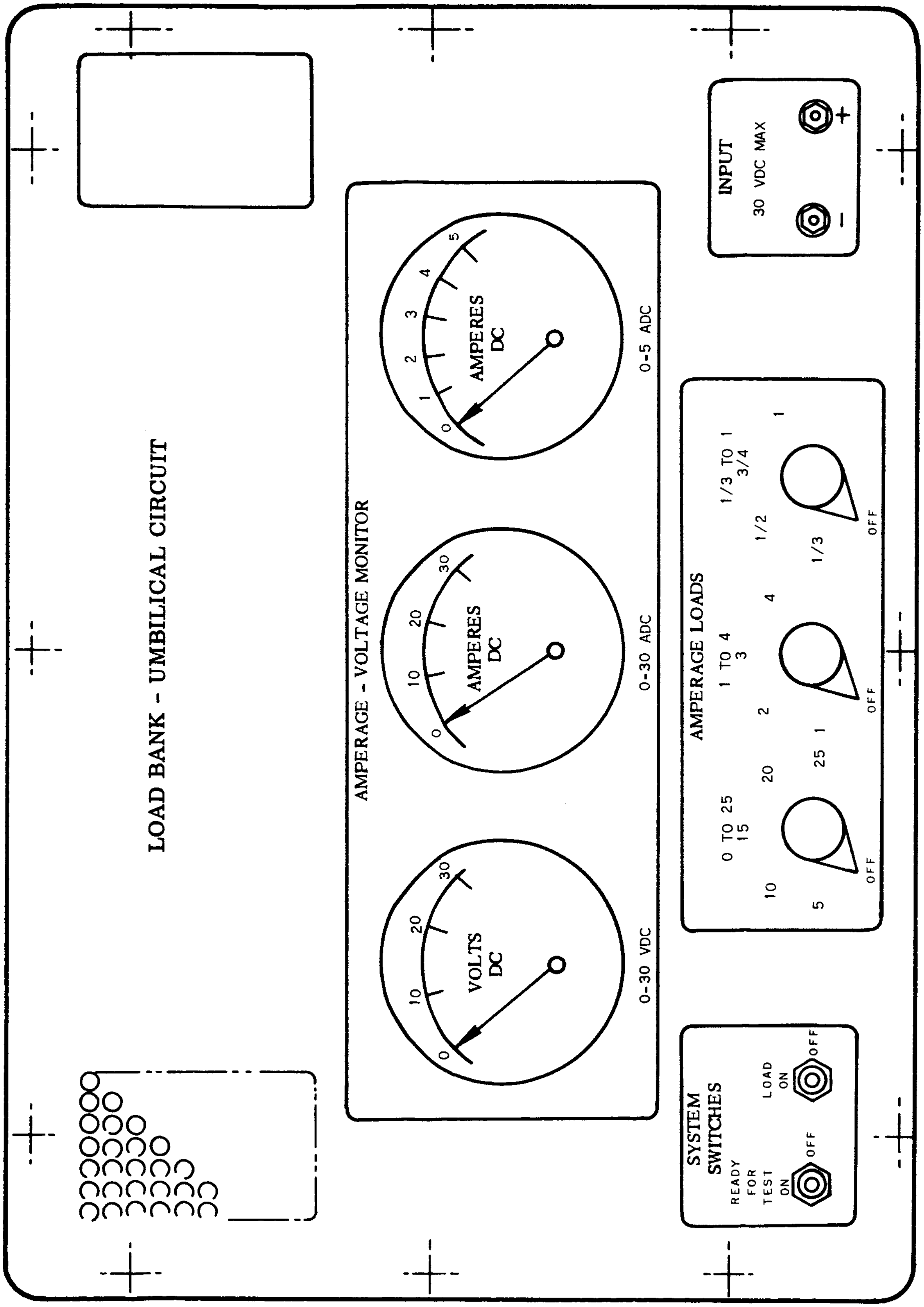


Figure 18.6-1. Umbilical Circuits Load Bank Panel

Entrance and discharge of cooling air occurs through two grilled openings in the upper part of the panel.

The Load Bank is designed for use on d-c circuits only at potentials of 7 to 30 volts and can apply a resistance load as high as 30 amperes at 28 volts. In use, the Load Bank is connected to the circuit to be tested by means of the test leads attached to the input current jacks on the Load Bank Panel. Application of power at the input current jacks activates the panel voltmeter, but no load current is drawn by the Load Bank. In order to prevent inadvertent application of large current loads to circuits with low current ratings, an interlock relay circuit in the unit prevents closing of the load circuit unless the current control selector switches are all at the zero-current position.

When these switches are at zero, a momentary setting of the "Ready for Test" toggle switch to the ON position closes the load current contactor and enables application of loads to the circuit under test. These loads can be applied by means of the Load On-Off toggle switch and the Load Selector switches. Approximately one-third of an ampere will be drawn from the circuit under test when the Load Bank unit is in the "Ready for Test" condition.

The Load Selector switches provide selection of nominal load current values, in increments of one-quarter to one-third of an ampere, to a maximum of approximately 30 amperes. Actual load current is indicated on the panel ammeters. The 0-30 ammeter reads total current, including that drawn by the blower motor; the 0-5 ammeter reads only the current values selected below 5 amperes. The nominal current load values inscribed at each position of the selector switches are applicable to 28 vdc circuits only; other voltages will result in current values proportional to the voltage value. Figure 18.6-2 is a schematic diagram of the Load Bank unit.

18.6.3 FUNCTIONAL PROCEDURES. Instructions for the checkout and use of the Umbilical Circuits Load Bank are presented in the following procedures.

18.6.3.1 Checkout Procedure. The Load Bank test accessory must be tested prior to use to assure proper operation of the unit. Test equipment requirements are:

a. Multimeter, Simpson 260 or equivalent

b. Power Source, 7 vdc, 7-1/2 amperes

c. Power Source, 28 vdc, 30 amperes.

The procedure for checking out the multimeter is as follows:

a. Set all switches on the Load Bank unit to the OFF position. Set the multimeter to measure ohms on the RX100 scale. Connect the multimeter across the Load Bank unit input current jacks (observe polarity). The multimeter

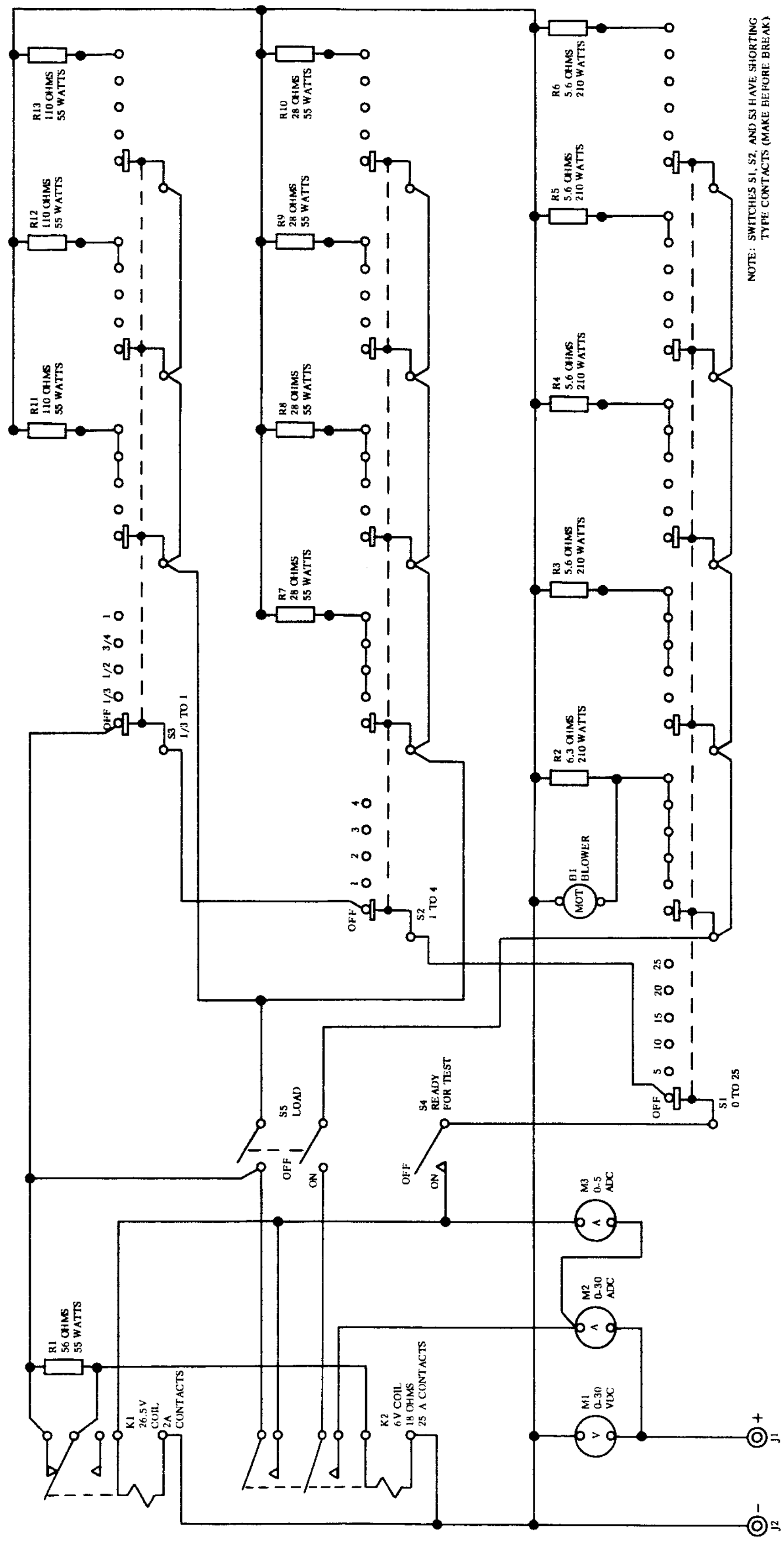


Figure 18.6-2. Umbilical Circuits Load Bank Schematic Diagram

shall read 500 ohms ± 10 percent. Operate the "Ready for Test" switch to ON and hold. The multimeter shall then read 17 ohms ± 10 percent. Release the switch and disconnect the multimeter.

b. Verify that the Load Bank Panel instruments calibration has not expired.

In the procedures below, S1 designates the selector switch marked 0 to 25; S2 designates the switch marked 1 to 4; and S3 designates the switch marked 1/3 to 1. A tolerance of ± 10 percent is allowed on the current and voltage values, except current values below 1 ampere; values below one ampere have a tolerance of ± 0.1 ampere.

The procedure for checking out the 7 vdc power source is as follows:

a. Verify that all Load Bank unit switches are OFF. Connect the 7 vdc power source to the Load Bank input jacks (observe polarity), and turn the power supply ON. The Load Bank Panel voltmeter shall then read 7 volts; and the 0-5 adc ammeter shall read a slight current, approximately 0.06 ampere.

b. Momentarily actuate the "Ready for Test" switch to ON. The 0-5 adc ammeter shall then indicate approximately 0.4 ampere.

c. Operate the "Load" switch to ON. The 0-5 adc ammeter shall still indicate 0.4 ampere.

d. Operate the load selector switches according to the steps indicated, and observe the respective load current ammeter readings as shown in Table 18.6-1.

TABLE 18.6-1. LOAD BANK CHECKOUT TABLE, 7 VDC SOURCE

Selector Switch			Ammeter	
S1	S2	S3	0-5 adc	0-30 adc
OFF	OFF	1/3	0.4	0
OFF	OFF	1/2	0.45	0
OFF	OFF	3/4	0.5	0
OFF	OFF	1	0.6	0
OFF	1	1	0.85	0
OFF	2	1	1.1	0
OFF	3	1	1.3	0
OFF	4	1	1.6	0
5	4	1	1.6	2.8
10	4	1	1.6	4.1
15	4	1	1.6	5.3
20	4	1	1.6	6.6
25	4	1	1.6	7.8

e. Verify that the "Load" switch turns the load current "off and "on."

f. Turn off and disconnect the power supply. Place all Load Bank switches at OFF.

The procedure for checking out the 28 vdc power source is as follows:

a. Verify that all Load Bank switches are OFF. Connect the 28 vdc power source to the Load Bank input jacks (observe polarity), and turn the power supply on. The Load Bank Panel voltmeter shall then read 28 volts. The 0-5 adc ammeter shall read a slight current, approximately 0. 06 ampere.

b. Momentarily actuate the "Ready for Test" switch to ON. The 0-5 adc ammeter shall then indicate one-third of an ampere.

c. Operate the "Load" switch to ON. The 0-5 adc ammeter shall still indicate one-third ampere.

d. Operate the load selector switches according to the steps indicated in Table 18. 6-2 and observe the respective load current ammeter readings.

TABLE 18. 6-2. LOAD BANK CHECKOUT TABLE, 28 VDC SOURCE

Selector Switch			Ammeter	
S1	S2	S3	0-5 adc	0-30 adc
OFF	OFF	1/3	1/3	0
OFF	OFF	1/2	1/2	0
OFF	OFF	3/4	3/4	0
OFF	OFF	1	1	0
OFF	1	1	2	0
OFF	2	1	3	0
OFF	3	1	4	0
OFF	4	1	5	0
5	4	1	5	10
Blower motor starts when S1 is switched to 5				
10	4	1	5	15
15	4	1	5	20
20	4	1	5	25
25	4	1	5	30

e. Turn off the power supply. Turn on the power supply. The Load Bank voltmeter shall then read 28 volts. The Load Bank ammeters shall read approximately 0. 06 amperes.

The Umbilical Circuits Load Bank is intended for use with the Umbilical Access Test Boxes. For a description of this latter equipment and the operating procedure for its use, see Subsection 18. 5 of this report.

18.6.3.2 Operating Procedure. To perform a load test on a particular umbilical circuit, proceed as follows:

Attach the proper Umbilical Access Test Box(es) to the umbilical cable connector plug(s) containing the two leads of the circuit to be tested. The vehicle side of the Umbilical Access Test Box(es) should be left disconnected. Energize the circuit to be tested from a source in the blockhouse or other control station. Connect the multimeter to the two test jacks of the circuit, verify that the voltage is not over 30 vdc, and note the polarity. Remove the multimeter. Verify that all switches on the Load Bank unit are off. Observing polarity, connect the Load Bank unit to the two test jacks noted above. Note the Load Bank Panel voltmeter reading (no load voltage). Operate the "Ready for Test" switch momentarily to ON. Set the load selector switches to a total setting approximating the load current specified for the test. Actuate the load switch to ON. Read the panel ammeters. Readjust the load selector switches so that the panel ammeters read as closely as possible to the specified current values. Note the panel voltmeter reading (loaded voltage). Place the load switch to OFF. Subtract the loaded voltage from the no-load voltage to obtain the load voltage drop. Compare the load voltage drop with the specified allowable load voltage drop to evaluate the performance and acceptability of the circuit. After completion of the test, turn off the circuit power source and disconnect the test equipment.

CAUTION

Do not apply loads in excess of maximum allowable currents; otherwise damage to system wiring or components may result. Allowable currents may be defined by one or more of the following:

a. Fuse or circuit breaker rating

b. Circuit wire size

c. Current rating of relay or switch contacts

d. Current rating of circuit elements

e. Current rating of power or signal source.

SECTION XIX

HANDLING AND ERECTING SYSTEMS

19.1 GENERAL DESCRIPTION

The handling and erecting systems include the vehicle transport equipment and handling fixtures required to: move the Centaur vehicle from the factory to the launch site, erect the vehicle at the launch pad for attachment and encapsulation of the payload, and operate the service tower stretch system.

19.2 TRANSPORTATION SYSTEM

19.2.1 TRANSPORTATION SYSTEM FUNCTION. The function of the Transportation system (see Figures 19.2-1 and 19.2-2) is to provide a means of handling and transporting the Centaur vehicle from the factory to the launch site. Figure 19.2-3 is a block diagram of the operations required in performing the transportation task. The system provides the Centaur vehicle and components with adequate protection from such environmental conditions as temperature, pressure, high g-loading, vibration, and contamination during road or air shipment. Table 19.2-1 lists the transportation system equipment.

TABLE 19.2-1. TRANSPORTATION SYSTEM EQUIPMENT

Nomenclature	Part Number	EID Number	Length (in.)	Width (in.)	Height (in.)
Centaur Trailer	55-09001	55-9501	600	95	40
Centaur Protective Cover	55-91101	55-9505	410	120	120
Centaur Pallet	55-91106	55-9506	510	130	70
Centaur Adapter, Auxiliary	55-91102	55-9508	30	120 diam	-
Centaur Adapter, Aft	55-91103	55-9512	120	120 diam	-
Centaur Adapter, Forward	55-91104	55-9511	45	120 diam	-
Centaur Adapter, Universal	55-91105	55-9510	15	120 diam	-
Centaur Pallet Lifting Sling	55-93001	55-9516	266	-	290
Engine Support Assembly, Aft	55-91113	55-9523	2	40	80
Safety Links, Forward Bulkhead	55-91112	55-9522	13	1/4 diam	-
Nose Fairing Handling Dolly	55-91138	55-9568	200	130	135
Interstage Adapter Handling Dolly	55-91140	55-9571	200	130	135
Air Transport Loading Kit	55-91003	55-9534	1682	104	55

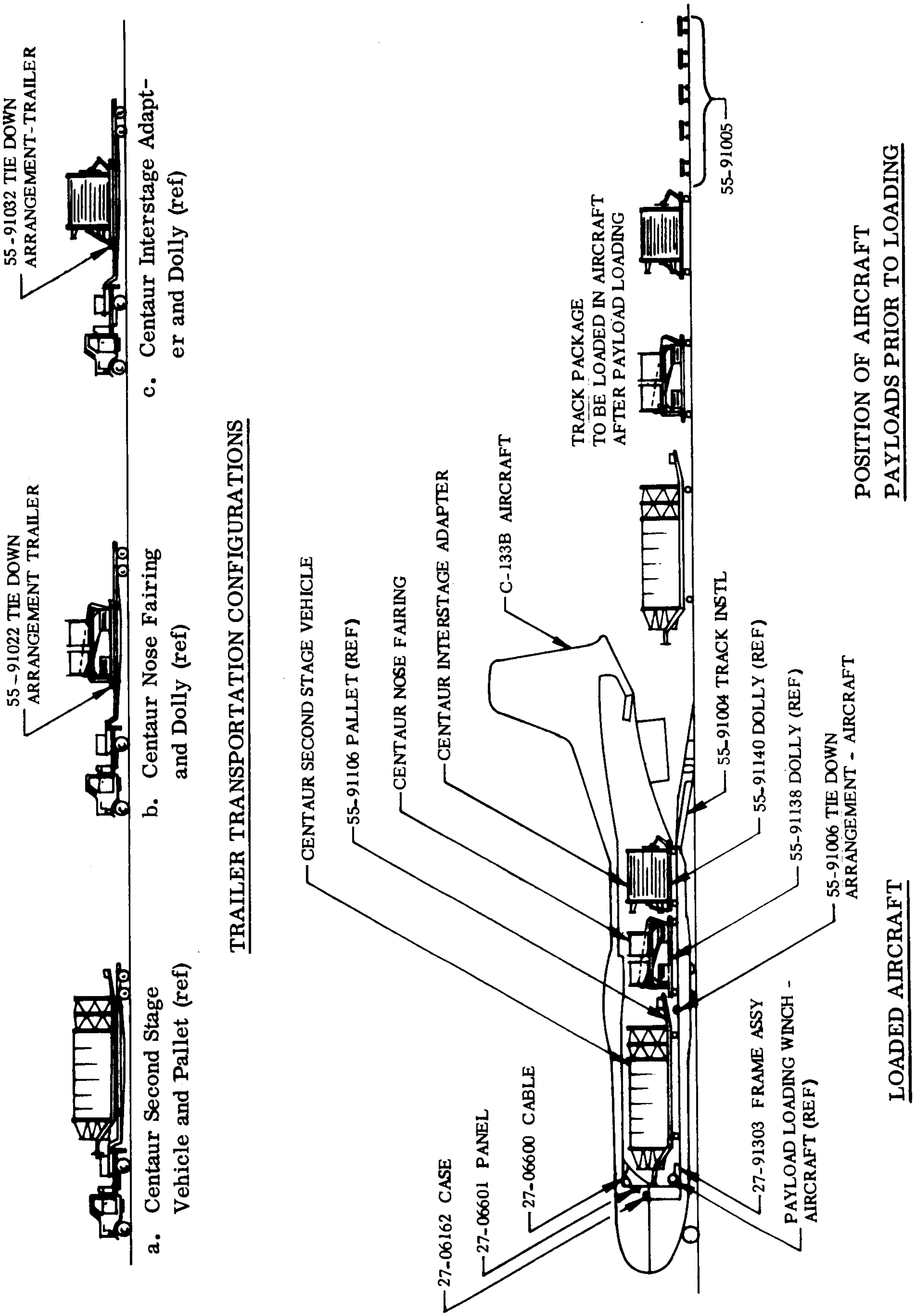


Figure 19.2-1. Transportation and Handling Equipment

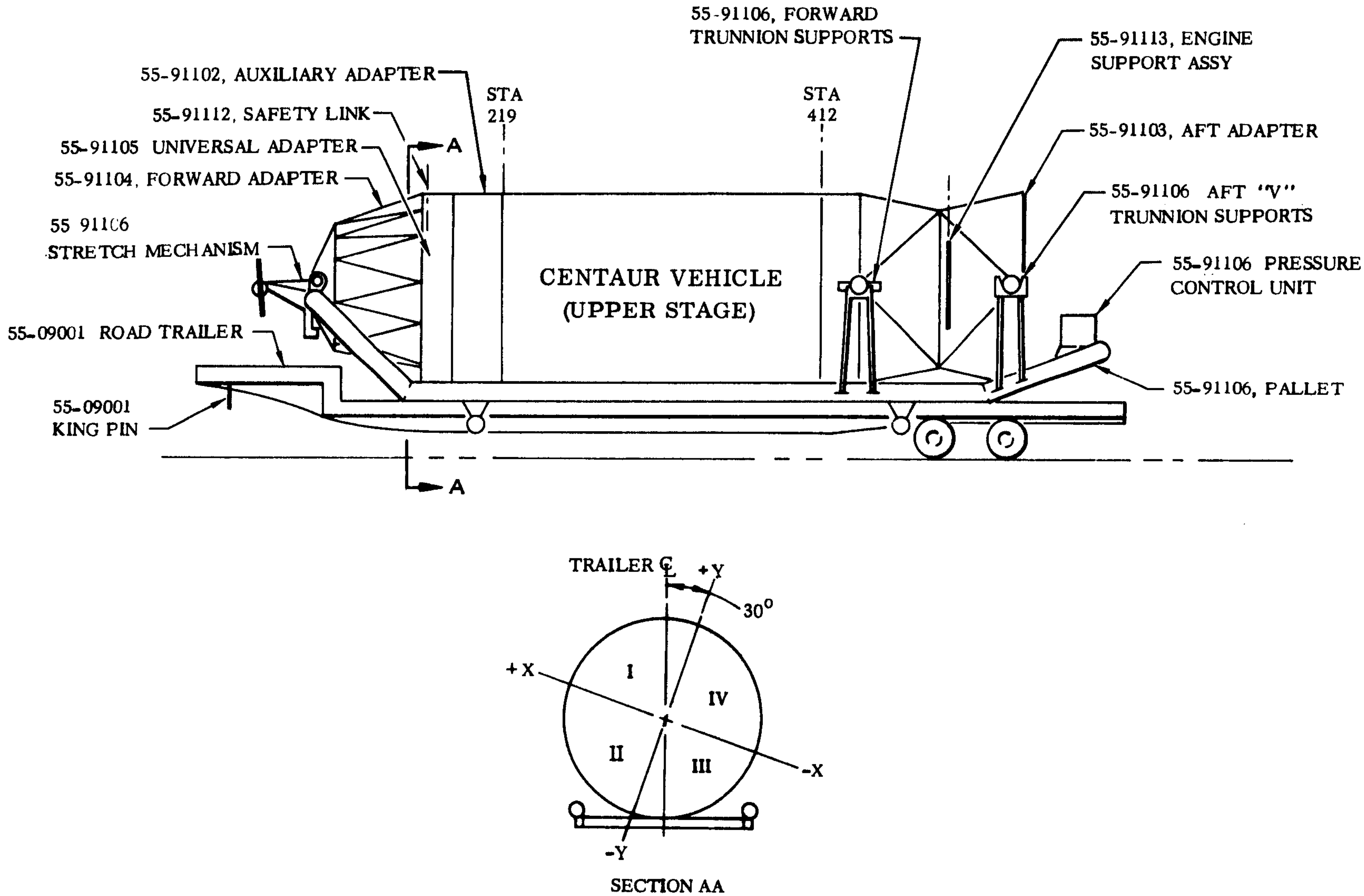


Figure 19.2-2. Centaur Tank Transportation and Handling GSE

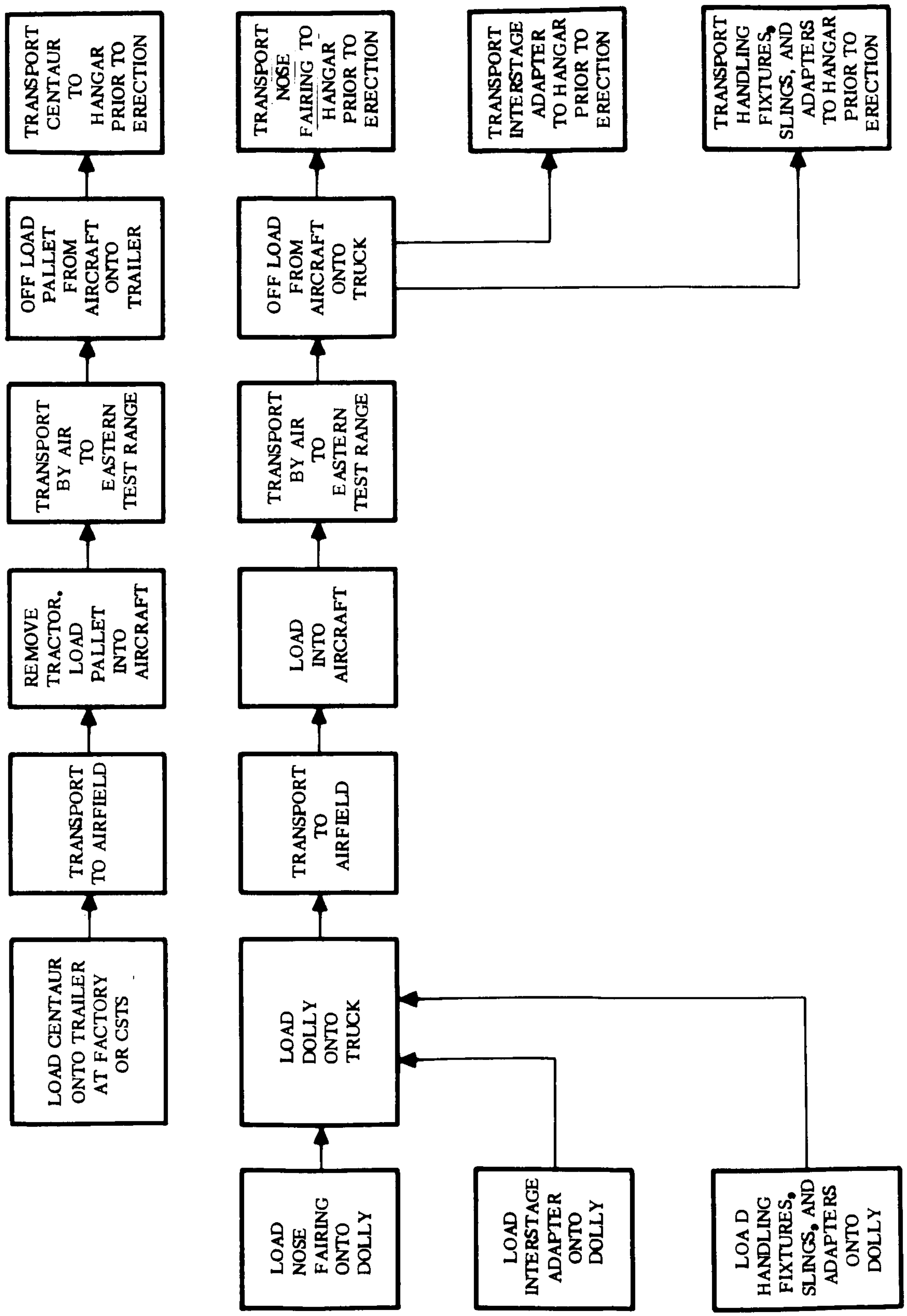


Figure 19.2-3. Transportation System Block Diagram

19.2.2 TRANSPORTATION SYSTEM EQUIPMENT. Equipment employed in Centaur vehicle transport is described in the following paragraphs.

19.2.2.1 Centaur Trailer (Figures 19.2-4 through 19.2-6). The Centaur trailer provides road transportation for the vehicle. The Centaur pallet containing the Centaur vehicle is tied down using turnbuckle linkages fastened to the trailer attach points. The trailer is equipped at its front end with a standard king-pin which is compatible with the standard commercial trailer fifth-wheel configuration. A special trailer suspension system absorbs the shock and vibrations produced during road or air transport.

19.2.2.2 Protective Cover (Figure 19.2-6). The Centaur protective cover is a lightweight, pliable, waterproof, flameproof, heat-reflecting cover provided to enclose and conceal the Centaur when mounted in the pallet. The cover provides weather and dust protection as well as security concealment during transportation.

19.2.2.3 Centaur Pallet (Figures 19.2-4 through 19.2-7). A pallet with casters is furnished to support the Centaur vehicle, with its attached forward and aft adapter assemblies, during ground handling and either over-highway or air transporting, and erection operations. It also provides a means of maintaining mechanical stretch to the vehicle in case of an inadvertant depressurization of the tanks. This pallet is provided with five trunnions: three of these are used during transportation, one attaching to the vehicle's forward attached adapter assembly and two to the vehicle's attached aft adapter assembly; the other two trunnions located on the extreme aft portion of the pallet are used when the vehicle is rotated to a vertical position prior to hoisting it into the service tower. The four aft trunnions are provided with adjustments for mating and alignment of the vehicle in the transport pallet.

A pressurization control system is provided as part of the transport pallet, consisting of gaseous nitrogen bottles and a control unit panel located near the aft end of the pallet. This system furnishes controlled pressure to the vehicle tanks during handling and transportation.

19.2.2.4 Centaur Forward and Aft Adapter Assemblies (see Figures 19.2-4, 19.2-5, and 19.2-7). These assemblies are provided to support the Centaur vehicle during transport by attaching them to the forward and aft mating flanges of the vehicle and to the forward and aft trunnion assemblies of the transport pallet. This arrangement also provides a means of applying stretch forces to the vehicle in case of an inadvertant tank depressurization. These adapter assemblies are attached to the vehicle prior to moving the vehicle from the docks to the transport pallet. In addition (by using slings and hoisting equipment), they provide a means of erecting the vehicle from the transport pallet to a vertical position at the service tower and hoisting it to a mating position with the booster vehicle in the service tower.

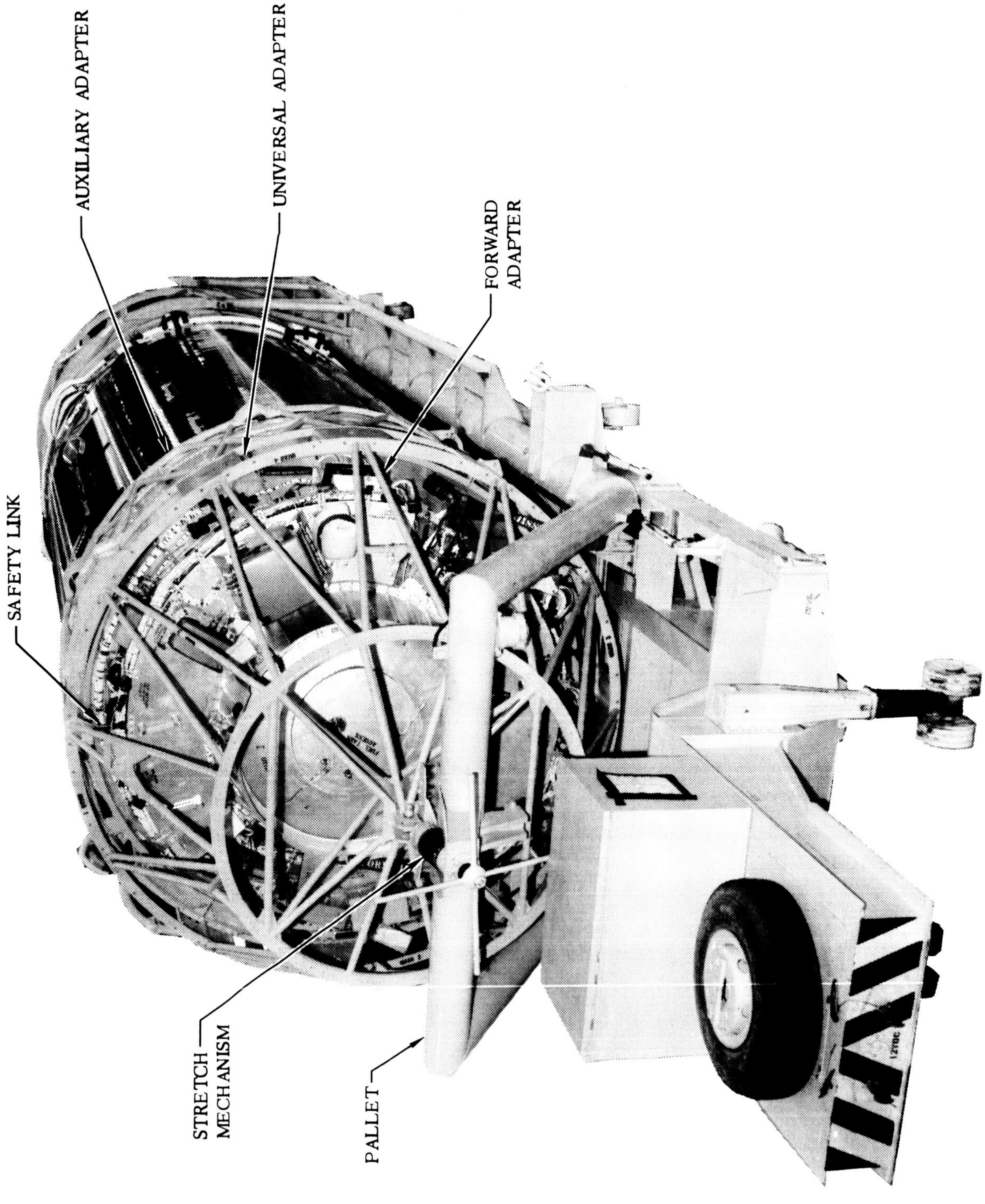


Figure 19.2-4. Centaur Trailer (Foward End)

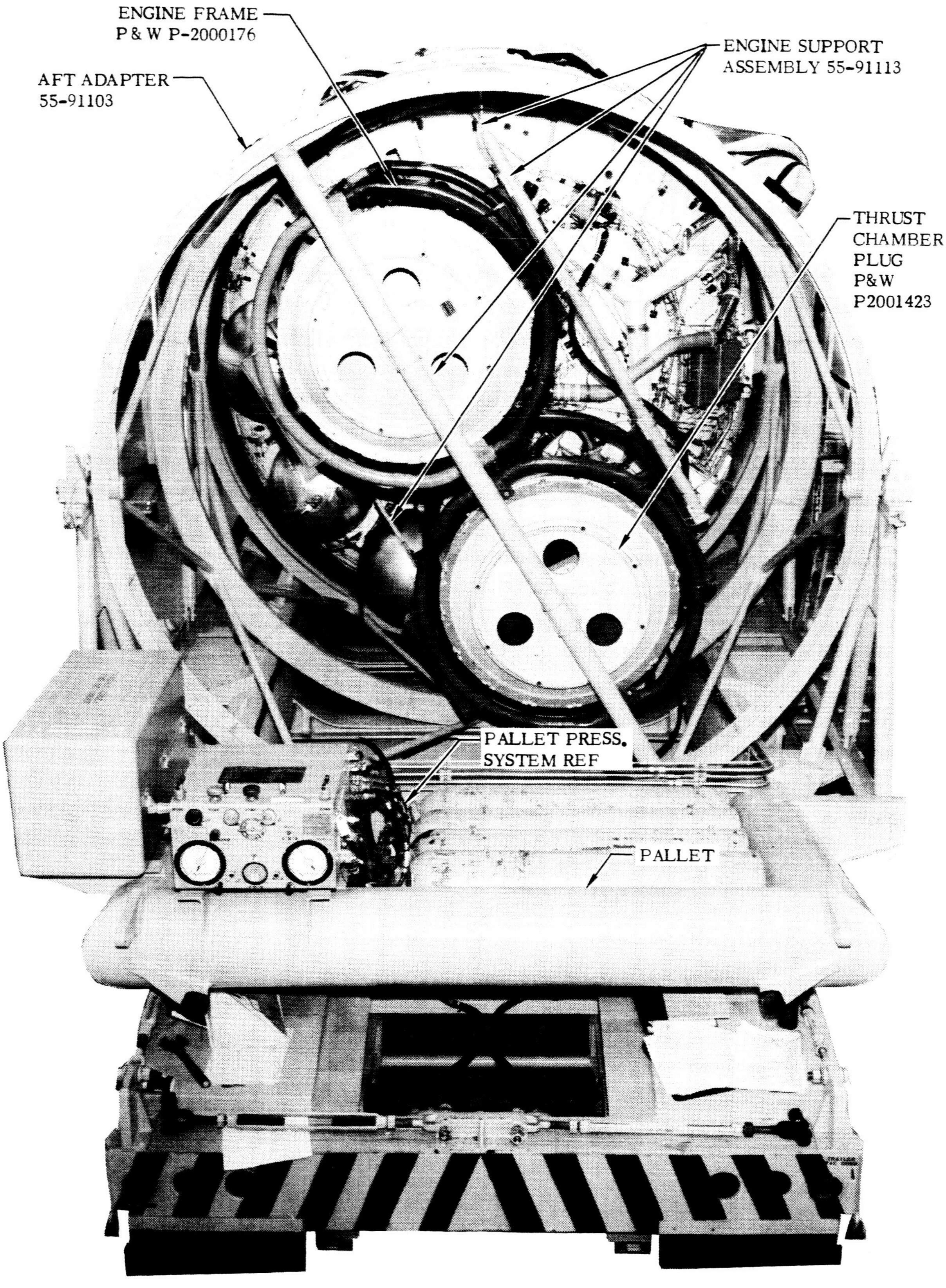


Figure 19.2-5. Centaur Trailer (Aft End)

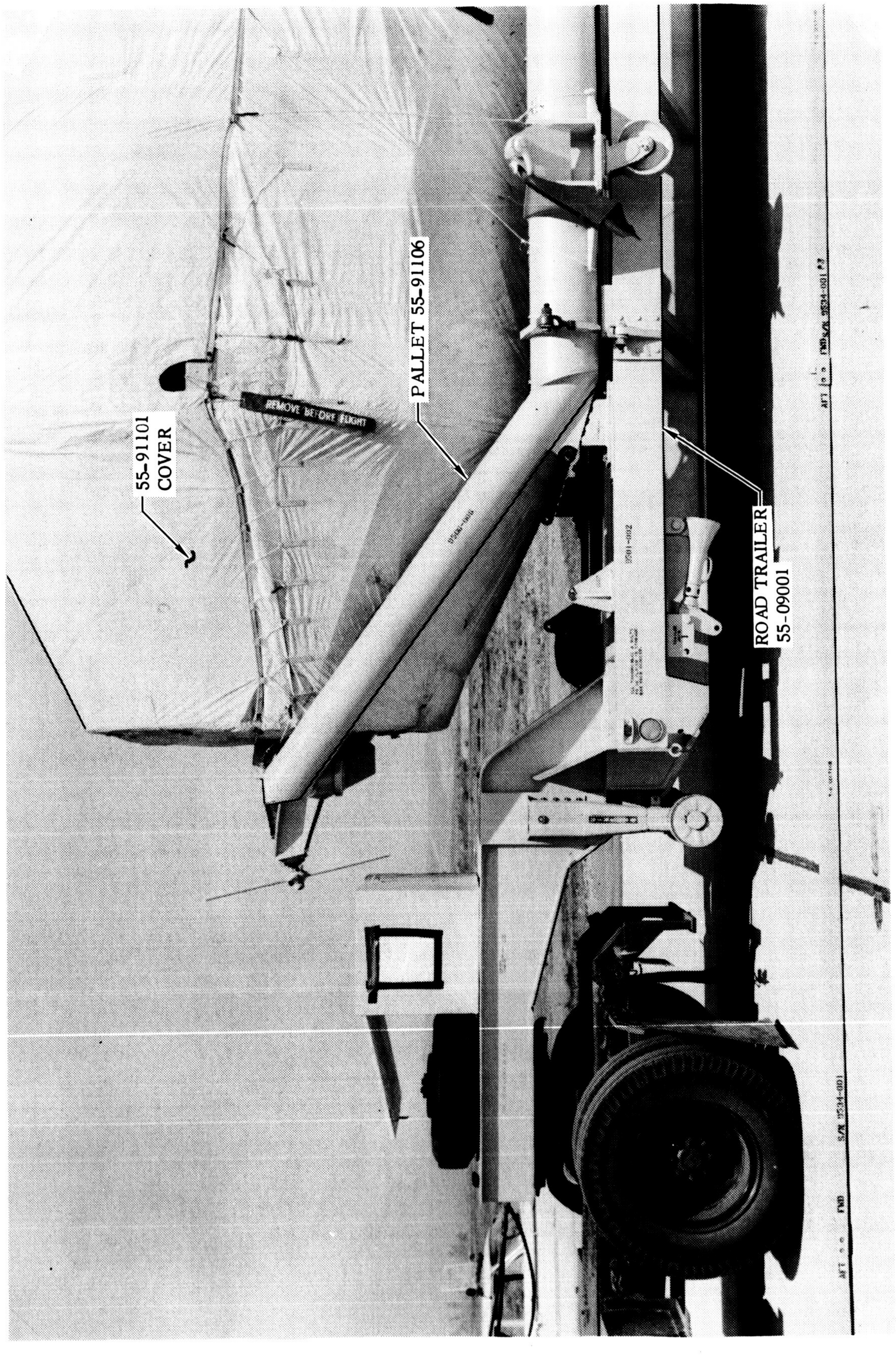


Figure 19.2-6. Centaur, Trailer, and Pallet

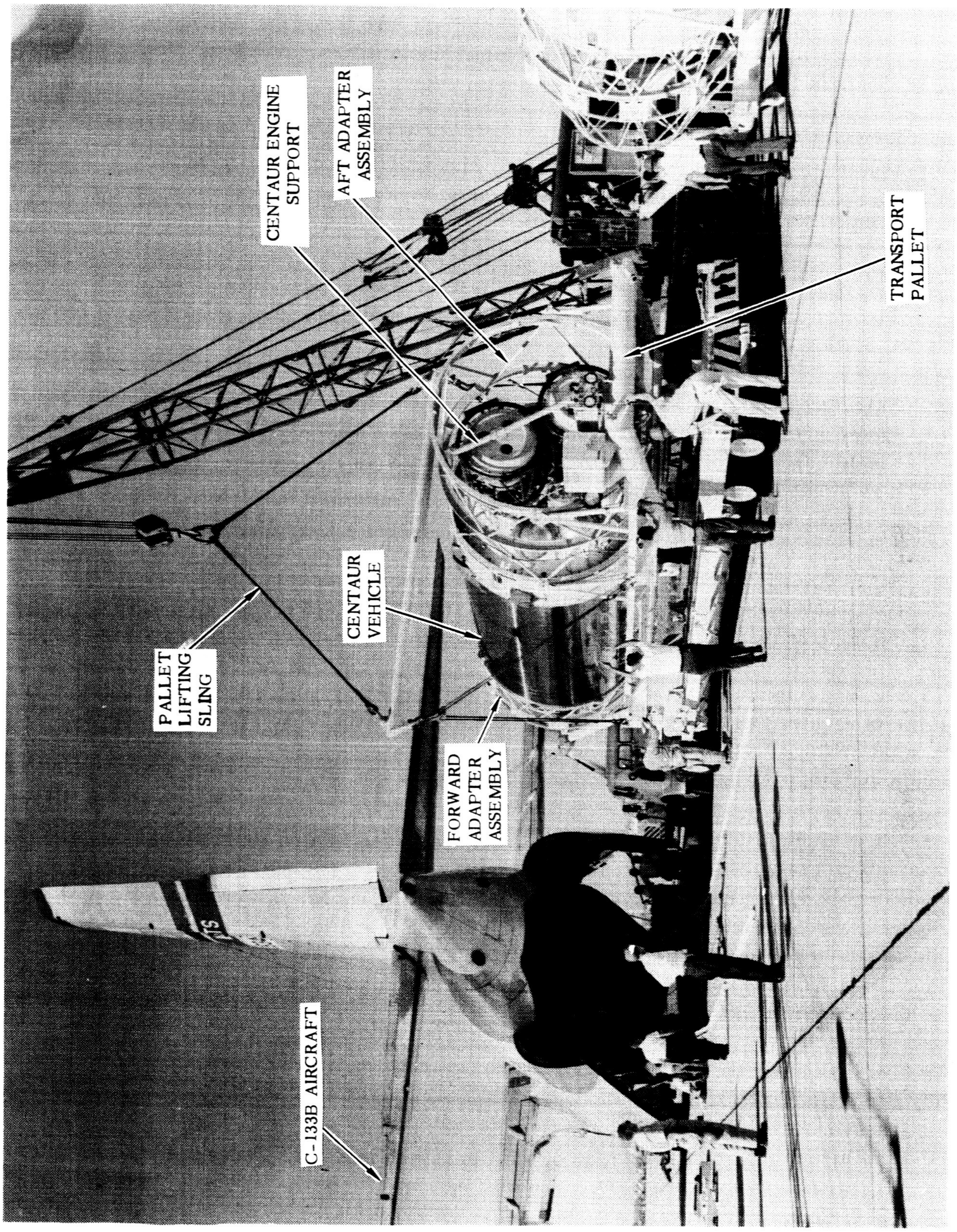


Figure 19.2-7. Centaur Transportation Pallet and Pallet Lifting Sling Arrangement

The forward adapter assembly is composed of three major units, referred to as the forward adapter, universal adapter, and auxiliary adapter. The aft adapter assembly consists of only one basic unit. The peculiar functional requirements of these adapters are described in the following paragraphs:

a. Forward Adapter: This adapter is made in a welded steel tubular truss construction designed for attachment to the forward trunnions of the transport pallet and for bolt attachment to the forward flange of the universal adapter at Station 174.

b. Universal Adapter: This adapter is a welded steel flanged spacer ring designed for bolt attachment to the forward adapter and auxiliary adapter at Station 189.

c. Auxiliary Adapter: This adapter is made in a welded tubular truss construction designed for bolt attachment to the aft flange of the universal adapter and the forward mating flange of the Centaur at Station 219. Stretch lugs located around the periphery of the forward ring are provided to facilitate attachment of the stretch sling.

d. Aft Adapter Assembly: This assembly is made in a welded tubular truss construction designed with four trunnion fittings, two of which are used during transportation and two for erection.

19.2.2.5 Centaur Sling Assembly - Pallet Lifting (see Figure 19.2-7). A sling assembly is required to load and unload the upper-stage transport pallet on and off the upper-stage trailer. This sling consists of wire rope and spreader bar assemblies with a single hoist attach point and four point attachments to the pallet.

19.2.2.6 Centaur Engine Support Assembly - Aft (see Figure 19.2-5). This support assembly is provided to assist in maintaining engine alignment and protecting the engine assembly during handling and transportation. The support assembly consists of a cross bar, which attaches to the engine frames (GFE), and two adjustable U-bolt plates that attach to the thrust chamber plugs (GFE). In the event of vehicle tank pressure loss, a link on the upper end of the cross bar is adjusted to take up the slack and relieve the load on the aft bulkhead.

19.2.2.7 Centaur Safety Link Installation - Forward Bulkhead (see Figure 19.2-4). A safety link installation provides support and forms a mechanical connection between the Centaur hydrogen tank forward bulkhead and the forward adapter in case of pressurization failure during transportation of the Centaur vehicle.

19.2.2.8 Centaur Interstage Adapter Dolly - Air Transport (see Figure 19.2-8). The interstage adapter dolly is a low-bed dolly with locking casters designed for limited road use. It is used for ground handling and air transporting the adapter. The dolly is

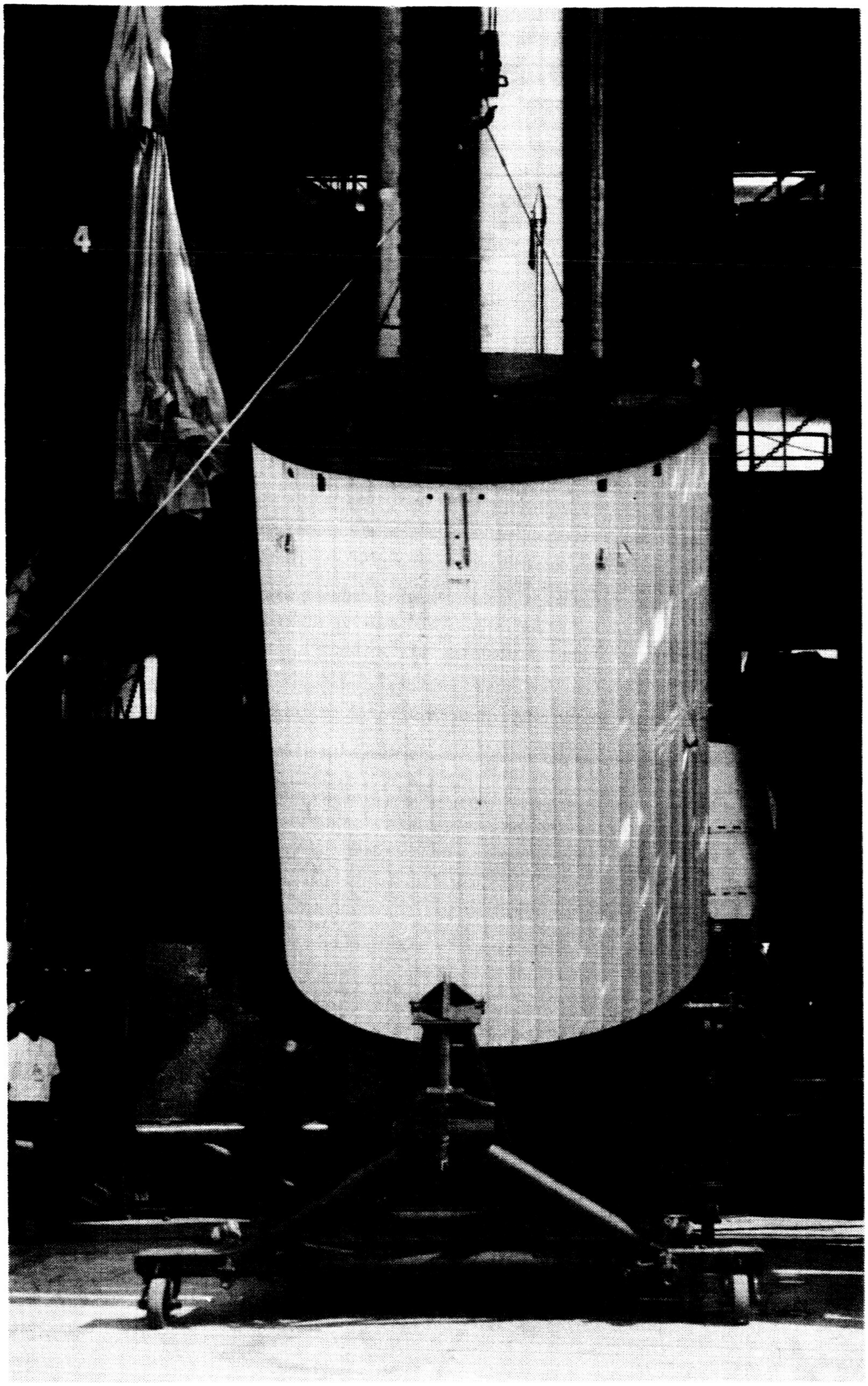


Figure 19.2-8. Interstage Adapter Handling Dolly

provided with tie-down fittings, miscellaneous hardware, and a tow-bar for manual and mechanical handling. The two dolly adapter rings are fitted to the ends of the interstage adapter. One ring is fitted with three short legs and fork lift receptacles permitting the adapter to be stood on end and moved locally by means of a forklift. For long haul transport, the adapter is lowered in a vertical attitude so that the aft adapter ring engages the two pivot points at the aft end of the dolly. The interstage adapter is then rotated down into the dolly. As it reaches the horizontal attitude, the forward adapter ring engages the dolly forward support. Each adapter ring is provided with a plywood bulkhead that seals all openings within the ring and thus protects the interior of the interstage adapter from contamination during transport.

19.2.2.9 Nose Fairing Handling Dolly - Air Transport (Figure 19.2-9). The nose fairing handling dolly provides the capability of handling and transporting the nose fairing. Two semicircular adapter rings are fitted to the two separated halves of the nose fairing.

Each nose cone half is lowered in a vertical attitude so that its adapter ring engages the two pivot points at the end of the dolly (one cone at the aft end and the other at the forward end). The cone halves are then rotated down to a near-horizontal attitude and their free ends supported on struts provided. The weather shroud for the cone section is then installed. The dolly nose fairing barrel mounting frames are lowered over the nose cones and secured to the dolly base frame. Two semi-circular adapters are fitted to each nose cone barrel half to lift the barrel halves onto the dolly barrel mounting frame. The barrels are then secured to the mounting frame and the barrel section weather shroud is installed.

19.2.2.10 Centaur Aluminum Air Transport Kit (Figure 19.2-1). This kit consists of one set of channel loading tracks (designed to accept the flat casters of the Centaur transport pallet), a pressurization warning system, and miscellaneous hardware. It is used for loading the Centaur into the C-133B aircraft.

19.3 ERECTION SYSTEM

19.3.1 ERECTION SYSTEM FUNCTION. The function of the Centaur vehicle erection system is to erect safely and efficiently the Centaur vehicle components from their respective trailers and dollies onto the launch pad ramp area and into launch position in the service tower. The Centaur vehicle components include the interstage adapter, Centaur stage, nose fairing adapter, insulation panels, and the nose cone fairing. Figure 19.3-1 is a sequence diagram of the erection sequence. The erection system is capable of lifting and mating the components in a 25 knot wind. The total elapsed time required to erect the Centaur vehicle and payload is 24 hours.

19.3.2 SERVICE TOWER. The service tower provides an enclosure for housing the booster and Centaur launch vehicle during mating and prelaunch operations (refer to Subsection 20.1). The service tower houses the bridge crane, winches, snatch block

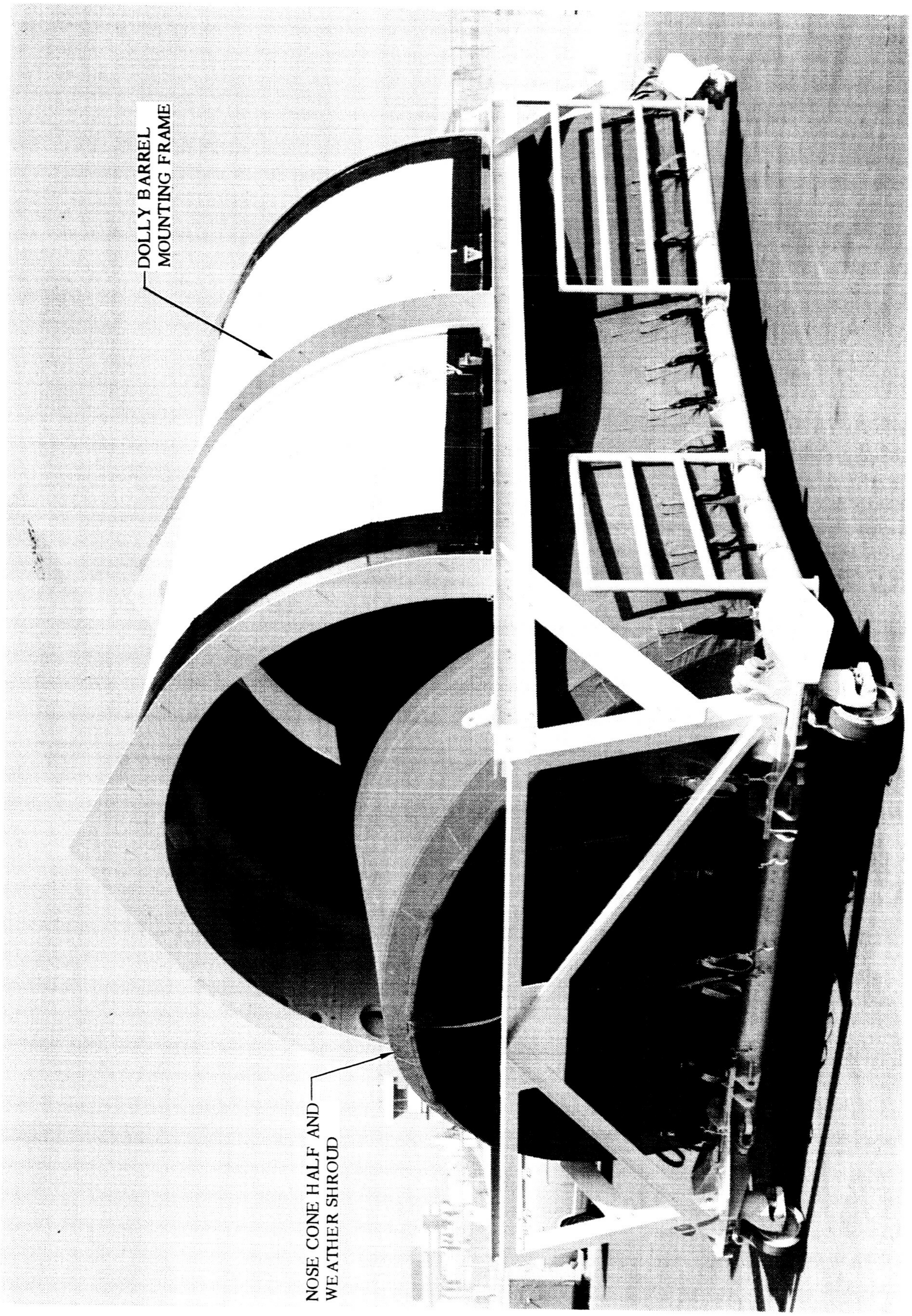
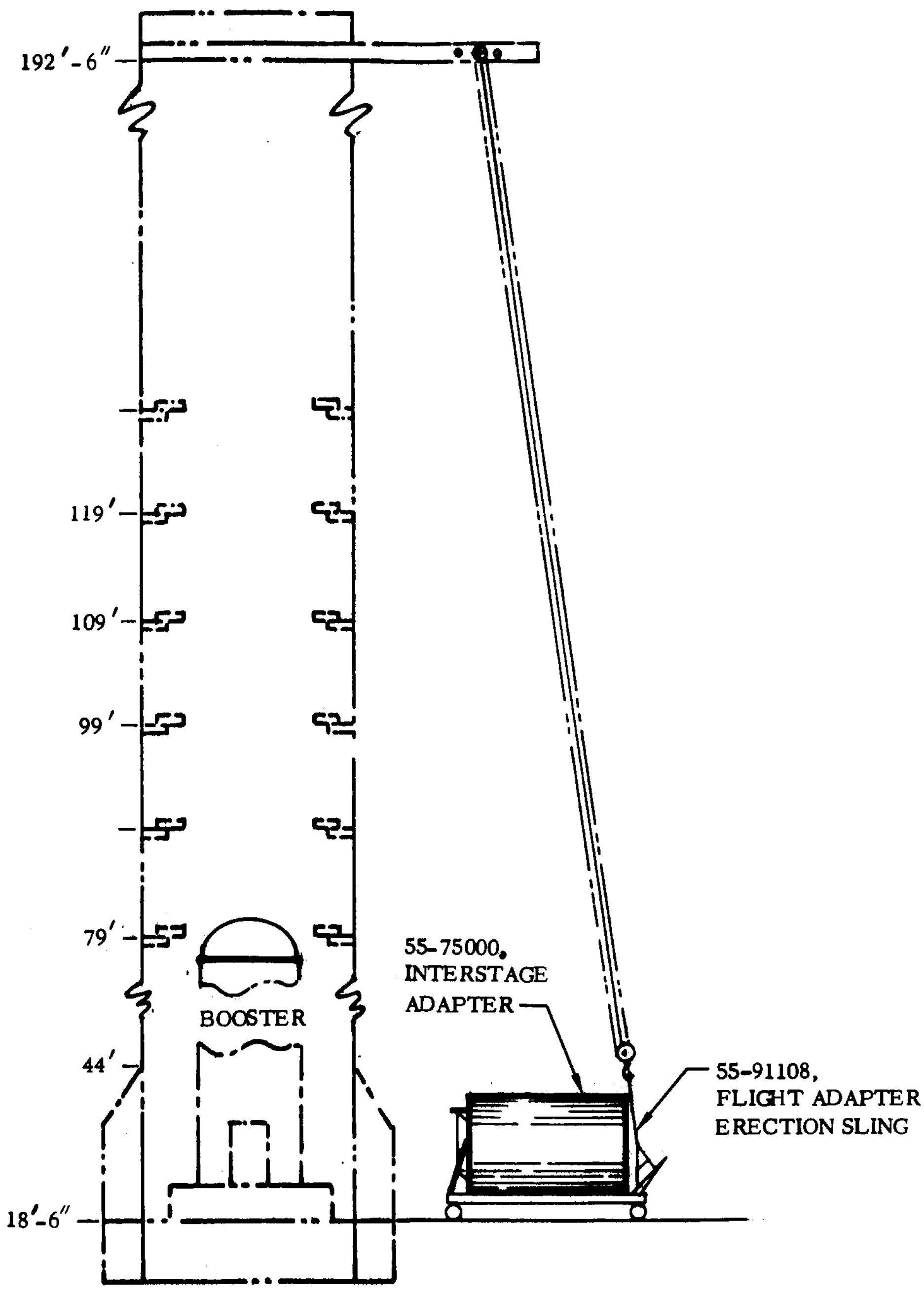
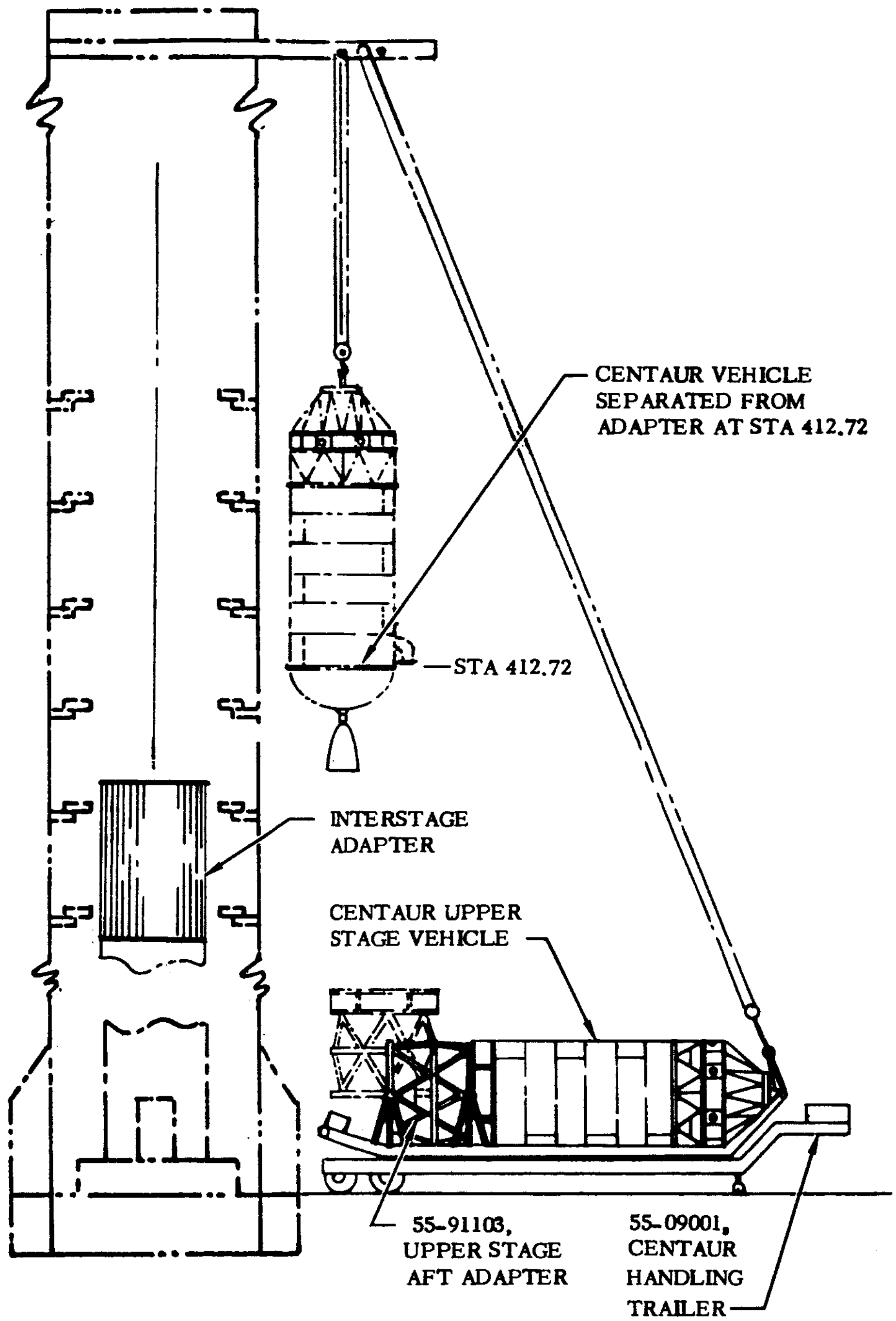


Figure 19.2-9. Nose Fairing Handling Dolly



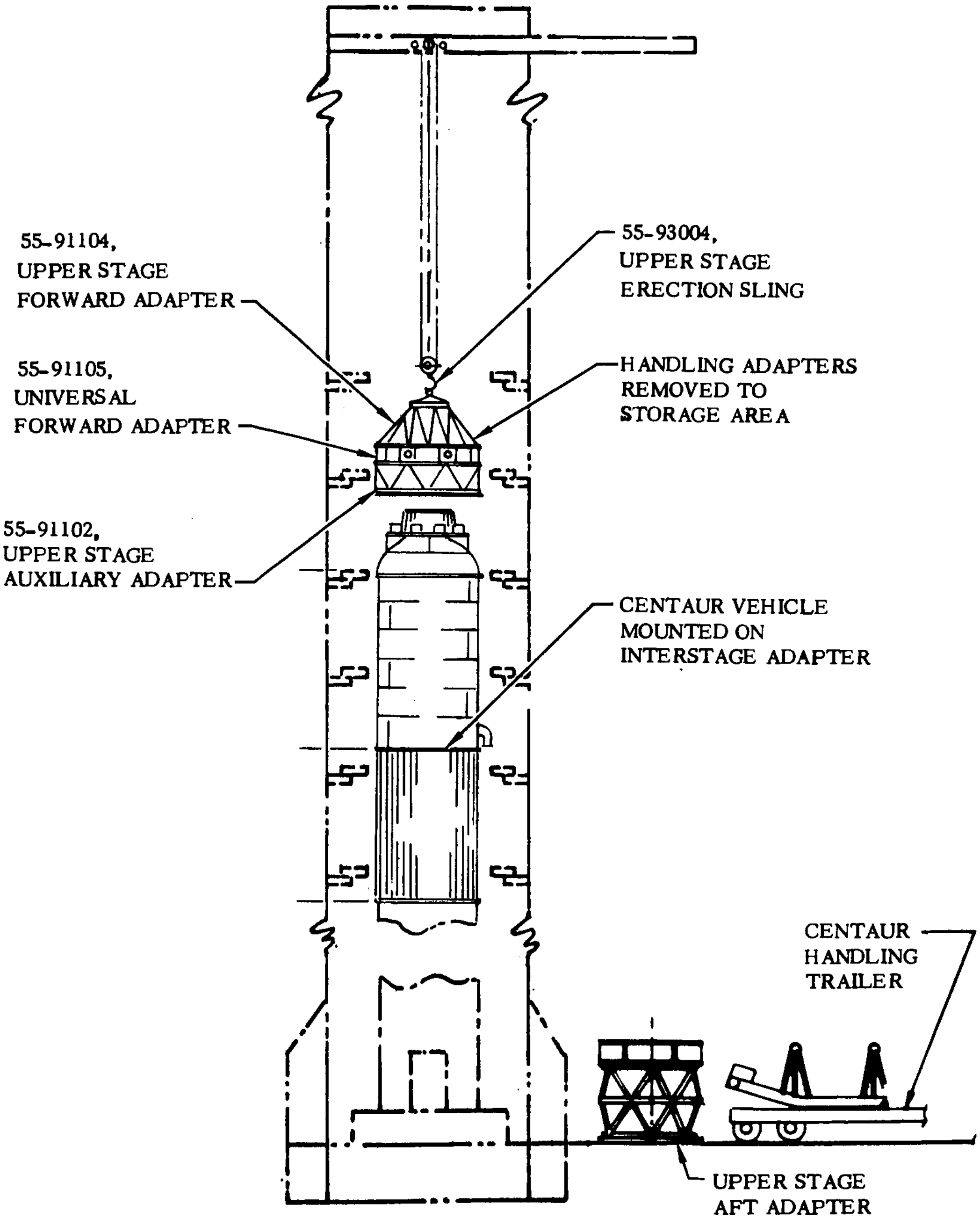
Step 1:
Installing Insterstage Vehicle Adapter

Figure 19.3-1. Centaur Vehicle Erection Sequence (Sheet 1 of 7)



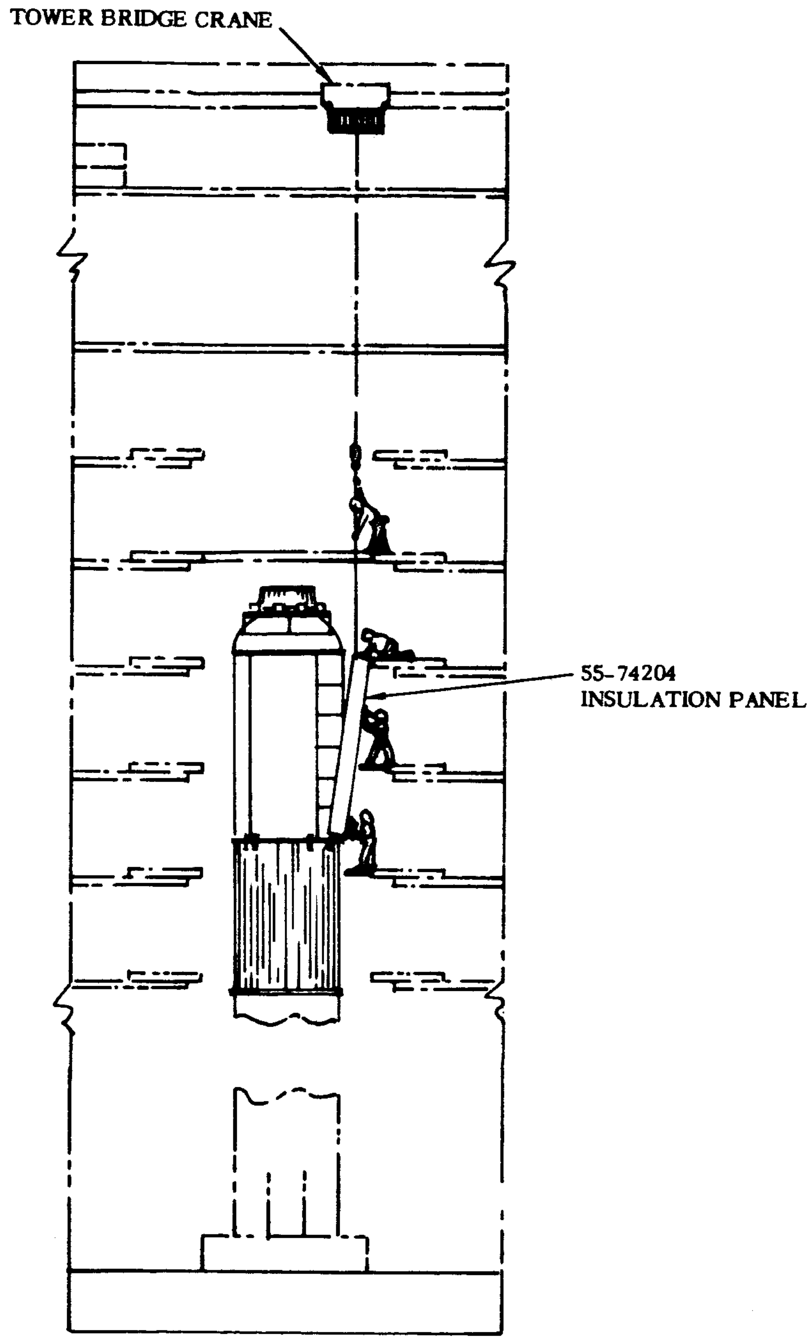
Step 2:
Installing Centaur Vehicle

Figure 19.3-1. Centaur Vehicle Erection Sequence (Sheet 2 of 7)



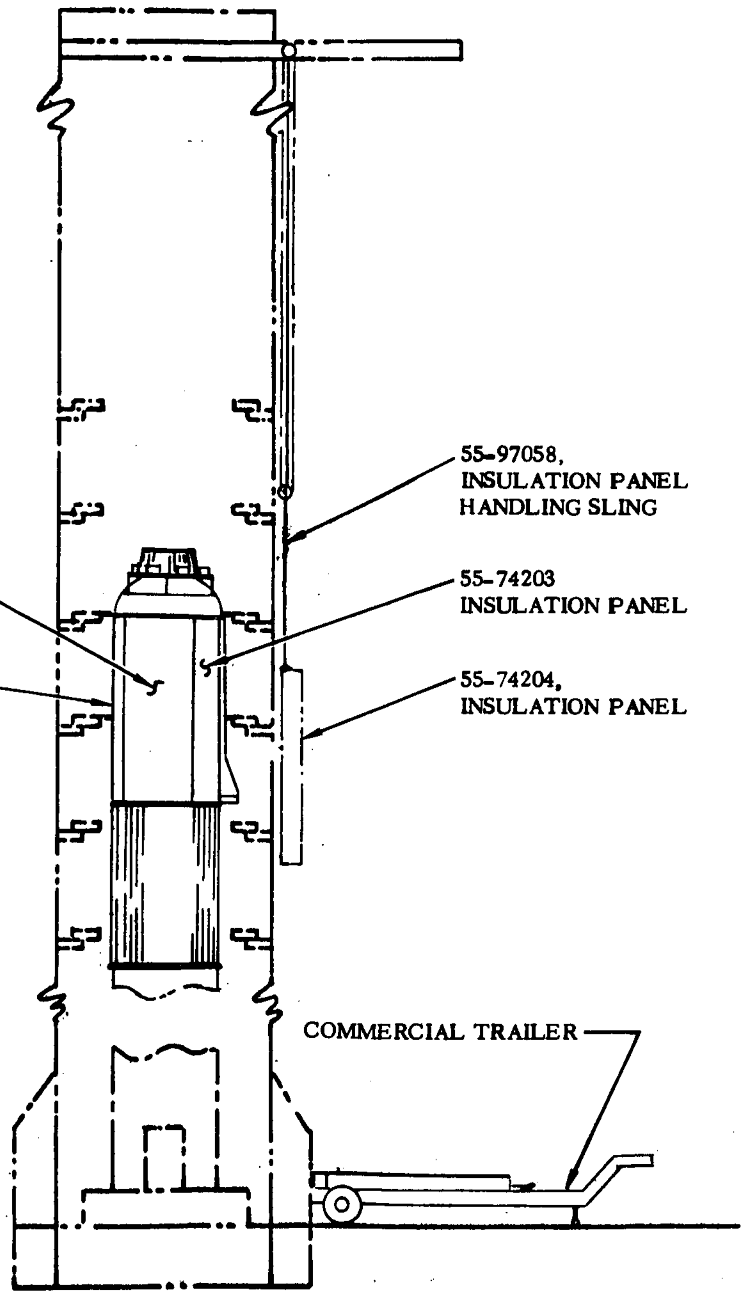
Step 3:
Removing Centaur Vehicle Handling Adapters

Figure 19.3-1. Centaur Vehicle Erection Sequence (Sheet 3 of 7)



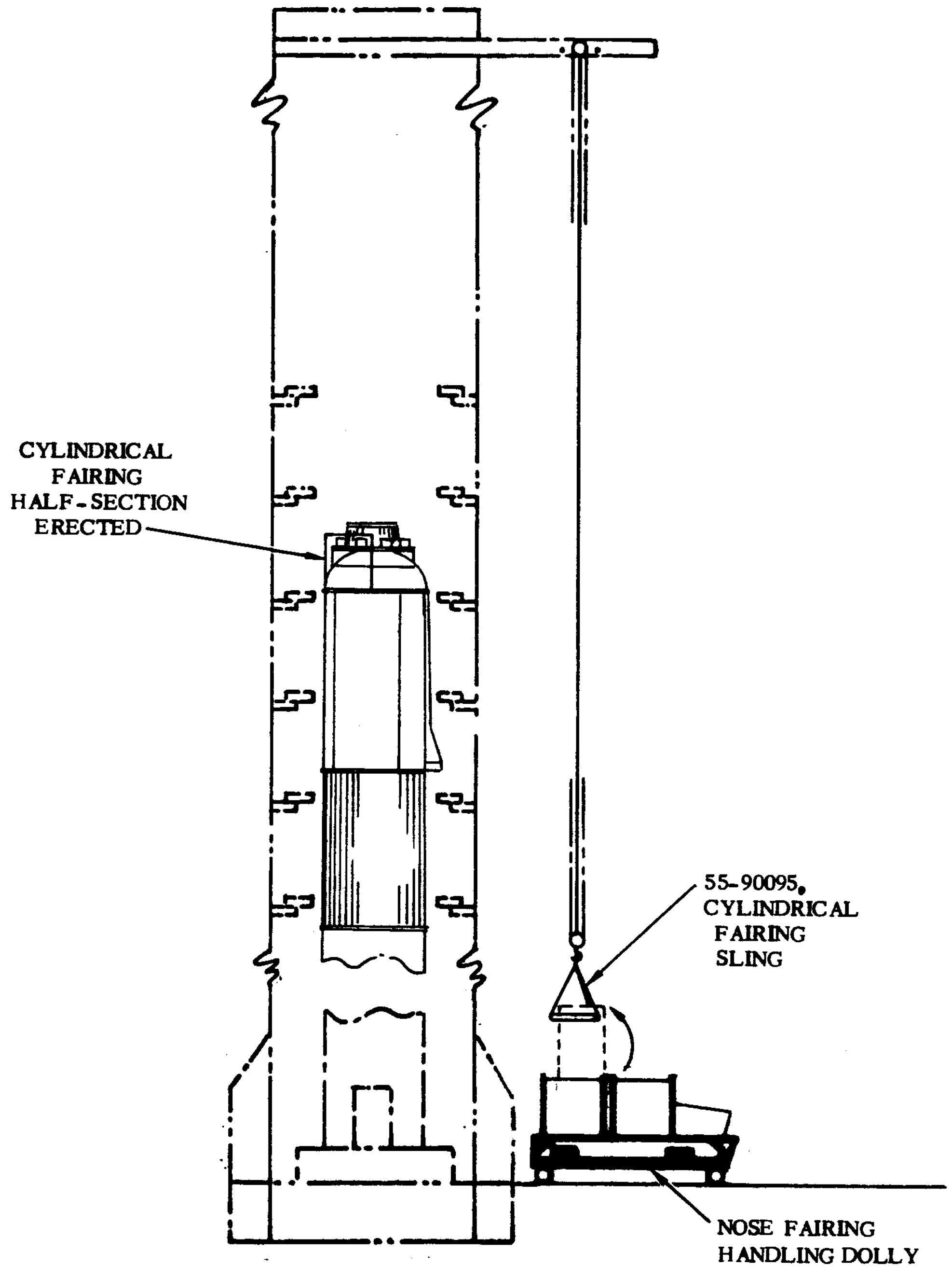
Step 4:
Installing Centaur Tank Insulation Panels

Figure 19.3-1. Centaur Vehicle Erection Sequence (Sheet 4 of 7)



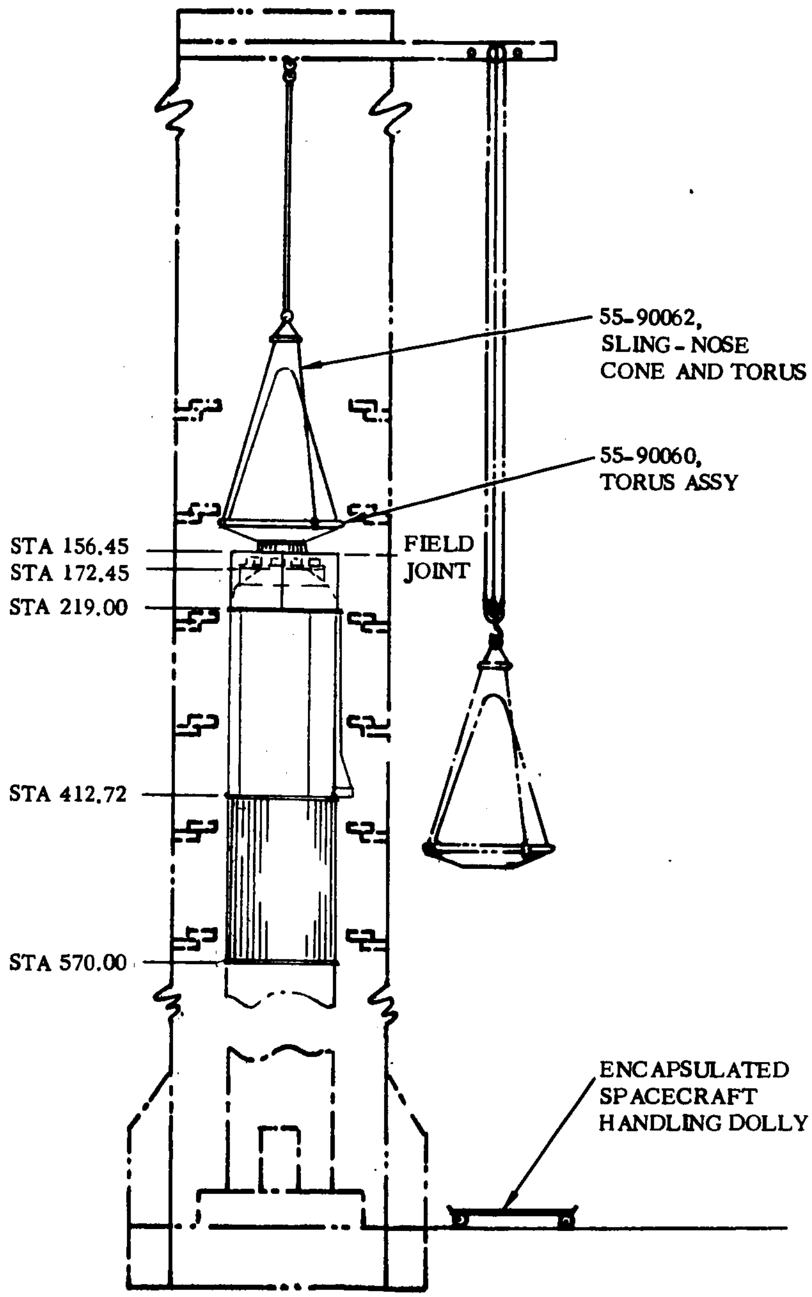
Step 5:
Installing Centaur Tank Insulation Panels

Figure 19.3-1. Centaur Vehicle Erection Sequence (Sheet 5 of 7)



Step 6:
Installing Nose Fairing Barrel Section

Figure 19.3-1. Centaur Vehicle Erection Sequence (Sheet 6 of 7)



Step 7:
Spacecraft Being Installed

Figure 19.3-1. Centaur Vehicle Erection Sequence (Sheet 7 of 7)

and cables comprising the stabilization installation, and the ramp tiedown plates used during the erection operation. Work platforms are provided at each level for vehicle access during mating operations. The service tower also houses the stretch mechanism which applies a stretch load to the Centaur vehicle when required.

19.3.2.1 Erection Stabilization Installation. The erection stabilization installation (see Figure 19.3-2) consists of two vertical-tensioned cables, two snatch block assemblies anchored to the ramp, and two horizontal ground level cables connecting to electric motor operated winches. The vertical stabilization cables (1/2-inch wire rope) are located in front of the tower, approximately 29 feet from the Y-Y axis. The distance between the cable centers is 13 feet. The cables are offset from the X-X axis such that the Centaur vehicle is erected two feet west of the X-X axis to provide adequate clearance from the umbilical tower platforms. The upper ends of the vertical cables are connected to the movable bridge crane and the lower ends connect into the snatch block assemblies located approximately four feet above the ramp surface. Tension is applied to the vertical stabilization cables by two three-ton capacity, electrically operated winches. The winches are located approximately 25 feet from the snatch block assemblies. The winch 1/2-inch wire rope cable feeds through the snatch block assemblies and anchors to the ramp plate. The two-pully snatch block configuration provides a two-to-one load ratio (i.e., the load in the vertical cables is twice that of the winch cables). A ten-ton capacity tensiometer is installed in each vertical cable, approximately five feet above the ramp surface. The tensiometers are used to measure the tension load in the vertical cables.

19.3.3 INTERSTAGE ADAPTER ERECTION. The interstage adapter handling and transport dolly, (see Figure 19.2-8) is positioned on the ramp with the aft rotation trunnions located directly under the tower bridge crane hook and midway between the vertical stabilization cables. The dolly brakes are set and the dolly is tied down to the ramp. The interstage adapter sling (see Figure 19.2-8) is connected to the forward mounting ring brackets and to the bridge crane hook. The erection kit (P/N 55-96118) is installed on the aft mounting ring to provide a rotation pivot point. The adapter forward support attachment hardware is disconnected from the dolly and the adapter is then rotated to the vertical position about the aft trunnions. The aft trunnion attachment hardware is disconnected and the adapter is raised clear of the dolly. The dolly is then moved away from the ramp area and the adapter is lowered until the aft mount ring base pads rest on the ramp. The aft mount ring is disconnected and the adapter is raised two feet to allow installation of the stabilization guide fittings and attachment to the tower stabilization cables. Tag lines are attached to the outboard ends of the guide fittings. The tower stabilization cables are tensioned to 7,500 pounds by the electrically operated winches. The adapter is raised (see Figure 19.3-3) to Tower Station 89, the stabilization cable tension is reduced to 2,000 pounds and the adapter is moved into the tower. The adapter is positioned directly over the booster. The stabilization cable tension is removed, the adapter guide fittings are removed, and the adapter is rotated and lowered to proper booster mating position (see Figure 19.3-4) and bolted to the booster.

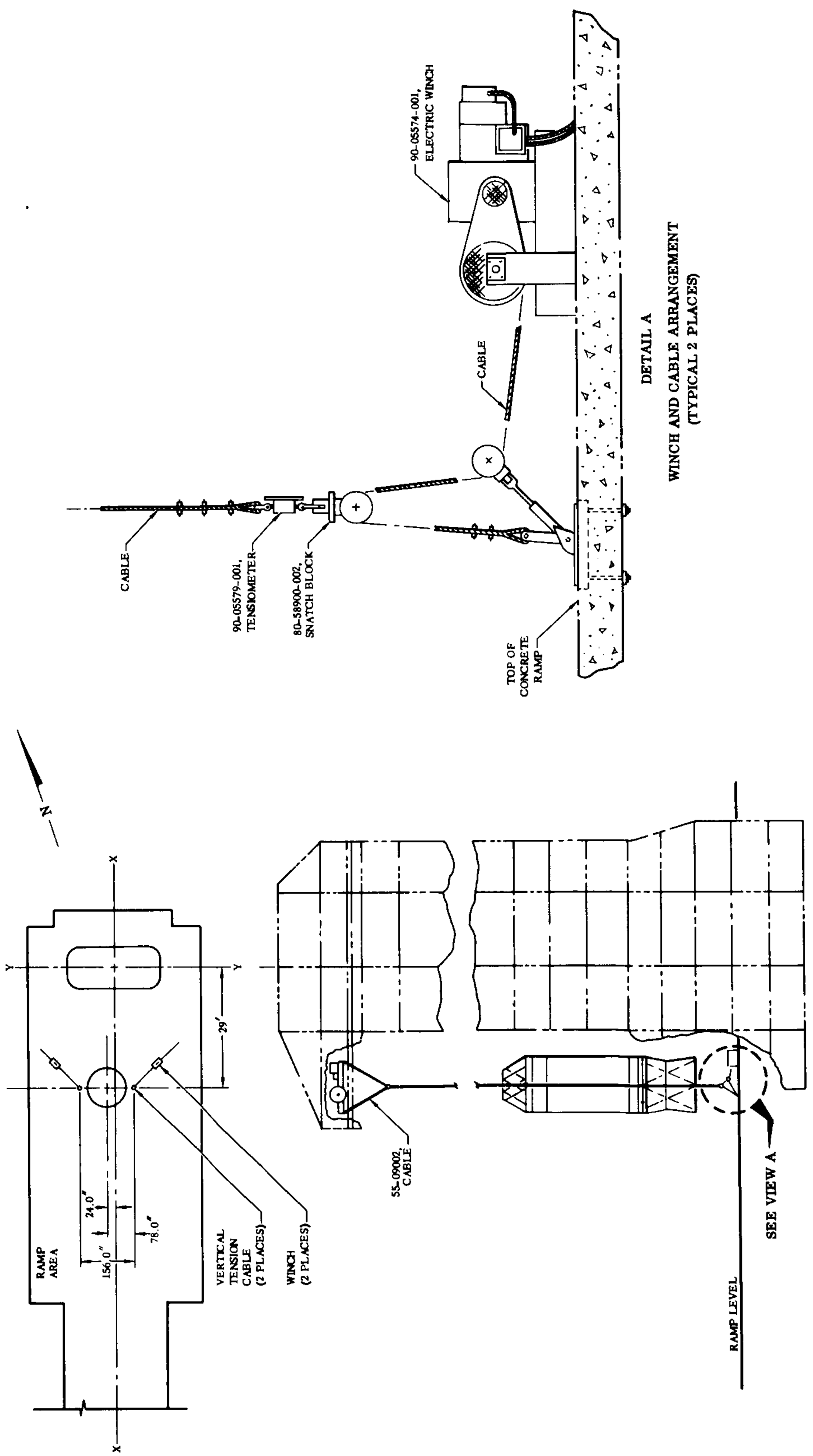


Figure 19.3-2. Erection System Stabilizer Installation

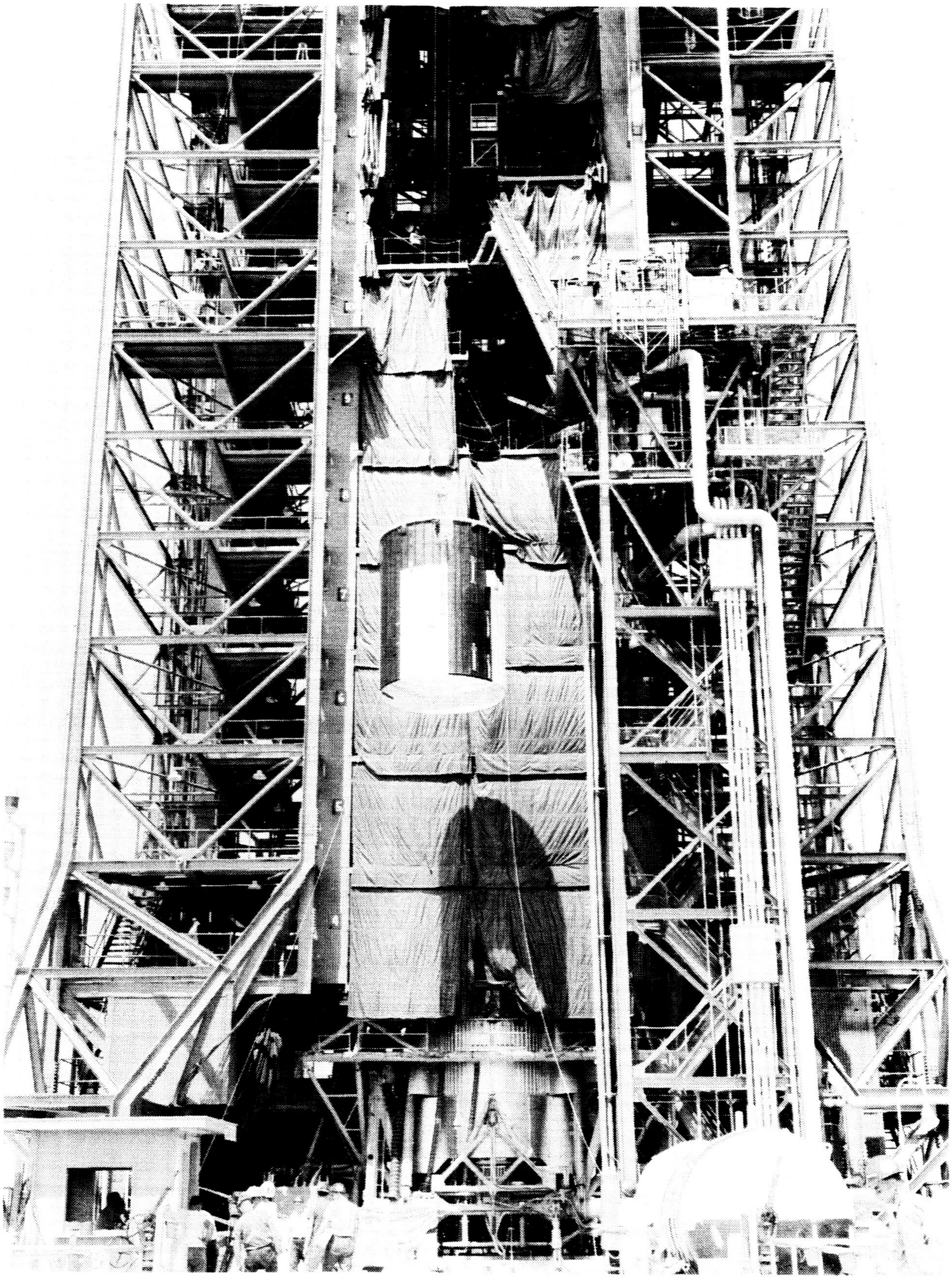


Figure 19.3-3. Interstage Adapter Erection

Figure 19.3-4. Interstage Adapter/Booster Mating

19.3.4 CENTAUR STAGE ERECTION. The Centaur trailer and pallet assembly (see Figure 19.3-5) is positioned on the ramp with the pallet aft rotation trunnions located directly under the tower bridge crane hook and midway between the vertical stabilization cables. The trailer brakes are set. The Centaur erection sling is then connected to the forward adapter assembly and to the bridge crane hook. The bridge crane is operated until the cable slack is taken up. The stabilization pillow block guide fittings are installed on the vehicle aft ring (at Station 412.72) and on the aft ring of the forward adapter (Station 170).

The pallet forward pillow block trunnions are opened and the pallet support strut and stretch cylinder fittings are disconnected from the forward adapter assembly. The trailer pressurization lines are disconnected from the vehicle after pressure check to verify that the LO_2 tank pressure is 9.0 ± 0.5 psig and that the LH_2 tank pressure is 5.0 ± 0.5 psig. The vehicle is then rotated about the aft pallet trunnions to the vertical position. The aft trunnion pins are then removed from the vehicle and it is hoisted clear of the pallet (see Figure 19.3-6). The trailer/pallet is moved from the ramp area and the vehicle is lowered to the ramp supported by the aft adapter base (see Figure 19.3-7). The aft engine supports and thrust chamber shipping plugs are removed and the aft adapter is disconnected from the vehicle aft ring (at Station 412.72). The vertical stabilization cables are inserted into the vehicle pillow block guide fittings. Two tag lines are attached to the engine bulkhead strut fittings and the bridge crane is then employed to raise the vehicle clear of the aft adapter. The tension on the vertical stabilization cables is increased to 7,500 pounds during the raising of the vehicle to a position above the interstage adapter (see Figure 19.3-8). The tension is lowered to 2,000 pounds as the vehicle is moved into the tower and positioned directly over the interstage adapter. Once the vehicle is positioned, the stabilization cable tension is reduced to zero, the vehicle pillow block guide fittings are removed, and the vehicle is lowered and mated to the interstage adapter (see Figure 19.3-9). After mating, the forward adapter is unbolted from the vehicle (Station 219) and lowered to the ramp area.

19.3.5 INSULATION PANEL ERECTION. The insulation panel shipping container (see Figure 19.3-10) is positioned on the ramp between the vertical stabilization cables. The first insulation panel is removed from the container and positioned for attaching the erection sling. The erection sling (see Figure 19.3-11) is attached to the bridge crane hook and lowered until the upper spreader-bar reaches the level of the insulation panel. The upper spreader-bar is then attached to the top of the insulation panel angle brackets and the panel is raised approximately two feet above the ramp. The lower spreader-bar is attached to the insulation panel bottom angles. Tag lines are attached to the outer ends of the lower spreader-bar. The pillow block guide fittings located at each end of the spreader-bars are attached to the vertical stabilization cables. The tension on the cables is increased to 7,500 pounds during the vertical ascent. The panel is raised (see Figure 19.3-12) till it clears the Centaur vehicle. The stabilization cable tension is reduced to 2,000 pounds while the insulation panel is moved into the tower. The pillow block guide fittings are disconnected from stabilization cables, and the lower spreader-bar and tag lines are removed. The insulation panel is lowered

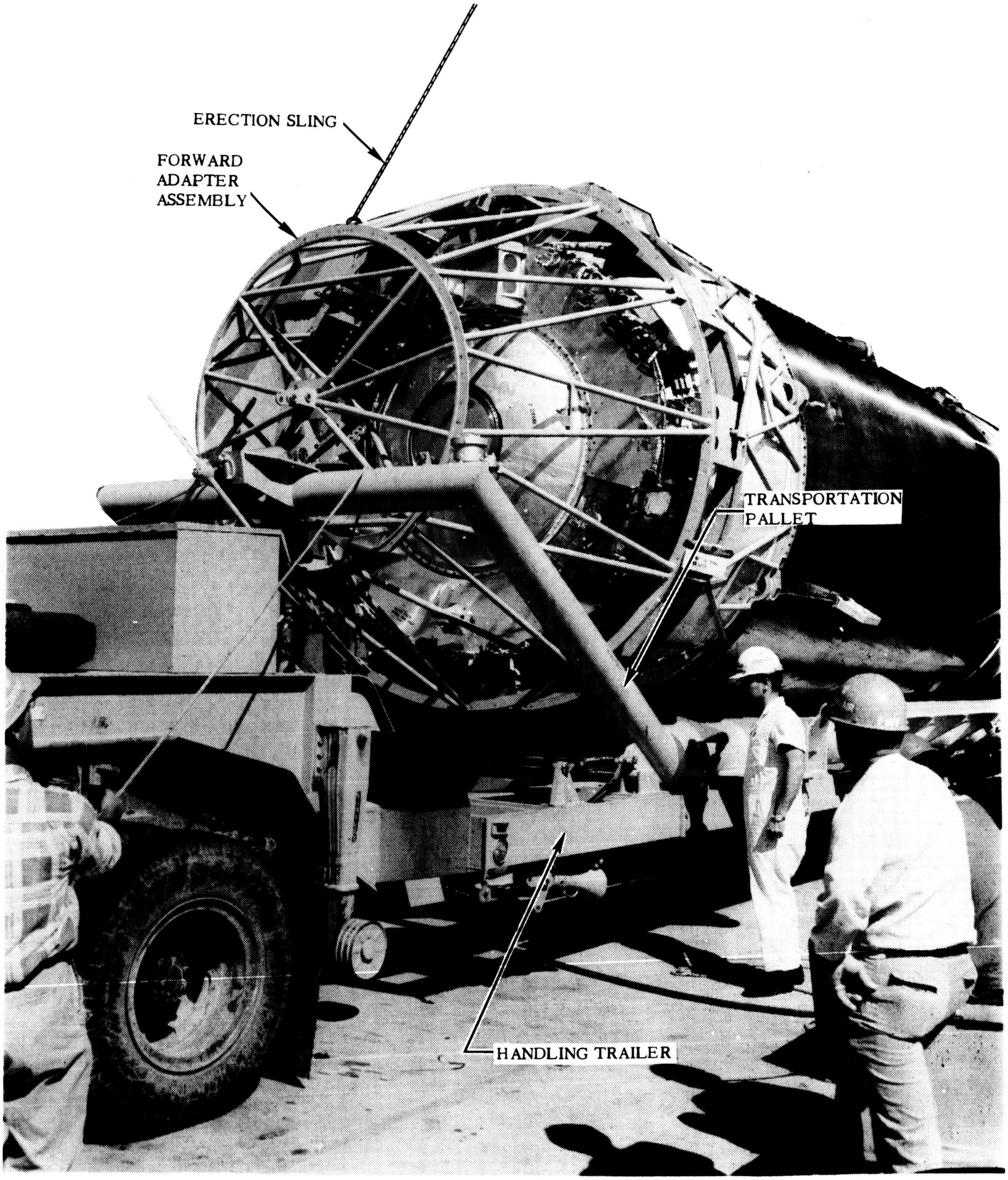


Figure 19.3-5. Centaur Vehicle, Pallet, and Handling Trailer Arrangement

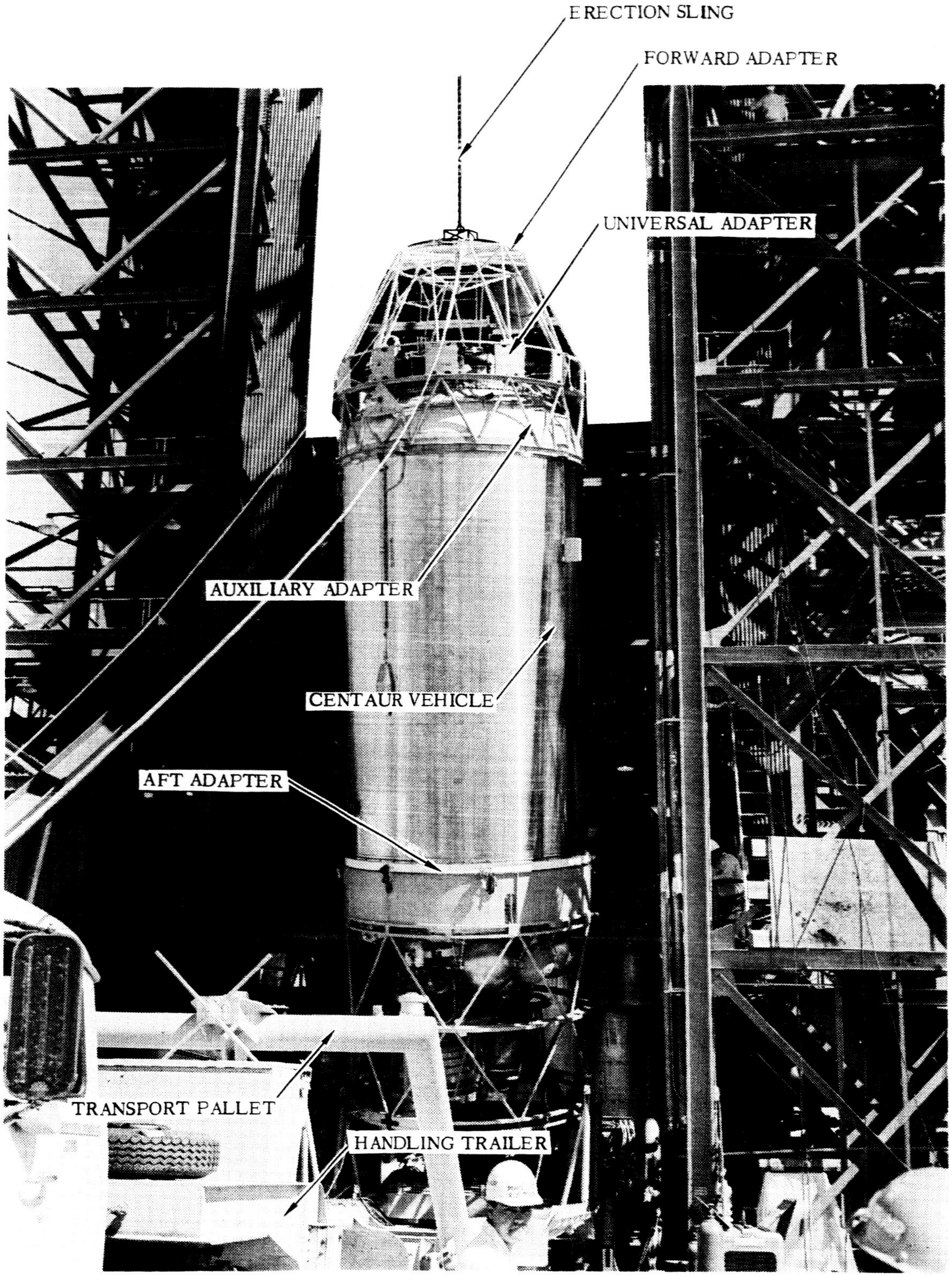


Figure 19.3-6. Centaur Erection Sling Arrangement

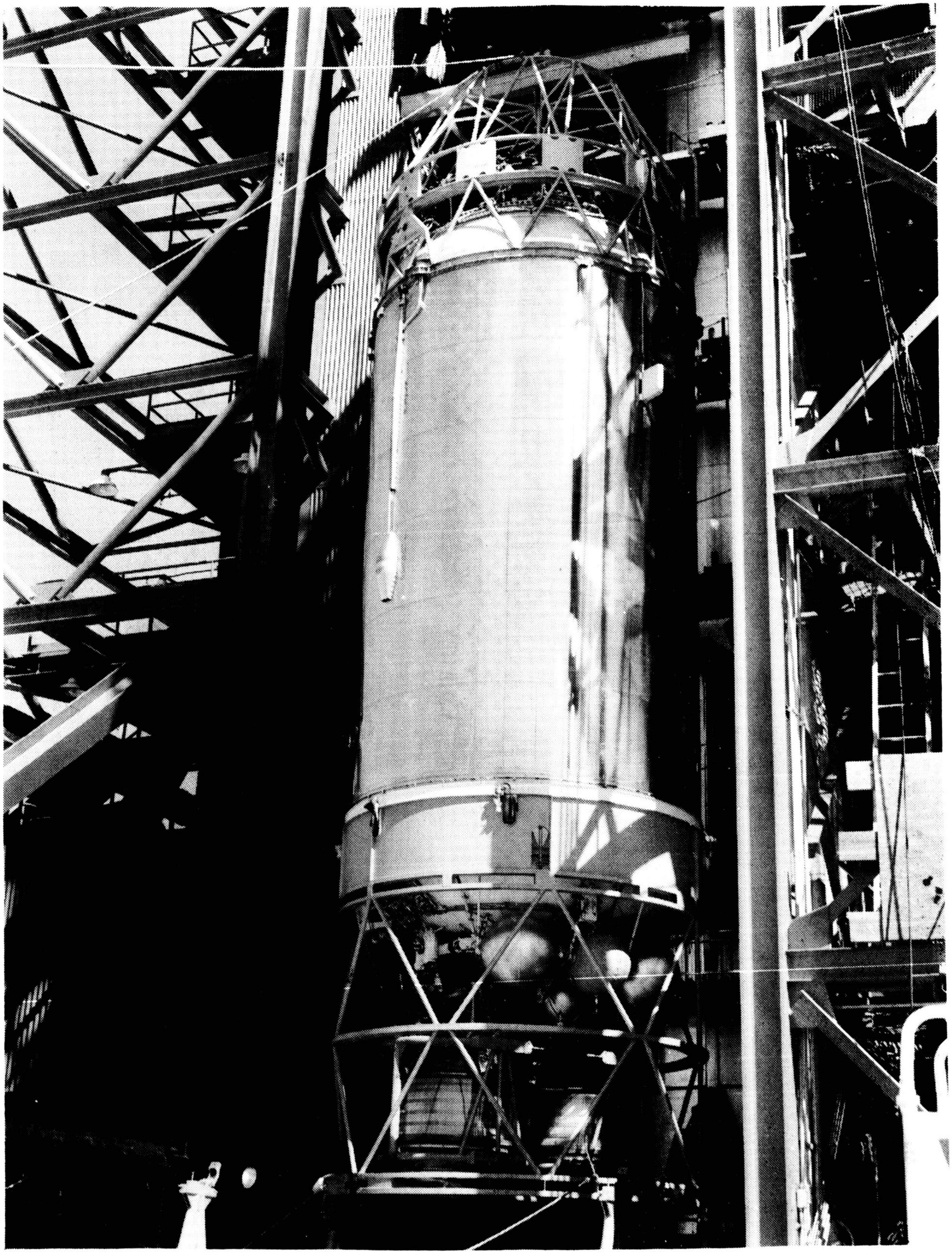


Figure 19.3-7. Centaur Vehicle Ready for Erection

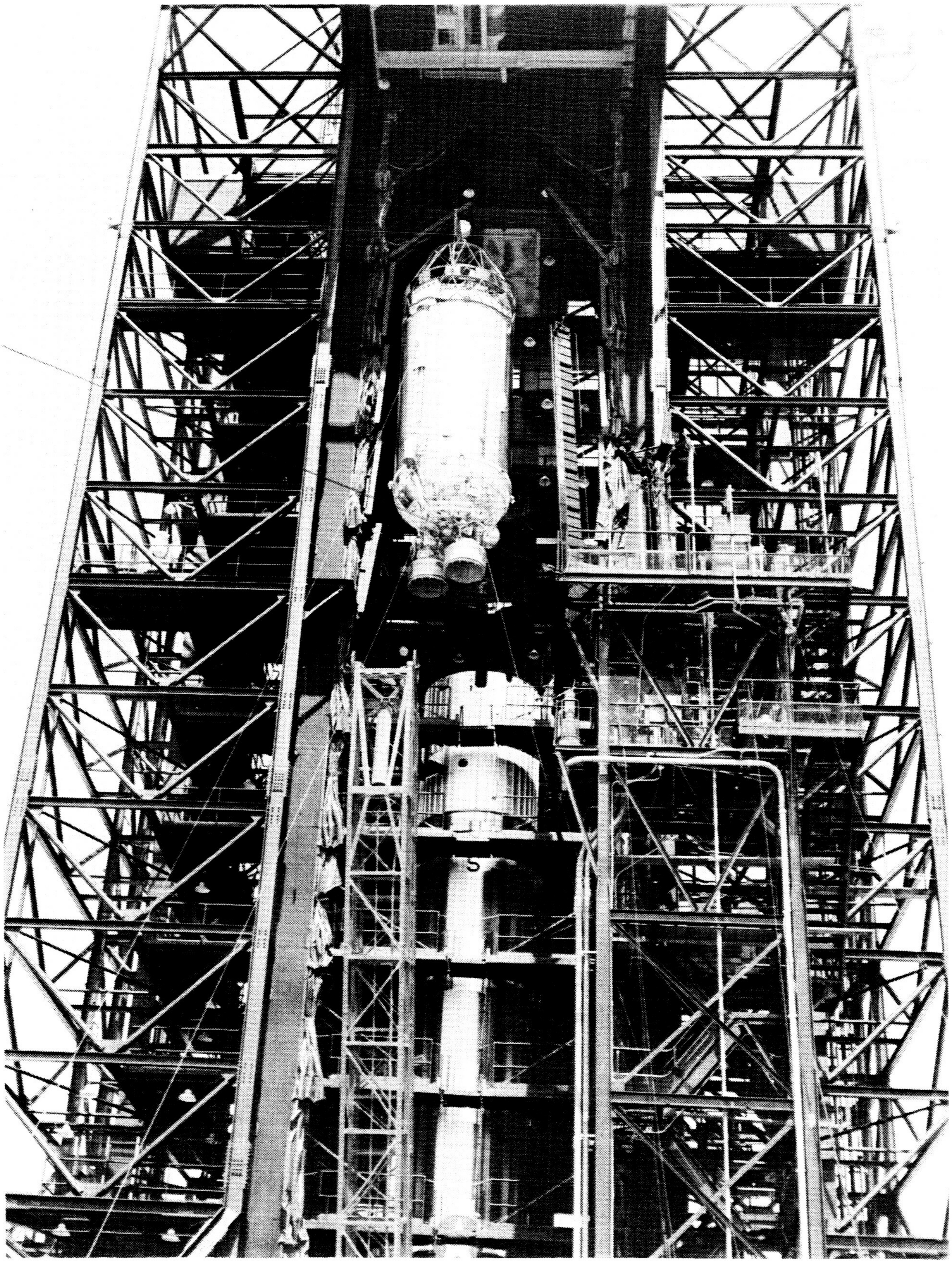


Figure 19.3-8. Centaur Vehicle Erection

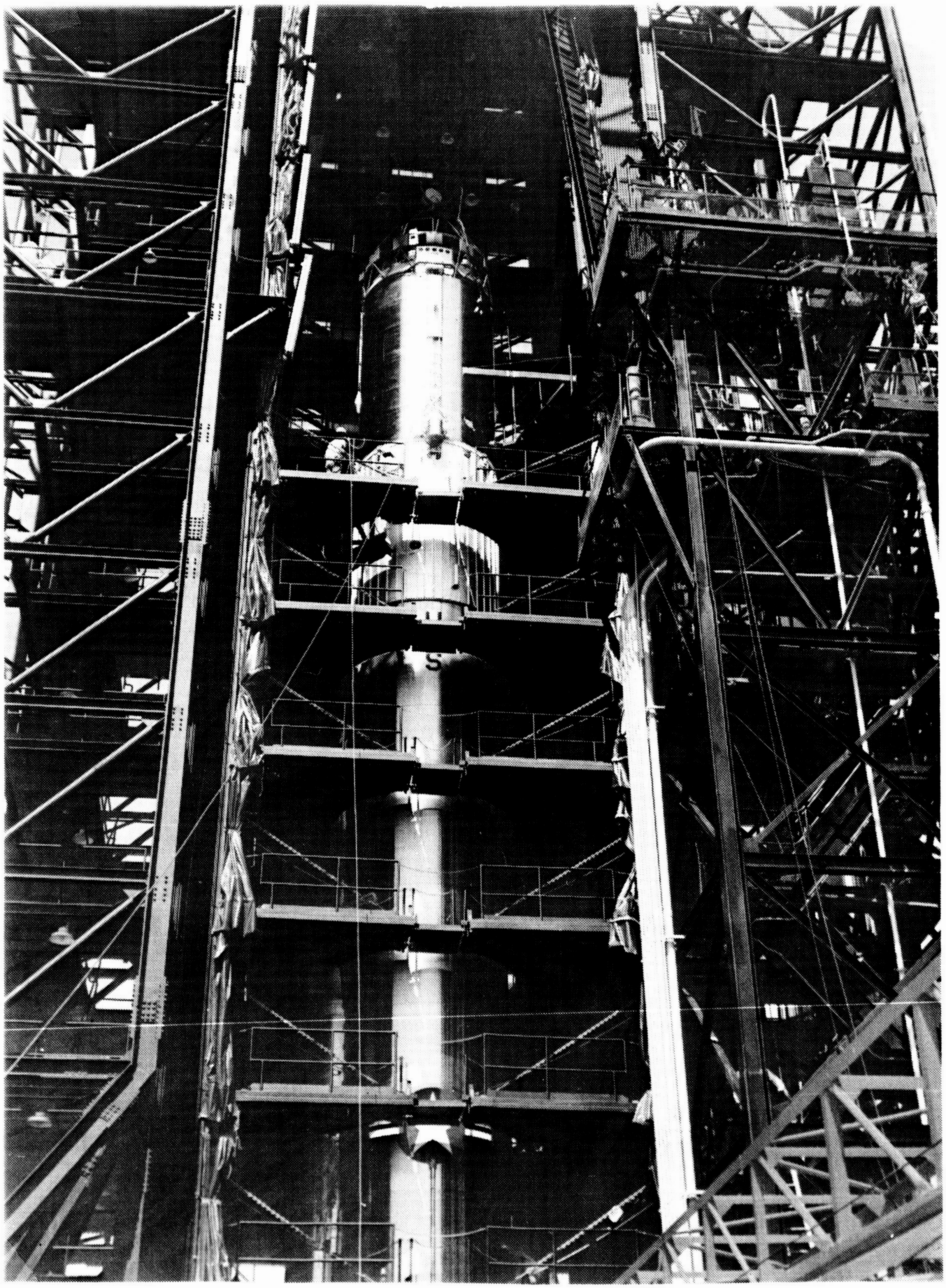


Figure 19.3-9. Centaur Vehicle Mated to Interstage Adapter

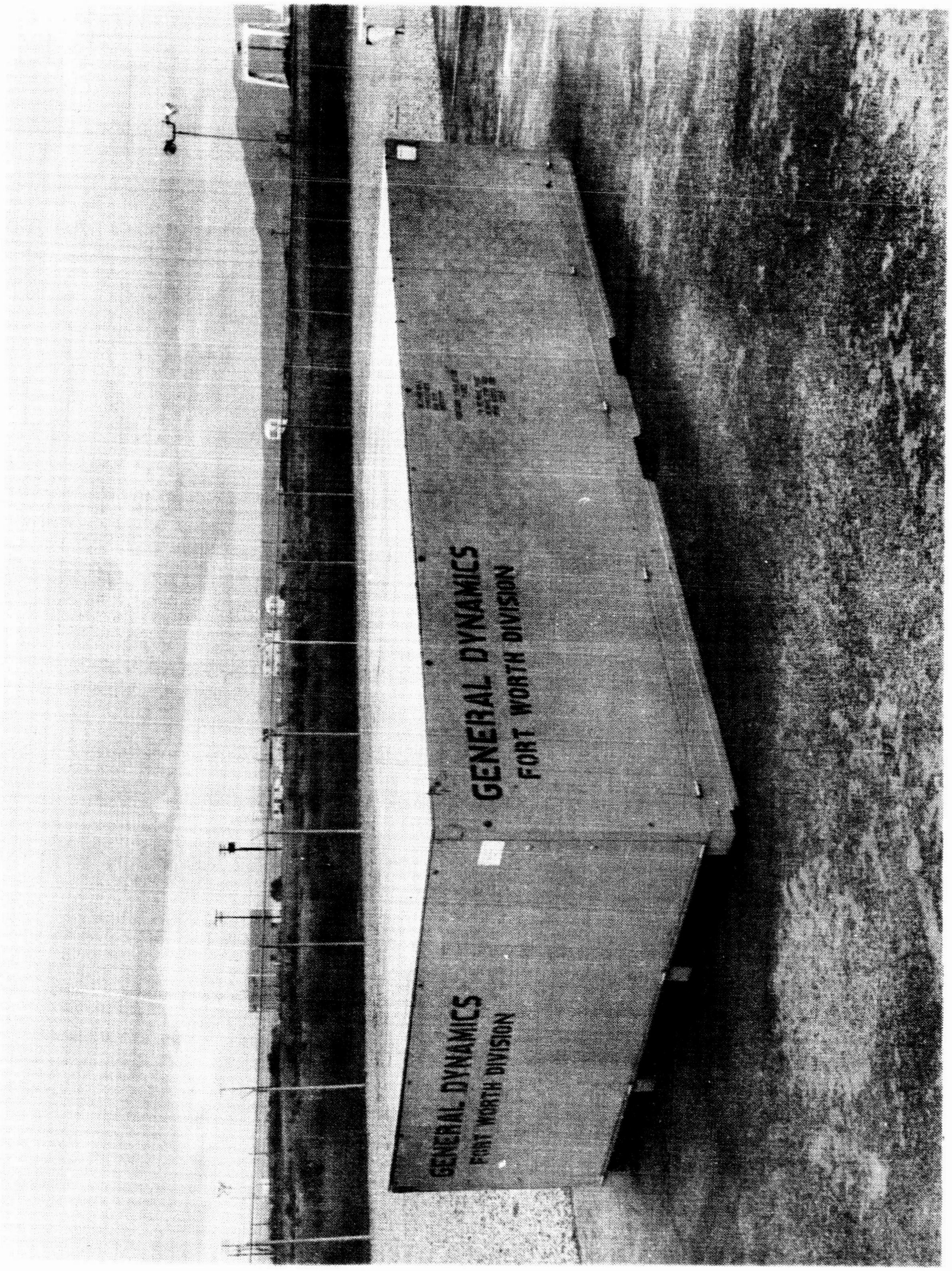


Figure 19.3-10. Insulation Panel Shipping Crate

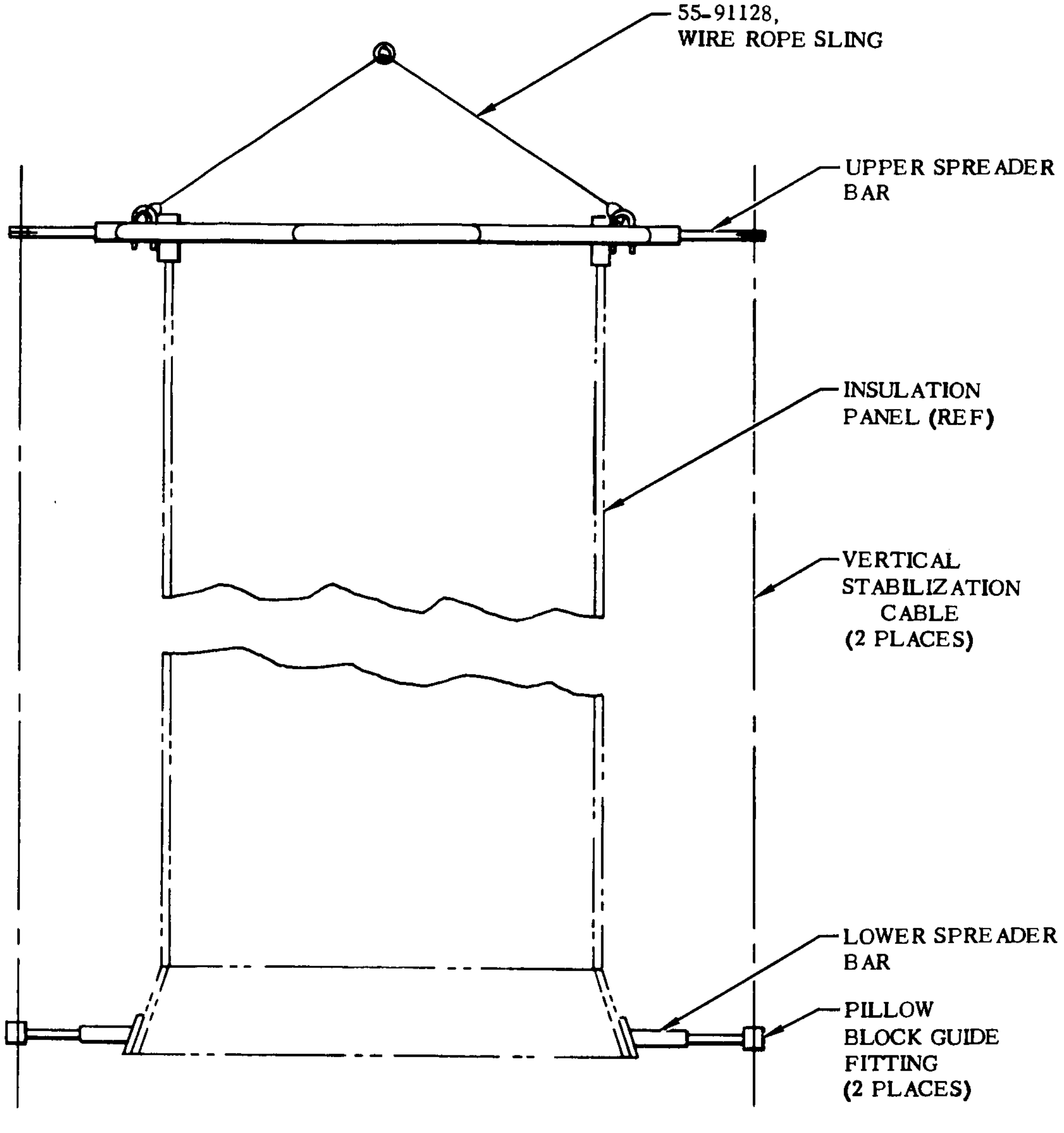


Figure 19.3-11. Insulation Panel Erection Sling, P/N 55-97063

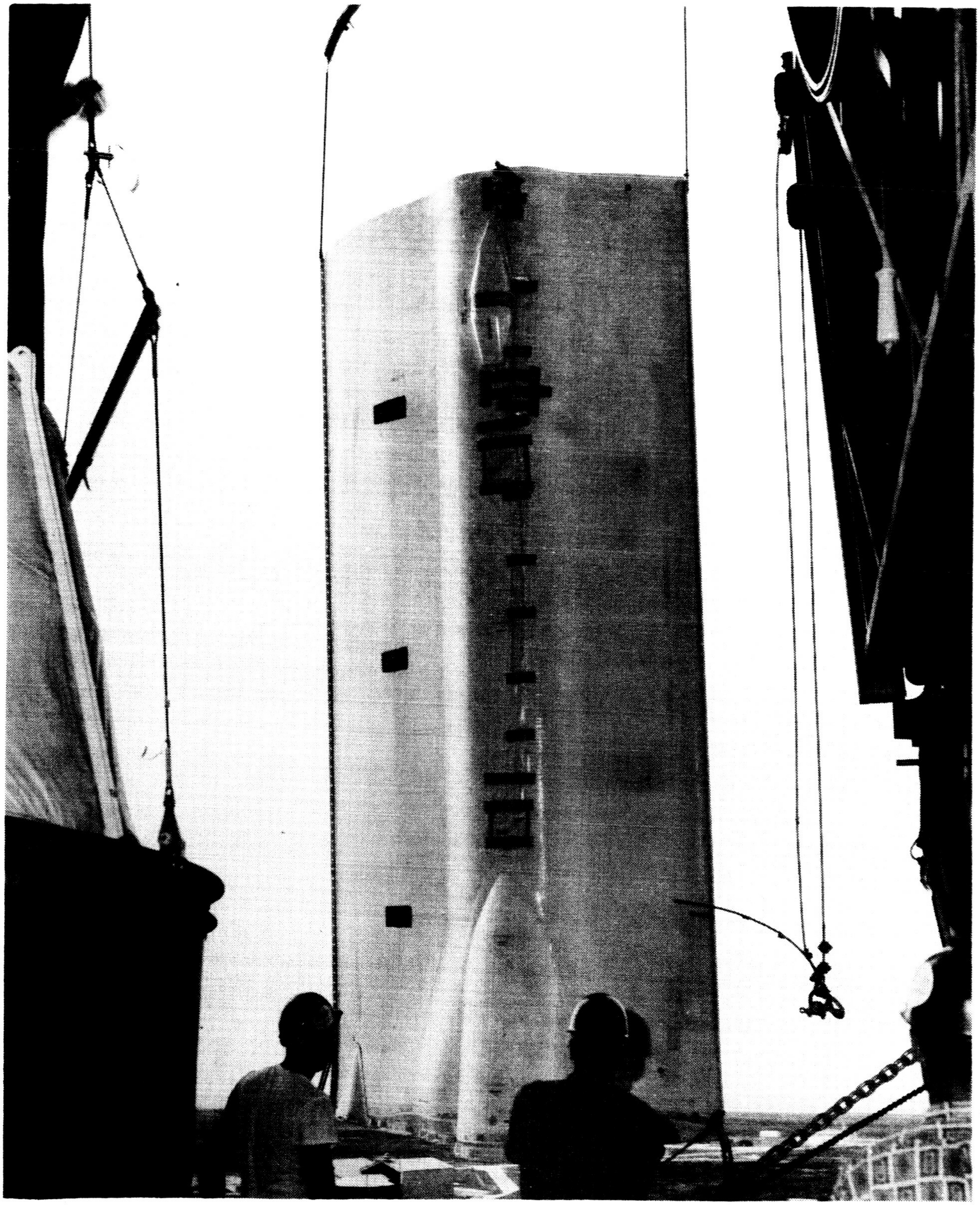


Figure 19.3-12. Insulation Panel Erection

into proper position on the Centaur vehicle and strapped into place. The upper spreader-bar is removed and the sling is lowered to the ramp. A similar procedure is followed for raising the three other insulation panel sections. When all of the panels have been positioned on the vehicle, they are then bolted in place and the nylon straps are removed.

19.3.6 CYLINDRICAL NOSE FAIRING ERECTION. The nose fairing dolly is positioned on the ramp between the vertical stabilization cables. The fairing erection sling (see Figure 19.3-13) is connected to one of the two cylindrical nose fairing sections at three points and the free end attached to the bridge crane hook. The cylindrical fairing section is lifted and rotated out of the dolly. The dolly is removed from the ramp area. The fairing section is lowered and the sling counter balance block is adjusted so that the fairing section hangs level. Two tag lines are attached to the sling near the pillow block guide fittings. The vertical stabilization cables are attached to the pillow block guide fittings and the tension raised to 7,500 pounds. The fairing is hoisted to Station 99, the stabilization cable tension is reduced to 2,000 pounds, and the fairing is moved into the tower over the Centaur Station 219 ring. The stabilization cables and tag lines are then removed and the fairing is lowered and mated to the Centaur Station 219 ring. The sling is removed and lowered to the ramp area and attached to the second cylindrical fairing section.

The second fairing section is erected in the same manner as the first.

19.3.7 ENCAPSULATED SPACECRAFT ERECTION. The Surveyor spacecraft encapsulation is performed in the Explosive Safe Facility (ESF) area (see Subsection 19.4). The GFE encapsulated spacecraft transport trailer is positioned on the ramp between the vertical stabilization cables. The erection sling is attached to a five-ton hydraset which is connected to the bridge crane hook. The sling is then attached to the cylindrical nose fairing torus assembly in three places (see Figure 19.3-14). The pillow block guides are mounted on the torus assembly. The attachments between the torus assembly and the trailer are removed and the torus ring is leveled by adjusting the sling turnbuckles.

The encapsulated spacecraft assembly is raised several feet above the trailer; and three torus support arm sway braces and three tag lines are attached to the torus assembly. The vertical stabilization cables are inserted into the pillow block guide assemblies. The tension on the stabilization cables is raised to 7,500 pounds and the encapsulated spacecraft is erected to Station 119. The stabilization cable tension is reduced to 2,000 pounds and the encapsulated spacecraft is moved into the tower to a position directly above the cylindrical nose fairing. Three fairing doors and the thermal bulkhead tubes and bracket are removed from the cylindrical nose fairing prior to spacecraft mating. The three sway braces and tag lines are removed from the encapsulated spacecraft assembly. The vertical stabilization cables are disconnected, and the spacecraft is lowered to a position several inches above the cylindrical nose fairing. The spacecraft is aligned and lowered using the hydraset.

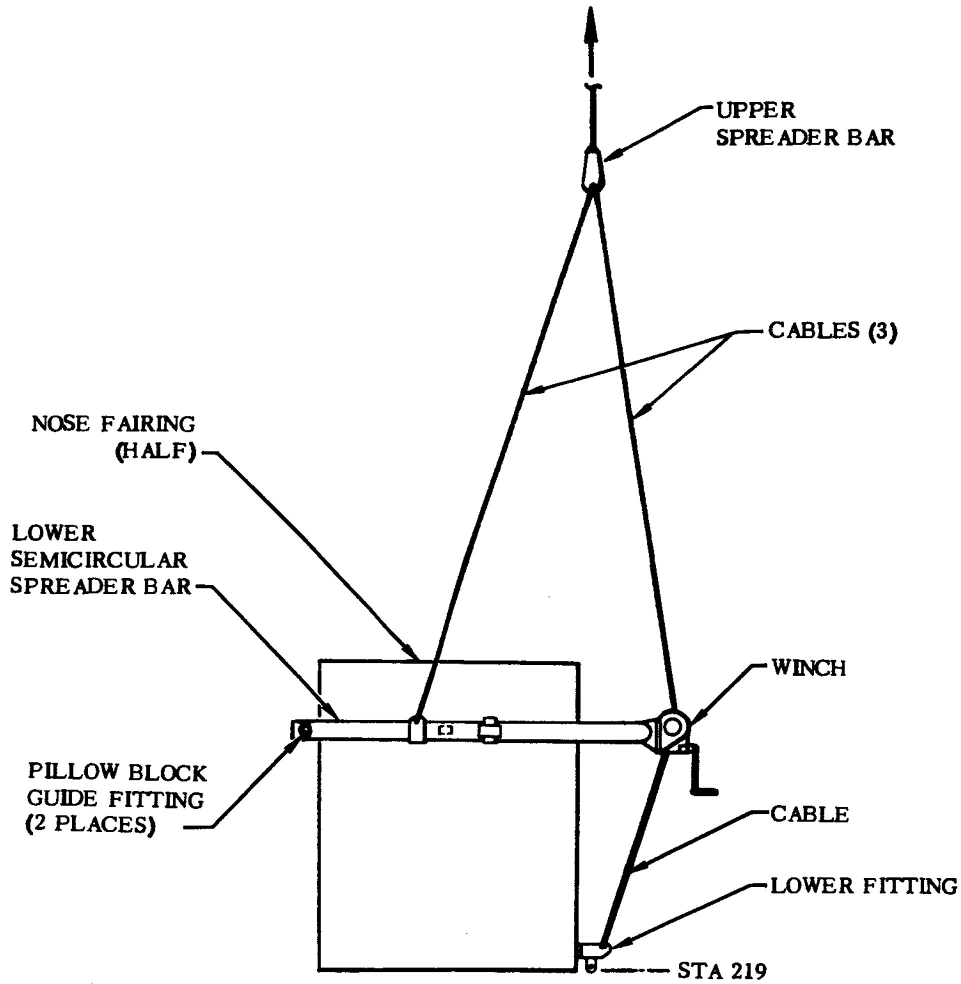


Figure 19.3-13. Cylindrical Nose Fairing Sling, P/N 55-90095

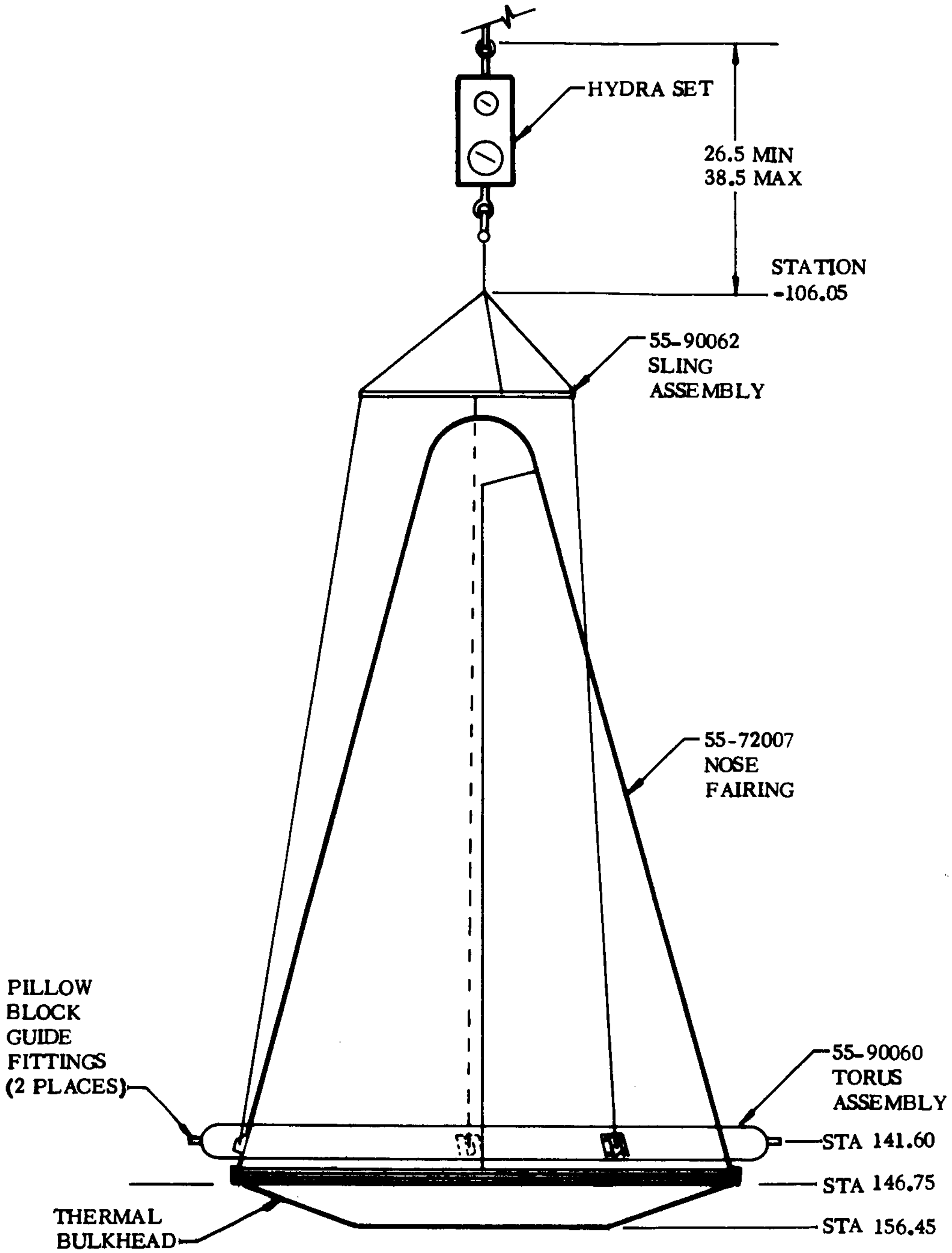


Figure 19.3-14. Torus/Nose-Cone Sling

The field joint, Station 156.45, is the first mating surface. The attachment screws at the field joint are installed. Six nose cone support screws are installed on the torus and the nose cone is lowered the last 1/2-inch onto the cylindrical nose fairing mating ring, Station 146.75, using the hydraset. The nose cone is then mated to the cylindrical nose fairing (see Figure 19.3-15). The thermal bulkhead tubes and brackets are installed and the sway braces and torus assembly are disconnected and removed from the tower. The three cylindrical nose fairing doors are installed, completing the erection sequence.

19.3.8 ERECTION SLINGS. The slings used during the erection operation are listed in Table 19.3-1.

TABLE 19.3-1. ERECTION SLINGS

Nomenclature	Part Number
Interstage Adapter Sling	55-91108
Interstage Adapter Stabilization Fittings	55-96118
Centaur Erection Sling	55-93004
Insulation Panel Sling	55-97063
Cylindrical Fairing Sling	55-90095
Torus/Nose-Cone Sling	55-90062

19.3.8.1 Interstage Adapter Sling (Figure 19.2-8). The interstage adapter stabilization erection fittings (P/N 55-96118) consist of two sheet metal fittings which attach to the adapter aft ring at Station 570. A diagonal sheet-metal brace is attached to the horizontal fittings at Station 570 and to an adapter longitudinal stiffener at Station 535. The horizontal bar is installed on the adapter's X-X axis and contains a pillow block guide at each end for attaching the vertical stabilization cables. The sling (P/N 55-91108) connects to the forward ring and consists of a ten-foot diameter structural ring with a wire cable assembly attached at two points.

19.3.8.2 Centaur Erection Sling (Figure 19.3-6). The erection sling (P/N 55-93004) is a single-line wire rope, approximately six feet in length with on adapter end fitting which mates with the forward handling adapter nose fitting. The upper sling end has a loop to connect to the service tower bridge crane hook.

19.3.8.3 Insulation Panel Sling (Figure 19.3-11). The insulation panel stabilization erection sling consists of an upper spreader bar with a wire cable attached at two places and a lower spreader bar. The upper spreader bar is curved so that it can be attached to the upper outboard end of the insulation panel. The upper spreader bar is fabricated from 3-1/2-inch diameter aluminum tubing, and fittings are utilized to attach

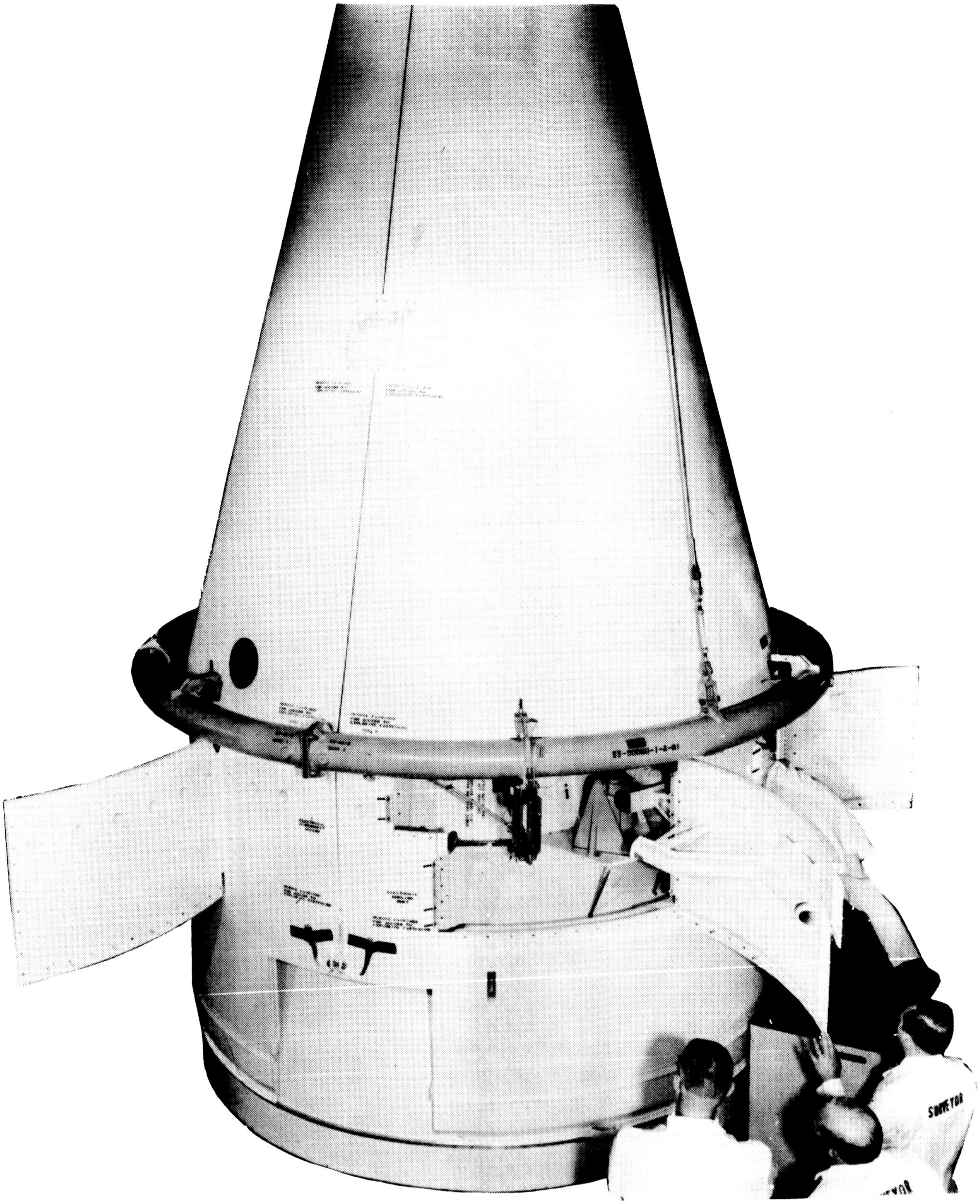


Figure 19.3-15. Spacecraft Mated to Cylindrical Nose Fairing

it to the existing insulation panel longitudinal angle holes. The wire rope sling connects to "U" fittings which are attached to the upper surface of the spreader bar. The hinged pillow-block guide fittings are located at the ends of the upper spreader-bar assembly. The lower spreader-bar assembly is a straight two-inch diameter aluminum tube which is installed on the lower inboard end of the insulation panels. Hinged pillow-block guide fittings are located at the ends of the lower spreader-bar assembly.

19.3.8.4 Cylindrical Nose Fairing Sling (Figure 19.3-13). The cylindrical nose fairing erection sling consists of a semicircular spreader-bar, a straight spreader-bar, three cables connecting the circular spreader-bar to the upper straight spreader-bar, a lower fitting connecting to the lower end of the cylindrical nose fairing half, a hand operated winch attached to the semi-circular spreader bar, and a cable from the winch connecting to the lower fairing fitting.

The semicircular spreader-bar connects to the cylindrical nose fairing, with pin fittings, at the outer ends. The pin fittings are adjustable to provide for all possible tolerances. The semicircular spreader-bar is fabricated from four-inch diameter steel tubing. The upper (straight) spreader-bar is fabricated from a five-inch "I" beam and has a fitting on the upper side for connection with the utility hoist hook the upper spreader-bar has three fittings on the lower side (one on each end and one in the center), to which the three cables connect. The lower end of the three cables connects to three fittings on the upper side of the semicircular spreader-bar.

The hand operated winch, attached to the midpoint of the semicircular spreader-bar, is used for adjusting the length of the cable connecting to the lower fairing, in order to ensure vertical alignment of the nose fairing during erection. Pillow block guide fittings are provided at the ends of the semicircular spreader-bar.

19.3.8.5 Torus/Nose-Cone Sling (Figure 19.3-14). The torus/nose-cone sling consists of the torus assembly (P/N 55-90060) and the handling and erection sling (P/N 55-90062). The torus assembly is a six-inch tube formed into a semicircle approximately 135 inches in diameter and is fabricated from mild tube steel. It is provided with pillow block guide fittings which attach to the torus ring and extend outboard to provide a thirteen-foot distance between the guide centerlines. The torus assembly is attached to the nose cone by fittings located at six points around the torus circumference. The handling and erection sling consists of a delta spreader-bar, three cables connecting the torus assembly to the upper side of the delta spreader-bar, and three short cables connected to a central fitting which attaches to the hydraset and then to the bridge crane hook.

19.4 ENCAPSULATION

19.4.1 FUNCTION OF ENCAPSULATION. The primary functions of the spacecraft encapsulation are to provide a means of mating and supporting the spacecraft during flight and to provide environmental protection for the spacecraft during ground handling operations, preflight checkout, and launch. The mating operation requires the use of the aft payload adapter, which mounts to the Centaur payload tank ring at Station 172.57, and the forward payload adapter, which is mounted to the spacecraft. The forward payload adapter is mated to the aft adapter at the field splice, Station 156.45. Refer to Section IV for additional discussion of the payload interface. The nose fairing is provided with a thermal bulkhead and air-conditioning ducts, which ensure a controlled contaminant-free environment for the spacecraft. Refer to Section III for a detailed description of the nose fairing.

The spacecraft encapsulation is performed in the Final Assembly Building at the Explosion Safe Facility, Cape Kennedy. Table 19.4-1 lists the equipment required during the encapsulation sequence.

TABLE 19.4-1. ENCAPSULATION EQUIPMENT

Nomenclature	Part Number
Torus Assembly	55-90060
Torus Assembly Handling Cart	55-90061
Nose-Cone/Torus Sling Assembly	55-90062
Forward Adapter Ring	55-90063
Nose-Cone Support Ring	55-90064
Torus Assembly Handling Sling	55-90065
Forward Adapter Installation	55-71141
Nose-Fairing Erection Sling	55-93000
Aft Adapter Installation	55-71146
Work Stands	GFE

19.4.2 FINAL ASSEMBLY BUILDING. The Final Assembly Building (see Figure 19.4-1) contains two separate assembly areas connected by a common air lock. One area contains the spacecraft handling equipment and is used to prepare the spacecraft for encapsulation; the other area is the encapsulation area which houses the slings and fixtures required during the encapsulation operation. Both areas, including the air lock, are maintained under clean-room conditions to minimize spacecraft contamination.

19.4.3 ENCAPSULATION SEQUENCE. Refer to Figure 19.4-2 for the sequence of operations. Each major step in the encapsulation sequence is supported by Figures 19.4-3 through 19.4-10, depicting the operation.

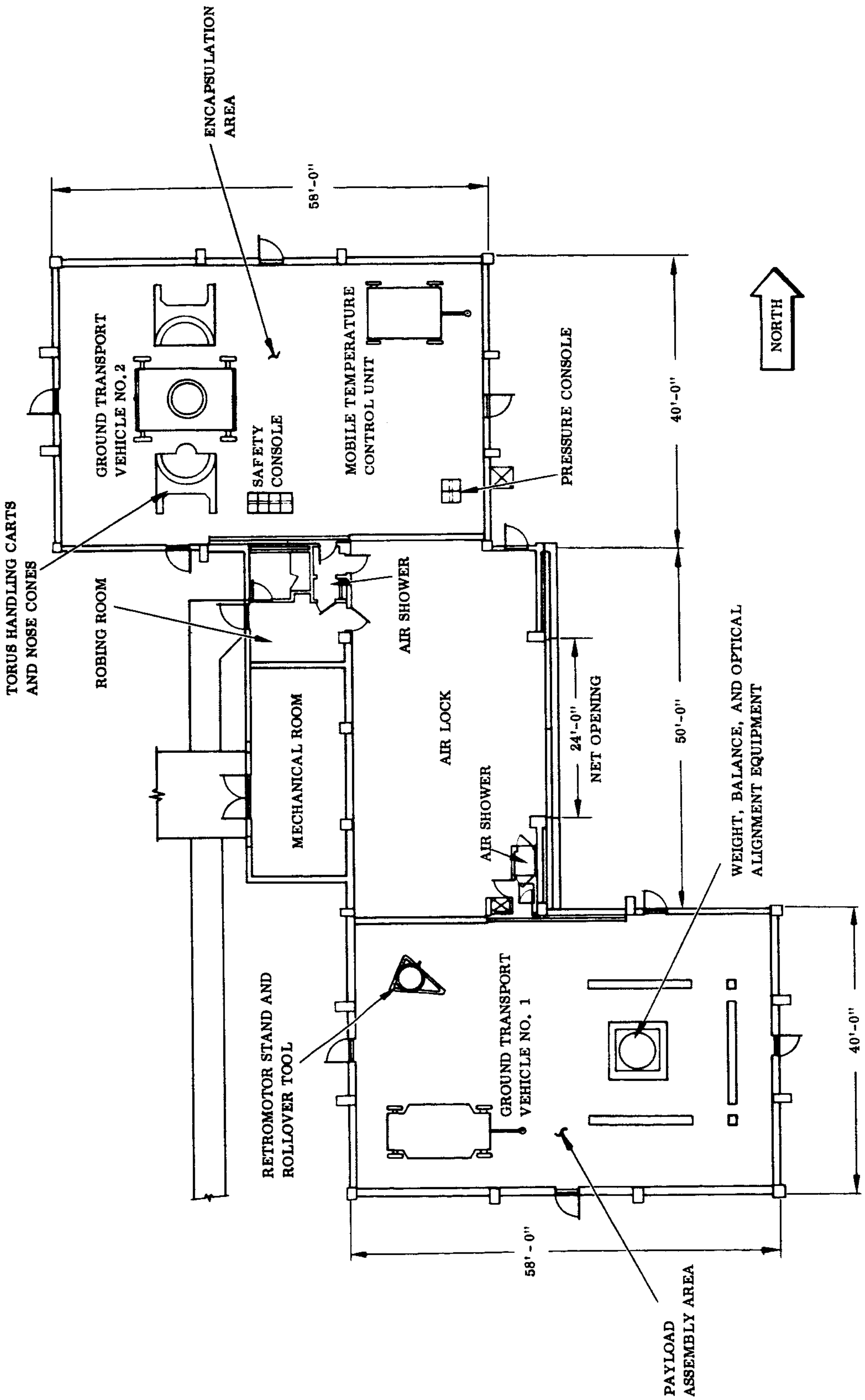


Figure 19.4-1. Final Assembly Building at the Explosion Safe Facility

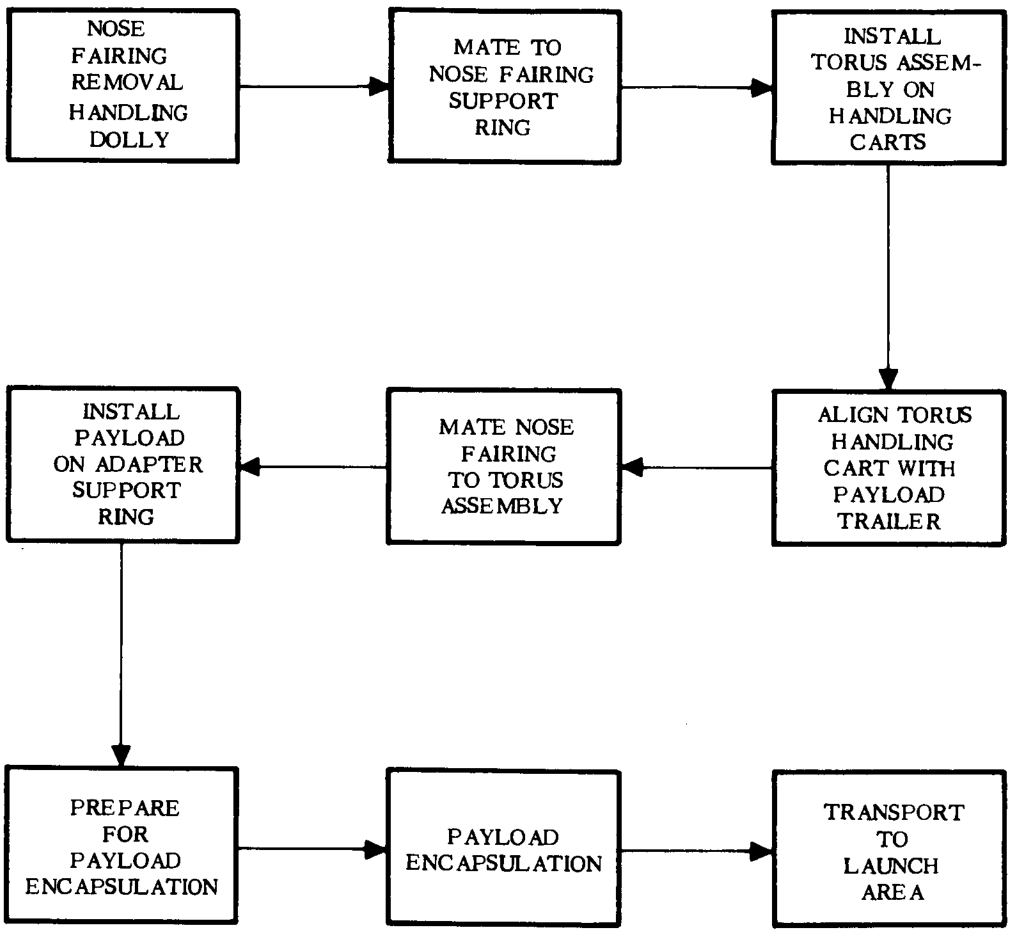
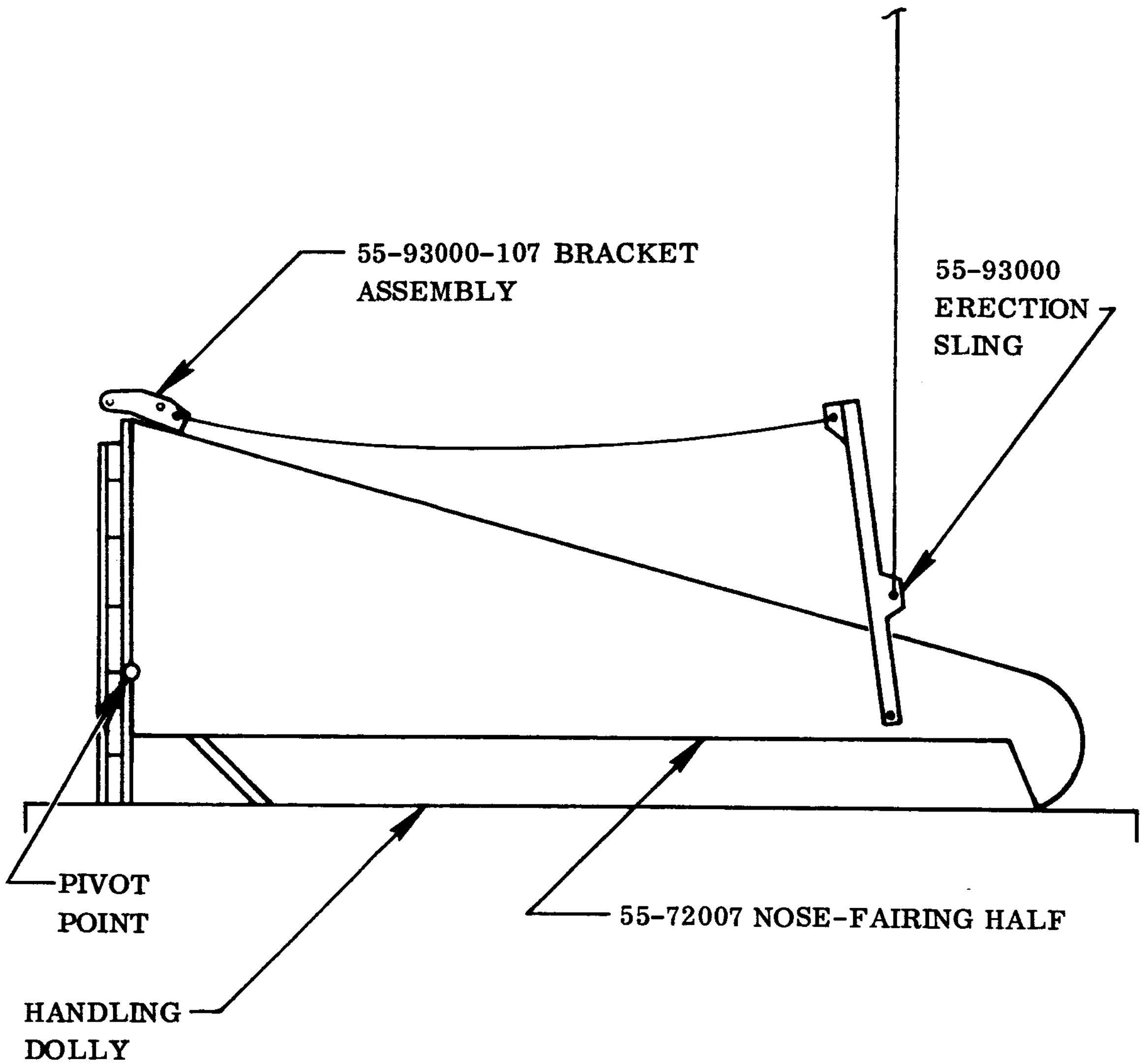


Figure 19.4-2. Spacecraft Encapsulation Functional Block Diagram



Step 1:
Preparing to Transfer Nose Fairing Half from
Handling Dolly to Nose Fairing Support Ring

Figure 19.4-3. Payload Encapsulation Operations Showing Sequential Events, Step 1

Step 1. Nose-Fairing Transfer from Dolly to Ring. The nose fairing handling dolly is moved into the airlock. The nose fairing erection sling (P/N 55-93000) is attached to the overhead crane hook and to the Quad I-III nose-fairing half as shown in Figure 19.4-3. The fairing tiedown bolts are removed and the fairing is rotated to a vertical position. The rotation bracket assembly is removed and the fairing is lifted clear of the dolly and lowered to its mating position on the support ring.

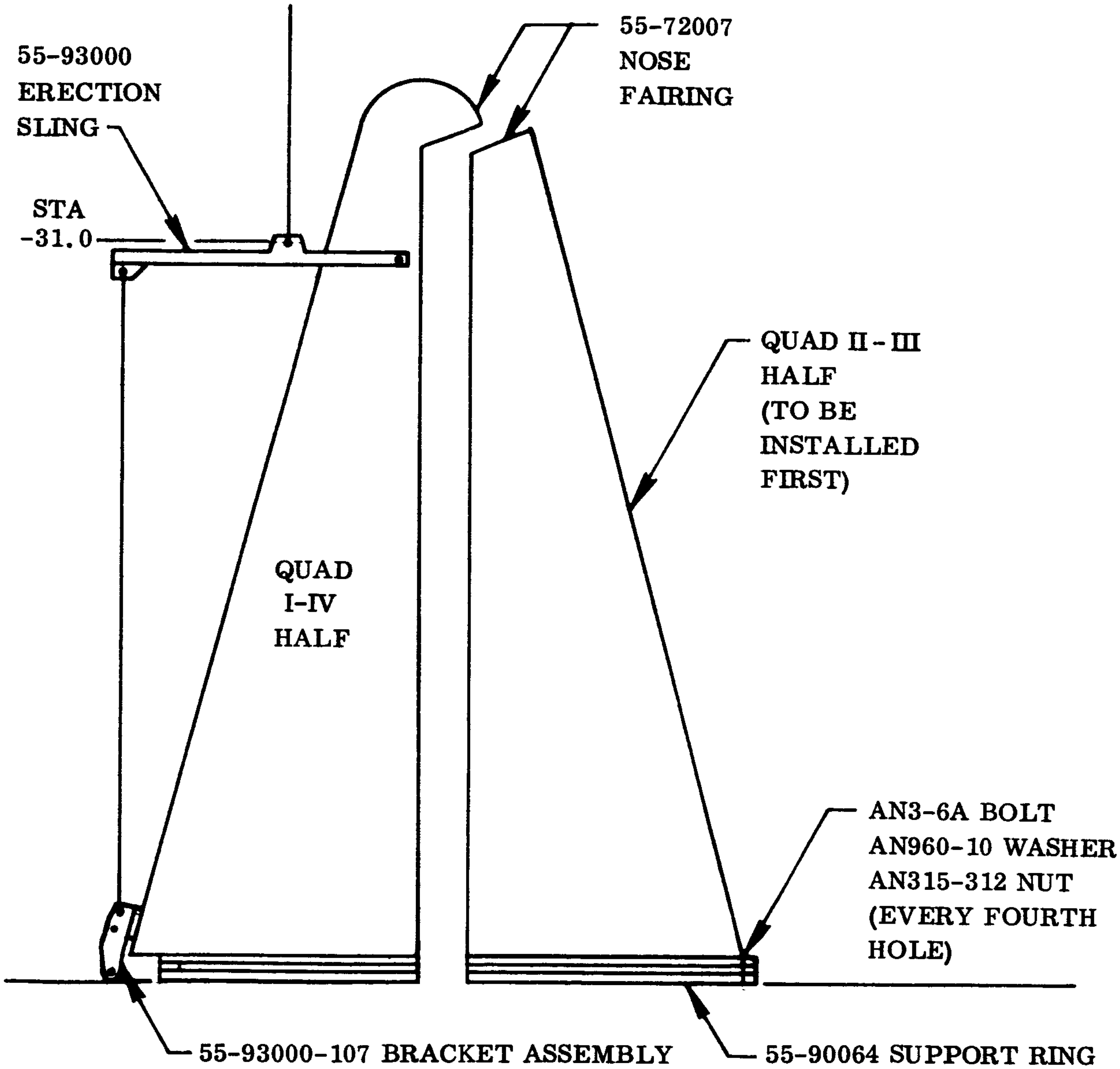
A similar procedure is followed for the Quad I-IV fairing half.

Step 2. Mating to Nose Fairing Support Ring. The nose fairing support ring (P/N 55-90064) is positioned in the airlock directly below the overhead crane. The ring is split along its X-X axis and its halves are moved approximately three feet apart. The nose fairings are lowered to mating position on each ring half and bolted to the ring using six bolts (see Figure 19.4-4 Step 2a). The nose fairing is cleaned and wiped down with solvent (TEC 901) and the two halves are moved together and bolted at the X-X axis. Work stands are positioned around the nose fairing to fasten the fairing latches (see Figure 19.4-4 Step 2b). The nose fairing and work stands are moved into the encapsulation area.

Step 3. Loading Torus Assembly on Handling Cart. The torus assembly handling carts are moved into position in the encapsulation area so that the two carts are separated twelve feet and facing one another. The torus ring support "U" bolts are removed from the Quad II-III handling cart and the supports are leveled (see Figure 19.4-5 Step 3a). The Quad II-III torus ring is prepared for mating with the handling cart by rotating the three nose fairing support blocks (P/N 55-90066) away from the torus ring (see Figure 19.4-5 Step 3b). The torus handling sling (see Figure 19.4-5 Step 3c) is attached to the overhead crane and to three attach points on the torus ring. The ring is hoisted and positioned in the handling cart (see Figure 19.4-5 Step 3d). The "U" bolts are then installed and tightened, and the sling is removed.

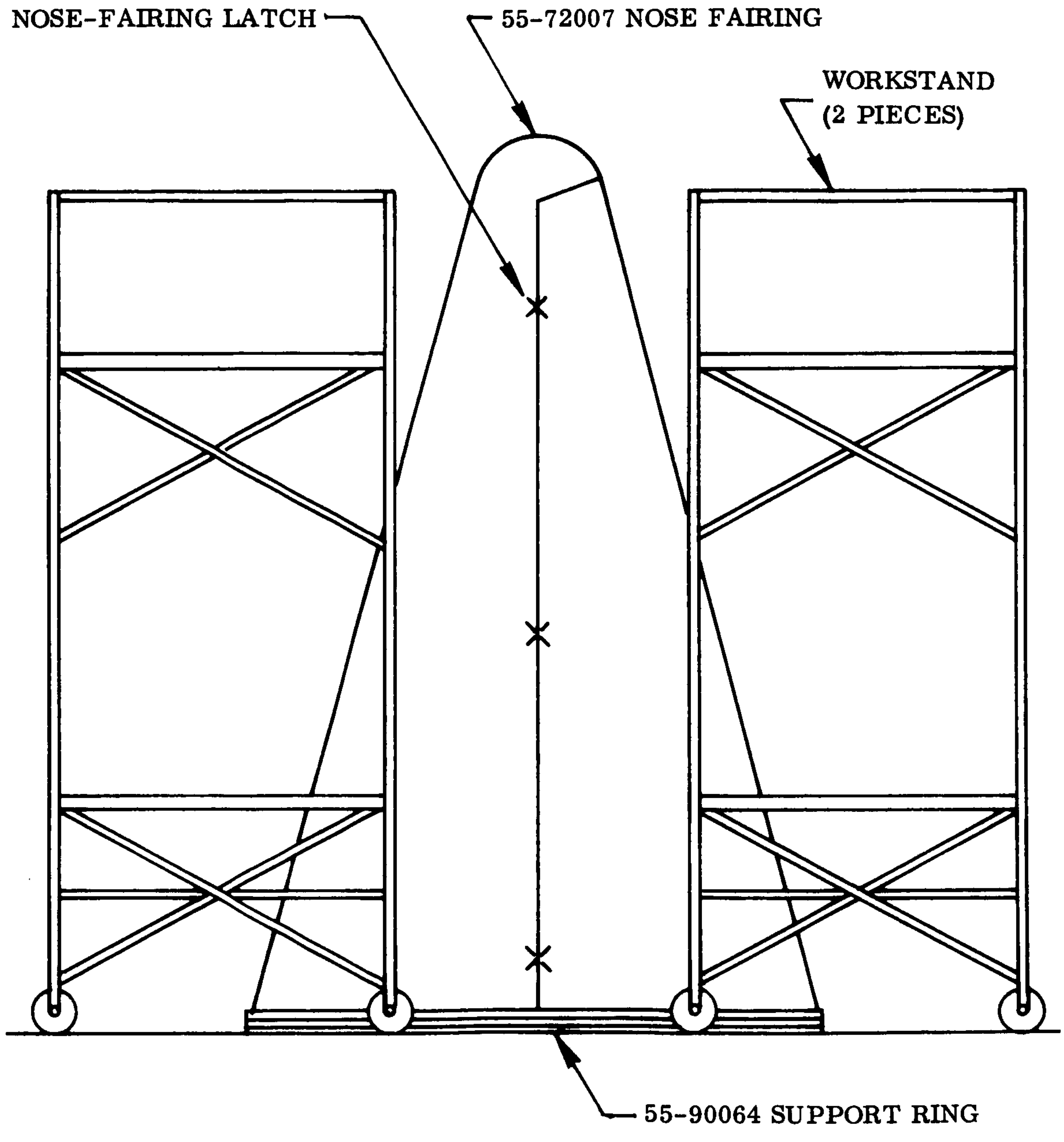
Following the same procedure, the Quad I-IV torus ring is also loaded into its handling cart.

Step 4. Alignment of Torus Handling Cart with Payload Trailer. The ground transport vehicle which transports the encapsulated payload to the launch area is moved from the payload assembly area into the encapsulation area and positioned between the torus handling carts. The trailer is jacked up and leveled. The forward adapter support ring and forward payload adapter are loosely bolted to the trailer in a position oriented to the trailer X-X and Y-Y axes (see Figure 19.4-6 Step 4a). The two torus handling carts are moved into position around the trailer and adjusted so that the mating planes coincide with the vertical centerline of the trailer X-X axis, and the trailer and torus Y-Y axes are aligned. The two torus halves are bolted together (see Figure 19.4-6 Step 4b). Four trailer-to-torus support jacks are installed to hold the torus assembly. The "U" bolts tieing the torus assembly to the handling cart are removed and the handling carts are backed away from the torus/trailer assembly. Three payload support



Step 2a:
Mating Nose-Fairing Halves on Nose-Fairing Support Ring

Figure 19.4-4. Payload Encapsulation Operations Showing Sequential Events, Step 2 (Sheet 1 of 2)



Step 2b:
Positioning Work Stands for Fastening Nose-Fairing Latches

Figure 19.4-4. Payload Encapsulation Operations Showing Sequential Events, Step 2 (Sheet 2 of 2)

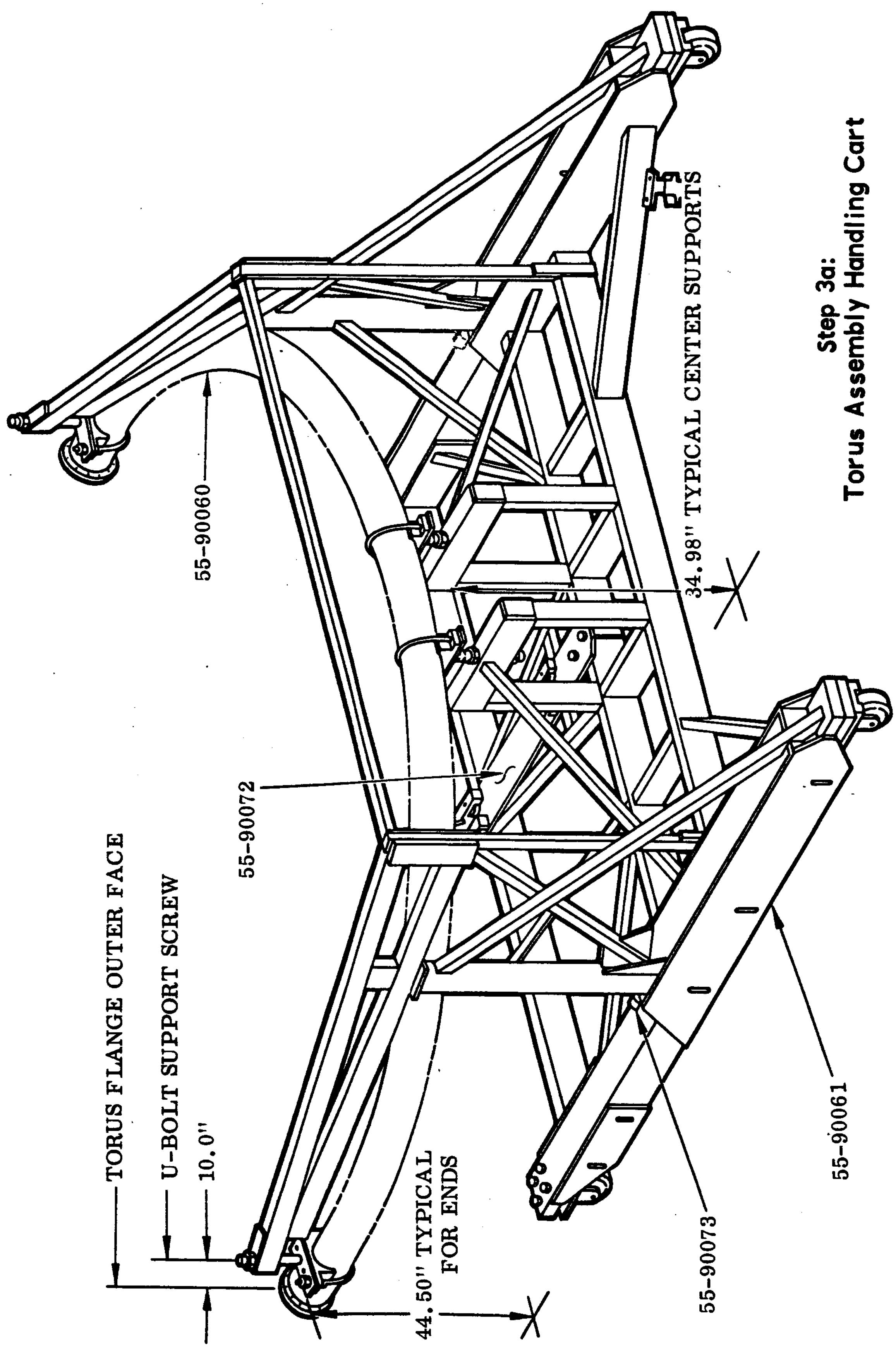
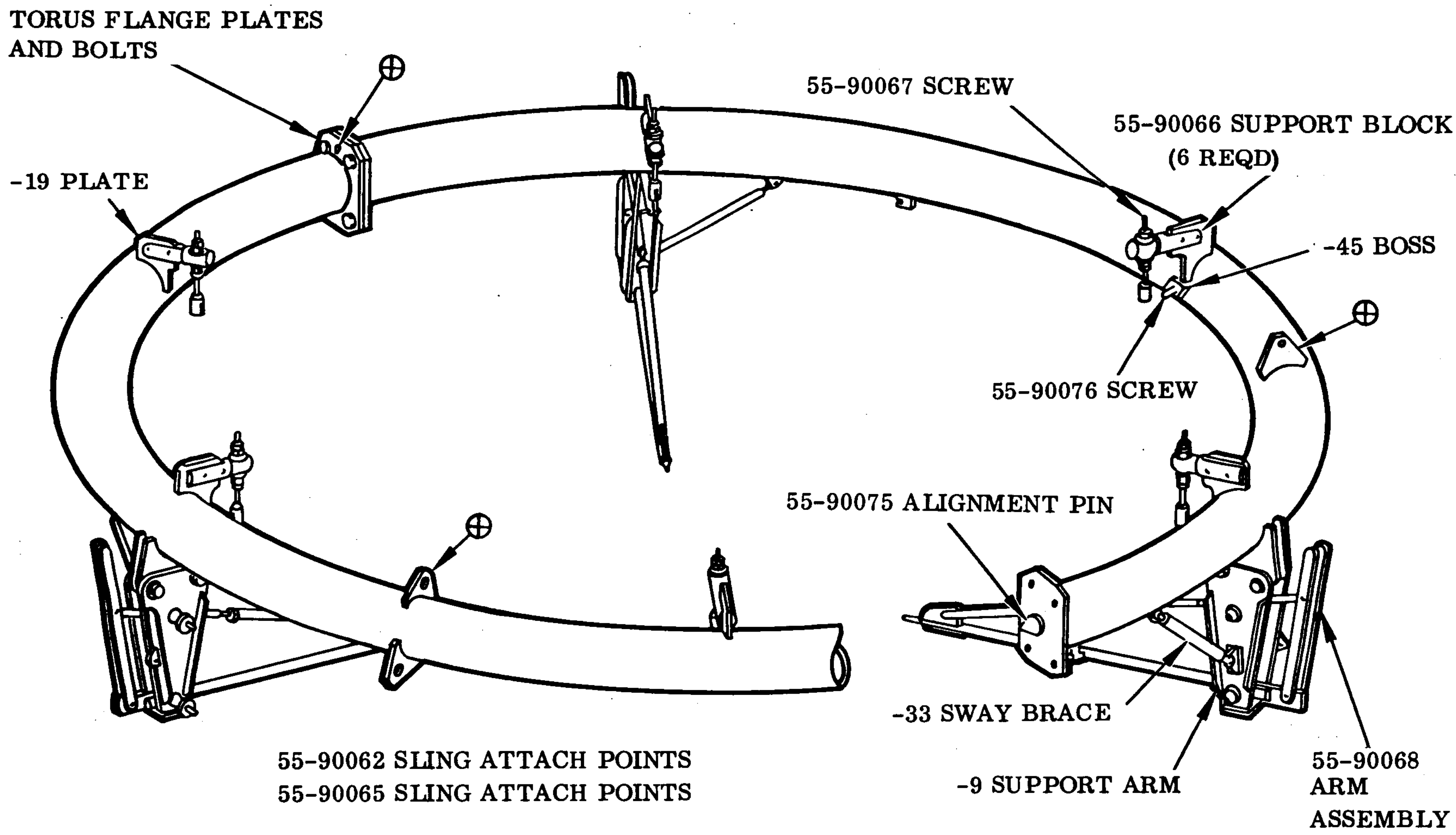
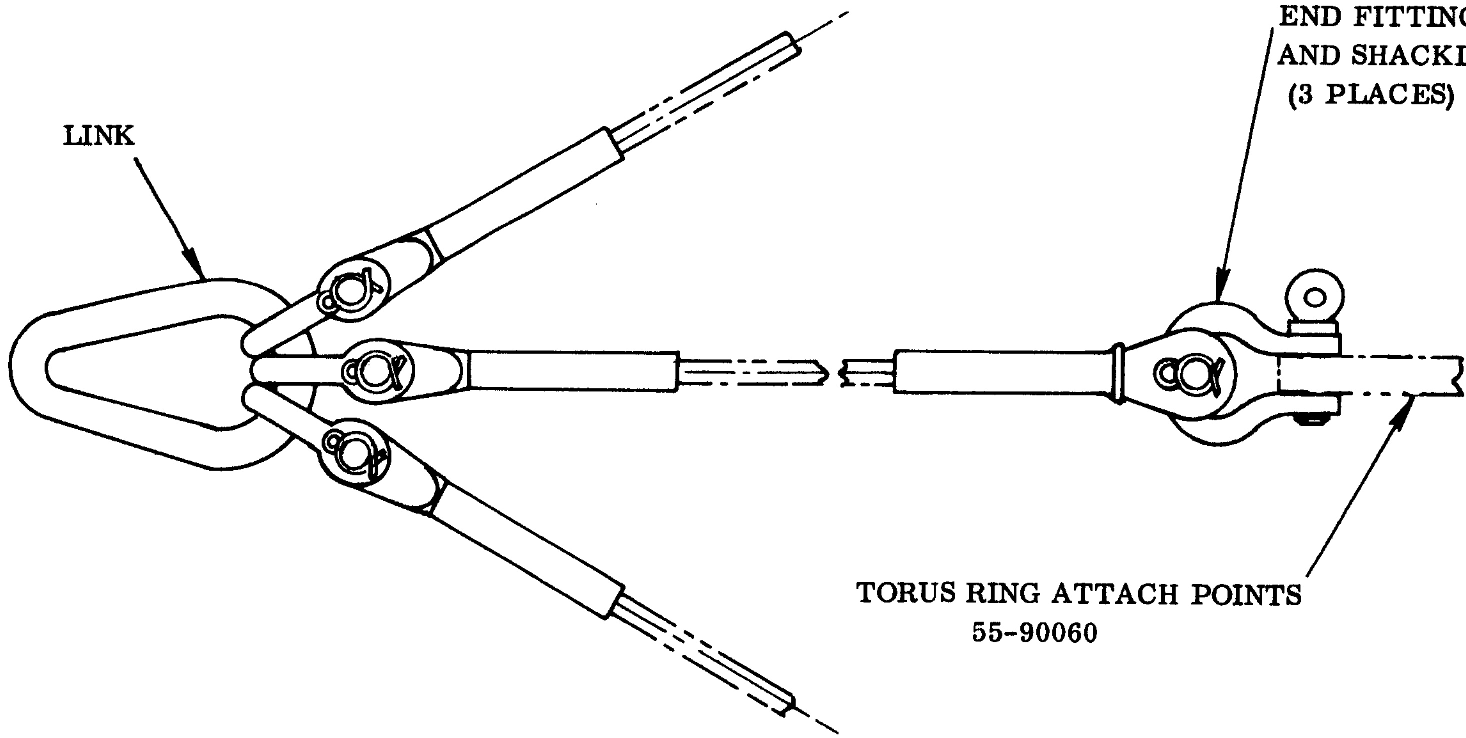


Figure 19.4-5. Payload Encapsulation Operations Showing Sequential Events, Step 3 (Sheet 1 of 4)



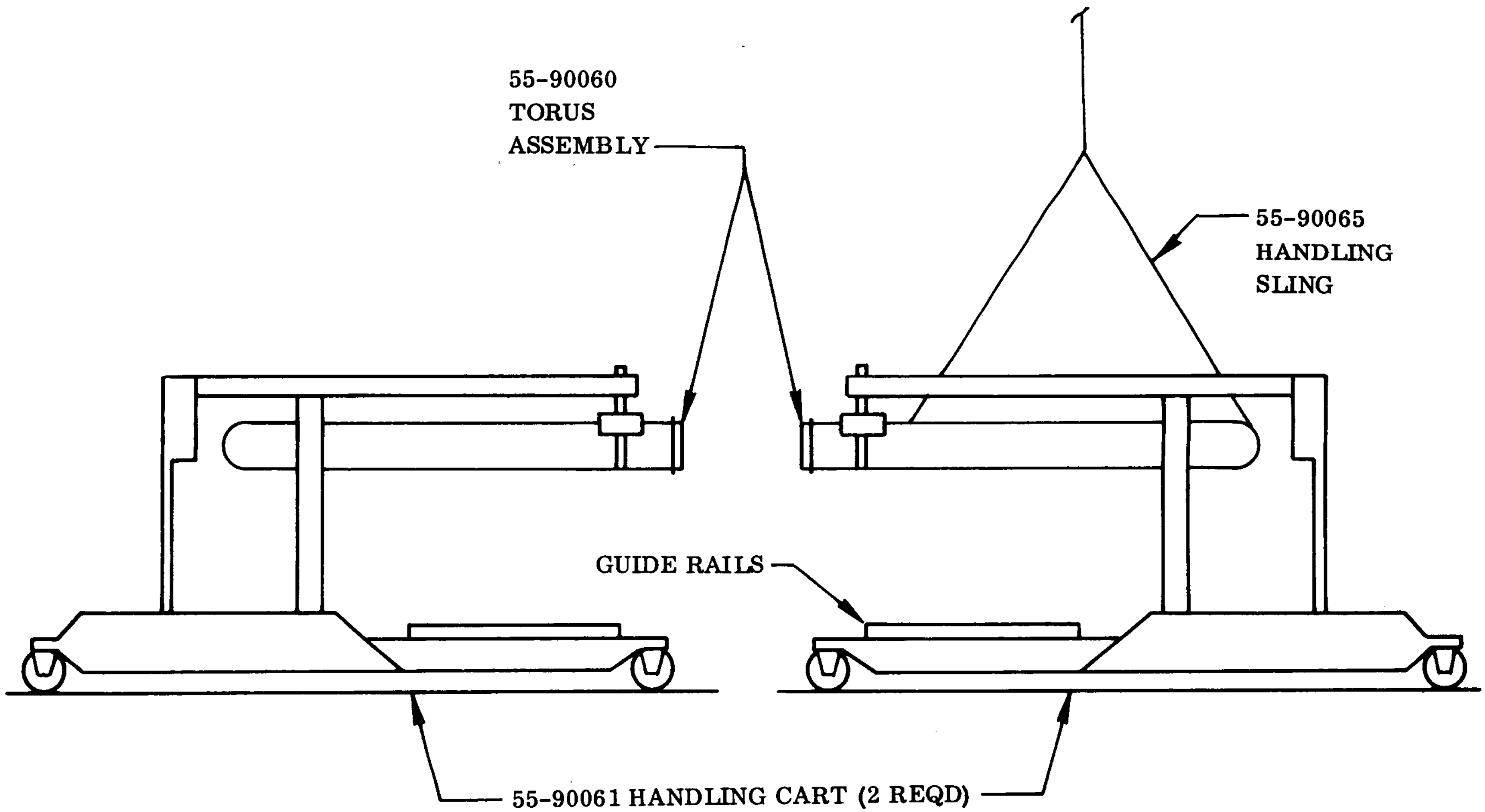
Step 3b:
Torus Assembly Fixture (P/N 55-90060)

Figure 19.4-5. Payload Encapsulation Operations Showing Sequential Events, Step 3 (Sheet 2 of 4)



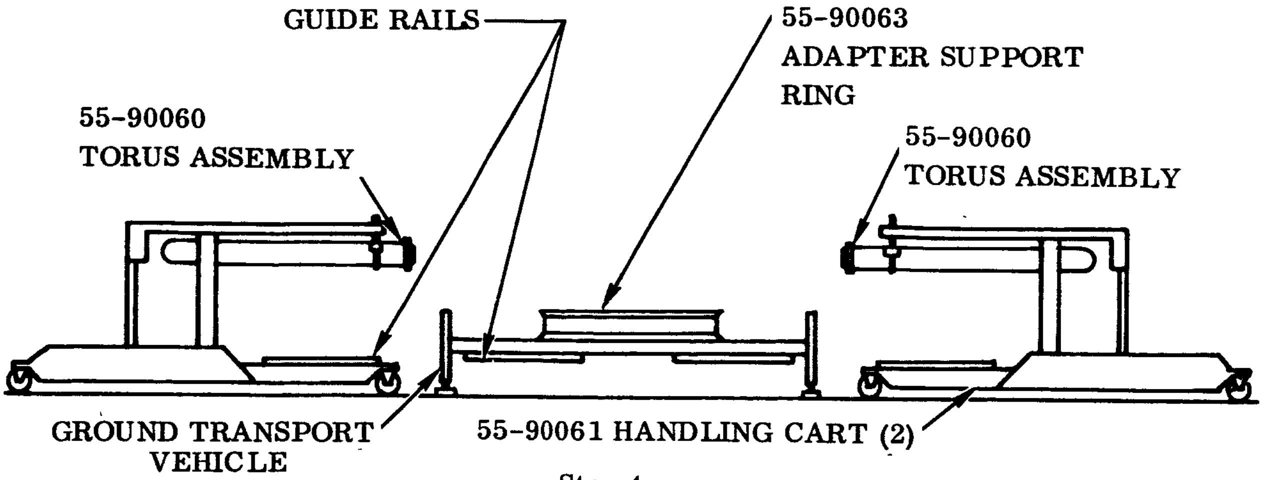
Step 3c:
Torus Handling Sling (P/N 55-90065)

Figure 19.4-5. Payload Encapsulation Operations Showing Sequential Events, Step 3 (Sheet 3 of 4)

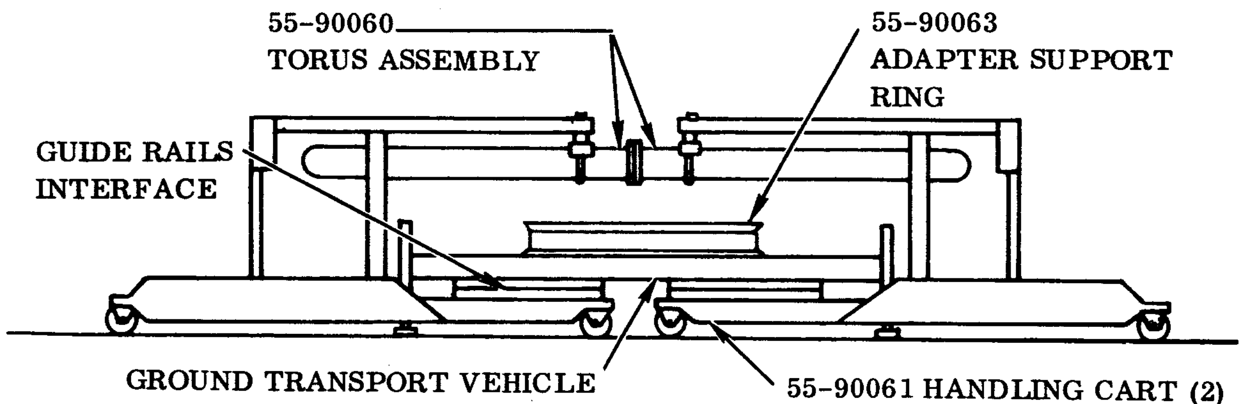


Step 3d:
Loading Torus Assembly on Torus Assembly Handling Cart

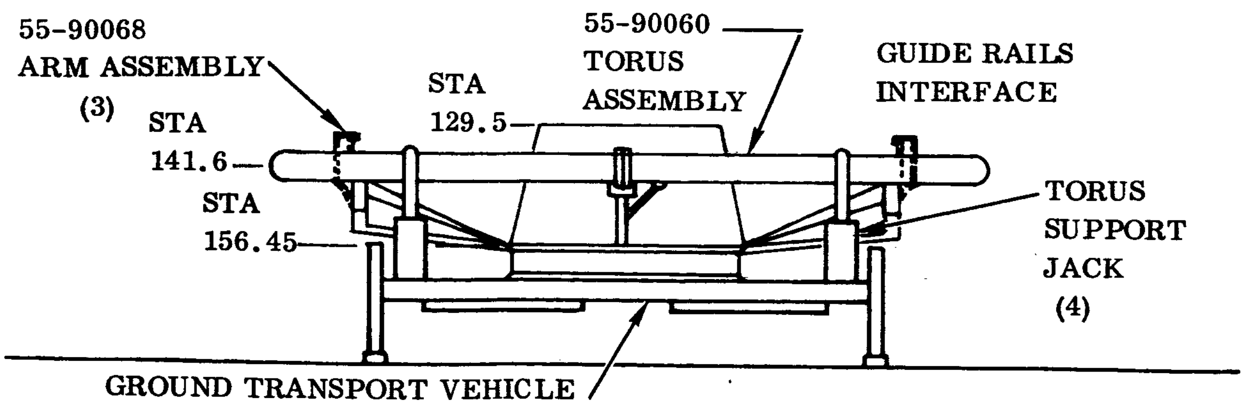
Figure 19.4-5. Payload Encapsulation Operations Showing Sequential Events, Step 3 (Sheet 4 of 4)



Step 4a:
Positioning Ground Handling Trailer and Installing
Adapter Support Ring



Step 4b:
Aligning and Mating Torus Assembly on Handling Carts



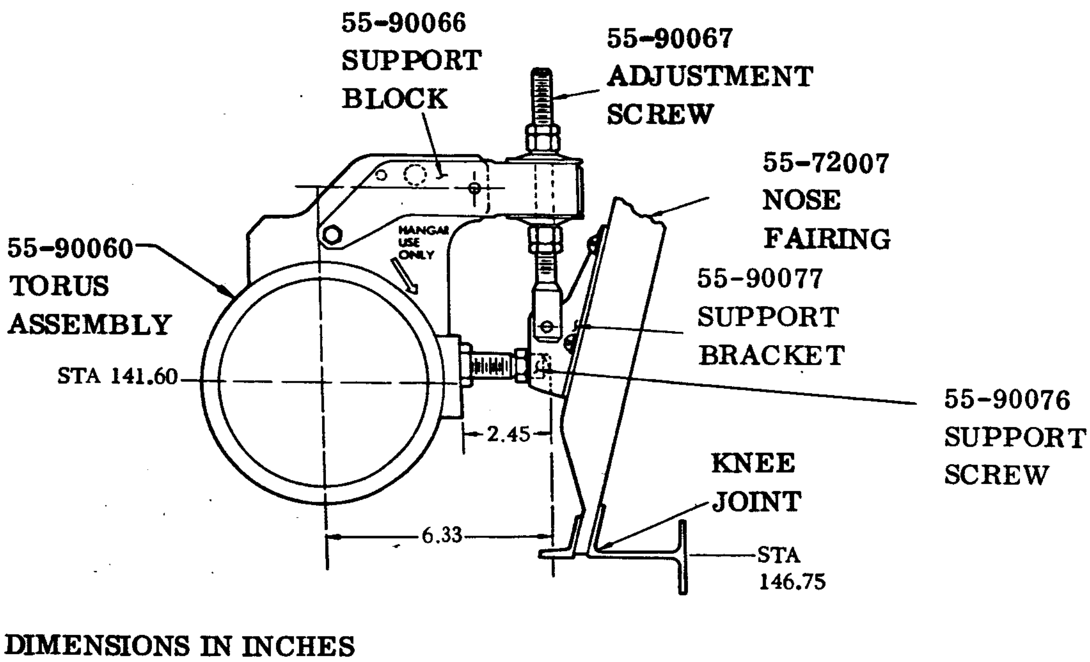
Step 4c:
Aligning Payload Support Arm

Figure 19.4-6. Payload Encapsulation Operations Showing Sequential Events, Step 4 arms are installed on the torus assembly (see Figure 19.4-6 Step 4c) and adjusted to ensure proper alignment with the payload adapter. After alignment, the adapter bolts are tightened. The three payload support arm locations are marked and they are removed from the torus assembly. The handling carts are moved up to the trailer and mated together. The "U" bolts are installed to hold the torus, and the trailer-to-torus support jacks are removed.

Step 5. Mating Nose Fairing with Torus Assembly. Six nose fairing support brackets (P/N 55-90077) are installed on the nose fairing at inserts just above the Station 146.75 joint. On the torus assembly, the six nose fairing support blocks (P/N 55-90066) are readied to receive the nose fairing (see Figure 19.4-7 Step 5a). The nose fairing sling assembly (P/N 55-90062) is attached to the overhead crane and positioned above the nose fairing. The sling is lowered and attached to the support bracket located on the Y-Y axis of Quad I-IV nose fairing and to brackets 120 degrees from the Y-Y axis. The nose fairing support bolts are removed and the nose fairing is lifted free of its support ring. The nose fairing is oriented to the torus and slowly lowered until the fairing support screws (P/N 55-90076) mate with the fairing support brackets (see Figure 19.4-7 Step 5b). The nose fairing X-X axis separation plane is adjusted to align with the torus assembly separation plane and the three unused support brackets are pinned to the support block. The sling assembly is disconnected and removed, and the remaining support brackets are pinned to the support block. All six adjustment screws (P/N 55-90067) are tightened to snugly fit the support brackets. The work stands are used to remove the nose fairing latching bolts. The torus mating bolts are removed, and the handling carts are moved away from the trailer (see Figure 19.4-7 Step 5c). The thermal bulkhead is attached to the nose fairing knee joint, Station 146.75. After thermal bulkhead installation on each nose fairing half, the handling carts are moved to the trailer and mated together to ensure proper thermal bulkhead fit. The air-conditioning duct and adapters are installed on the Quad I-IV thermal bulkhead.

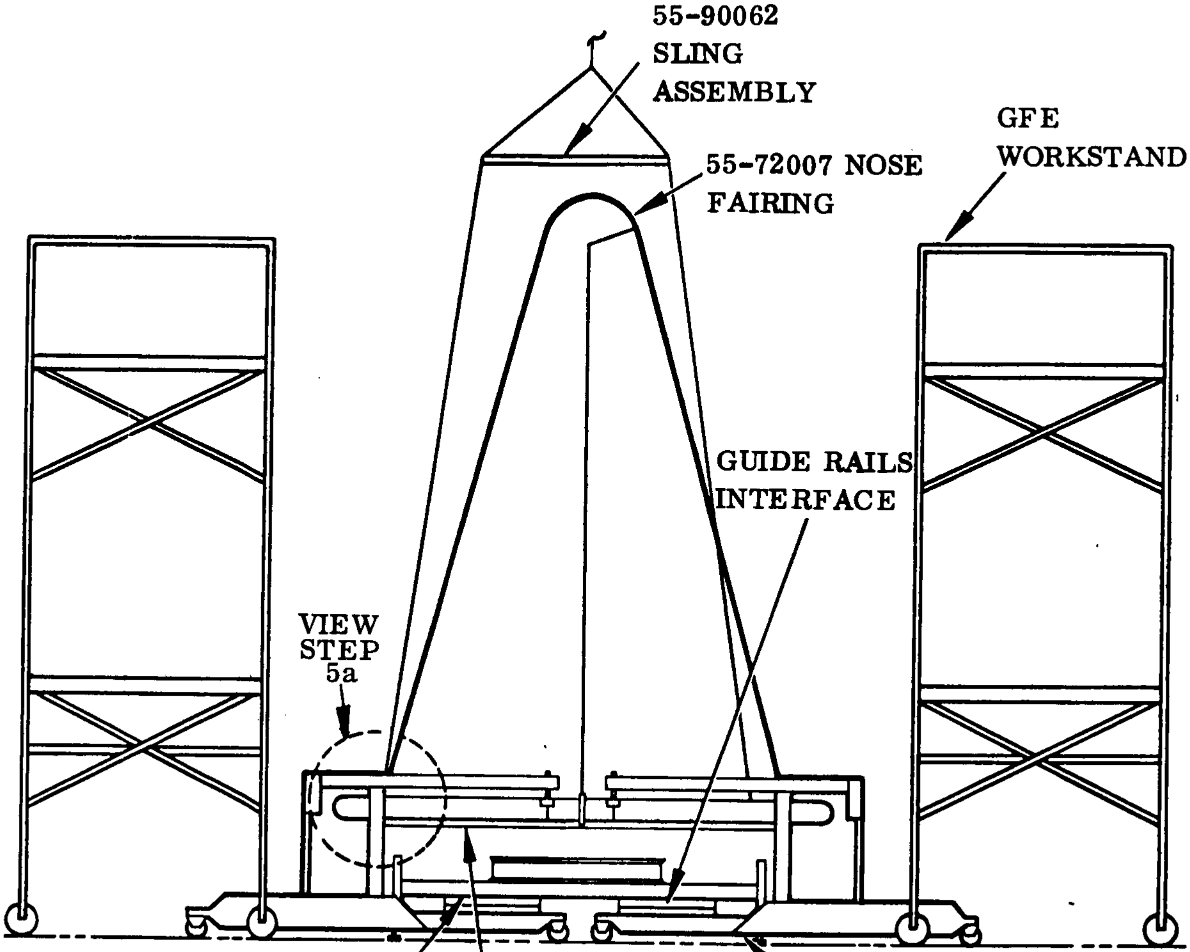
Step 6. Installing Payload on Payload Adapter. The payload is installed on the payload adapter while on the ground transport trailer. The overhead crane is positioned above the payload which has been moved into the encapulation area from the payload assembly area. A hydraset and sling are attached to the crane. The three free ends are attached to the payload. The payload is slowly lifted free from its handling cart, (see Figure 19.4-8, Step 6a), positioned over the ground transport trailer and slowly lowered onto the trailer (see Figure 19.4-8, Step 6b). The last half-inch of travel requires the use of the hydraset. The payload is mated to the payload adapter, and the sling is removed from the payload.

Step 7. Preparation for Payload Encapsulation. Prior to payload encapsulation, a final configuration check of the payload is made. The mechanical and electrical integrity of the payload is verified. The flight batteries are installed and final weight and balance checks are completed.



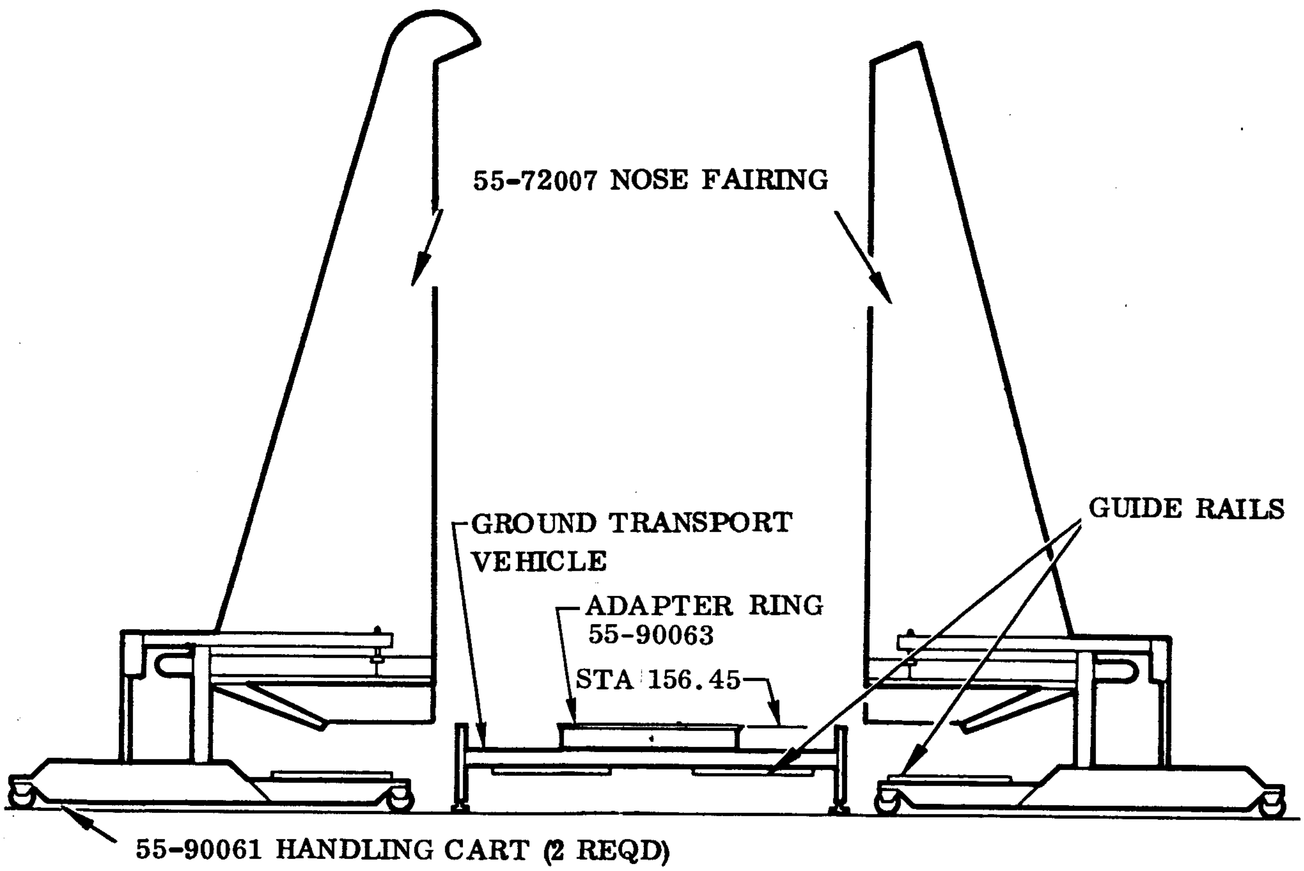
Step 5a:
Nose Fairing Support Blocks Preparation

Figure 19.4-7. Payload Encapsulation Operations
Showing Sequential Events, Step 5 (Sheet 1 of 3)



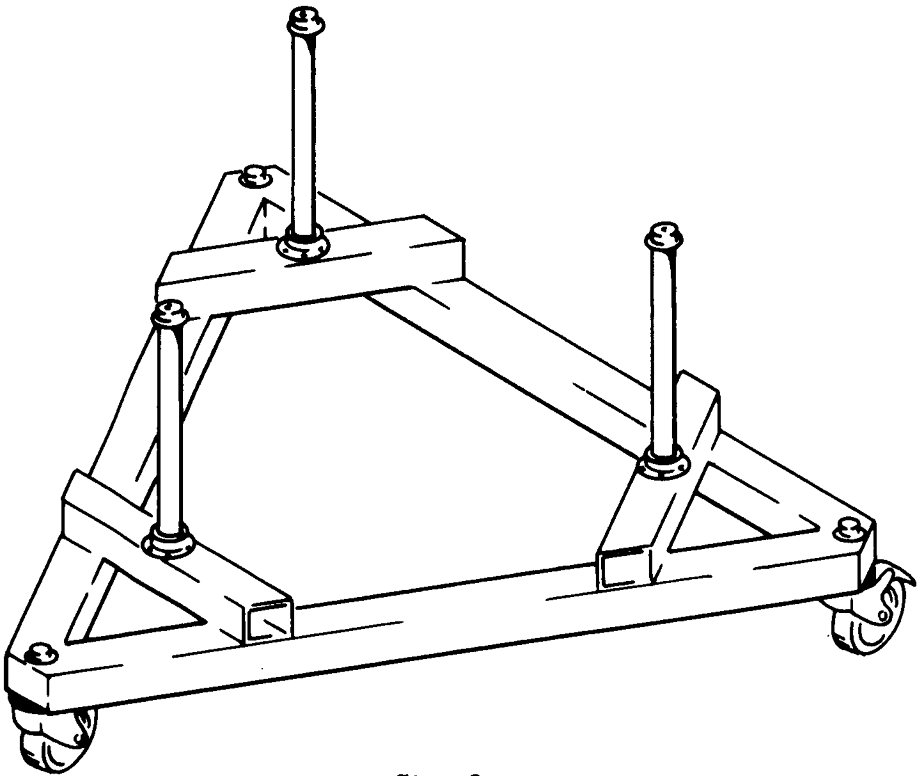
Step 5b:
Mating Nose Fairing with Torus Assembly

Figure 19.4-7. Payload Encapsulation Operations
Showing Sequential Events, Step 5 (Sheet 2 of 3)



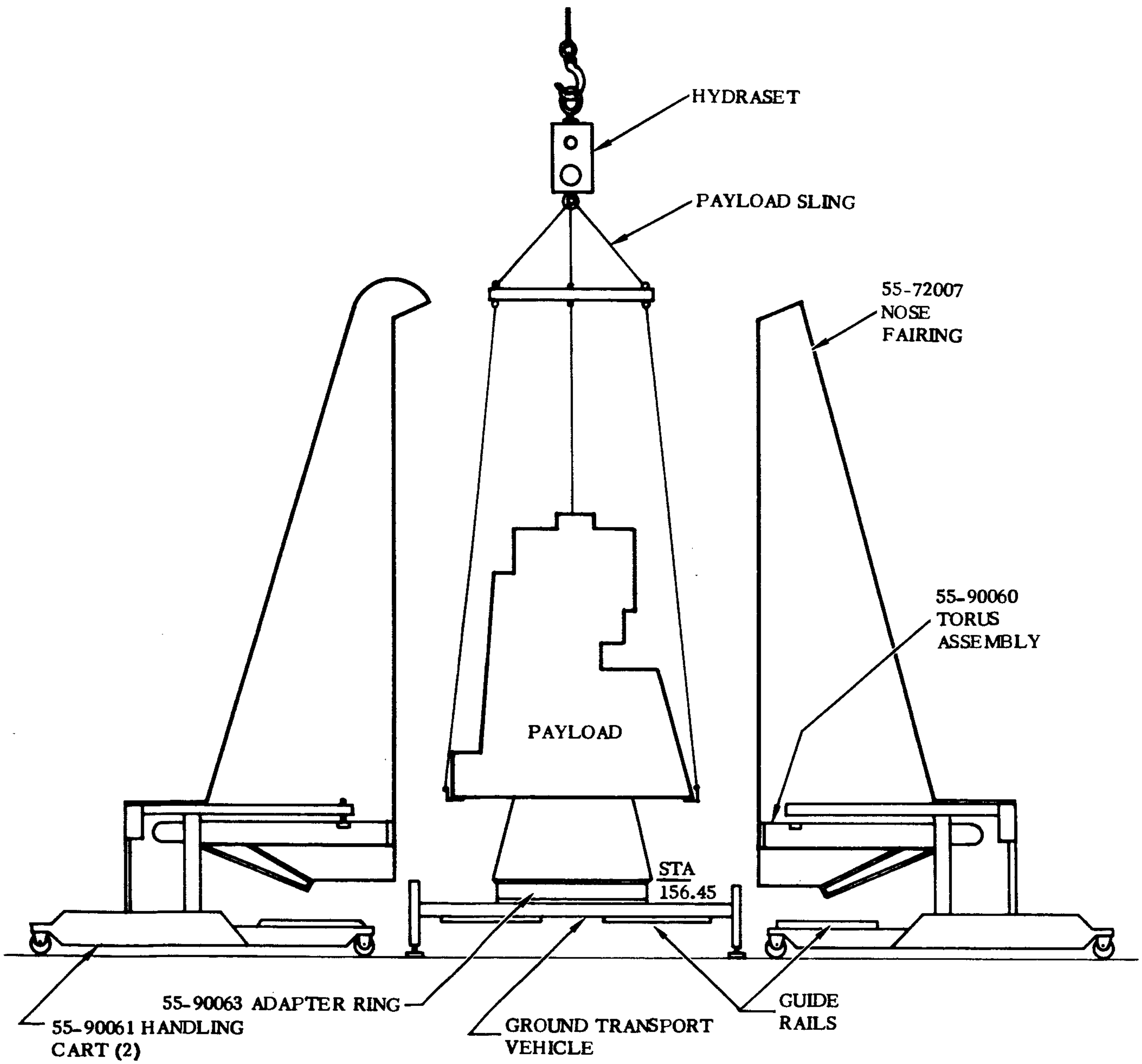
Step 5c:
Nose Fairing Supported by Torus Assembly

Figure 19.4-7. Payload Encapsulation Operations Showing Sequential Events, Step 5 (Sheet 3 of 3)



Step 6a:
Payload Handling Cart (GFE)

Figure 19.4-8. Payload Encapsulation Operations, Step 6 (Sheet 1 of 2)



Step 6b:
Mating Payload to Support Adapter Ring

Figure 19.4-8. Payload Encapsulation Operations, Step 6 (Sheet 2 of 2)

Step 8. Payload Encapsulation. The Quad I-IV and Quad II-III nose fairing handling carts are moved into position around the payload and mated by bolting the torus rings together. Six nose fairing explosive bolts are installed on the latch assemblies. The four torus support jacks and three payload support arm assemblies are installed, (see Figure 19.4-9, step 8a). The eight "U" bolts tieing the torus to the handling carts are removed and the carts are moved away from the nose fairing assembly (see Figure 19.4-9, step 8b). The mobile temperature control unit is connected to the nose fairing assembly. The trailer/torus/support jack tie rods and sway braces are installed and the trailer is then slowly lowered down onto its tires.

Step 9. Transport to Launch Area. During the spacecraft transport from the explosive safe facility to the launch pad, conditioned air is supplied to the spacecraft from the mobile temperature control unit. The unit is in turn powered by a mobile power generator. Figure 19.4-10, step 9, shows the sequence of operations in transporting the spacecraft to the launch pad.

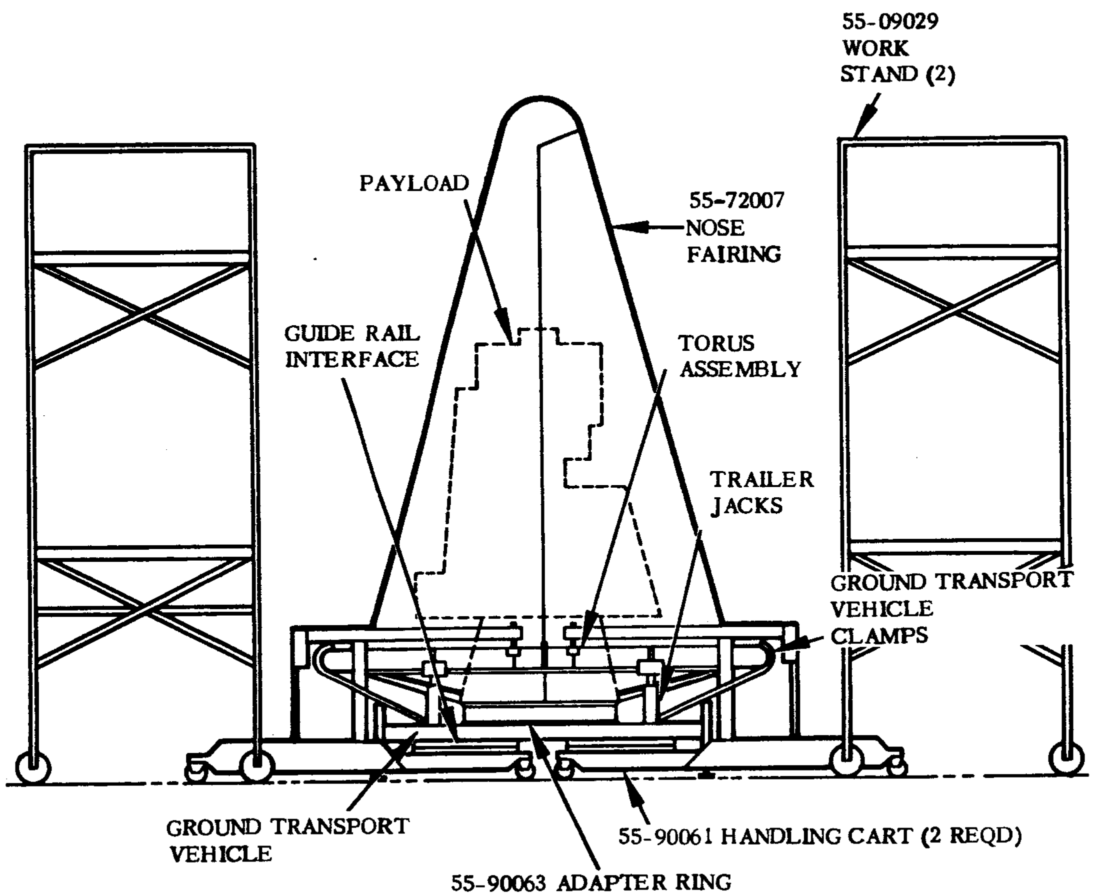
19.5 STRETCH SYSTEM

19.5.1 STRETCH SYSTEM FUNCTION. The primary function of the service tower stretch system is to maintain the booster, Centaur/booster, or payload/Centaur/booster in a stretch condition whenever the Centaur or booster tanks are depressurized. The stretch system consists of two pneumatically operated stretch cylinders located on the service tower at Station 181, and two steel cables connecting the two cylinders to a common link. The link serves as the attachment point for the stretch slings. Control of the stretch pressure is provided manually from the stretch sling pneumatic panel located at tower Station 179, and remotely from the pressurization first and second stage panels of the launch control equipment located in the blockhouse. Table 19.5-1 lists the different stretch configurations, slings, and adapters used with the booster/Centaur/payload vehicle.

Detailed information about the stretch system is contained in the Complex 36B Stretch System Operation and Maintenance Manual, Report No. GDA63-1008, revised 1 May 1965.

TABLE 19.5-1. STRETCH SYSTEM CONFIGURATION

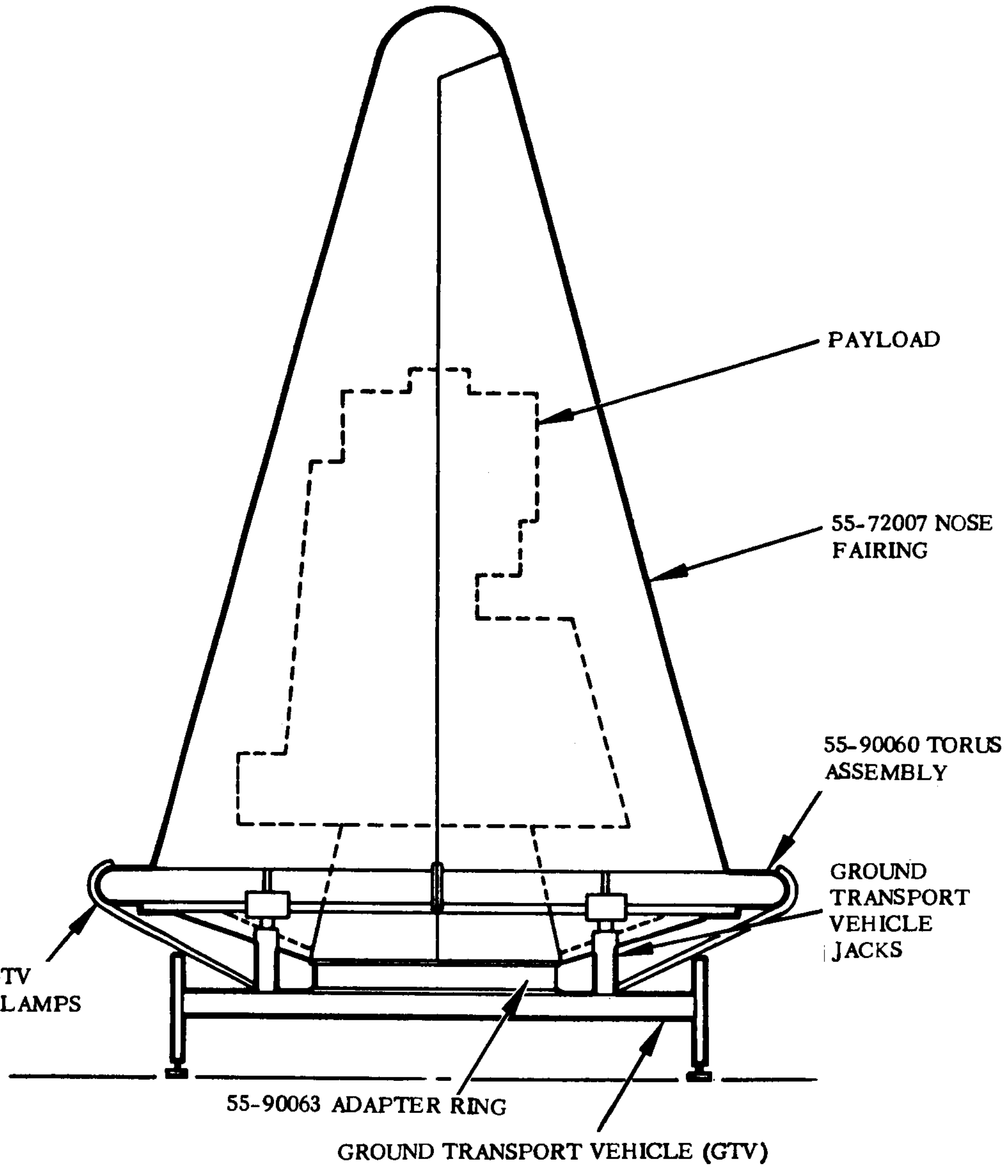
Configuration	Adapter	Stretch Sling
1. Booster Stretch	55-91117 or 55-91102	55-91043 (3-cable sling)
2. Booster Stretch with Interstage Adapter		55-91043 (2-cable sling)
3. Booster/Centaur Stretch	55-91102	55-91043 (5-cable sling)
4. Booster/Centaur/Barrel Section Stretch	55-97050 and 55-91117	55-91043 (3-cable sling)
5. Booster/Centaur/Payload Stretch	55-91102, Vehicle Stretch Torus 55-90094, and Payload Torus 55-90060	55-91043 (3-cable sling) and 55-90081 (sling)



Step 8a*:
Encapsulating the Payload

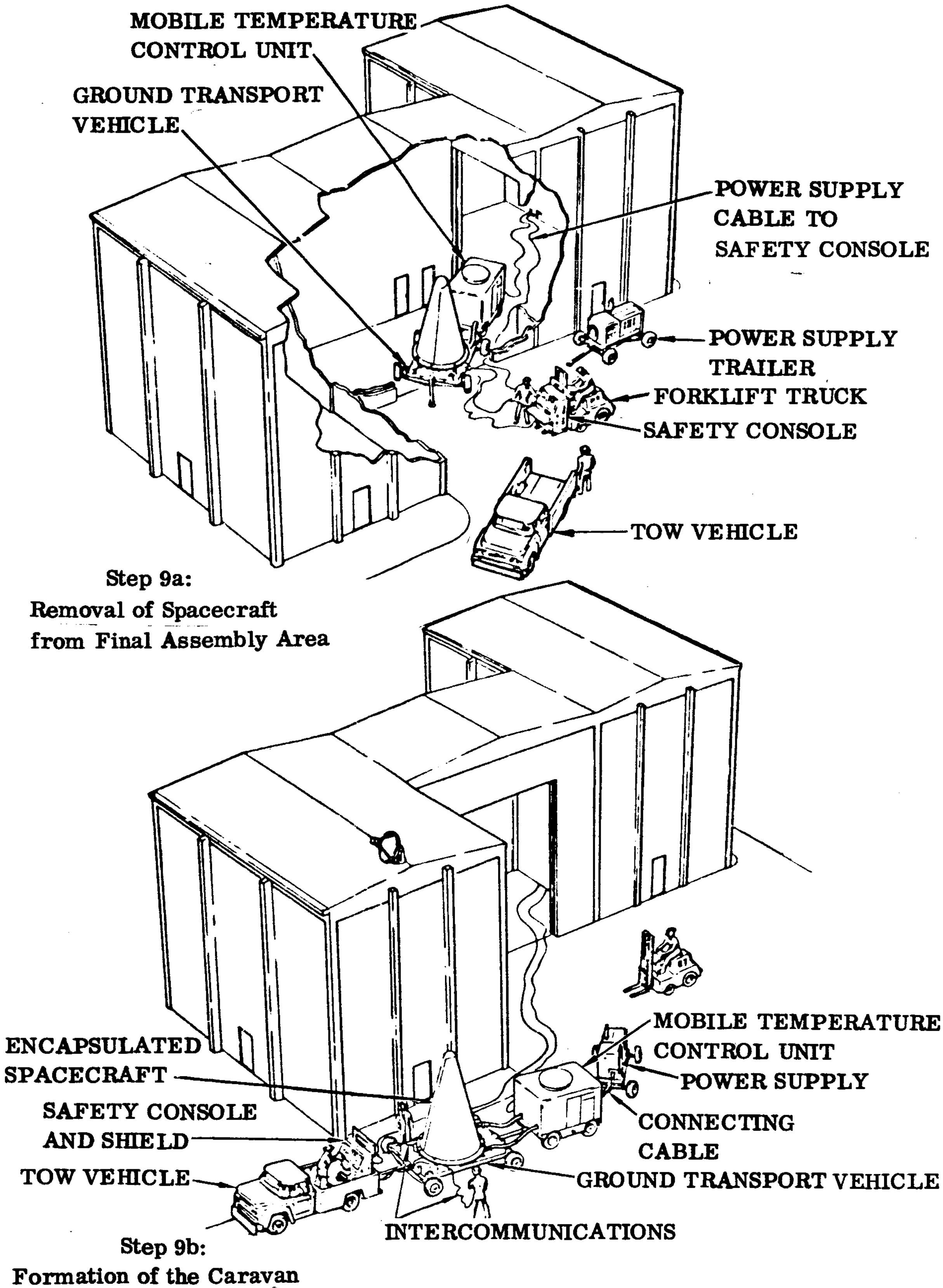
NOTE:
* Step 7 requires no illustration

Figure 19.4-9. Payload Encapsulation Operations, Step 8 (Sheet 1 of 2)



Step 8b :
Completing Payload Encapsulation

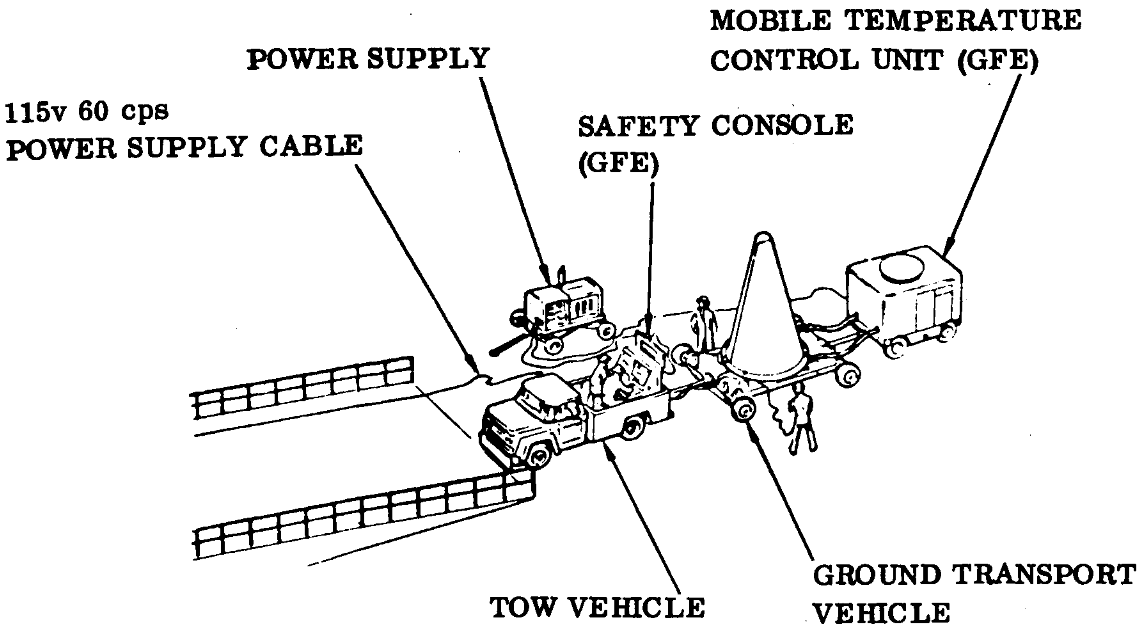
Figure 19. 4-9. Payload Encapsulation Operations, Step 8 (Sheet 2 of 2)



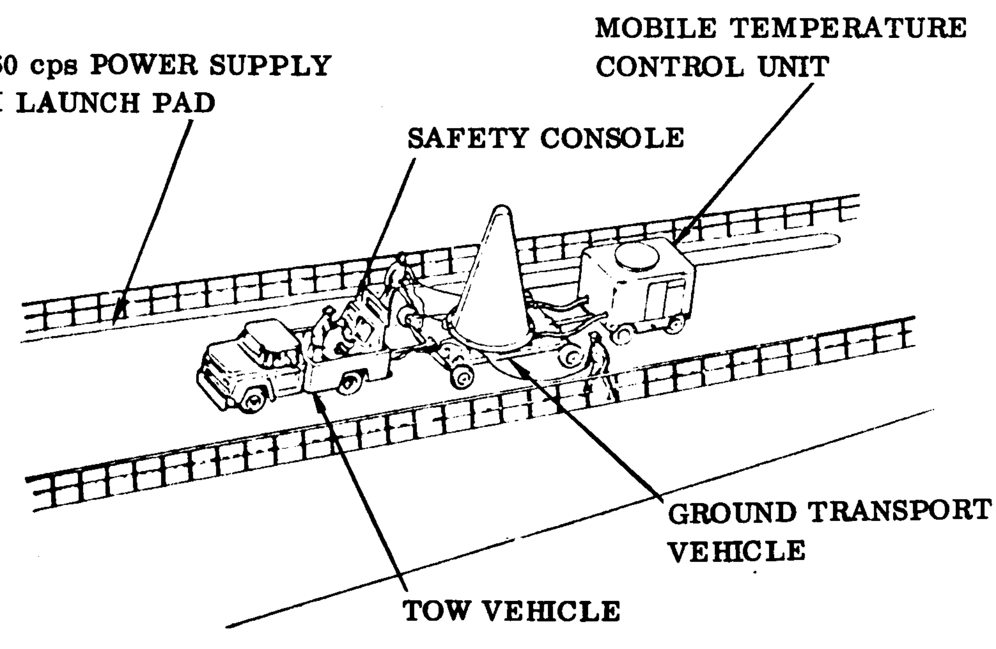
Step 9a:
Removal of Spacecraft from Final Assembly Area

Step 9b:
Formation of the Caravan

Figure 19.4-10. Payload Encapsulation Operations, Step 9 (Sheet 1 of 3)

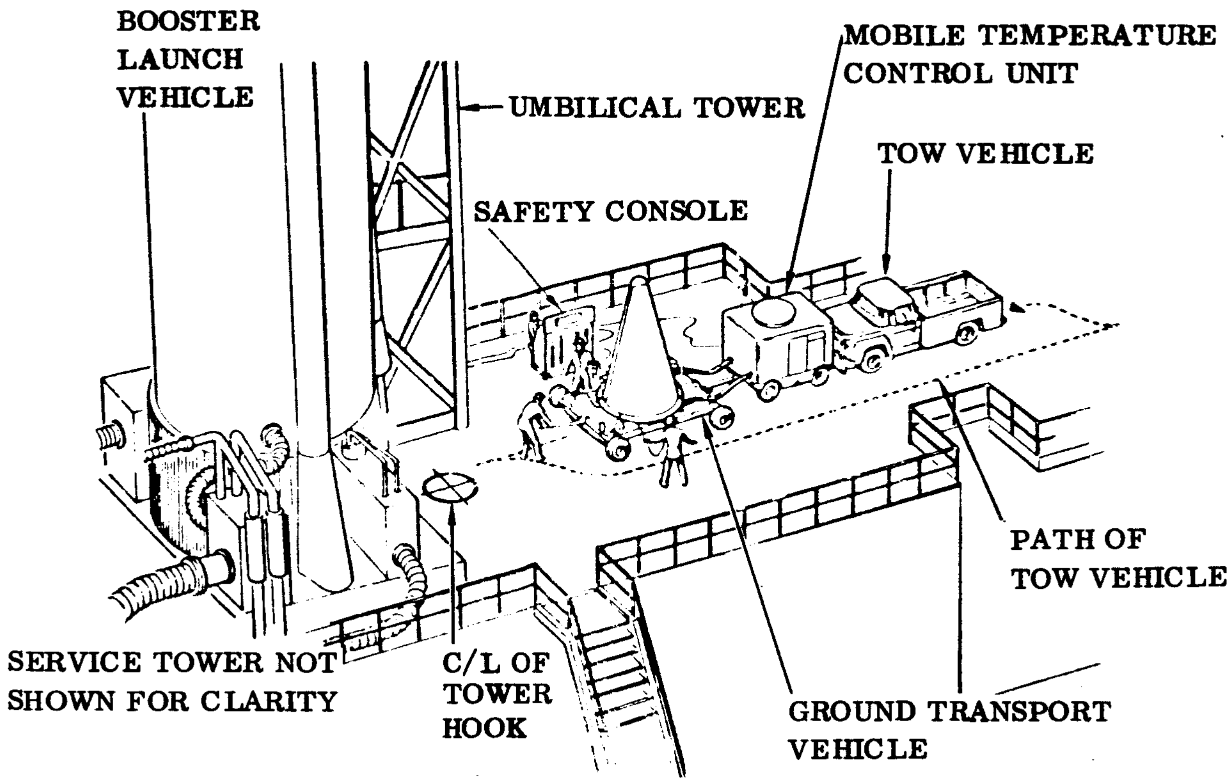


Step 9c:
Entrance to Launch Pad Ramp

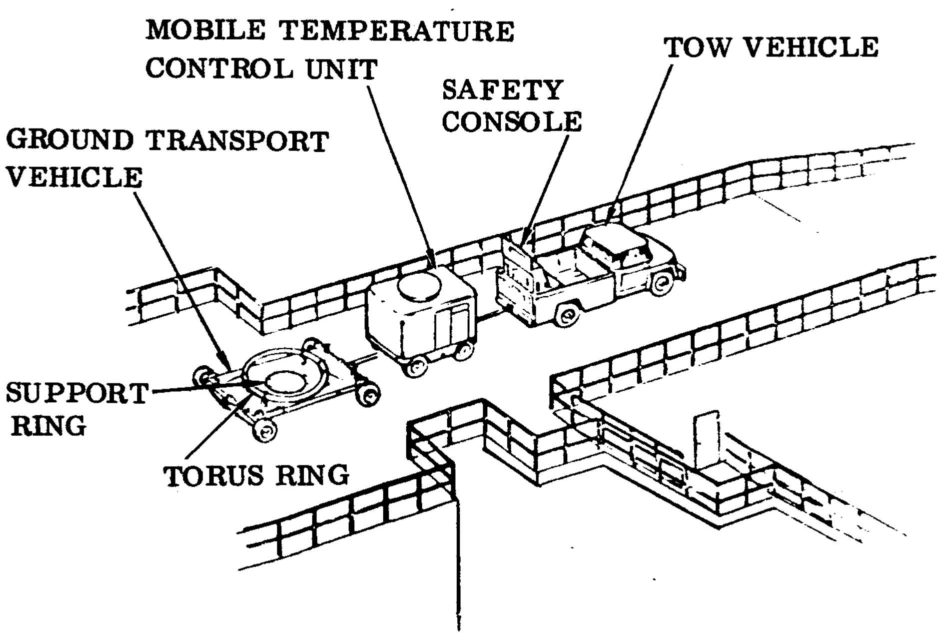


Step 9d:
Ascending the Launch Pad Ramp

Figure 19. 4-10. Payload Encapsulation Operations, Step 9 (Sheet 2 of 3)



Step 9e:
Positioning the Spacecraft on the Launch Pad Ramp



Step 9f:
Removal of Transport Equipment

Figure 19. 4-10. Payload Encapsulation Operations, Step 9 (Sheet 3 of 3)

SECTION XX

LAUNCH SERVICES

20.1 SERVICE TOWER

The service tower utilized for Centaur is a mobile structure that travels on rails under its own motive power. It is moved away from the launch pad prior to tanking at the prearranged time in the countdown (reference Subsection 21.1).

20.1.1 SERVICE TOWER FUNCTION. The tower performs several service functions in support of Centaur as follows:

a. Provides hoist and supporting structure for erection and assembly of the vehicle (reference Section XIX of this volume and Figure 20.1-1).

b. Provides supporting structure for stretch system (reference Section XIX of this volume and Figure 20.1-2).

c. Provides a mobile platform for locating Ground Support Equipment (GSE) that is used for checkout of vehicle (reference Figures 20.1-3, 20.1-4, and 20.1-5).

d. Provides environmental protection from wind and rain for vehicle during its assembly and checkout.

e. Provides fire protection for vehicle during assembly and checkout.

f. Provides access to vehicle access doors, pyrotechnics, and umbilical connections (reference Section II of Volume I).

The various functions of the service tower are illustrated in Figures 20.1-1 through 20.1-8.

20.1.2 SERVICE TOWER CONTROL. The tower is manually controlled from a control room on the tower. All service lines for power, pneumatics, and water are disconnected manually prior to removing the tower from the launch pad.

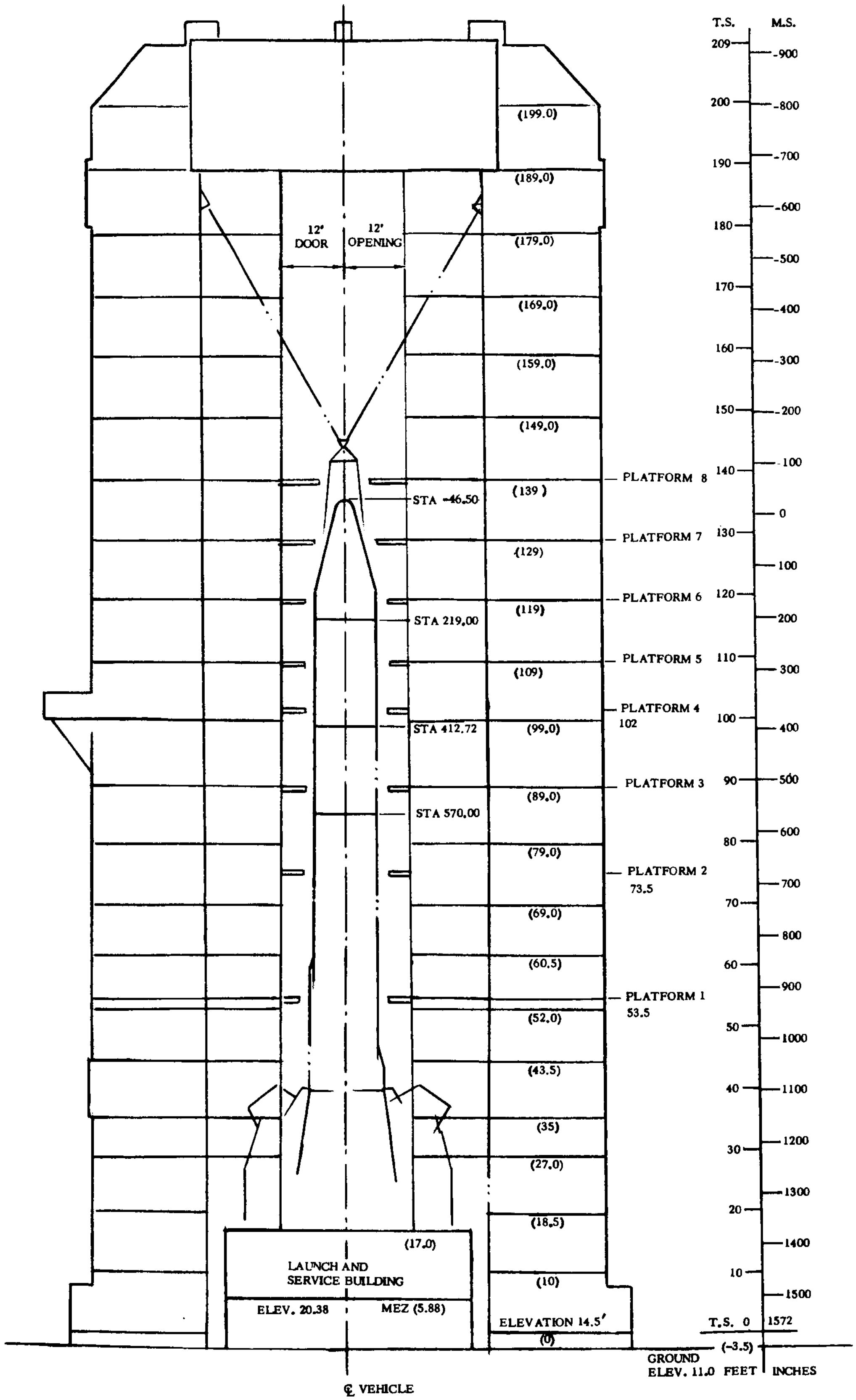


Figure 20. 1-1. South Elevation 36B Service Tower

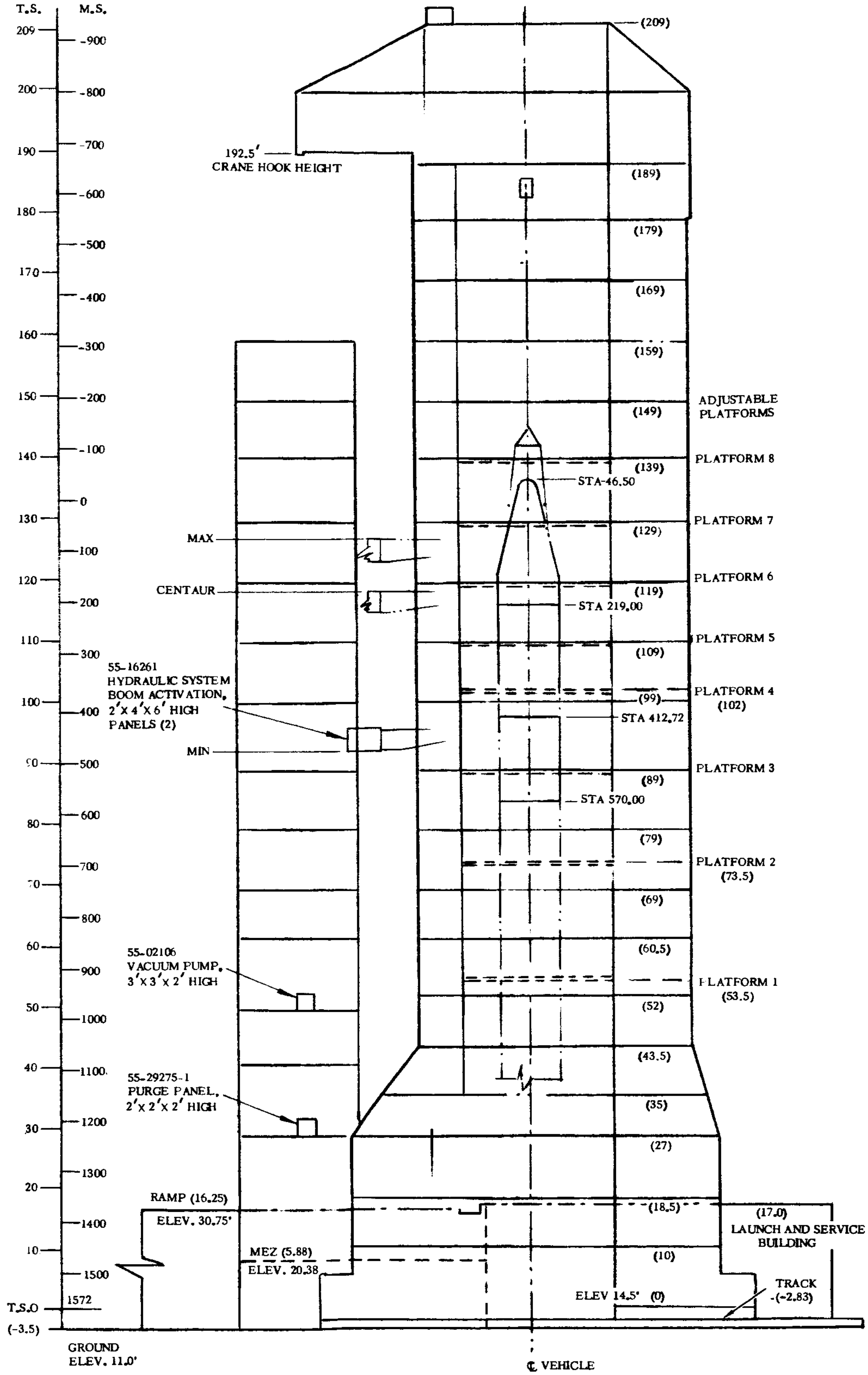


Figure 20. 1-2. East Elevation - Service and Umbilical Towers

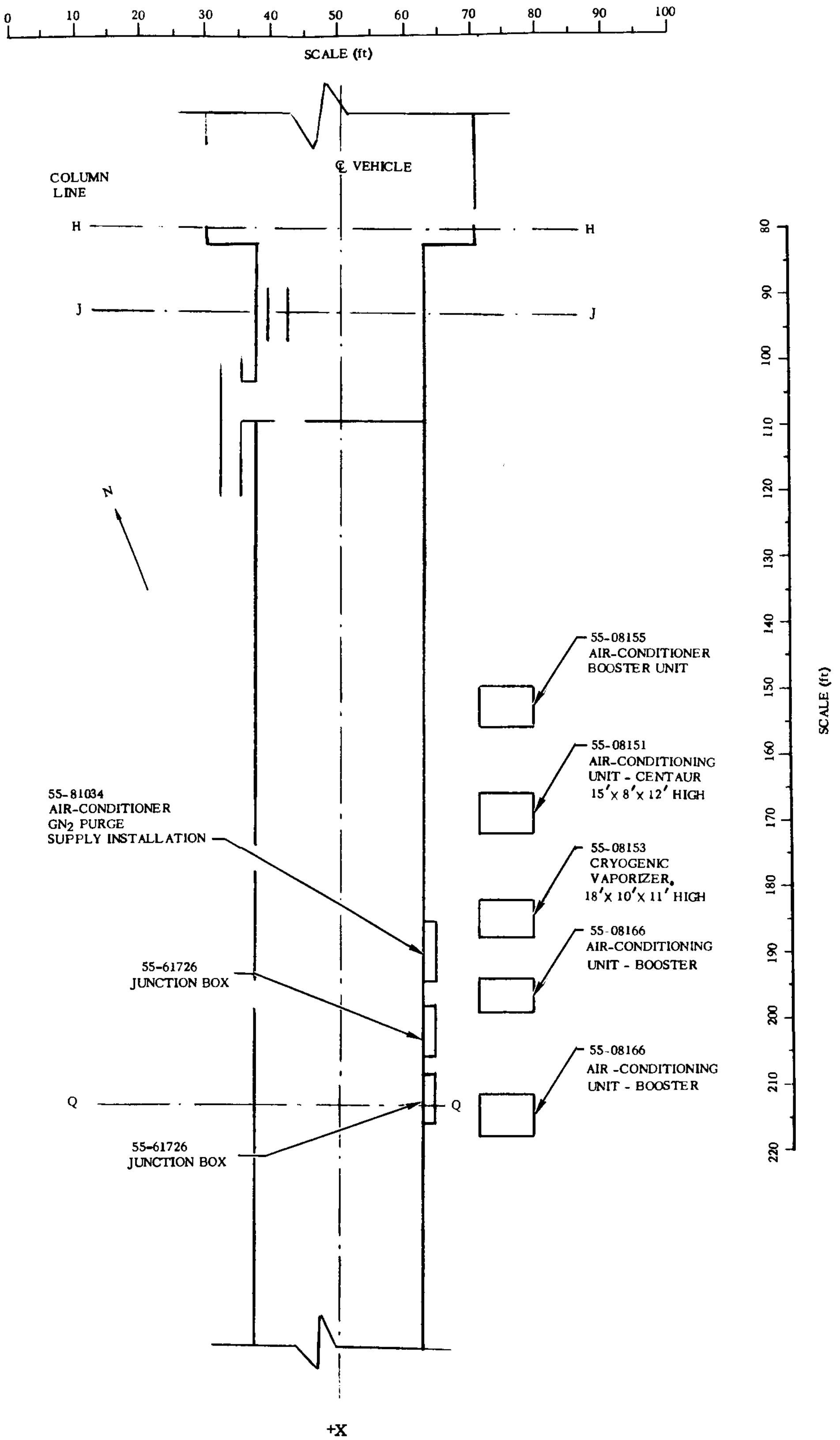


Figure 20. 1-3. (Sheet 1 of 2) Plan at Tower-Station - 3. 5' ~ elevation 11. 0'

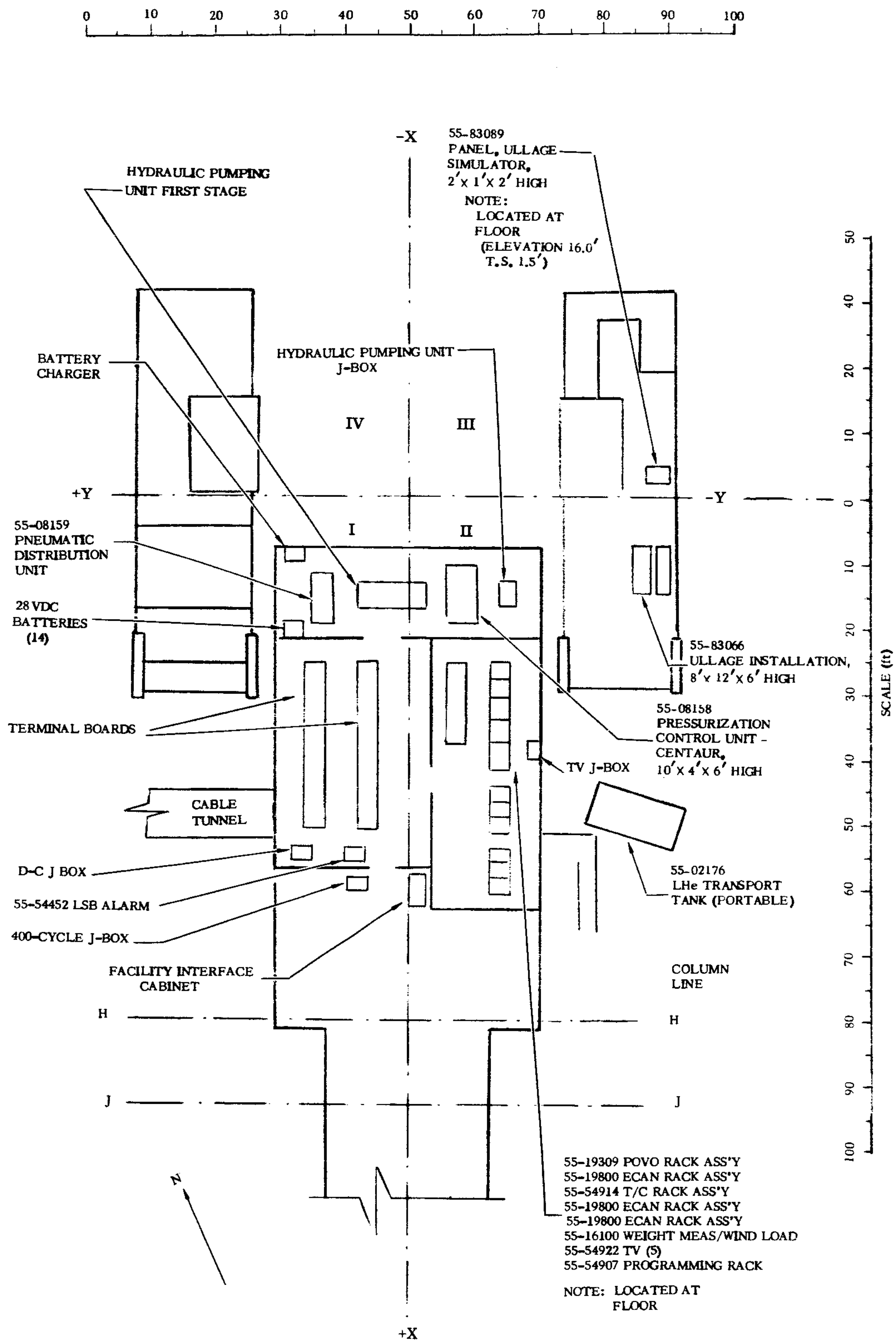


Figure 20.1-3. (Sheet 2 of 2) Plan at Tower-Station - 3.5' ~ elevation 11.0'

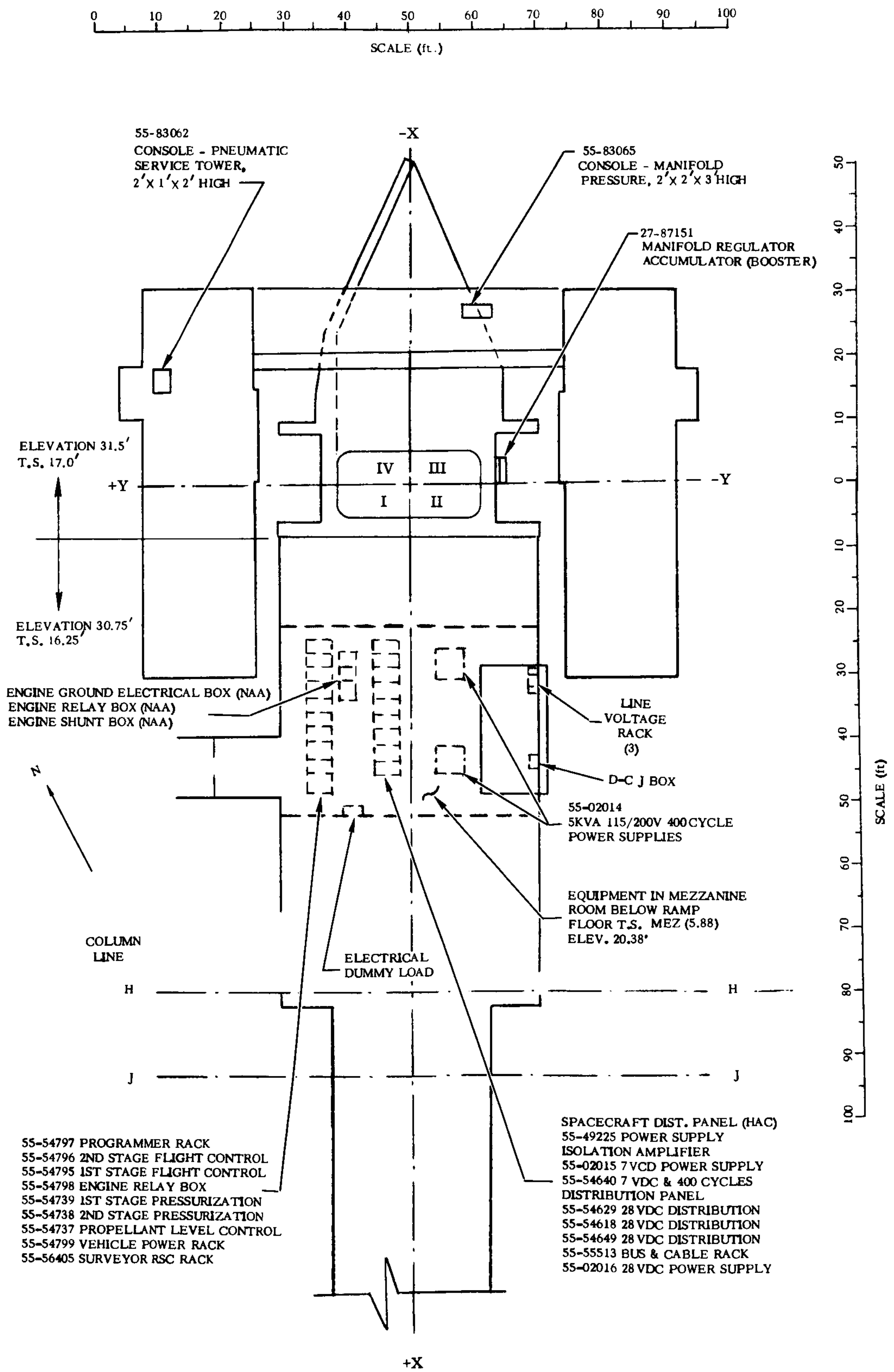


Figure 20. 1-4. Plan View at Tower - Station 18. 5'~ Elevation 30. 0'

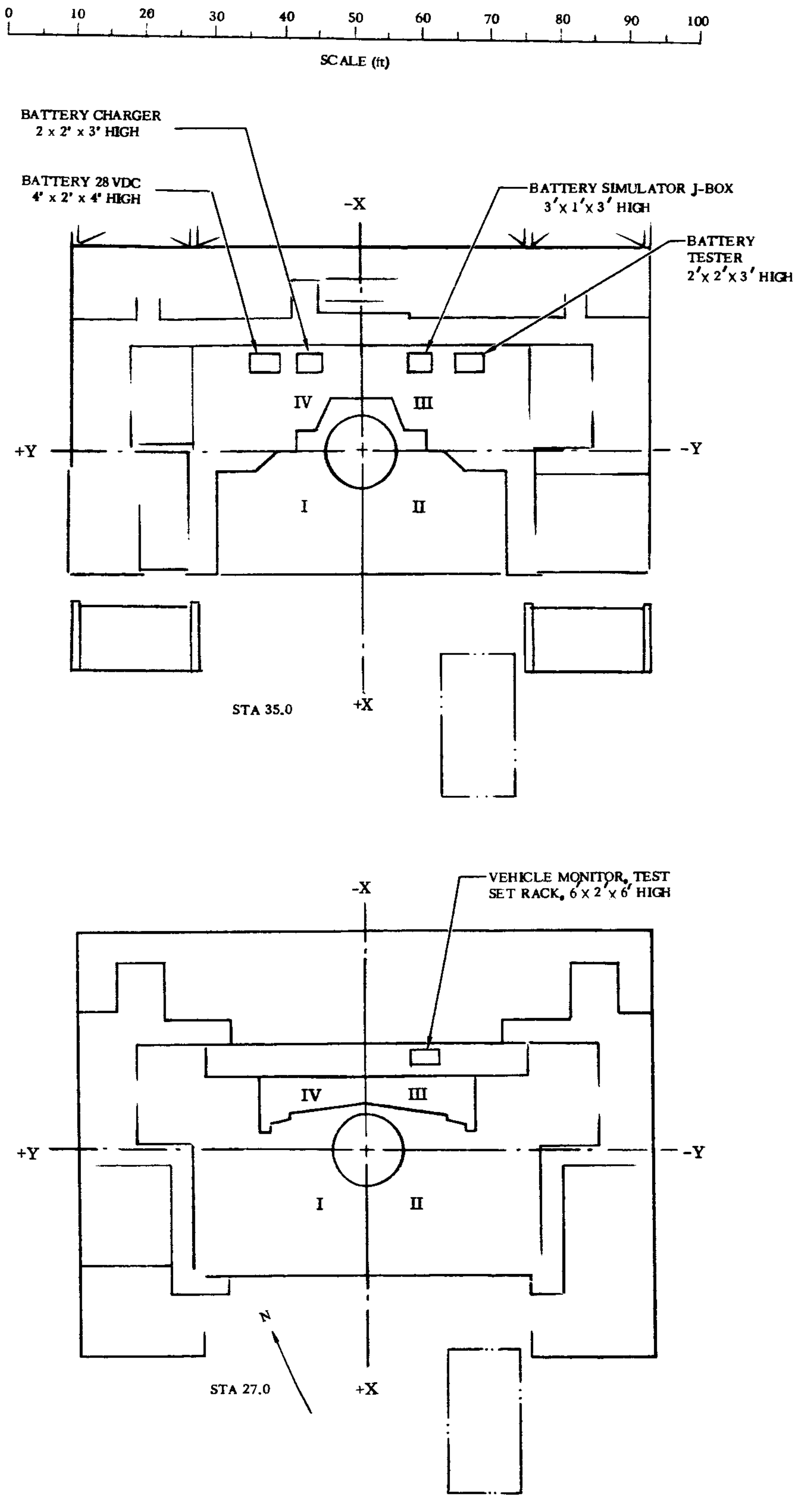


Figure 20.1-5. Service Tower - Station 27.0' and 35.0'

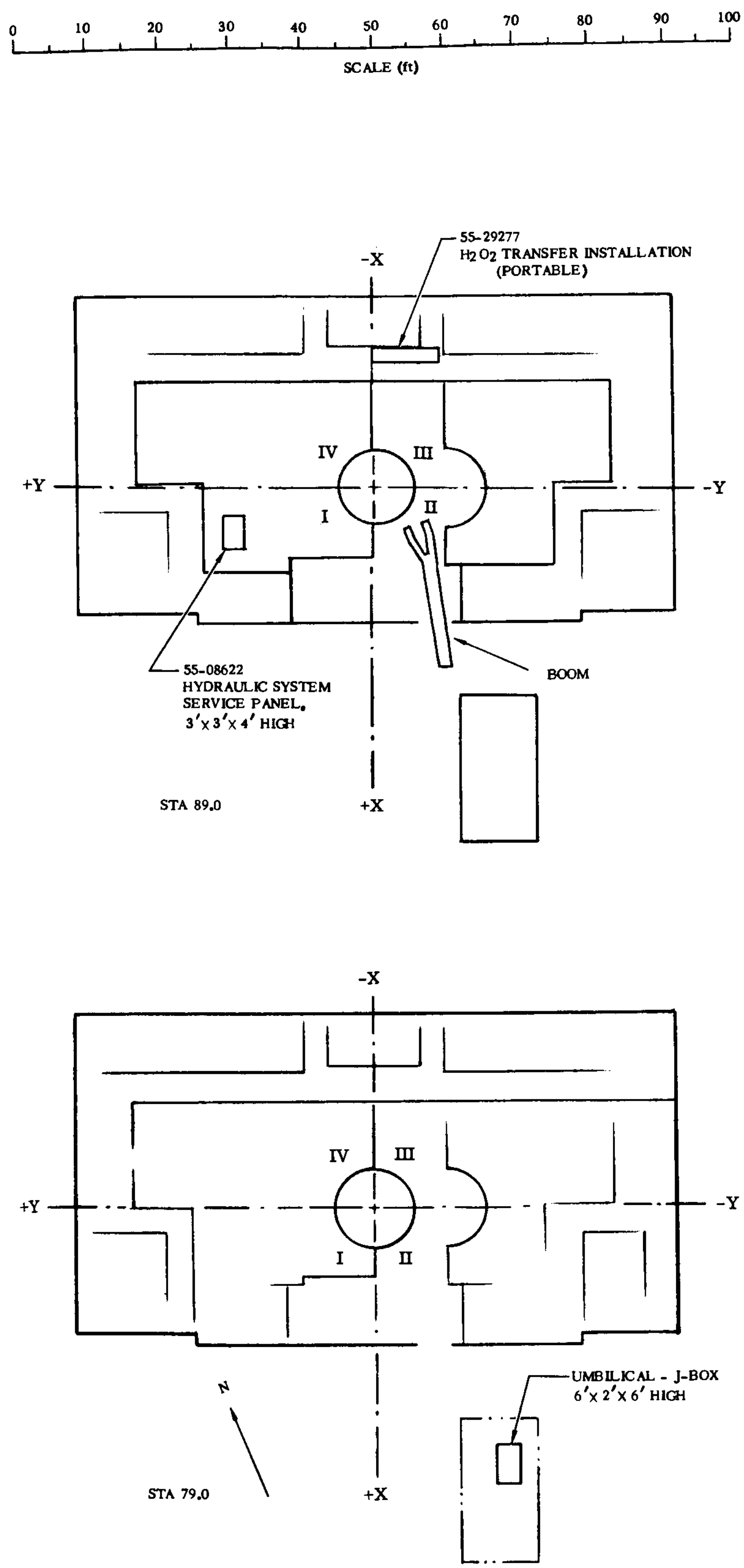


Figure 20. 1-6. Service Tower - Station 79. 0' and 89. 0'

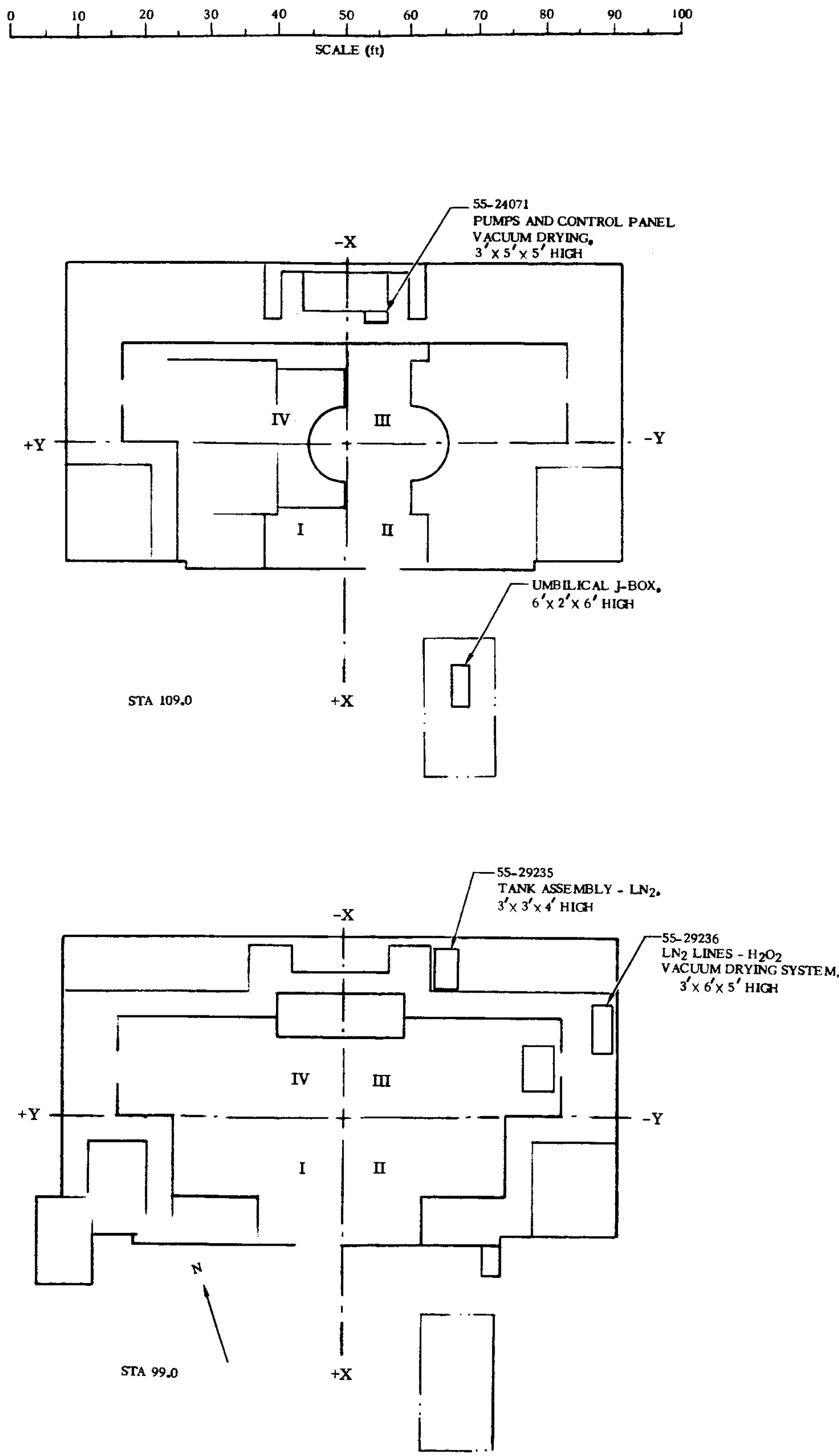


Figure 20.1-7. Service Tower - Station 99.0' and 109.0'

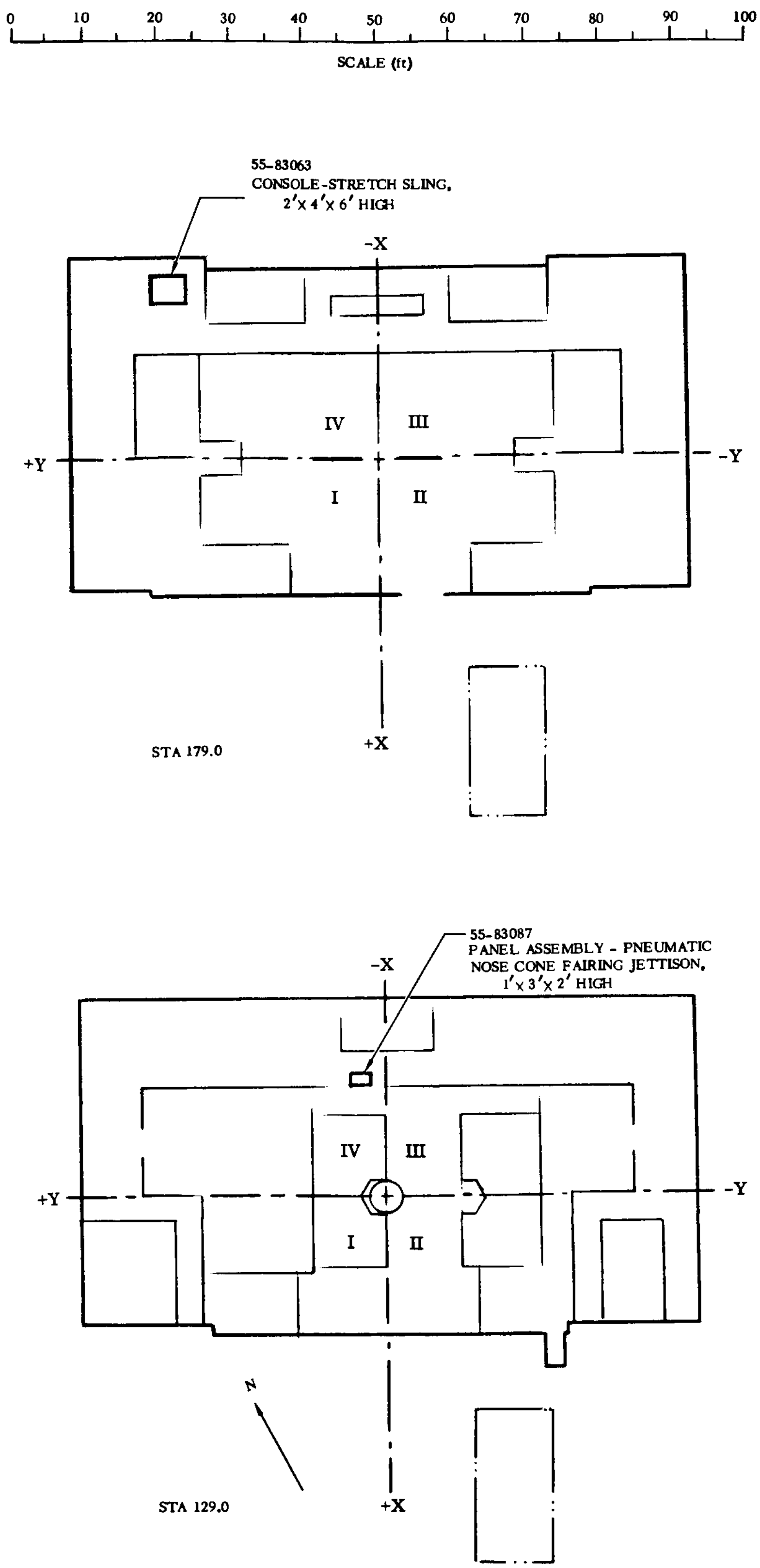


Figure 20. 1-8. Service Tower - Station 129. 0' and 179. 0'

20.2 AREA SERVICE REQUIREMENTS

20.2.1 SERVICE AREAS. The service areas of a typical launch complex similar to ETR Complex 36B are defined in Figure 20.2-1. These areas are established to show the distribution of the service equipment outlined in Subsections 20.3 through 20.6 of this section which is required to support the Centaur vehicle. The separation distances between areas and the location of GSE is established with reference to applicable documents of Section XXII of this volume. A letter code for each area is given in Table 20.2-1. Area services such as lighting, space, utility power, and floor loading are listed in Table 20.2-2.

TABLE 20.2-1. SERVICE AREA CODES

Code Letter	Designation
A	Vehicle Assembly
C	Cable Tunnel
E	Electrical Transfer Room
G	Gas Storage
H	Hydrogen Storage
L	Launch Operations
O	Oxygen Storage
R	Ramp
S	Launch and Service Building
T	Service Tower
U	Umbilical Tower
V	Ready Room

20.2.2 FIRE PROTECTION. The distribution of fire protection facilities is illustrated in Table 20.2-3. It should be noted that water systems are not recommended in areas where electrical equipment may be damaged.

20.2.3 AIR-CONDITIONING AND PNEUMATICS SERVICE. Table 20.2-4 lists the service requirements for Centaur facilities. Specific requirements to support the Centaur vehicle are covered in Sections VII and X of Volume I.

20.2.4 CAMERA LOCATIONS. Camera locations to support the Centaur vehicle are illustrated in Figure 20.2-2 and the characteristics of each installation are listed in Table 20.2-5.

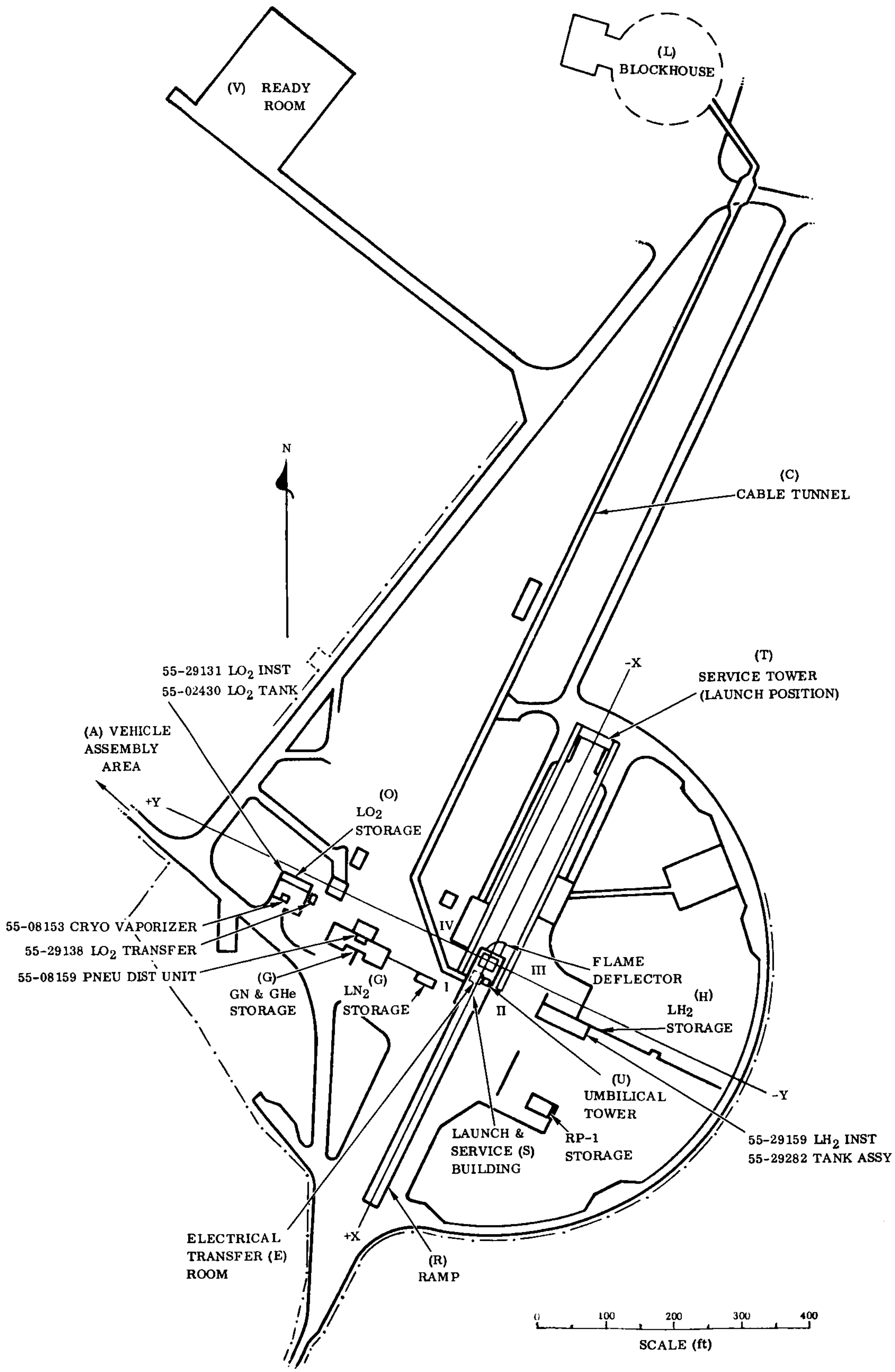


Figure 20.2-1. Complex 36B Service Areas

TABLE 20.2-2 AREA SERVICES

Function	Area Code	Crane Service (ft.)	Crane Service (tons)	Space (ft^2)	Light (ft. candles)	Utility Power (volts)	Utility Power (cycles)	Utility Power (kva)	Floor Load (lb/ft^2)
Receiving	A	30	10	10,000	80	—	—	—	W*
Assembly	A	30	10	10,000	80	—	—	—	W
Checkout	A	30	10	10,000	80	—	—	—	W
Offices	A	None	None	6,000	100	—	—	—	100
Cableway	C	None	None	2,400	50	—	—	—	100
Transfer Room	E	None	None	2,500	80	—	—	—	150
Terminal Room	E	None	None	2,500	80	—	—	—	150
Gas Storage	G	None	None	2,500	50	—	—	—	W
Hydrogen Storage	H	None	None	3,500	50	—	—	—	W
Launch Operations	L	None	None	2,500	100	—	—	—	100
Telemetry	L	None	None	1,000	80	—	—	—	100
Equipment Storage	L	None	None	900	50	—	—	—	W
Oxygen Storage	O	None	None	3,500	50	—	—	—	W
Ramp	R	None	None	—	50	—	—	—	W
Parts Crib	S	None	None	300	50	—	—	—	100
Tool Storage	S	None	None	300	50	—	—	—	100
Service Tower	T	200	10	9,600	80	—	—	—	100
Umbilical Tower	U	200	10	2,000	80	—	—	—	100
Ready Room	V	None	None	2,000	100	—	—	—	100
Total Complex (Power)						480 115/200 28	60 400	450 3 300/ Amperes	

NOTE:

* "W" indicates that load is established for maximum axle load for service trucks. Centaur trailer has a maximum of 8 kips per axle for a dual axle.

TABLE 20.2-3. FIRE PROTECTION

Function	Area Code	Automatic Sprinkler	Firex	Hose Reel	Carbon Dioxide	Hand Extinguisher
Receiving	A	Yes	No	Yes	No	Yes
Assembly	A	Yes	No	Yes	No	Yes
Checkout	A	Yes	No	Yes	No	Yes
Offices	A	No	No	Yes	No	Yes
Cableway	C	No	No	No	Yes	No
Transfer Room	E	No	No	No	Yes	No
Terminal Room	E	No	No.	No	Yes	No
Gas Storage	G	Yes	Yes	Yes	No	No
Hydrogen Storage	H	Yes	Yes	Yes	No	No
Launch Operations	L	No	No	Yes	No	Yes
Telemetry	L	Yes	No	Yes	No	Yes
Equipment Storage	L	No	No	Yes	No	Yes
Oxygen Storage	O	Yes	Yes	Yes	No	No
Ramp	R	No	Yes	No	No	No
Parts Crib	S	Yes	No	No	No	Yes
Tool Storage	S	Yes	No	No	No	Yes
Service Tower	T	Yes	Yes	No	No	Yes
Umbilical Tower	U	Yes	No	No	No	Yes
Ready Room	V	No	No	Yes	No	Yes

TABLE 20.2-4. AIR-CONDITIONING AND PNEUMATIC SERVICE

Function	Area Code	GN_2 (cfm)	GN_2 Stations	Air - Conditioning					
				Equipment (kw)	Occupancy (persons)	Temperature (°F dry bulb)		Relative Humidity (percent)	Vent (cfm)
						Max	Min		
Receiving	A	—	—	—	3	N*	N	N	N
Assembly	A	—	—	—	20	N	N	N	N
Checkout	A	—	—	—	5	N	N	N	N
Offices	A	—	—	—	30	80	70	—	600
Cableway	C	—	—	—	—	—	—	—	—
Transfer Room	E	10	1	25	10	75	—	45	3,000
Terminal Room	E	—	—	30	30	75	—	50	600
Gas Storage	G	—	—	—	—	—	—	—	—
Hydrogen Storage	H	—	—	—	—	—	—	—	—
Launch Operations	L	—	—	40	40	75	—	50	800
Telemetry	L	—	—	30	30	75	—	50	600
Equipment Storage	L	—	—	—	3	—	—	—	—
Oxygen Storage	O	—	—	—	—	—	—	—	—
Ramp	R	—	—	—	—	—	70°	—	—
Parts Crib	S	10	1	—	2	N	N	N	N
Tool Storage	S	—	—	—	2	N	N	N	N
Service Tower	T	10	2/deck	—	20	—	—	—	—
Umbilical Tower	U	10	2/deck	—	10	—	—	—	—
Ready Room	V	—	—	—	120	—	—	—	—

NOTE:

* N indicates 75 ± 10° and 4 air changes per hour.

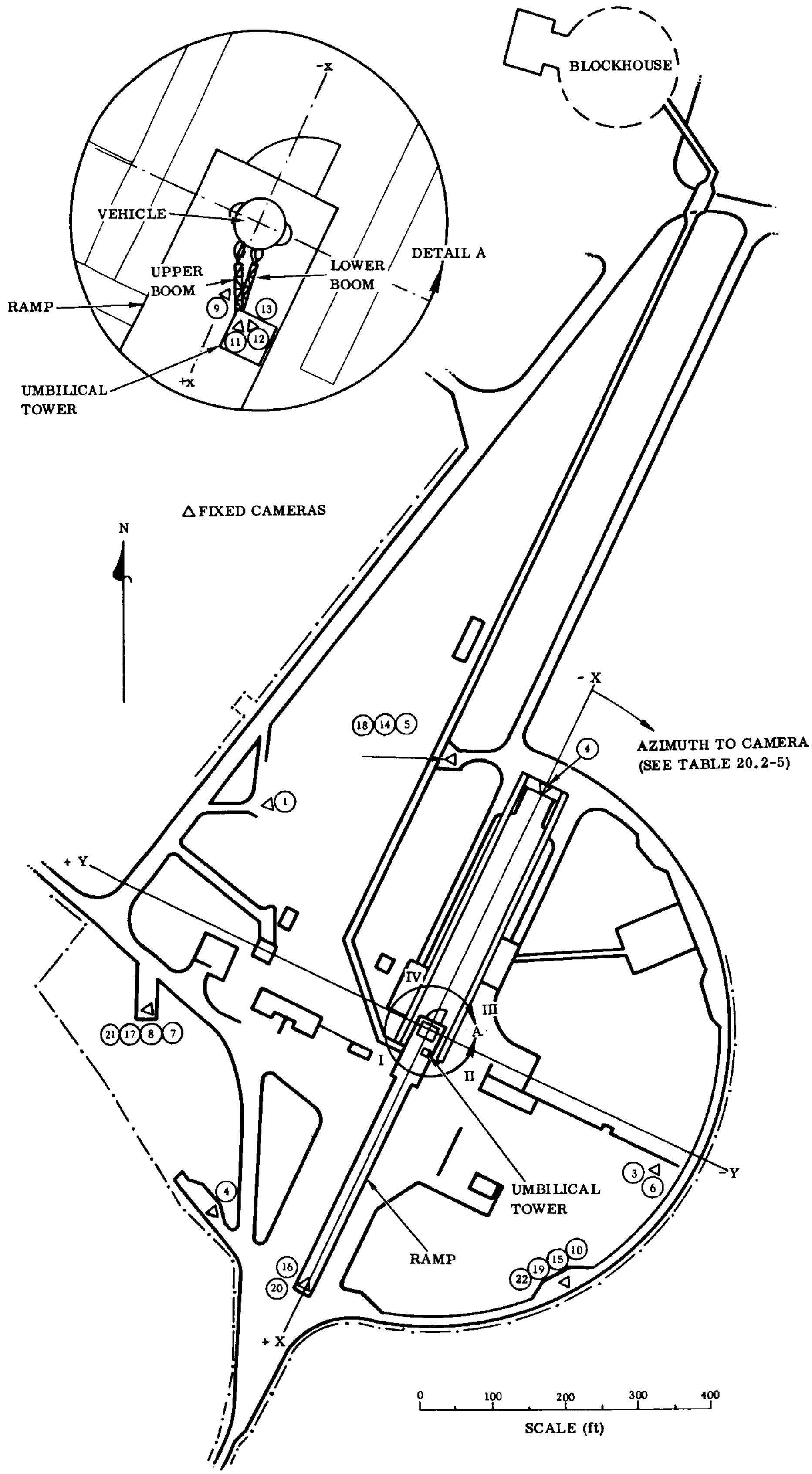


Figure 20.2-2. Complex 36B Camera Locations

TABLE 20.2-5. CAMERA REQUIREMENTS

No.	Location: Elev (ft)	Location: Azimuth* (deg)	Location: Dist (ft)	Time (sec)	Camera Description	Purpose and Remarks
1	0	300	400	Remote Control	16 mm, color, 24 fps, skin exposure; remote control by test conductor; view entire vehicle	Emergency camera and general surveillance
2 3 4	100 50 0	0 90 0	400 400 400	Remote Control	16 mm, color, 96 fps, skin exposure; remote control by test conductor; view entire vehicle	Emergency high speed surveillance
5 6 7	50 50 0	340 90 240	400 400 400	T-6/T+10	16 mm, color, 96 fps, skin exposure; view entire vehicle	High speed evaluation of vehicle during booster ignition and vehicle liftoff
8 9	0 **	240 **	400 **	T-6/T+10	16 mm, color, 400 fps, 100 percent image-to-frame ratio, to show Centaur lower umbilical T-6 seconds to T+10 seconds.	Close-up study of lower umbilical release
10 11	0 **	125 **	400 **	T-0/T+10	16 mm, color, 400 fps, 100 percent image-to-frame ratio, to show Centaur upper umbilicals	Close-up study of umbilical release action, upper umbilicals
12	140	**	**	T-6/T+10	16 mm, color, 400 fps to show upper umbilical boom. Camera on top of umbilical tower looking down	Record horizontal traverse of upper umbilical boom
13	140	**	**	T-6/T+10	16 mm, color 400 fps to show lower umbilical boom. Camera on top of umbilical tower looking down	Record horizontal traverse of lower umbilical boom

TABLE 20.2-5. CAMERA REQUIREMENTS (Continued)

No.	Location			Time (sec)	Camera Description	Purpose and Remarks
	Elev (ft)	Azimuth* (deg)	Dist (ft)			
14	0	340	400	T-6 / T+10	16 mm, color, 96 fps, to show entire Centaur stage centered in bottom of frame	Surveillance of Centaur during liftoff
15	0	125	400			
16	0	180	400			
17	0	240	400			
18	0	340	400	T-6 / T+10	70 mm, color, 30 fps, to show entire vehicle centered in bottom frame	Surveillance of entire vehicle during liftoff
19	0	125	400			
20	0	180	400			
21	0	240	400			
22	0	125	400		16 mm, color, 64 fps, to center on the H_2O_2 vent on the interstage adapter	Surveillance of H_2O_2 vent for possible liquid loss during launch operations

*Azimuth is measured clockwise from -X axis.

**See detail A Figure 20.2-2.

20.3 COMMUNICATION AND TELEVISION SERVICE

Missile Operations Intercommunications Systems (MPO/S) comprise 20 channel stations. The number of stations in each area is tabulated in Table 20.3-2; and for purpose of systems checkout during countdown, each channel on the system is assigned to a specific group of launch operation tasks. For example, the grouping for a typical countdown is as indicated in Table 20.3-1.

The operation and maintenance of the Television system is covered in detail in Paragraph 2-62 of Report No. GD/C-BYH64-002, dated 15 October 1965. An outline of the number of cameras and monitors required for Centaur coverage is contained in Table 20.3-2.

TABLE 20.3-1. COMMUNICATIONS ASSIGNMENT

Channel	Group	Channel	Group
1	Test Conductor	11	Pneumatics - Centaur
2	Blockhouse Monitor	12	Pneumatics - Booster
3	Booster Propulsion	13	Spare
4	Centaur Propulsion	14	NASA Data
5	Vehicle Electrical	15	Propellant Utilization
6	Complex Electrical	16	NASA Engineering
7	Booster Autopilot	17	Propellant Loading
8	Centaur Autopilot	18	Guidance
9	Landline	19	Spacecraft
10	Telemetry	20	NASA Project Net

TABLE 20.3-2. COMMUNICATION SERVICE

Function	Area Code	MOP/S* Stations	Closed Circuit Range Safety Telephone	Television		
				Camera Stations	Monitors	Remarks
Receiving	A	—	—	—	—	—
Assembly	A	3	1	—	—	—
Checkout	A	3	—	—	—	—
Offices	A	1	—	—	—	—
Cableway	C	—	—	—	—	—
Transfer Room	E	2	—	—	—	—
Terminal Room	E	2	—	—	—	—
Gas Storage	G	2	—	1	—	View Launch Pad
Hydrogen Storage	H	1	—	1	—	View Launch Pad
Launch Operations	L	25	1	1	6	View Launch Pad
Telemetry	L	2	—	—	—	—
Equipment Storage	L	—	—	—	—	—
Oxygen Storage	O	1	—	—	—	—
Ramp	R	1	—	1	—	View Launch Pad
Parts Crib	S	0	—	—	—	—
Tool Storage	S	0	—	—	—	—
Service Tower	T	12	—	—	—	—
Umbilical Tower	U	4	—	2	—	View Umbilicals
Ready Room	V	3				—
Total		62	2	6	6	Reference Dwg. No. 55-54922

NOTE:

* MOP/S = Missile Operations Intercommunications Systems

SECTION XXI

LAUNCH OPERATIONS

The data presented in this section outlines the scope of launch operations for those Centaur vehicles which are similar to the second stage of Atlas/Centaur AC-12. This data defines the event-time relationships and equipment limitations that must be maintained to satisfy the requirements of the Centaur systems.

21.1 COUNTDOWN TIME VERSUS EVENTS

An outline of the countdown time versus events is tabulated in Table 21.1-1. Periods of particular interest which affect Ground Support Equipment (GSE) and facilities capabilities are the times allocated to RF silence, destructor installation, range safety tests, tower removal, and the contingency hold. The automatic countdown is presented in Table 21.1-2, which defines the items automatically controlled by Centaur GSE and facilities.

Propellant tanking events are described in Table 21.1-3, which shows the required capabilities of the Propellant Loading Instrumentation system and its relation to the quantities of propellants that are tanked at the time a particular event.

TABLE 21.1-1. MAJOR BOOSTER/CENTAUR/PAYLOAD COUNTDOWN EVENTS AND TIMES*

Time (min)	Event
T-470	Start pre-countdown testing
T-470	Start guidance system final calibration
T-360	Start connection of Booster batteries
T-335	Start Booster and Centaur autopilot testing
T-315	Start spacecraft tests
T-300	Complete guidance and autopilot tests
T-300	Start of complete countdown
T-300	Start Booster propulsion final inspection and securing
T-300	Start TLM and RF system early checks
T-300	Start propellant system check

NOTE:

*Based on latest available countdown data for AC-6. AC-12 countdown data will be prepared on X-20 days (approximately).

TABLE 21.1-1. MAJOR BOOSTER/CENTAUR/PAYLOAD COUNTDOWN EVENTS AND TIMES (Continued)

Time (sec)	Event
T-300	Start Centaur propulsion preparation
T-280	Start range countdown
T-280	Start facility, Booster, and Centaur pneumatic preparation
T-280	Start insulation panel purge
T-270	Start Booster and Centaur hydraulic checks
T-260	Start ground support preparations
T-260	Pressurize holddown system
T-260	RF silence
T-260	Start mechanical installation of destructor and/or arm-safe initiators
T-220	Mechanical installation of destructors complete
T-220	Life RF silence
T-220	Activate Booster TLM battery
T-215	Start range safety command tests
T-195	Complete range safety command tests
T-195	Establish RF silence
T-190	Start electrical connection of pyrotechnics and destruct units
T-150	Complete electrical connection of pyrotechnics and destruct units
T-150	Lift RF silence
T-150	Start air-conditioning final preparations
T-145	Start guidance/autopilot (GAP) test
T-120	Complete ground support systems preparations
T-120	Start tower removal
T-112	Start C-Band system test
T-110	Complete Booster propulsion inspection and securing
T-110	Complete GAP test
T-110	Start guidance final alignment
T- 90	Complete air-conditioning final preparations
T- 90	Built-in contingency hold
T- 83	Go to area-"Red" condition
T- 80	Start LO_2 system chilldown
T- 75	Start Centaur main engine purge
T- 75	Pressurize to step II pressures
T- 75	Complete guidance final alignment
T- 70	Start TLM and RF tests
T- 70	Start Centaur helium storage
T- 60	Secure Centaur LO_2 at 55 percent
T- 60	Start LH_2 Chilldown
T- 60	Start Booster propellant tanking
T- 50	Complete Centaur helium storage

TABLE 21.1-1. MAJOR BOOSTER/CENTAUR/PAYLOAD COUNTDOWN EVENTS AND TIMES (Continued)

Time (min)	Event
T-45	Start guidance ready preparations
T-45	Seal blockhouse
T-45	Start Centaur purge bottle storage
T-40	Complete LH_2 chilldown
T-40	Complete LO_2 tanking
T-40	Start LH_2 tanking
T-30	Start Booster and Centaur final autopilot checks
T-30	Complete guidance ready preparations
T-28	Start Centaur LO_2 topping
T-23	Start liquid helium chilldown
T-22	Start final range safety command test
T-15	Start Booster propellant topping
T-12	Complete Booster final autopilot tests
T-12	Complete Centaur purge bottle storage
T-11	Start RSC AGC test
T-10	Complete Centaur final autopilot tests
T-10	Start fuel depletion final checks
T-10	Top helium bottles
T- 9	Complete RSC AGC test
T- 5	Built-in contingency hold
T- 5	Turn on Centaur battery preload
T- 5	Turn on gas generator purge
T- 5	Turn on thrust section GN_2 heater
T- 5:00	Arm purge vent door squib
T- 5:00	Prepare hydrogen vent purge
T- 5:00	Change tank pressure sensing to manual
T- 5:00	Open airborne purge bottle valve
T- 5:00	Turn on track washdown water
T- 5:00	Perform PU exercise
T- 4:30	Set Booster roll program flight azimuth
T- 4:30	Switch range safety command to internal power
T- 4:30	Switch telemetering to internal power
T- 4:30	Switch Centaur to internal power
T- 4:30	Switch guidance to flight mode
T- 4:30	Cage gyros
T- 3:30	Turn off Centaur battery preload
T- 3:00	Put Centaur propulsion system in launch condition
T- 2:35	Secure Booster propellant topping

TABLE 21.1-1. MAJOR BOOSTER/CENTAUR/PAYLOAD COUNTDOWN EVENTS AND TIMES (Continued)

Time (min)	Event
T- 2:35	Complete Booster engine preparations
T- 2:15	Start flight pressurization
T- 2:00	Switch Booster to internal power
T- 2:00	Arm Booster, Centaur, and destruct systems
T- 1:30	Secure LH_2 tanking
T- 1:30	Check status of all systems
T- 1:15	Secure Centaur LO_2 topping
T- 1:00	Switch pressurization to internal
T- 1:00	Arm Booster and Centaur programmers
T- 0:40	Evaluate oil from Booster engine systems
T- 0:30	Calibrate TLM
T- 0:15	Initiate engine start
T+ 0:10	Water systems on
T+ 0:15	Systems shutdown
T+ 2:00	Secure water systems
T+11:40	Send RF disable command
T+11:40	Open blockhouse seals

NOTE:

Spacecraft countdown items are excluded since these are primarily spacecraft launch-director responsibilities.

TABLE 21.1-2. AUTOMATIC COUNTDOWN EVENTS

Time (sec)	Function
T-14.70	Depress test conductor console start switch
T- 9.69	Guidance flight mode "SET" command
T- 7.89	Guidance flight mode acceptance
T- 7.87	Engine start relay activation
T- 7.87	Top pad cooling start
T- 7.87	Turbopump chilldown secure
T- 7.87	Guidance manual hold lockout
T- 7.87	Guidance flight mode acceptance
T- 7.87	Guidance optical loop open
T- 7.87	Fairing hatch door close command

TABLE 21.1-2. AUTOMATIC COUNTDOWN EVENTS (Continued)

Time (sec)	Function
T- 7.86	Booster start tanks pressurization command
T- 7.45	Start tanks pressurized
T- 7.45	Insulation panel purge prelaunch vent squib firing command
T- 7.35	Centaur fuel vent valve lock command
T- 7.33	Start H_2 vent stack purge
T- 6.00	Start pad area fixed cameras
T- 3.45	Eject Centaur upper umbilicals and aft plate
T- 3.25	Backup lanyard pull upper umbilical ejection
T- 3.10	Booster engines ignition start
T- 3.09	Booster vernier engines flight lock-in
T- 2.59	Booster vernier engines complete
T- 0.92	Booster main engines complete
T- 0.91	Disable permit cutoff block
T- 0.80	Release signal initiation
T- 0.00	2-inch motion
T- 0.00	Booster programmer start
T- 0.00	Manual reset disable
T- 0.00	Reset sequence clock to T-0
T- 0.00	Command booster hydraulic pump stop
T- 0.00	Command sustainer hydraulic pump stop
T- 0.00	Command LO_2 flow control valve close
T- 0.00	Command LH_2 flow control valve close
T- 0.00	RP-1 fill and drain valve control power off
T- 0.00	Command LO_2 fill and drain valve control power off
T+ 0.01	Start Centaur lower boom retract delay relay
T+ 0.03	Eject Booster propellant loading umbilical
T+ 0.03	Eject Booster vehicle power umbilical
T+ 0.03	Eject Booster engines tanking and pneumatics umbilicals
T+ 0.03	Eject Booster landline instrumentation umbilicals
T+ 0.03	Eject Centaur T-0 umbilical
T+ 0.15	Centaur T-0 umbilical ejection backup
T+ 0.15	Centaur LO_2 and LH_2 fill and drain line disconnection
T+ 0.15	Centaur pneumatic lines disconnection
T+ 0.40	Start Centaur upper boom retraction
T+ 0.40	Start Centaur lower boom retraction

TABLE 21.1-3. PROPELLANT TANKING CONDITIONS FOR SPECIFIED EVENTS (TYPICAL ACTUAL TANKING EVENTS)

EVENT	TIME		PERCENT OF TARGET FROM PLIS		DENSITY (lb/ft^3)	
	(min)	(sec)	LO_2	LH_2	LO_2	LH_2
Start of Centaur LO_2 Chilldown	T-80	2	—	—	—	—
Start of Centaur LO_2 Tanking	T-71	39	—	—	—	—
Secure LO_2	T-64	2	65	—	—	—
Start LH_2 Chilldown	T-62	28	—	—	—	—
Start LH_2 Tanking	T-43	42	—	—	—	—
1st LH_2 Probe Activation (Element A)	T-28	6	—	98.6	—	4.208
LH_2 Tanking Complete	T-26	27	—	100.8	—	4.208
Start LO_2 Topping	T-20	44	—	—	—	—
LO_2 Probe Activation (Element A)	T-13	19	98.3	—	68.73	—
LO_2 Probe Activation (Element B)	T-13	17	98.3	—	68.73	—
LO_2 Tanking Complete	T-12	25	100.0	—	68.72	—
Secure LO_2	T-11	1	99.9	—	68.72	—
Secure LH_2 Tanking	T-1	30	—	>101.1	—	4.21
Only LH_2 Probe Activation (Element B)	T-1	13	—	101.1	—	4.21
Last LH_2 Probe Activation (Element A)	T-0	44	—	100.6	—	4.21

21.2 LAUNCH-ON-TIME CONSTRAINTS

To achieve a high probability of launch success for the Centaur vehicle, it is essential that the airborne and ground supporting systems support a contingency hold and turnaround capability commensurate with operational mission requirements.

The contingency hold capability of the Centaur vehicle, after propellant tanking has been completed, is 120 minutes. The demonstrated turnaround capability of the Centaur vehicle and supporting ground systems in the event of a launch abort is one day. There is, however, an eight-day limitation which is based on the continuous presence of the Hydrogen Peroxide (H_2O_2) monopropellant in the vehicle. A turnaround period of two days is required if this limitation is exceeded.

21.2.1 VEHICLE CONSTRAINTS TO HOLD CAPABILITY. Four airborne systems constrain the Centaur vehicle hold capability.

21.2.1.1 Range Safety Command System. The Range Safety Command system presents two constraints to the Centaur vehicle hold capability.

The batteries supplying system power are limited to 40 minutes on internal power. During existing countdown operations, the system is switched to "internal" at T-5 minutes and remains on "internal" throughout vehicle flight. In the event of a countdown delay after T-5 minutes, the system hold capability can be extended to the vehicle contingency delay requirement by returning the system to external power until countdown is resumed.

The total time from the performance of the Range Safety Command system destruct tests to liftoff is limited to ten hours. The destruct tests are presently performed 205 minutes prior to liftoff. The 205 minute launch countdown in addition to the 120 minute contingency delay requirement is less than the ten hour limitation; however, the time location of the destruct test within the launch countdown is dependent upon the mission requirements because vehicle access is required. The system constraint on vehicle hold capability should, therefore, be evaluated independently for each mission.

21.2.1.2 Vehicle Power System. The vehicle power and telemeter battery is limited to 40 minutes on internal power. During existing countdown operations, the system is switched to "internal" at T-4 minutes and remains on "internal" throughout the vehicle flight. In the event of a countdown delay after T-4 minutes, the system hold capability can be extended to the vehicle contingency delay requirement by returning the system to external power until countdown is resumed.

21.2.1.3 Centaur Guidance System. The Guidance system does not constrain the vehicle hold capability except under the following conditions:

a. If a Guidance system hold occurs during the Guidance Autopilot (GAP) test, a recycle to the start of the GAP test is required.

b. If neither the prime nor backup Launch-On-Time (LOT) signal accept is verified, a new LOT will have to be set, and a revised LOT constant and revised J-sum constant read-in and verified.

c. If a hold of 35 seconds or greater is necessary after guidance enters flight mode, liftoff must be rescheduled to allow a re-initiation of inflight guidance. This procedure requires a recycle to guidance final align (optical), and would take an estimated 60 minutes to accomplish.

21.2.1.4 Vehicle Propellant Levels and Vent Lockup. Countdown delays following LO_2 and LH_2 propellant topping, secured at approximately T-75 seconds and T-90 seconds, respectively, are limited to zero and 3 minutes. The LH_2 limitation is based on the propellant required to accomplish mission objectives. The LO_2 limitation is based on a structural requirement for a maximum ullage of 12 cubic feet at Booster Engine Cutoff (BECO) for the Booster/Centaur vehicle. Each of these constraints will require an independent evaluation for each mission to establish the hold capability.

Lockup of the LH_2 vent valve is an additional constraint to vehicle hold capability. To prevent combustion of the hydrogen vent gas during the flight, the vent valve is closed prior to liftoff and maintained closed until the vehicle leaves the earth's atmosphere. The total lockup time allowed is a function of the LH_2 propellant tank ullage volume, the propellant tank pressure redline, and the propellant tank heat input. The allowed time, therefore, will have to be evaluated for each mission independently. For the Surveyor mission, the lockup time is a maximum of 12 seconds prior to liftoff. Therefore, closing the vent valve at T-7 seconds allows a maximum vehicle hold capability of 5 seconds.

21.2.2 VEHICLE CONSTRAINTS TO TURNAROUND CAPABILITY. Three Centaur airborne systems constrain the vehicle turnaround capability.

21.2.2.1 Reaction Control System. The Centaur vehicle turnaround capability is constrained by the eight-day limitation for the presence of H_2O_2 in the vehicle. Following an eight-day "tanked" period, the H_2O_2 must be drained and the system storage bottle and lines dried. The drying operation consists of purging the system supply bottle and plumbing and reducing the system pressure below H_2O_2 vapor pressure to eliminate the liquid H_2O_2. This operation requires approximately two days to accomplish.

21.2.2.2 Vehicle Power System. The vehicle power system battery is limited to 15 days activated life. If the battery has not been subjected to an internal load during the launch countdown, there is no requirement to change the batteries within the life period. If internal loads have been applied, the battery will be replaced. This operation takes approximately two hours to accomplish after access to the vehicle.

21.2.2.3 Range Safety Command System. The Range Safety Command batteries are limited to 15 days activated life. If the batteries have not been subjected to internal loads, there is no requirement to change the batteries within the life period. If internal loads have been applied, however, the batteries will be replaced. This operation takes approximately two hours to accomplish after access to the vehicle.

21.2.3 GROUND SUPPORTING SYSTEM CONSTRAINTS TO HOLD CAPABILITY. The fluid storage capacities of the ground supporting systems must be adequate to support the vehicle requirements for accomplishing mission objectives and to support the contingency delays that may occur.

Table 21.2-1 summarizes the Centaur fluid requirements to support the Centaur vehicle launch operation, including the 120 minute contingency delay. Each supporting system is listed showing the following information:

a. System Usable Capacity. The usable capacity listed is based on the system storage at Complex 36B.

b. System Usage. The system usage to support the launch operation is listed and is categorized as to vehicle or GSE requirements.

c. Range Countdown Requirement. Column 1 defines the system requirement to support the range countdown, from T-280 minutes to T-0.

d. Usage Rate. Column 2 defines the system usage rate during the range countdown.

e. Abort Requirement. Column 3 denotes the fluid requirement for vehicle support in the event of a launch abort.

f. Maximum Rate during Hold. Column 4 indicates the maximum usage rate of the system in the event of a contingency delay. The delay is assumed to have occurred after propellant tanking.

g. 120 Minute Hold Reserve. Column 5 identifies the total system capacity required to support the 120 minute contingency delay.

h. Total Requirements. Column 6 sums the total system requirements to support the Centaur vehicle launch operation.

21.2.4 GROUND SUPPORTING SYSTEM CONSTRAINTS TO TURNAROUND CAPABILITY. The ground supporting systems primary constraint to vehicle turnaround is the availability of the fluids required to reload the system storage capacity to the launch requirement level. To support a 24-hour turnaround period, the fluid priority for the launch complex must be established prior to the time of abort.

TABLE 21.2-1. CENTAUR FLUID USAGE - COMPLEX 36B

SYSTEM	RANGE COUNTDOWN T-280 MIN	USAGE RATE	ABORT	MAXIMUM RATE DURING HOLD	120-MINUTE HOLD RESERVE	TOTAL REQUIREMENTS
LO_2 TRANSFER SYSTEM	7,515 gal	300 gpm	0	3 gpm	360 gal	7,875 gal
Usable Capacity: 36,500 gallons						
Vehicle:						
Centaur Tanking	2,775 gal	1-300 gpm	0	N/A		
Centaur Boiloff	210 gal	1-3 gpm	0	3 gpm	360 gal	
GSE:						
Pressurization Losses	1,530 gal	N/A	0	N/A		
Childown Losses	3,000 gal	N/A	0	N/A		
LH_2 TRANSFER SYSTEM	13,800 gal	750 gpm	0	45 gpm	5,400 gal	19,200 gal
Usable Capacity: 25,000 gallons						
Vehicle:						
Centaur Tanking	9,400 gal	10-750 gpm	0	N/A		
Centaur Boiloff	1,800 gal	30-45 gpm	0	45 gpm	5,400 gal	
GSE:						
Pressurization Losses	1,100 gal	-	0	N/A		
Childown Losses	1,500 gal	-	0	N/A		

TABLE 21.2-1. CENTAUR FLUID USAGE - COMPLEX 36B (Continued)

SYSTEM	RANGE COUNTDOWN T-280 MIN	USAGE RATE	ABORT	MAXIMUM RATE DURING HOLD	120-MINUTE HOLD RESERVE	TOTAL REQUIREMENTS
LHe SYSTEM	160 gal	5 gpm	0	5 gpm	600 gal	760 gal
Usable Capacity: 900 gallons						
Vehicle:						
Engine Chilldown	85 gal	3-5 gpm	0	5 gpm	600 gal	
GSE:						
Pressurization Losses	35 gal	N/A	0	N/A		
Chilldown Losses	40 gal	N/A	0	N/A		
LN_2 SYSTEM	1,800 gal	N/A	0	N/A	0	1,800 gal
Usable Capacity: 25,000 gallons						
GSE:						
LO_2 Subcooler Fill	1,800 gal	N/A	0	N/A		
LO_2/LN_2 SUBCOOLER	38 gal	1 gpm	0	1 gpm	120 gal	158 gal
Usable Capacity: 1,204 gal LN_2						
GSE:						
LO_2 Chilldown	38 gal	1 gpm	0	1 gpm	120 gal	

TABLE 21.2-1. CENTAUR FLUID USAGE - COMPLEX 36B (Continued)

SYSTEM	RANGE COUNTDOWN T-280 MIN	USAGE RATE	ABORT	MAXIMUM RATE DURING HOLD	120-MINUTE HOLD RESERVE	TOTAL REQUIREMENTS
LN_2 STORAGE TANK PRESSURIZING SYSTEM	3, 540 lb	N/A	0	N/A	0	3, 540 lb
Usable Capacity: 5, 110 lb						
GSE:						
Tank Pressurization	3, 540 lb	N/A	0	N/A		
HELIUM SYSTEM, 6,000 PSIG (Pressurization Supply)	16, 570 scf	10-50 scfm	20,400 scf	50 scfm	6, 000 scf	42, 970 scf
Usable Capacity: 92, 800 scf						
Vehicle:						
Propellant Tank Pressure	350 scf	N/A	0	N/A		
Airborne Helium Bottle Charge	470 scf	N/A	0	N/A		
Inflight Purge Bottle Charge	470 scf	N/A	0	N/A		
P&W Engine Blowdown	350 scf	N/A	0	N/A		
LHe Transfer Line/ P&W Engine Purge	5, 650 scf	10-50 scfm	12,000 scf	50 scfm	6, 000 scf	
LH_2 Tank Purge		N/A	8,400 scf	N/A		
Error Contingencies	9, 280 scf	N/A	0	N/A		

TABLE 21.2-1. CENTAUR FLUID USAGE - COMPLEX 36B (Continued)

SYSTEM	RANGE COUNTDOWN T-280 MIN	USAGE RATE	ABORT	MAXIMUM RATE DURING HOLD	120-MINUTE HOLD RESERVE	TOTAL REQUIREMENTS
HELIUM SYSTEM, 6,000 PSIG (Insulation Panel Purge)	1,453 lb	2.0 to 4.67 lb/min	630 lb	4.67 lb/min	560 lb	2,643 lb
Usable Capacity:						
6,000 lb						
Vehicle:						
Insulation Panel Purge						
P&W Engine Injector						
Hydraulic Pump Coupling						
LH_2 Low Pressure Duct						
P&W Seal Cavity						
LO_2 and LH_2 Boost Pump Seals						
Total Purges						
High Flow	513 lb	4.67 lb/min	280 lb	4.67 lb/min		
Low Flow	340 lb	2.0 lb/min	350 lb	N/A		
Error Contingencies	600 lb	N/A	N/A	N/A		
GN_2 SYSTEM, 6,000 PSIG (Routine Use)	2,175 lb	7.8 lb/min	1,730 lb	7.8 lb/min	935 lb	4,840 lb
Usable Capacity:						
9,600 lb						
Vehicle:						
LH_2 Vent Stack Purge	60 lb	10 lb/min	30 lb	N/A	0	
GSE:						
LH_2 Vent Stack Purge (Storage Tank)	45 lb	0.71 lb/min	0	0.71 lb/min	85 lb	

TABLE 21.2-1. CENTAUR FLUID USAGE - COMPLEX 36B (Continued)

SYSTEM	RANGE COUNTDOWN T-280 MIN	USAGE RATE	ABORT	MAXIMUM RATE DURING HOLD	120-MINUTE HOLD RESERVE	TOTAL REQUIREMENTS
Terminal Box Purges	2,000 lb	7.1 lb/min	1,700 lb	7.1 lb/min	850 lb	
Nose Fairing Jettison Bottle Charge	15 lb	N/A	0	N/A		
Umbilical Boom Hydraulic Charge	55 lb	N/A	0	N/A		
GN_2 SYSTEM, 2,400 PSIG (Air-Conditioning Supply)	22,560 lb	235 lb/min	42,900 lb	235 lb/min	28,200 lb	93,660 lb
Usable Capacity: 146,500 lb						
Vehicle:						
Forward Compartment Cooling	7,200 lb	75 lb/min	4,500 lb	75 lb/min		
Interstage Adapter Heating	15,360 lb	160 lb/min	38,400 lb	160 lb/min		

21.3 PRELAUNCH ACCEPTANCE TESTS

The Prelaunch Acceptance Tests used at Complex 36B are delineated below by system functions in Tables 21.3-1 through 21.3-15, giving the type of test, procedure identifying number, test date in terms of "M" days prior to launch, and the objectives and limitations of the tests.

The system functions covered by these tables are as follows:

TABLE 21.3-1. AIRFRAME SEPARATION SYSTEM

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
Functional Check of Centaur Vehicle (Pneumatic) Flight Separation Mechanisms AA65-0508-074-04	-40	Establishes the readiness of the Centaur vehicle pneumatic separation mechanisms by: 1. Leak checking the Centaur nose fairing thruster bottle installations. 2. Leak checking the Centaur LH_2 vent duct disconnect. 3. Leak check of Centaur LO_2 vent duct.
Activation & Charging AA65-0506-185-04	-13	Activates and charges Centaur pyrotechnic and RSC batteries. This procedure is accomplished in the vehicle assembly hangar.
Pyrotechnic Checkout Procedure (Electrical) AA65-0506-180-04	-10	Checks the Atlas/Centaur pyrotechnics prior to specific items being assigned to the flight vehicle. The following are checked for corrosion, dents, frayed insulation, loose or incorrectly assembled components, and general damage. 1. Destruct box (Booster) 2. Destruct box (Centaur) 3. Latch pin squibs 4. Thruster bottle explosive valves 5. Retro-rockets 6. Gas generator igniters 7. Shaped charge detonators 8. Hyperbols 9. Surveyor disconnect squibs

TABLE 21.3-2. ENVIRONMENTAL CONTROL SYSTEM

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
Launch Vehicle Air-Conditioning (A/C) Checkout (L/C) AA65-0506-193-04	-44	Functionally checks A/C System using GN_2, in launch or tanking configuration, using associated piping, storage bottles, regulating stations, and duct work. Test prepares A/C units for tanking or launch.
Centaur Air-Conditioning Validation AA65-0507-009-04	-31	Ensures the proper operation of the Centaur air-conditioning unit, with related piping and duct work, for use with air or GN_2.
Pyrotechnic Circuit Functional Check AA65-0506-188-04	-28 thru -0	Functionally checks the following pyrotechnic circuits: 1. Retro-rockets 2. Booster separation conax valve 3. Programmed pressurization explosive valve 4. Booster/Centaur separation shaped charge detonators 5. Skirt separation shaped charge detonators 6. Centaur insulation panel shaped charge detonators 7. Purge vent actuators 8. Nose fairing latches 9. Thruster bottle explosive valves 10. Surveyor electrical disconnect 11. Surveyor separation latches 12. B 600PJ9 disconnect

TABLE 21.3-3. PROPULSION SYSTEM

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
Centaur Engine Control Validation AA64-0506-103-04A	-55	Validates the ground side of the second stage engine control system by actuating valve functions and observing indicator lamp responses.
Booster Pump Overspeed and Underspeed Check-out AA65-0506-162-04	-45	Functionally checks the LH_2 and LO_2 booster pump speed control system by observing the output frequency of the speed control pickup which controls the speed limiting valve.
H_2O_2 Vacuum Drying System Validation AA65-0502-079-04	-44	Provides a validation checkout of the H_2O_2 vacuum drying system after installation and prior to operational use. The test includes a leak and functional check of the LN_2 supply vacuum pump, skid assembly, vacuum lines, and manifolds.
Turbopump Chilldown Electrical Validation AA65-0506-204-04	-43	Verifies that electrical control portion of the turbopump chilldown system is operating satisfactorily by verifying correct meter polarity, lamp indications, switch functions and adjustment of the flow control valve resistor network.
Centaur Vehicle Hydrogen Peroxide System Leak and Functional Check AA65-0502-062-04	-35	Verifies readiness of Centaur vehicle hydrogen peroxide engine systems and boost pump systems for vehicle testing and flight. Engine solenoids must not be actuated without verification that autopilot system is in correct configuration.

TABLE 21.3-3. PROPULSION SYSTEM (Continued)

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
Centaur Pratt and Whitney Engine Leak and Functional Check AA65-0502-061-04	-35 to -20	Verifies readiness of Centaur vehicle main engines for preflight testing and flight by accomplishing the following leak and functional checks: 1. Low pressure LH_2 and LO_2 system - leak check 2. Turbopump - torque check 3. Engine control regulators and relief valves - leak check 4. Engine pneumatic control system - leak and functional check 5. LH_2 and LO_2 pump inlet shutoff valves - functional check 6. Main engine purge - functional check 7. Ignition system - functional check 8. Main engine system - leak check 9. Engine standby purge operation
LO_2 Pump LC RPM Check AA62-0502-024-03A	-29	Provides a method of checking the LO_2 pump (LC) RPM. The RPM is checked with a strobotach and adjusted if necessary. Pump designations (LA) and (LB) apply to LO_2 pumps used for tanking and pump (LC) is used for LO_2 topping.

TABLE 21.3-3. PROPULSION SYSTEM (Continued)

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
Hydrogen Peroxide System Passivation Check AA65-0502-074-04	-27	Performs the following H_2O_2 system operations using the 55-29276 H_2O_2 transfer system: 1. H_2O_2 system tanking operations 2. H_2O_2 system passivation check (4 hrs.) and boost pump control systems hot firing 3. H_2O_2 bottle drain and system purge and dry operation Each H_2O_2 drum used will have been sampled by the Pan American sampling section within the 3-day period preceding delivery to GD/C per GD/C Specification 0-73019.
Centaur Engine Electrical Checkout AA65-0506-177-04	-22	Verifies the proper operation of engine electrical components.
Centaur Hydrogen Peroxide System and Bladder Leak Check AA65-0502-075-04	-13	Establishes the integrity of the Centaur vehicle hydrogen peroxide engine and boost pump systems for preflight tests and launch.
Trichlorethylene Engine Flush and System Functional Check AA65-0502-071-04	-12	Ensures the cleanliness of the Centaur engine system. A leak check is also accomplished when engines are purged with trichlorethylene.

TABLE 21.3-3. PROPULSION SYSTEM (Continued)

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
Centaur Vehicle Propulsion Readiness and Operations AA65-0502-063-04	-2	Performs all Centaur propulsion operations which must be accomplished during the readiness period prior to Centaur vehicle tanking or launch operations. They are: 1. Turbopump torque check 2. Transducer calibration 3. Thrust controller bellows check 4. Engine system leak check 5. Valve functional check 5. Ignition system functional check 7. System heater check 8. Engine purge functional check 9. Engine standby purge operation 10. Propulsion system countdown preparations 11. H_2O_2 tanking preparations 12. H_2O_2 tanking 13. H_2O_2 bottle passivation check 14. Boost pump and H_2O_2 engine firings 15. H_2O_2 system securing

TABLE 21.3-4. PROPELLANT LOADING SYSTEM

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
LH_2 Tanking Controls System Validation AA64-0506-125-04A	-60	Validates the Centaur LH_2 tanking controls system by functionally checking all wiring and components to associated interfaces. The fill and drain valve indicator control assembly is not checked but is validated during the complete system test.
Filling LH_2 Storage Tank AA65-0502-083-04	-60	Fills the LH_2 storage tank.
Hydrogen Peroxide Transfer Unit Validation and Checkout AA65-0502-073-04	-56	Verifies the ability of the NASA-64-LOC 20009 hydrogen peroxide pump and cart to transfer H_2O_2 and/or AAA distilled water.
LHe System Validation AA65-0502-077-04	-51	Validates the LHe system with or without LHe in the dewar.
LH_2 Cold Flow with LN_2 AA65-0502-046-04	-50 to -46	Verifies that liquid hydrogen storage and transfer systems are capable of performing their intended function by operating the systems with liquid nitrogen.
Hydrogen Peroxide Tanking and Vacuum Drying Operations AA65-0502-064-04	-43	The following operations are accomplished: 1. Tanking of H_2O_2 bottle using H_2O_2 transfer system 2. H_2O_2 bottle drain 3. H_2O_2 system purge and dry (complete system wetted) 4. H_2O_2 system purge and dry (bottle wetted only) 5. Vacuum drying operations 6. H_2O_2 bottle standby preparations 7. Purge of H_2O_2 transfer system

TABLE 21.3-4. PROPELLANT LOADING SYSTEM (Continued)

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
Propellant Level Second Stage Validation AA65-0506-198-04	-42	Vehicle LH_2 and LO_2 probes are simulated, sensor line attenuation adjusted, if necessary, and simulated threshold resistance of the probes recorded.
Resistance Checkout of LO_2 and LH_2 Probes AA65-0506-182-04	-39	Checks liquid oxygen and liquid hydrogen hot wire level probes to verify probe installation and resistance.
LH_2 System Validation AA65-0502-043-04	-30	Validates the liquid hydrogen system by: 1. Setup and check of all regulator settings and remotely operated valves 2. Leak checking the transfer system, pneumatic lines supplying control pressure, and purge system 3. Application of a cracking and reseat pressure for all relief valves 4. Operation with LN_2 for cryogenic shock

TABLE 21.3-4. PROPELLANT LOADING SYSTEM (Continued)

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
Liquid Oxygen System Leak Check AA65-0502-049-03A	-29	Accomplishes the following: 1. Leak check LO_2 transfer lines 2. Leak check LO_2 transfer unit pneumatic lines 3. Cycle LO_2 transfer unit valves 4. Check LO_2 transfer unit valve control pressure switch 5. Check transfer unit valve packing glands for proper sealing of valve stems 6. Leak check Atlas and Centaur topping valves 7. Record gage calibration data
Centaur LO_2 Tanking Controls System Validation AA64-0506-105-04	-28	Functionally checks all wiring and components in the system to associate interfaces.
Centaur Propellant Utilization System Leak Check AA63-0501-013-03C	-27	This test accomplishes a leak check on the propellant utilization (PU) system and a functional (flow) check on the PU constant flow valves.
Propellant Utilization Validation AA65-0501-025-15	-26	Validates the propellant utilization ground control and monitor systems for Complexes 36A and 36B.

TABLE 21.3-4. PROPELLANT LOADING SYSTEM (Continued)

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
PLCU Readiness AA65-0506-161-04	-25 -2	Simulates a wet condition on fuel and LO_2 Propellant Loading Control Unit probes. Proper indicator lights in the blockhouse and transfer room are then verified. This test verifies the readiness of the PLCU system.
Propellant Utilization Calibration and Functional AA65-0501-026-03	-21 -15 -6	Provides for calibrating and functionally testing the Centaur advanced propellant utilization system prior to flight. The P/U servopositioners are set to a nominal angle by simulating propellant tank levels.
GSE LO_2 Storage Tank Fill and Topping Operation AA65-0502-056-04	-18	Fills the LO_2 storage tank.

TABLE 21.3-5. PNEUMATIC SYSTEM

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
Venting of Centaur Tanks to Zero psig (Vehicle in Service Tower) AA65-0508-080-04	As required	Vents Centaur propellant tanks to zero psig with vehicle in service tower when venting of the tanks is required for replacement or modification of integrated hardware.
Vent Centaur Tanks to Zero psig (Vehicle in Transport Trailer) AA65-0508-081-04	As required	Vents the Centaur propellant tanks to zero psig with the vehicle in the transport trailer when replacement of components or field modifications require zero tank pressure.
Ground Pneumatic System Leak Check AA65-0508-076-04	-60	Ensures that the ground pneumatic system is leak free.
Pneumatic Distribution System Validation AA65-0508-043-04	-60	Ensures that the ground pneumatic distribution system will function properly to support the operational pneumatic requirements of the launch complex. Test consists of leak, contamination, and functional checks of the pneumatic distribution system, while simulating the output demands.
Centaur Purge Control Validation AA64-0506-115-04A	-59	Validates the electrical portion of the purge control system. The pneumatic distribution unit is not included in this test.
Service Tower Pneumatic System AA64-0508-048-04	-57	Determines that the service tower pneumatic system (STP) functions properly. Test includes pressurization of lines, gaseous leak checks, valve actuations, as well as light and gage indications. Power distribution unit must be validated prior to applying power to pneumatic equipment.
Centaur PCU and Ground Pneumatic System Validation AA65-0508-084-04	-56 to -37	Accomplishes a functional check of all units in the Centaur pressurization control unit (PCUC). It determines the operational readiness of the PCUC to perform the following functions:

TABLE 21.3-5. PNEUMATIC SYSTEM (Continued)

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
		1. Maintain Centaur LO_2 and LH_2 tank pressures at standby levels. 2. Check of functions to increase or decrease tank pressures. 3. Check of A/B helium storage bottles charge system. 4. Check of emergency raise and lower tank pressures.
Centaur Ground Intermediate Bulkhead Vacuum System Checkout AA65-0508-086-04	-55	Establishes readiness of Centaur ground intermediate bulkhead vacuum system by performing a functional check of vacuum pump and vacuum control box.
Stretch System Validation (Pneumatic) AA64-0508-049-04	-52	Determines that the stretch sling pneumatic system functions properly in conjunction with the pneumatic control system. The test includes checks of stretch sling pressurization panel components, automatic and manual mode; system test for Atlas, Atlas/Centaur, and Atlas/Centaur/Surveyor configurations; gaseous leak checks; and pressure switch adjustments. The following tests must be satisfactorily completed prior to running this test: 1. Pneumatic distribution system validation 2. Reverification of stretch sling installation to tower structure
Centaur Insulation Panel Purge System Validation AA65-0508-079-04	-50 -43 -23	Ensures the readiness of the Centaur insulation panel purge system.

TABLE 21.3-5. PNEUMATIC SYSTEM (Continued)

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
Centaur Purge Control System Validation AA65-0506-210-04	-43	Validates, by electrical tests, the Centaur purge control system, to associated mechanical interfaces.
Centaur Tank Pressurization Changeover AA65-0508-070-04	-42	Provides instructions for Centaur (second-stage) LO_2 (lower) and LH_2 (upper) tanks pressurization changeover from one method of pressurization to another (trailer to complex).
Centaur Pressurization Control System AA65-0506-139-04	-39	Electrically validates the Centaur pressurization control system to the associated mechanical equipment interfaces.
Checkout of Booster/ Centaur Safety Stretch Sling Pneumatic System AA65-0508-066-04	-36	Ensures proper operation of the stretch sling pneumatic system. Manual and automatic stretch are applied to both the Booster and Booster/Centaur sling configurations.
Centaur Airborne Pneumatic System Checkout AA65-0508-073-04	-35	**Ensures readiness of the airborne pneumatic system for vehicle testing and flight. This test accomplishes a leak check** of the Centaur airborne pneumatic system, operational checks of airborne pneumatics valves and components, including a remote high pressure helium storage cycle. Portions of the Centaur Airborne pneumatic system not checked during this test are accomplished during the Pratt-Whitney leak and functional test.

TABLE 21.3-5. PNEUMATIC SYSTEM (Continued)

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
Centaur Vent Valves Checkout AA65-0508-067-04	-31	Verifies the proper operation of LH_2 and LO_2 tank relief valves by increasing tank pressure using the pressure control switch on the Centaur pressurization panel. Cracking and reseat pressures are observed and recorded. Valve open and close switches are actuated and lights checked for proper indication. To accomplish this test, the Centaur must be mated to the booster and erected, and the service tower must be in place.
Centaur (Burp) Pressurization and Autopilot Programmer Integrated System Checkout AA65-0508-075-04	-30	Verifies readiness of the Centaur burp pressurization system by simulating in-flight pressurization increase of the Centaur LO_2 and fuel tanks prior to engine start. Autopilot programmer control, required to initiate this function, is also verified. The following must be accomplished prior to this test: 1. Centaur mated to the booster and erected; service tower in place. 2. Centaur lower umbilical boom connected to the vehicle with all umbilical cables and pneumatic lines installed on the boom. 3. Centaur propellant control unit checked and verified as flight ready. 4. Centaur programmer checkout procedure accomplished. 5. Centaur airborne pneumatic system checkout procedure accomplished.

TABLE 21.3-6. HYDRAULIC SYSTEM

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
Centaur Ground and A/B Hydraulic System Check-out and Bleed AA65-0508-056-04	-39	Fills, bleeds, and leak checks the Centaur ground and airborne hydraulic systems supporting autopilot functions required for checkout and flight. Shall be run prior to autopilot tests utilizing hydraulic system (see Table 21.3-8).
Centaur Hydraulic Power Package Functional Test AA65-0508-062-04	-14	Functionally checks the Centaur hydraulic power packs. This includes a fill and bleed and validation of the hydraulic checkout unit, followed by performance tests (flow versus RPM) of the main hydraulic pumps and the recirculation pumps using the hydraulic checkout cart. The hydraulic checkout cart may not be operated while pyrotechnics are installed on the vehicle.
Airborne Hydraulic Readiness Operations AA65-0508-059-04	-1	Prepares the airborne hydraulic system for launch countdown operations. Centaur airborne hydraulic systems are checked for proper bleed, and accumulators checked for proper charge. The circulating pump electric motor drives are checked for proper operation.

TABLE 21.3-7. ELECTRICAL CONTROL AND POWER SYSTEMS

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
Centaur Telemeter RMS Battery Activation AA65-0506-189-04	AS REQUIRED	Test procedure covers: 1. Inspection of inactive batteries 2. Activation of the batteries 3. Pressurizing 4. Load test of the activated batteries 5. Charging of activated batteries 6. Discharge of activated batteries 7. Storage of inactive and activated batteries
Test Conductor System Validation AA64-0506-108-04A	-65	Validates the test conductor system by verifying that indicated command and response signals are correct within the system and at interface points of associated systems.
400 Cycle Power System Validation AA64-0506-099-04	-65	Validates the 400 cycle power system, which includes the control and distribution system. The system is functionally checked to the interface of other systems.
60 Cycle Power Control System Validation AA64-0506-095-04B	-64	Validates the 60 cycle power control system by certifying that system is installed per drawing and functions as required.
Centaur Vehicle Ground Power Validation Procedure AA64-0506-127-04	-61	Validates the Centaur vehicle ground power control system by functionally checking the interface with and to associated systems.

TABLE 21.3-7. ELECTRICAL CONTROL AND POWER SYSTEMS (Continued)

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
Gantry Test Rack Validation AA65-0506-141-04	-60	Validates the Gantry Test Rack (GTR) wiring after installation. A similar test is required after each modification.
DC Power Systems Validation AA64-0506-102-04A	-60	Demonstrates the proper operation of the DC ground power control and distribution systems by conducting functional checks to the interface of associated systems.
Squib Simulator Test and Calibration AA65-0506-183-04	-49	Calibrates the 55-55783 squib simulators used during Booster-Centaur preflight test operations, and verifies that simulators will respond to firing signals of proper magnitude and duration and will transmit firing information to the gantry test rack. Timing must have a range covering 0 to 100 milliseconds with a 1-millisecond resolution.
Booster and Centaur Stage Umbilical Adjustment and Checkout AA65-0506-171-04	-46	Prepares the Booster and Centaur umbilical connectors for test after Booster and Centaur erection and prior to turning on airborne power. Each Booster and Centaur connector (plug and receptacle) is examined, cleaned, lubricated, adjusted, and mated. An electrical eject test is performed for Centaur umbilicals. The umbilical monitors are also checked. The 2-in. rise backup circuitry is also checked.
RF Ground System - Centaur - Validation AA64-0506-126-04	-41	Validates the Centaur RF ground control system by functionally checking to the interface between it and associated systems.

TABLE 21.3-7. ELECTRICAL CONTROL AND POWER SYSTEMS (Continued)

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
Centaur Green Box Validation AA65-0506-217-04	-35	Validates the green Centaur destructor test box by performing: 1. An arm/safe indicator electrical check 2. An arm/safe command check 3. A resistance measurement of all the unit circuitry
Centaur Range Safety Command Receiver Sensitivity Calibration AA65-0503-032-04	-35	Calibrates the open and closed loop sensitivity and selectivity of the RSC receivers in the Centaur vehicle. AGE voltage readings are obtained and compared for similarity, prior to launch, to verify proper receiver operation. RSC receiver sensitivity verification is obtained upon erection of the vehicle and following major RSC alterations or repairs. Range Frequency Control must be notified, prior to testing, to avoid interference with other AFETR RSC systems.
Missile Power Panel Meter Calibration AA65-0506-166-04	-31	Checks voltages on the vehicle power panel meters against comparable values taken at the vehicle for establishing system measurement accuracy data. Values taken in this test are used as a reference during any major test where redlines, on voltage and frequency, are required.
Centaur/Surveyor RSC Blockhouse Compatibility AA65-0506-153-04	-31	Functionally checks the Centaur range safety command system, in a closed loop configuration, utilizing the propulsion system and Surveyor RSC system. Verification must be obtained, prior to test, that red boxes are not installed on the Centaur stage and that green boxes are installed.

TABLE 21.3-7. ELECTRICAL CONTROL AND POWER SYSTEMS (Continued)

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
Pyrotechnic Fit Check, Mech Installation, and Electrical Connection for Flight AA65-0506-181-04	-28 -9	Ensures proper installation and electrical connection of Atlas/Centaur pyrotechnics.
(Radio Frequency) Azusa, if installed, and C-Band RF Cable Calibration AA62-0503-011-03	-27	Verifies that installed RF cables have not changed their electrical characteristics in transit from the factory to the Complex. When connecting equipment to the vehicleborne system, care must be taken that the minimum bend radius of the spiroline cable is not exceeded (refer to MPS 25.10).
Calibration of Voltage Measurements Utilizing ECAN System AA62-0501-008-15C	-23	This test electrically calibrates the recording instruments used for the recording and display of voltage measurements.
PU Valve Angle Setting AA65-0501-027-15B	-22	Sets the electrical limits of the PU canister with the vehicle in the vertical position and verifies that the error demodulator output will be enough to control PU valve at port uncovery.
Surveyor RSC GSE Validation AA65-0506-197-04	-21	Provides for checkout of Surveyor RSC GSE system.
Centaur Blockhouse Compatibility (Electrical) AA65-0506-145-04	-20	Checks the main battery and pyrotechnic battery heater circuits. Evaluates the power changeover switch and evaluates the inverter voltage and frequency regulation.

TABLE 21.3-7. ELECTRICAL CONTROL AND POWER SYSTEMS (Continued)

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
Integrated Launch Control AA65-0506-144-04	-14	Demonstrates: 1. Prestart and release sequences and timer functions in test conductor's console using the Launch Control Simulator (LCS) and other test circuitry 2. Complete release sequence with an actual engine valve sequence using the GTR to simulate pressure switches and igniters 3. Test conductor's launch control cutoff capability for ground power failure 4. Capability of RCA sequencer to hold at the three fire points. 5. Automatic Centaur fuel vent valve close command during engine sequence
Centaur Battery Activation AA65-0506-173-04	-12	Outlines the procedure to be used for activating the Centaur main battery and telemetry batteries.
Complex Electrical Readiness Test AA65-0506-155-04	-4	Verifies that launch control and facility electrical systems are in a flight configuration. This test is performed on the day before launch. All switches, plugs, terminal boards, relay boxes, and launcher boxes are inspected, closed, and sealed. The emergency 60-cycle generator and various 28-vdc supplies are operated and checked for correct voltage.
Booster/Centaur Vehicle RF & Electrical Readiness Test AA65-0506-156-04	-1	This test is performed to fulfill Booster and Centaur RF and electrical readiness requirements. The test provides for installation of range safety command, telemetry, pyrotechnic, and Booster and Centaur main batteries. The test includes a check of all electrical connections.

TABLE 21.3-8. FLIGHT CONTROL SYSTEM

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
Centaur A/P Gyro Replacement AA65-0504-078-04	AS REQUIRED	Tests ensure proper operation of the canister and include -- checking signal amplifier limiting, torquing gain, end to end position gain during powered and coast phases, position channel limiting, and gyro polarity. A check of Booster/Centaur steering interface is also accomplished.
Centaur A/P Programmer Replacement AA65-0504-077-04	AS REQUIRED	Tests ensure proper operation of the canister and include -- operation of the arming circuits, integrator switching times, programmer switching sequence, check of enable and backup times, rate gyro gain changes, channel selector gains and limits, programmer discrete checks, and Centaur/Booster interface checks.
Centaur A/P Servo Replacement AA65-0504-076-04	AS REQUIRED	The static and dynamic characteristics of the servo loop are determined by performing static gain, end to end, and frequency response checks. Integral gains, servo switching functions, and engine feedback nulls are verified for proper operation. An engine alignment is performed to ensure proper thrust vector alignment.
Validation of the Centaur Rate Gyro Checkout Set AA63-0504-041-03	-41	Checks the supply, switching, and bias voltages supplied by the Centaur rate gyro checkout set, nulling circuit accuracy, monitoring circuits, and load resistances.
Centaur A/P Validation AA64-0504-057-04	-41	Validates the Centaur flight control system and applicable circuits in the associated test panel, end to end. Validation of the 400 cycle instrumentation system is a prerequisite for this test.

TABLE 21.3-8. FLIGHT CONTROL SYSTEM (Continued)

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
A/P AGE Test Equipment Calibration AA65-0504-065-04	-40	Calibrates operational A/P AGE systems. Range timing is used as the time standard.
Centaur Rate Gyro Checkout AA64-0504-042-03	-38	Checks rates, command gains, and limits in powered and coast phases of the Centaur rate gyro using the Centaur rate gyro checkout set and Decker gyro test table.
Centaur Autopilot Main Engine Alignment Check AA65-0504-072-04	-36	Adjusts the main engine hydraulic actuators to lengths that will yield the required engine offsets. Alignment is determined by measuring the offset, in milliradians, between a straight edge, attached to the engine bell and aligned to the X-X and Y-Y axis, and a level (level indicating true horizontal) which is an integral part of a gunner's quadrant. Alignment is adjusted with actuator locks installed and checked with vehicle AC and DC power and hydraulics applied to provide autopilot engine null in place of actuator locks.
Centaur Autopilot Readiness Test AA65-0504-073-04	-36	Determines that rate gyros, channel selector, signal amplifiers, attitude engine control logic circuits, servoamplifiers, integrators, and hydraulic actuators are functioning satisfactorily prior to proceeding with integrated tests. Determines that design parameters of the Centaur autopilot system are satisfied.

TABLE 21.3-8. FLIGHT CONTROL SYSTEM (Continued)

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
Booster/Centaur A/P Programmer Sequence Test AA65-0504-074-04	-23	Verifies that the Centaur and Booster autopilot programmers will function normally in inflight configuration. The Booster and Centaur programmers are armed and Booster programmer start is initiated at the AGE Control panel. Booster Sustainer Engine Cutoff initiates Centaur programmer start. Both programmers are run through a complete sequence. Programmer functions are monitored on telemetry, Esterline-Angus recorders, gantry test rack, and actual solenoid pickup points on Centaur engine functions and vent valves. Booster programmer loads are simulated by using squib simulator boxes.
Booster/Centaur A/P and Guidance Integrated Test AA65-0504-075	-21	Determines that the Booster autopilot, Centaur autopilot, and guidance systems are operationally compatible and checks A/P end to end gains. To allow engine gimbaling, the Centaur LO_2 and LH_2 tank pressures are raised to 15.0 psig.

TABLE 21.3-9. GUIDANCE SYSTEM

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
Validation of the Marginal Test Equipment AA63-0504-038-03B	-61	Validates the guidance system marginal test equipment by checking: 1. Computer voltage levels 2. Incremental input circuits 3. Delta T1 and T2 4. Write head power 5. Memory drum voltages and frequency 6. DC voltage variation
Validation of the Tape Reader AA63-0504-045-03	-50	Validates proper performance of the tape reader.
Voltage Controlled Oscillator/Amplifier Validation AA65-0504-082-15	-50	Provides a functional check of the SK 967-4-3006 voltage control oscillator and power amplifier assembly.
Validation of Card Checker AA63-0504-039-03	-50	Validates the proper operation of the 55-04086-3 card checker.
Validation of RL + R Junction Box AA65-0504-083-15	-50	Validates the remote load and read junction box and cables for use with the flight computer.

TABLE 21.3-9. GUIDANCE SYSTEM (Continued)

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
Validation of Function Generator AA63-0504-037-15D	-49	Provides tests and test methods acceptable for validating the function generator and associated cables.
Validation of the Guidance Signal Conditioner Test Set AA63-0504-040-03A	-49	Verifies that the signal conditioner test set is in the correct configuration for calibration of the A/B guidance signal conditioner.
Validation of Computer Input/Output Tester AA63-0504-036-15A	-49	Provides tests and test methods acceptable for validating the input/output tester and associated cables.
IGS Computer Flight Simulation Test AA63-0504-027-15J	-48	Provides a check of the inflight program using the function generator to simulate the inertial platform. Test is performed in the computer lab and uses discrete signal times and telemetry data to evaluate computer performance.
Laboratory Alignment Procedure for Inertial Guidance System AA62-0504-019	-45	Determines the performance of the Centaur inertial guidance system in the ETR laboratory, by performing a preflight lab test. Testing is by section, as follows: 1. Gimbal slew test 2. Launch test align 3. Gimbal response test 4. Resolver chain gain, phase shift and linearity test 5. Integrated test 6. Final align and gyro compassing 7. Earth spin test 8. Porro prism test 9. Post test operations

TABLE 21.3-9. GUIDANCE SYSTEM (Continued)

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
Guidance Optical Alignment AA65-0504-081-04	-47 -15 -0	Assures proper operation and alignment of the inertial guidance optical system at the launch site after missile erection and prior to and during tanking and launch countdown operations.
IGS Computer Functional Test AA62-0504-022-15	-42	Verifies the proper operation of the IGS computer.
Validation of Inertial Guidance System Ground Support Equipment AA62-0504-021-03	-42	Validates the guidance system launch control equipment.
Validation of the Guidance Signal Conditioner Test Set AA63-0504-040-15	-41	Ascertains that the signal conditioner test set is in the correct configuration for calibration of the A/B guidance signal conditioner 55-04031-1 and 55-04331-1.
IGS Laboratory Alignment AA62-0504-019-15	-39	Determines the performance of the IGS, in the ETR laboratory, prior to flight. Test is divided into five parts. Test may be accomplished in one day if required, or may be accomplished over a two-day period. Special sequencing of the five test sections is required: one-day tests vs. two-day tests.
Checkout of Inertial Lab Equipment AA62-0504-017-15	-39	Validates the IGS checkout equipment, in the ETR laboratory, through the use of an MGS simulator.

TABLE 21.3-9. GUIDANCE SYSTEM (Continued)

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
IGS Computer Marginal Test AA64-0504-050-15	-39	Establishes a confidence level on the computer, P/N 55-04332, by utilizing test equipment, set to marginal values. Facility AC & DC power must be maintained throughout the entire test, and cooling air must be applied to the computer.
Guidance Signal Conditioner Checkout AA63-0504-043-15	-39	Verifies the proper operation of the airborne guidance signal conditioner, using the 55-45080 signal conditioner test set.
IGS Complex Validation AA65-0504-079-04	-36	Validates the IGS checkout equipment at Complex 36B through the use of an IGS simulator at the umbilicals.
IGS Launch Site Alignment AA65-0504-080-04	-26	This test is designed to ensure proper operation and alignment of the inertial guidance system at the launch site after erection and mating and prior to launch countdown. Support is required from Atlas and Centaur autopilot and telemetry.

TABLE 21.3-10. RF SYSTEMS

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
Range Safety Command System Checkout Set Validation **AA63-0503-015-03B**	**-42**	**Verifies that the range safety command checkout set is in satisfactory operating condition.**
Range Safety Command Centaur - Power Control Validation **AA64-0506-128-04A**	**-40**	**Validates the Centaur RSC GSE system by actuating and observing complete system operation.**
Azusa, Type C Coherent Carrier Transponder B/H Compatibility Check **AA62-0503-009-15F**	**-34**	**Confirms compatibility of Azusa coherent type transponder with blockhouse and range.**
C-Band Beacon Test Set Validation **AA63-0503-012-15C**	**-31**	**Ensures that C-Band beacon test set is functioning properly. A spot check of power output and interrogation of a test transponder demonstrates operational readiness.**
C-Band Beacon Blockhouse Compatibility Test **AA62-0503-010-15H** **(Continued)**	**-27**	**Determines acceptance of C-Band beacon by measuring and recording the following:** **1. Transmitter frequency** **2. Transmitter power** **3. Receiver sensitivity** **4. Random pulse count**

TABLE 21.3-10. RF SYSTEMS (Continued)

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
C-Band Beacon Blockhouse Compatibility Test AA62-0503-010-15H (Continued)	-27	5. Pulse jitter and maximum interrogation rate 6. Pulse rise time and decoder limits 7. Beacon response delay 8. Beacon recovery time and pulse width
C-Band Receiver Validation AA63-0503-018-15B	-24	Verifies that C-Band receivers have the required sensitivity and video output to correctly monitor C-Band beacon transponder input and output signals.

TABLE 21.3-11. TELEMETRY SYSTEM

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
Booster/Centaur Transducer Ringout (Complex and Hangar) AA62-0501-001-03	-47 -30	Confirms the correct resistance to ground of Atlas and Centaur transducers and continuity of subsystems wiring and facility wiring to proper print configuration.
Instrumentation Checkout Test Set Validation AA64-0503-020-15	-42	Validates the instrumentation checkout test set. With power applied to the test set, the stimulus panel tens and units selectors must not be placed on identical positions as this will short out the power supply.
Centaur Telemetry System Blockhouse Compatibility Test AA65-0503-036-04	-25	Provides: 1. Telemetry system compatibility check with the blockhouse. During this test, power is supplied to the sandwich plugs which are not connected to the individual telemetry packages. Power is turned on and a voltage reading is taken to determine that proper voltage and polarity is present. Commutator control voltages are also verified 2. Telemetry package test. This test checks the input voltage and RF output of each package 3. System telemetry test. This test verifies correct power supply voltages, transmitter frequencies, and commutator speeds. During this test recordings are made with power applied to all systems

TABLE 21.3-11. TELEMETRY SYSTEM (Continued)

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
Centaur Telemetry System Functional Test **AA65-0503-037-04**	-24	**Determines the operational readiness of the telemetry system while utilizing the telemetry trailer or telemetry ground station. Status of spare telemetry systems is also verified with this test procedure.** **1. Power output verified** **2. Transmitter frequency verified** **3. SCO's checked** **4. Commutated pulse trains checked** **5. All measurements checked and calibration functions verified**
Calibration of Voltage Measurements Not Utilizing ECAN System Electrical Calibration and Null **AA63-0501-018-15**	-23	**Electrically calibrates the recording instruments used for recording and display of voltage and electrical current measurements. By performing the required voltage measurements and adjustments, the recorder is set up to record and display those current and voltage measurements not programmed through the signal conditioning equipment.**
Potentiometer Pressure Measurement Calibration Procedure (Utilizing Excitation Calibration and Normalization System) **AA65-0501-002-15**	-20	**Calibrates the recording instruments used for the recording and display of potentiometer pressure measurements when using ECAN and/or potentiometer signal conditioning systems. This test verifies that the appropriate panel meter, oscillograph, or null balance recorder calibrate and signal input circuitry is correctly wired and the recording instrument is calibrated for the measurement called out on the calibration data sheet.**

TABLE 21.3-11. TELEMETRY SYSTEM (Continued)

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
Centaur Pratt & Whitney Engine Transducer Test AA64-0503-022-15	-17	Checks continuity, insulation resistance, and igniter box, on Pratt & Whitney engine measurements. Resistance checks are performed on all Pratt & Whitney engine measurements. Insulation resistance checks are performed on the pressure switch transducers, pump speed pickup, and all measurement leads to ground. Igniter box pressure measurements are resistance checked and the output signal monitored. Cooling is required prior to power application on any telemetry package.
Centaur Pump Speed Transducer Test AA64-0503-021-15	-17	Checks the resistance of boost and main engine pump speed transducers and boost pump temperature transducers. Telemetry packages are operated and boost and main engine pump speed transducer outputs simulated with a signal generator. Data recordings are made and the dropout voltage measured. Cooling is required prior to power application on any telemetry package.
Centaur Pratt & Whitney Engine Transducer Test AA64-0503-022-15A	-17	Checks continuity, insulation resistance, and igniter box on Pratt & Whitney engine measurements. Resistance checks are performed on all Pratt & Whitney engine measurements. Insulation resistance checks are performed on the pressure switch transducers, pump speed pickup, and all measurement leads to ground. Igniter box pressure measurements are resistance checked and the output signal monitored. Pod cooling is required prior to power application on any telemetry package.

TABLE 21.3-12. LANDLINE INSTRUMENTATION SYSTEM

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
Checkout of Sequence Recorder System AA65-0506-165-04	-46	Checks out the sequence recording system and associated circuitry by establishing proper performance of isolation diodes, verification that designated pen and indicating light are correctly wired through the patch panel, verifying landline circuitry to the point of measurement pickup, and verifying that recording pens and indicating lights are operating properly.
Nose Fairing Instrumentation Test AA65-0503-023-15A	-34	Measurements on the nose fairing are checked as follows: 1. Temperature measurements - checked for correct continuity readings 2. Thermocouples heat simulated and output voltage polarity verified 3. Pressure measurements - excitation voltage applied and output monitored during pressure stimulation

TABLE 21.3-13. UMBILICAL SYSTEM

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
Validation of Umbilical Boom System AA65-0508-082-04	-45 -16	Validates the umbilical boom system on Complex 36B and demonstrates the capability of the lanyard cylinders to disconnect the umbilicals from the vehicle and of the booms to retract within a specified time.
Boom Retract with Lanyards Connected AA63-0508-025-03	-41	Demonstrates capability of lanyard cylinders to disconnect umbilicals from the Centaur and of booms to retract within a specified length of time.
Boom System Hydraulic Fill and Bleed AA64-0508-046-04	-25	Provides instructions for filling and bleeding the umbilical boom hydraulic system.

TABLE 21.3-14. HANDLING AND ERECTING SYSTEMS

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
Unloading Centaur Vehicle, Nose Fairing, and Interstage Adapter and Pallets From C-133 Aircraft AA65-0509-021-04A	Upon receipt of vehicle	Unloads Centaur vehicle, nose fairing, interstage adapter, and handling pallets from the C-133 aircraft.
Upper Stage Removal AA65-0509-027-04	As required	Removes the Centaur vehicle from the Complex 36B service tower.
Complex 36B Erection System Checkout Using Centaur Whalebone AA65-0509-030-04	-65	Verifies that Centaur erection operation is properly sequenced by erecting the Centaur whalebone in the Complex 36B service tower. Required only when significant modifications have been made on the erection system.
Upper Stage Vehicle and Trailer Preparations for Transportation AA65-0509-025-04	-45	Ensures transportation readiness of Centaur vehicle and its handling trailer prior to relocation, from hangar to launch complex.
Hangar Weighing of Centaur Vehicle AA63-0509-002-03A	-44	Actual weight of Centaur vehicle is obtained, in the hangar, prior to erection. Using a weights kit, weighing pylons and slings, Centaur vehicle and adapters are raised from handling pallet and a weight reading obtained.

TABLE 21.3-15. INTEGRATED AND SERVICE TESTS

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
ALNOR Dewpointer Instrument Operation AA65-0502-057-04	As required	Determines the dewpoint of a desired gas volume when required.
Centaur Electrical Receiving Inspection AA65-0506-154-04	-61	A systematic visual inspection is made of electrical equipment, for proper installation, and open paperwork reviewed as a preparation for erection.
Wind Load Monitoring System Validation AA65-0501-005-04	-60	Validates the proper operation of the wind load monitoring system by performing IRIG band frequency measurements and internal calibrations of the system.
Centaur Launch Controls Simulator System Validation AA64-0506-100-04	-60	Validates the Centaur launch control simulator system. The simulator is exercised to demonstrate commands and responses to interfacing points of associated systems.
Pad Safety System Validation AA65-0506-190-04	-60	Validates Convair portion of the pad safety system and verifies correct processing of signals from operating systems going to the pad safety officer's console.
Booster/Centaur and Facility Transducers Ringout (Complex and Hangar) AA64-0501-021-03	-47	Determines by ringout that the continuity and resistance to ground of the Booster, Centaur and facility transducers, subsystems wiring, and facility wiring conform with print configuration.

TABLE 21.3-15. INTEGRATED AND SERVICE TESTS (Continued)

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
Fluids Sampling AA62-0510-004-04	-41	Samples fluids used on Atlas/Centaur vehicles, to verify purity per specification.
Complex Mechanical Readiness AA65-0508-052-04	-21 -1	Prepares the following ground systems to support tanking tests, readiness demonstrations, or launch operations: 1. Liquid oxygen 2. RP-1 fuel 3. Liquid hydrogen 4. Water 5. Pneumatics 6. Launcher 7. Service tower 8. Air-conditioning 9. Umbilical boom 10. Stretch sling Each section of this test is complete in itself and any part thereof may be performed on X-2 day, at the discretion of the engineer in charge of the respective system.

TABLE 21.3-15. INTEGRATED AND SERVICE TESTS (Continued)

TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
Flight Control and Propellant Tanking Integrated Test **AA65-0500-010-04**	-15	Demonstrates that the ground and airborne propellant systems and associated support systems are capable of supporting a launch. Autopilot and guidance systems are operated during a simulated flight, under cryogenic conditions, and the Centaur RSC system operated using flight type batteries with an inert destructor and a spacecraft arm-safe initiator.
Flight Acceptance Composite Test (Plugs Out) **AA65-0500-007-04**	-10	Demonstrates, on an integrated basis, the operation of all airborne electrical systems during a simulated flight with guidance in "flight" mode. Telemetry and the gantry test rack are used for event monitoring. The following test data applies: 1. Automatically initiating programmer sequencing upon completion of a simulated launch release sequence with umbilical ejection 2. Transmitting telemetry data through open loop to ground receiving stations. 3. Transmitting booster pitch and roll steering commands from the Atlas programmer 4. Interrogation of the C-Band beacon by the range contractor 5. Evaluation of the Azusa performance by the range contractor (if Azusa is installed) 6. Evaluation of battery performance by current and voltage recordings in the gantry test rack 7. All discretes generated by programmer backup

TABLE 21.3-15. INTEGRATED AND SERVICE TESTS (Continued)

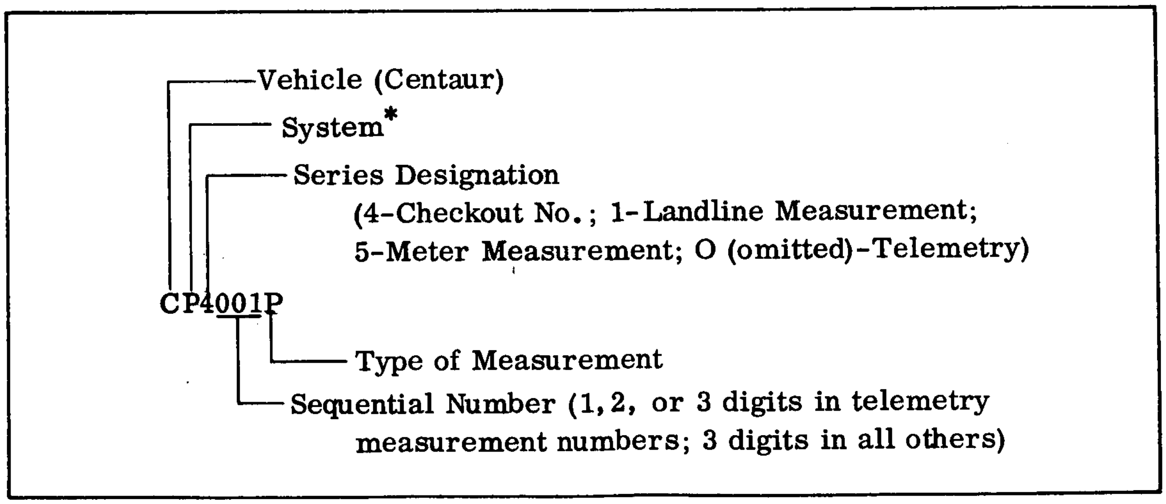
TYPE OF TEST PROCEDURE NO.	"M" DAYS PRIOR TO LAUNCH	OBJECTIVES AND LIMITATIONS
Launch Countdown Operations AA65-0500-008-04	-0	Demonstrates, on an integrated basis, the operation of all airborne electrical systems, during a simulated flight, after the FACT test "plugs-out," with guidance in the integrated test mode and utilizing launch control GSE, landline instrumentation, and telemetry, for event monitoring. This test is the final composite systems test. Prepares the vehicle for launch and subsequent flight.

21.4 TEST PARAMETERS

Functional outputs of ground systems or components of systems, known as parameters, are tested at various levels of launch preparedness. These tests provide an indication of the precision required for the Ground Support Equipment (GSE) or facilities that support the Centaur vehicle. A coding for each measurement identifies the measurement by system, series, and type. The coding is defined in Figure 21.4-1 and in Table 21.4-1, and the parameters are defined in Tables 21.4-2 through 21.4-9.

Table 21.4-1	Coding System for Test Parameters
Table 21.4-2	Environmental Control Systems Test Parameters
Table 21.4-3	Propellant Loading Systems Test Parameters
Table 21.4-4	Pneumatic Systems Test Parameters
Table 21.4-5	Electric Power and Control System Test Parameters
Table 21.4-6	Flight Control System Test Parameters
Table 21.4-7	RF Systems Test Parameters
Table 21.4-8	Umbilical Systems Test Parameters
Table 21.4-9	Handling and Erection Systems Test Parameters

Current parameters are maintained and updated as in Section 9 of the Centaur Unified Test Plan, Convair Report No. AY62-0047, which should be consulted for uses other than predesign activity.



NOTE:
*See Table 21.4-1 for identification of system symbols.

Figure 21.4-1. Coding System for Test Parameters

TABLE 21.4-1. CODING SYSTEM FOR TEST PARAMETERS

Symbol	System	Type of Measurement
A	Airframe	Acceleration
B	Beacon	Rotation Rate
C	Beacon	Current
D	Range Safety Command	Deflection
E	Electrical	Power
F	Pressurization	Force
G	Guidance (Radio)	Lab Analysis
H	Hydraulic	Position
I	Guidance (Inertial)	Intensity
J	Guidance (Inertial)	Phase Shift
K	Guidance (Inertial)	Resistance
L	Launcher	Velocity
M	Miscellaneous	Mass
N	Facilities and Site	Camera Coverage
O	Facilities and Site	Vibration
P	Propulsion	Pressure
Q	Propulsion	Frequency
R	Propulsion	Rate
S	Flight Control System	Strain
T	Telemetering	Temperature
U	Propellant Utilization	Volume
V	Propellant Utilization	Voltage
W	Propellant Utilization	Time
X	External	Discrete Position
Y	Payload	Acoustical
Z	Azusa Transponder	Azimuth

TABLE 21.4-2. ENVIRONMENTAL CONTROL SYSTEMS TEST PARAMETERS

CHECKOUT NUMBER	PARAMETER	TEST CONDITION	LEVEL OF TEST: SYST	P-IN	P-OUT	TKNG	CRT	CTDN	UNIT	NOMINAL AND TOLERANCE ETR 36B	REMARKS
CENTAUR ELECTRONIC EQUIPMENT COMPARTMENT											
CN4191T	Temperature		X					X		50 ± 5	Operational Vehicles
CN4271P	Static Pressure		X					X	in. H_2O	12 min	At disconnect
CN4666L	GN_2 or Air Flow		X					X	lb/min	70 ± 5	At disconnect
CN4667U	Dew Point		X						°F	40 max	In the duct
INTERSTAGE ADAPTER											
CN4171L	Air Flow		X			X		X	lb/min	105 ± 10	At disconnect
CN4172P	Air Static		X			X		X	in. H_2O	5.5 min	At disconnect
CN4273P	Static (GN_2) Pressure		X			X		X	in. H_2O	13 min	At disconnect
CN4668L	GN_2		X			X		X	lb/min	150 ± 10	At disconnect
CN4669U	Dew Point		X						°F	40 max	In the duct
CN4890T	Temperature					X		X	°FDB	130 ± 5	Cryogenics tanked. In vehicle A/B duct
			X			X		X		110 ± 5	Prior to tanking. In vehicle A/B duct
PAYLOAD AIR-CONDITIONING											
CN4280L	GN_2 or Air Flow			X					lb/min	75 ± 3.5	Operational Vehicles

TABLE 21.4-2. ENVIRONMENTAL CONTROL SYSTEMS TEST PARAMETERS (Continued)

CHECKOUT NUMBER	PARAMETER	TEST CONDITION	LEVEL OF TEST: SYST	P-IN	P-OUT	TKNG	CRT	CTDN	UNIT	NOMINAL AND TOLERANCE ETR 36B	REMARKS
PAYLOAD AIR-CONDITIONING (Continued)											
CN4281T	Temperature		X		X	X		X	°FDB	85 ± 5	At disconnect. In the duct
CN4282U	Dew Point		X			X		X	°F	68 ± 5	R & D only
			X			X		X		40 max	At disconnect
CN4283P	Static Pressure		X			X		X		To be added	At disconnect

TABLE 21.4-3. PROPELLANT LOADING SYSTEMS TEST PARAMETERS

CHECKOUT NUMBER	PARAMETER	TEST CONDITION	LEVEL OF TEST: SYST	P-IN	P-OUT	TKNG	CRT	CTDN	UNIT	NOMINAL AND TOLERANCE ETR 36B	REMARKS
HYDROGEN PEROXIDE SYSTEM											
CN4137P	GN_2 Purge Pressure		X			X		X	psig	50 ± 5	This function will be handled by the 55-24023-5 checkout panel
LIQUID HELIUM SYSTEM											
CN4138U	Dewar Level					X		X	gal	750 min	Dewar capacity 100 nominal
CN4139P	Controller Gas Supply Pressure	Set Pressure Regulator PCV He 16	X			X		X	psig	35 ± 1	Read on He 24
CN4140P	Dewar Vacuum Jacket Pressure	LHe in Dewar	X			X		X	micron	0.1 max	
CN4141P	Transfer Line Vacuum Jacket Pressure	Line warm	X			X		X	micron	40 nom	50 max
CN4142T	Dump Valve Temperature	LHe in line	X			X		X	°F	-200 nom	To be measured only if a helium flow is conducted
CN4143P	Dump Actuating Pressure		X			X		X	psig	90 ± 10	
CN4144P	GH_2 Purge Supply Pressure		X			X		X	psig	2,200 ±50	

TABLE 21.4-3. PROPELLANT LOADING SYSTEMS TEST PARAMETERS (Continued)

CHECKOUT NUMBER	PARAMETER	TEST CONDITION	LEVEL OF TEST						UNIT	NOMINAL AND TOLERANCE	REMARKS
			SYST	P-IN	P-OUT	TKNG	CRT	CTDN		ETR 36B	
LIQUID OXYGEN TANKING SUBSYSTEM CONTROL											
CN4089W	2-inch Riseoff		X						sec	10.0 ± 0.5	5030A2K1 TDDO Relay
CN4090W	Main Transfer Transfer Line Vent		X						sec	10.0 ± 0.5	2080A9K1 TDPU Relay
2ND STAGE PROPELLANT LEVEL CONTROL SUBSYSTEM											
CN4091K	95% LO_2 Sensor Crossover Point	Set decade resistance box or equivalent probe simulator at bulkhead interface to determine control unit crossover	X						ohm	4.0 ± 0.1	Adjust A1R13 and A1R14 in 2nd Stage Point Sensor Assembly to obtain primary and secondary wet lights at optimum setting of 4.0 ohms
CN4092K	99.8% LO_2 Sensor Crossover Point	Set decade resistance box or equivalent probe simulator at bulkhead interface to determine control unit crossover	X						ohm	4.0 ± 0.1	Adjust A1R17 and A1R18 in 2nd Stage Sensor Assembly to obtain primary and secondary wet lights at optimum setting of 4.0 ohms

TABLE 21.4-3. PROPELLANT LOADING SYSTEMS TEST PARAMETERS (Continued)

CHECKOUT NUMBER	PARAMETER	TEST CONDITION	LEVEL OF TEST						UNIT	NOMINAL AND TOLERANCE	REMARKS
			SYST	P-IN	P-OUT	TKNG	CRT	CTDN		ETR 36B	
2ND STAGE PROPELLANT LEVEL CONTROL SUBSYSTEM (Continued)											
CN4093K	100.2% LO_2 Sensor Cross-over Point	Set decade resistance box or equivalent probe simulator at bulkhead interface to determine control unit crossover							ohm		Adjust A1R21 and A1R22 in 2nd Stage Point Sensor Assembly to obtain primary and secondary wet lights at optimum setting of 4.0 ohms
CN4094K	Overfill LO_2 Sensor Cross-over Point	Set decade resistance box or equivalent probe simulator at bulkhead interface to determine control unit crossover	X						ohm		Adjust R1 and R2 in Topping Control Unit chassis to obtain primary and secondary wet lights at optimum setting of 4.0 ohms
CN4095K	95% LH_2 Sensor Crossover Point	1st Test Condition: Set A1R15 and A1R16 on 2nd Stage Point Sensor Assembly with 5.00 ± 0.05 vdc excitation	X						ma	641 ± 10	Line compensation potentiometer adjustment with 1.00 ohm resistance load at bulkhead interface

TABLE 21.4-3. PROPELLANT LOADING SYSTEMS TEST PARAMETERS (Continued)

CHECKOUT NUMBER	PARAMETER	TEST CONDITION	LEVEL OF TEST: SYST	P-IN	P-OUT	TKNG	CRT	CTDN	UNIT	NOMINAL AND TOLERANCE ETR 36B	REMARKS
2ND STAGE PROPELLANT LEVEL CONTROL SUBSYSTEM (Continued)											
CN4095K (Continued)		2nd Test Condition: Wet test	X						ohm	1.8 ± 0.1	Wet indicator on 2nd Stage Point Sensor Assembly
		3rd Test Condition: Dry test	X						ohm	2.6 ± 0.1	Dry indicator on 2nd Stage Point Sensor Assembly
		4th Test Condition: Vary resistance of load at bulkhead interface to determine crossover current	X						ma	558 ± 10	A control unit check to read current to sensor at at crossover
CN4096K	99.8% LH_2 Sensor Crossover Point	1st Test Condition: Set A1R19 and A1R20 on 2nd Stage Point Sensor Assembly with 5.00 ± 0.05 vdc excitation	X						ma	641 ± 10	Line compensation potentiometer adjustment with 1.00 ohm resistance load at bulkhead interface
		2nd Test Condition: Wet test	X						ohm	1.8 ± 0.1	Wet indicator on 2nd Stage Point Sensor Assembly

TABLE 21.4-3. PROPELLANT LOADING SYSTEMS TEST PARAMETERS (Continued)

CHECKOUT NUMBER	PARAMETER	TEST CONDITION	LEVEL OF TEST						UNIT	NOMINAL AND TOLERANCE	REMARKS
			SYST	P-IN	P-OUT	TKNG	CRT	CTDN		ETR 36B	
2ND STAGE PROPELLANT LEVEL CONTROL SUBSYSTEM (Continued)											
CN4096K (Continued)		3rd Test Condition: Dry test	X						ohm	2.6 ± 0.1	Dry indicator on 2nd Stage Point Sensor Assembly
		4th Test Condition: Vary resistance of load at bulkhead interface to determine crossover current	X						ma	558 ± 10	A control unit check to read current to sensor at crossover
CN4097K	100.2% LH_2 Sensor Crossover Point	1st Test Condition: Set A1R23 and A1R24 on 2nd Stage Point Sensor Assembly with 5.00 ± 0.05 vdc excitation	X						ma	641 ± 10	Line compensation potentiometer adjustment with 1.00 ohm resistance load at bulkhead interface
		2nd Test Condition: Wet test	X						ohm	1.8 ± 0.1	Wet indicator on 2nd Stage Point Sensor Assembly
		3rd Test Condition: Dry test	X						ohm	2.6 ± 0.1	Dry indicator on 2nd Stage Point Sensor Assembly

TABLE 21.4-3. PROPELLANT LOADING SYSTEMS TEST PARAMETERS (Continued)

CHECKOUT NUMBER	PARAMETER	TEST CONDITION	LEVEL OF TEST: SYST	P-IN	P-OUT	TKNG	CRT	CTDN	UNIT	NOMINAL AND TOLERANCE ETR 36B	REMARKS
2ND STAGE PROPELLANT LEVEL CONTROL SUBSYSTEM (Contiued)											
CN4097K (Continued)		4th Test Condition: Vary resistance of load at bulkhead interface to determine crossover current	X						ma	558 ± 10	A control unit check to read current to sensor at crossover
CN4116P	Tanking Pressure Set Point Regulator OV-17-3		X			X		X	psig	155 ± 5	Indicated by red pointer, bottom scale of OV-28-1 with the Storage Tank Pressure Mode Selector on 1st Stage Tanking Panel in the TANK position (Valve OV-30-2 energized)
CN4117P	Heat Exchanger Air Temperature Set Point OV-24-1		X			X		X	°F	40 ± 1	Indicated by red pointer

TABLE 21.4-3. PROPELLANT LOADING SYSTEMS TEST PARAMETERS (Continued)

CHECKOUT NUMBER	PARAMETER	TEST CONDITION	LEVEL OF TEST: SYST	P-IN	P-OUT	TKNG	CRT	CTDN	UNIT	NOMINAL AND TOLERANCE ETR 36B	REMARKS
2ND STAGE PROPELLANT LEVEL CONTROL SUBSYSTEM (Continued)											
CN4120P	Centaur Topping Valve Transducer Supply Pressure Regulator O-30-1		X			X		X	psig	20 ± 2	Read on Gage O-28-1
CN4121U	Storage Tank Level					X		X	gal	36,000 min 38,000 nom	Read on Indicator O-36-1
CN4122T	Transfer Line Dew Point		X			X		X	°F	-60 max	
CN4125P	Throttling Valve Cushion Pressure Regulator F-59-1		X			X		X	psig	50 ± 5	Read on Gage F-60-1
CN4126P	Terminal Box Purge Pressure Regulator F-57-1		X			X		X	in. H_2O	5.0 ± 0.5	Read on Gage F-48-1
CN4127P	Terminal Box Purge Pressure Switch F-58-1		X			X		X	in. H_2O	3.0 ± 0.5	Set on increasing pressure as read on Gage F-48-1
CN4128P	Line Blanket Pressure Regulator F-11-2		X			X		X	psig	5.0 ± 2.0	Read on Gage F-35-2
CN4129P	Storage Tank Blanket Pressure Regulator F-29-2		X			X		X	psig	5.0 ± 2.0	Read on Gage F-36-3
CN4130U	Storage Tank Level					X		X	gal	13,000 min 14,400 nom	Read on Indicator F-4-1

TABLE 21.4-3. PROPELLANT LOADING SYSTEMS TEST PARAMETERS (Continued)

CHECKOUT NUMBER	PARAMETER	TEST CONDITION	LEVEL OF TEST SYST	P-IN	P-OUT	TKNG	CRT	CTDN	UNIT	NOMINAL AND TOLERANCE ETR 36B	REMARKS
2ND STAGE PROPELLANT LEVEL CONTROL SUBSYSTEM (Continued)											
CN4131P	GN_2 Storage Pressure					X		X	psi	1,400 min 1,500 nom	Read on Gage N-28-2
CN4169P	Storage Tank Vacuum		X			X		X	mi-cron	500 max	Read on Gage O-46-1
LH_2 SYSTEM											
CN4154U	Storage Tank Level					X		X	gal	25,000 min	28,000 nominal
CN4155P	Storage Tank Transfer Pressure H-35-2					X		X	psig	12.1 ± 0.5	Read on Gage H-38-1
CN4156P	GN_2 Supply Pressure		X			X		X	psig	800^{+0}_{-50}	
CN4157P	Vaporizor Valve Supply H-35-1		X			X		X	psig	20 ± 2	Read on Gage H-42-1
CN4158P	Cabinet Purge Pressures H-31-1 and H-31-2		X			X		X	in. H_2O	5.0 ± 0.5	Read on Gages H-20-1 and H-20-3
CN4159P	I/P Transducer Supply H-35-4		X			X		X	psig	20 ± 2	Read on Gage H-42-3
CN4160P	Vent Line Purge Pressure H-47-1		X			X		X	psig	20 ± 2	Adjust H-35-5 and Gage H-42-4
CN4161P	Storage Tank Vent Purge Supply H-37-1		X			X		X	psig	100 ± 10	Adjust H-11-6. Read Gage H-44-1

TABLE 21.4-3. PROPELLANT LOADING SYSTEMS TEST PARAMETERS (Continued)

CHECKOUT NUMBER	PARAMETER	TEST CONDITION	LEVEL OF TEST SYST	P-IN	P-OUT	TKNG	CRT	CTDN	UNIT	NOMINAL AND TOLERANCE ETR 36B	REMARKS
LH_2 SYSTEM (Continued)											
CN4162	Pressure Controller Proportional Band H-38-1		X			X		X	per-cent	20	Adjust manually to set point
CN4163P	Flow Control Valve Supply H-46-2		X			X		X	psig	100 ± 10	Read on Gage H-44-3
CN4164P	Flow Control Valve Cushion H-52-1		X			X		X	psig	50 ± 5	Read Gage H-51-1
CN4165P	Helium Supply Pressure		X			X		X	psig	800^{+0}_{-50}	
CN4166P	Helium Purge Supply H-47-2		X			X		X	psig	45 ± 5	Adjust H-46-1. Read on Gage H-44-2
CN4167P	Transfer Line Vacuum Jack-et Pressure	Line warm	X						mi-cron	500 max	40 nom
CN4168P	Storage Tank Vacuum Jack-et Pressure	Tank filled	X			X		X	mi-cron	20 max	10 nom
		Tank dry	X						mi-cron	150 max	
CN4170P	Storage Tank Chilldown Pressure H-35-3					X		X	psig	5.9 ± 0.5	Read on Gage on H-38-1

TABLE 21.4-4. PNEUMATIC SYSTEMS TEST PARAMETERS

CHECKOUT NUMBER	PARAMETER	TEST CONDITION	LEVEL OF TEST: SYST	P-IN	P-OUT	TKNG	CRT	CTDN	UNIT	NOMINAL AND TOLERANCE ETR 36B	REMARKS
PNEUMATIC DISTRIBUTION UNIT - PRIMARY											
CN4032P	Filter Air Supply Regulator		X			X		X	psig	35 ± 1	
CN4033P	Routine Use GN_2 Regulator		X			X		X	psig	3,600 ± 100	
CN4034P	Holddown Supply Regulator		X			X		X	psig	5,750 ± 100	
CN4035P	Primary Helium Regulator		X			X		X	psig	2,150 ± 50	
CN4036P	Routine GN_2 Control		X			X		X	psig	2,150 ± 50	
CN4037P	Control GN_2		X			X		X	psig	800 ± 50	
PNEUMATIC DISTRIBUTION UNIT - SECONDARY											
CN4038P	PLS Helium Control Supply		X			X		X	psig	800 ± 50	
CN4039P	PCUA Emergency Supply		X			X		X	psig	1,500 ± 100	
CN4040P	PCUA Primary Supply		X			X		X	psig	1,300 ± 50	
CN4041P	Booster Helium Charge		X			X		X	psig	3,250 to 3,325	
CN4042P	Utility GN_2 Supply		X			X		X	psig	100 ± 10	Set regulator with all purge panels off. Pneumatic setting with purges on shall be 40 psig min

TABLE 21.4-4. PNEUMATIC SYSTEMS TEST PARAMETERS (Continued)

CHECKOUT NUMBER	PARAMETER	TEST CONDITION	LEVEL OF TEST						UNIT	NOMINAL AND TOLERANCE	REMARKS
			SYST	P-IN	P-OUT	TKNG	CRT	CTDN		ETR 36B	
PNEUMATIC DISTRIBUTION UNIT - SECONDARY (Continued)											
CN4043P	Launch Stabilizer Supply		X			X		X	psig	2,075 ±50	
CN4044P	Holddown Pressure in Launch Mode (PS 77)		X			X		X	psig	Acutate 5,460 min Reset 5,600 max	On decreasing pressure On increasing pressure
CN4045P	Stabilizer Pressure OK (PS 78)		X			X		X	psig	Actuate 1,800 ± 100 Reset 2,000 max	On decreasing pressure On increasing pressure
CN4046P	Holddown Pressure in Standby (PS 200)		X			X		X	psig	Actuate 1,800 ± 100 Reset 2,000 max	On decreasing pressure On increasing pressure
CN4047P	PCUC Emergency Supply		X			X		X	psig	1,500 ± 100	
CN4048P	PCUC Primary Supply		X			X		X	psig	2,150 ± 50	
CN4049P	Purge Supply		X			X		X	psig	29 ± 1	Set with valve D118-13 closed
CN4051P	PCU and Service Tower Supply		X			X		X	psig	380 ± 20	
CN4052P	NCP and Purge Box Supply		X			X		X	psig	1,150 ± 10	

TABLE 21.4-4. PNEUMATIC SYSTEMS TEST PARAMETERS (Continued)

CHECKOUT NUMBER	PARAMETER	TEST CONDITION	LEVEL OF TEST: SYST	P-IN	P-OUT	TKNG	CRT	CTDN	UNIT	NOMINAL AND TOLERANCE ETR 36B	REMARKS
PNEUMATIC DISTRIBUTION UNIT - SECONDARY (Continued)											
CN4053P	Insulation Panel Purge Controller D-208		X			X		X	psig	15 ± 1	
CN4054P	I/P Purge High Flow		X			X		X	psig	*	*Set to obtain low and high flow pressure requirements at CF1146P
CN4055P	I/P Purge Low Flow		X			X		X	psig	*	
CENTAUR PRESSURE CONTROL UNIT											**Use CAP for static zero adjustment of valve positioners versus valve position
CN4829P	LO_2 Pressure Controller (Item 15-1)	Standby mode (19-1 closed)	X						psig	9.7 min	At 6 psig min CAP. Control Valve 13-1 fully open
	Tank Sense Pressure		X						psig	10.3 ± 0.2*	At 14 psig exact CAP. Control Valve 13-1 fully closed**
			X						psig	10.8 ± 0.2*	At 18 psig exact CAP Control Valve 14-1 start opening**

TABLE 21.4-4. PNEUMATIC SYSTEMS TEST PARAMETERS (Continued)

CHECKOUT NUMBER	PARAMETER	TEST CONDITION	LEVEL OF TEST: SYST	P-IN	P-OUT	TKNG	CRT	CTDN	UNIT	NOMINAL AND TOLERANCE ETR 36B	REMARKS
CENTAUR PRESSURE CONTROL UNIT (Continued)											
			X						psig	11.5 static max*	At 32 psig max CAP. Control Valve 14-1 fully open
			X						psig	12.0 dynamic max	At 32 psig max CAP. Control Valve 14-1 fully open
CN4830P	LH_2 Pressure Controller (Item 15-2)	Standby mode (19-2 closed)	X						psig	4.0 min	At 6 psig min CAP. Control Valve 13-2 fully open
	Tank Sense Pressure		X						psig	4.6 ± 0.2*	At 14 psig exact CAP. Control Valve 13-2 fully closed**
			X						psig	5.1 ± 0.2*	At 18 psig exact CAP. Control Valve 14-2 start opening**
			X						psig	5.8 static max*	At 32 psig max CAP. Control Valve 14-2 fully open
			X						psig	6.3 dynamic max	At 32 psig max CAP. Control Valve 14-2 fully open

TABLE 21.4-4. PNEUMATIC SYSTEMS TEST PARAMETERS (Continued)

CHECKOUT NUMBER	PARAMETER	TEST CONDITION	LEVEL OF TEST						UNIT	NOMINAL AND TOLERANCE ETR 36B	REMARKS
			SYST	P-IN	P-OUT	TKNG	CRT	CTDN			
CENTAUR PRESSURE CONTROL UNIT (Continued)											
CN4831P	A/B GHe Bottle Charge Pressure (Items 29 and 33)		X						psig	2,650 min	With 29 fully opened
			X						psig	2,815 ± 35	With 29 closed
			X						psig	2,900 ± 25	With 33 opening
			X						psig	3,050 max	With 33 fully opened. Fully opened to be checked by energizing Item 11-5 solenoid valve
CN4833P	Instrument Control GN_2 Pressure Switch (Item 5)		X						psig	26.0 ± 1.0	On decreasing pressure. Reset 29.0 psig max on increasing pressure
CN4834P	Tank Differential Pressure Switch (Item 28)		X						psig	2.5 ± 0.2 (69 in. H_2O)	On decreasing differential pressure. Reset 2.9 max (81 in. H_2O) on increasing differential pressure
CN4835P	A/B GHe Bottle Charge Pressure Switch (Item 30)		X						psig	Close at 2750 max Open at 2,600 min	On increasing pressure On decreasing pressure

TABLE 21.4-4. PNEUMATIC SYSTEMS TEST PARAMETERS (Continued)

CHECKOUT NUMBER	PARAMETER	TEST CONDITION	LEVEL OF TEST: SYST	P-IN	P-OUT	TKNG	CRT	CTDN	UNIT	NOMINAL AND TOLERANCE ETR 36B	REMARKS
CENTAUR PRESSURE CONTROL UNIT (Continued)											
CN4836P	Instrument Control GN_2 Regulator (Item 3)		X						psig	39.0 ± 2.0	
TOWER PRESSURE SYSTEM											
CN4056P	Manometer Pressure GN_2 Supply		X						psig	75 ± 5	
CN4057P	Manometer Pressure Helium Supply		X						psig	75 ± 5	
CN4657P	Centaur Upper Tank Low Pressure Warning Pressure Switch		X						psig	3.8 ± 0.2	On decreasing pressure. Reset 4.2 psig max on increasing pressure
CN4658P	Centaur Lower Tank High Pressure Warning Pressure Switch		X						psig	15.0 ± 0.4	On increasing pressure. Reset 11.8 psig min on decreasing pressure
CN4659P	Tank Differential Pressure Switch		X						psig	2.5 ± 0.2 (69 in. H_2O)	On decreasing differential pressure. Reset 2.9 (81 in. H_2O) max on increasing differential pressure

TABLE 21.4-4. PNEUMATIC SYSTEMS TEST PARAMETERS (Continued)

CHECKOUT NUMBER	PARAMETER	TEST CONDITION	LEVEL OF TEST: SYST	P-IN	P-OUT	TKNG	CRT	CTDN	UNIT	NOMINAL AND TOLERANCE ETR 36B	REMARKS
FACILITY HIGH PRESSURE											
CN4145P	Primary Helium Storage Bottle Pressure					X		X	psig	5,800 min	Nominal 6,000 psig. Do not use below 1,600 psig
CN4146P	Emergency Helium Storage Bottle Pressure					X		X	psig	5,800 min	Nominal 6,000 psig. Do not use below 3,600 psig
CN4147P	Facility GN_2 Storage Bottle Pressure					X		X	psig	5,800 min	Nominal 6,000 psig. Do not use below 1,100 psig
VACUUM DRYING SYSTEM											
CN4151P	Vacuum Drying System Vacuum		X						microns Hg	1,000 max	
A/C NITROGEN STORAGE AND SUPPLY SYSTEM											
CN4152P	GN_2 Storage Bottles		X			X		X	psig	$2,400^{+0}_{-100}$	Nominal 2,400 psig. Do not use below 600 psig.
CN4153P	Instrument Pressure Regulator NV-17-1		X			X		X	psig	25 ± 1	Read on "Regulator Output" Gage of NV-24-1
2ND STAGE PURGE SUBSYSTEM CONTROL											
CN4087W	Engine Purge Timer		X						sec	2.5 ± 0.01	5036A7K1 TDPU Relay

TABLE 21.4-4. PNEUMATIC SYSTEMS TEST PARAMETERS (Continued)

CHECKOUT NUMBER	PARAMETER	TEST CONDITION	LEVEL OF TEST SYST	P-IN	P-OUT	TKNG	CRT	CTDN	UNIT	NOMINAL AND TOLERANCE ETR 36B	REMARKS
PNEUMATIC CONTROL SUBSYSTEM											
CN4088W	Internal Permit Delay		X						sec	25.0 ± 1.0	5041A1K1 TDPU Relay
PNEUMATIC PURGE SYSTEM											
CN4062P	Electrical Purge Regulator (G-73-2)		X						in. H_2O	10 ± 5	

TABLE 21.4-5. ELECTRIC POWER AND CONTROL SYSTEM TEST PARAMETERS

CHECKOUT NUMBER	PARAMETER	TEST CONDITION	LEVEL OF TEST SYST	P-IN	P-OUT	TKNG	CRT	CTDN	UNIT	NOMINAL AND TOLERANCE ETR 36B	REMARKS
VEHICLE POWER CONTROL SUBSYSTEM											
CN4085W	Autopilot Reset		X						sec	0.5 ±0.1	5047A6K1 TDDO Relay
			X						sec	0.5 ±0.1	5047A1K1 TDPU Relay
CN4086W	Inverter Start		X						sec	2.5 ±0.1	5015A8K2 TDPU Relay
CN4611X	Main Battery Timer		X						min	20 ±1.0	2102M8, Meter
			X						min	20 ±1.0	2103M5, Meter

TABLE 21.4-6. FLIGHT CONTROL SYSTEM TEST PARAMETERS

CHECKOUT NUMBER	PARAMETER	TEST CONDITION	LEVEL OF TEST SYST	P-IN	P-OUT	TKNG	CRT	CTDN	UNIT	NOMINAL AND TOLERANCE ETR 36B	REMARKS
FLIGHT CONTROL SUBSYSTEM											
CN4063V	Flight Programmer Reset		X						volts rms	105 min	Voltage level sensing and pulsing circuit 5057A3K12
			X						sec	1.5 ± 0.5	
CN4064V	Isolation Amplifier	Gain	X						v/v	1 ± 0.1%	5054A1A1-A1A9 5055A1A1-A1A9
	Gain and Limit Adjust	Limit	X						vrms	15 ± 1.5	5059A1A4-A1A9 2094A1A1 5067A1A1-A1A9 5060A1A1-A1A9 5061A1A1-A1A9
CN4065V	Actuator Null Detectors		X						vrms	$1.20^{+0\%}_{-10\%}$	5058A1A1-A1A4
			X						vrms	$1.60^{+0\%}_{-10\%}$	5058A1A5-A1A6
			X						vrms	$1.30^{+0\%}_{-10\%}$	5058A1A7-A1A9
			X						vrms	$1.80^{+0\%}_{-10\%}$	5058A1A8-A1A10
CN4066V	Gyro Null Detectors		X						vrms	$0.20^{+0\%}_{-10\%}$	5058A1A11-A1A13
CN4067V	Fine Heater Sensors		X						vrms	LT 90 ± 2 MT 10 ± 1	5058A1A14-A1A16
CN4068W	Spin Motor Monitor		X						sec	2 ± 10%	5057A11K1 TDDO Relay

TABLE 21.4-6. FLIGHT CONTROL SYSTEM TEST PARAMETERS (Continued)

CHECKOUT NUMBER	PARAMETER	TEST CONDITION	LEVEL OF TEST						UNIT	NOMINAL AND TOLERANCE	REMARKS
			SYST	P-IN	P-OUT	TKNG	CRT	CTDN		ETR 36B	
FLIGHT CONTROL SUBSYSTEM (Continued)											
CN4069V	5 vdc Power Supply		X						vdc	5 ± 5%	2061A2PS1 2066A2PS1 5082A6PS1
CN4070V	10 vdc Power Supply		X						vdc	10 ± 5%	5082A1PS1 5082A8PS1
CN4071V	28 vdc Power Supply		X						vdc	28 ± 5%	5082A3PS1
CN4072V	Nulling Amplifier	Gain	X						v/v	4 ± 1.0%	5059A1A1-A1A3
	Gain and Limit Adjust	Limit	X						vrms	10 ± 1.0	
CN4073V	Resolver Input Test Signal		X						vrms	0.41 ± 5%	Adjust 5064A8T1 with 2063SL29 selected. All other outputs should be within 5% of selected value
CN4074V	Demodulator Input Test Signal		X						vrms	1.25 ± 5%	Adjust 5066A8T1 with 2063SL-43 and SL-46 selected. All other outputs should be within ± 5% of selected value

TABLE 21.4-6. FLIGHT CONTROL SYSTEM TEST PARAMETERS (Continued)

CHECKOUT NUMBER	PARAMETER	TEST CONDITION	LEVEL OF TEST: SYST	P-IN	P-OUT	TKNG	CRT	CTDN	UNIT	NOMINAL AND TOLERANCE ETR 36B	REMARKS
FLIGHT CONTROL SUBSYSTEM (Continued)											
CN4075Q	Fixed Frequency Test Signal		X						cps	1 ± 10%	Adjust 5068A4R1 with 2062SL-3, SL-5, and SL-24 selected and rotary switch No. 2 in position 10
			X						cps	10 ± 10%	Readjust 5068A4R1 with 2062SL-1, SL-5, and SL-24 selected and rotary switch No. 1 in position 6 All other outputs should be within ± 5% of selected value, except that frequencies of 20 cps or greater should be ±10%

TABLE 21.4-6. FLIGHT CONTROL SYSTEM TEST PARAMETERS (Continued)

CHECKOUT NUMBER	PARAMETER	TEST CONDITION	LEVEL OF TEST: SYST	P-IN	P-OUT	TKNG	CRT	CTDN	UNIT	NOMINAL AND TOLERANCE ETR 36B	REMARKS
FLIGHT CONTROL SUBSYSTEM (Continued)											
CN4077Q	Ramp Function Test Signal		X						sec to max	2.5 ± 10%	Select 2062SL-1, SL-8, and SL-24 Rotary Switch No. 1 in position 6
			X						cps	25 ± 10%	Select 2062SL-3, SL-8, and SL-24 Rotary Switch No. 2 in position 10
CN4107V	Step Function Test Signal		X						vrms	6.0 ± 3%	Adjust 5065A7T2 with 2062SL-6 selected and Rotary Switch No. 1 in position 1. All other outputs should be within ± 5% of selected value

TABLE 21.4-7. RF SYSTEMS TEST PARAMETERS

CHECKOUT NUMBER	PARAMETER	TEST CONDITION	LEVEL OF TEST: SYST	P-IN	P-OUT	TKNG	CRT	CTDN	UNIT	NOMINAL AND TOLERANCE: ETR 36B	REMARKS
RF CONTROL SUBSYSTEM											
CN4079V	7 vdc Power Supply	No load applied	X						vdc	8.0	Telemetry filament voltage
CN4081V	28 vdc Power Supply	No load applied	X						vdc	29.5	Telemetry voltage
CN4082W	28 v Power Delay	From application of filament power	X						sec	20 ±1.0	5049A3K2 TDPU Relay
CN4083W	Telemetry/ Battery Overtime		X						min	20 max	2102M7 Meter
CN4084W	RMS/Battery Overtime		X						min	60 max	2103M6 Meter

TABLE 21.4-8. UMBILICAL SYSTEMS TEST PARAMETERS

CHECKOUT NUMBER	PARAMETER	TEST CONDITION	LEVEL OF TEST: SYST	P-IN	P-OUT	TKNG	CRT	CTDN	UNIT	NOMINAL AND TOLERANCE: ETR 36B	REMARKS
LANYARD CYLINDERS, ACCUMULATORS, AND PNEUMATIC SUPPLY PILOTS											
CN4029X	Lower Boom Accumulator Pressure (SW A3119)	GN_2	X					X	psig	950 min	
CN4030P	Upper Boom Accumulator Pressure (SW A3019)	GN_2	X					X	psig	950 min	
CN4031P	Lower Boom Lanyard Cylinder T-4 Aft Plate	Hydraulic Fluid	X					X	psig	900 ±50	

TABLE 21.4-8. UMBILICAL SYSTEMS TEST PARAMETERS (Continued)

CHECKOUT NUMBER	PARAMETER	TEST CONDITION	LEVEL OF TEST: SYST	P-IN	P-OUT	TKNG	CRT	CTDN	UNIT	NOMINAL AND TOLERANCE ETR 36B	REMARKS
LANYARD CYLINDERS, ACCUMULATORS, AND PNEUMATIC SUPPLY PILOTS (Continued)											
CN4456P	Lower Boom Lanyard Cylinder T-4 Aft Plate	Time from initial pressure rise to final pressure rise at end of cylinder stroke	X					X	sec	1.20 min 1.60 max	Measurement No. CN1456P
CN4457P	Lower Boom Lanyard Cylinder T-0	Time from initial pressure rise to final pressure rise at end of cylinder stroke	X					X	sec	0.80 min 0.96 max	Measurement No. CN1457P
CN4458P	Upper Boom Lanyard Cylinder T-4 Electrical	Time from initial pressure rise to final pressure rise at end of cylinder stroke	X					X	sec	0.80 min 0.96 max	Measurement No. CN1458P
CN4459P	Lower Boom Accumulator Pressure	GN_2	X					X	psig	1,300 min 1,500 max	B/H Boom Hydraulic Panel Measurement No. CN1459P
CN4460X	Upper Boom Accumulator Pressure	GN_2	X					X	psig	1,300 min 1,500 max	B/H Boom Hydraulic Panel Measurement No. CN1460X
CN4463X	Upper Boom Accumulator Level (SW A3022)	Hydraulic Fluid	X					X	position	full	Measurement No. CN1463X

TABLE 21.4-8. UMBILICAL SYSTEMS TEST PARAMETERS (Continued)

CHECKOUT NUMBER	PARAMETER	TEST CONDITION	LEVEL OF TEST SYST	P-IN	P-OUT	TKNG	CRT	CTDN	UNIT	NOMINAL AND TOLERANCE ETR 36B	REMARKS
LANYARD CYLINDERS, ACCUMULATORS, AND PNEUMATIC SUPPLY PILOTS (Continued)											
CN4464X	Upper Boom Pilot Retract Signal (Valves A3017 and A3018)	Time from T-0 to rise of voltage on valve solenoid	X					X	sec	0.04 ± 0.01	Measurement No. CN1464X
CN4465X	Lower Boom Pilot Retract Signal (Valves A3117 and A3118)	Time from T-0 to rise of voltage on valve solenoid	X					X	sec	0.25 ± 0.03	Measurement No. CN1465X
CN4520X	Lower Boom Accumulator Level (SW A3122)	Hydraulic Fluid	X					X	position	full	Measurement No. CN1520X
CN4628X	Lower Boom Pneumatic Supply Pilot (PS A3137)	GN_2	X					X	psig	750 ±50	Measurement No. CN1628X
CN4629X	Lower Boom Pneumatic Supply Pilot (PS A3037)	GN_2	X					X	psig	750 ±50	Measurement No. CN1629X
UMBILICAL BOOM RETRACTION TIMES											
CN4268D	Lower Boom Retract Position (ROTAC A3113)	Time from T-0 to 13.0°	X					X	sec	1.10 min 1.70 max	Measurement No. CN1268D
		Time from T-0 to 35.0°	X					X	sec	2.30 min 3.20 max	
		Time from T-0 to 55.0°	X					X	sec	3.3 min 4.4 max	
CN4269D	Upper Boom Retract Position (ROTAC A3013)	Time from T-0 to 3.0°	X					X	sec	0.40 min 1.50 max	Measurement No. CN1269D

TABLE 21.4-8. UMBILICAL SYSTEMS TEST PARAMETERS (Continued)

CHECKOUT NUMBER	PARAMETER	TEST CONDITION	LEVEL OF TEST SYST	P-IN	P-OUT	TKNG	CRT	CTDN	UNIT	NOMINAL AND TOLERANCE ETR 36B	REMARKS
UMBILICAL BOOM RETRACTION TIMES (Continued)											
CN4269D (Continued)		Time from T-0 to 21.0	X					X	sec	1.60 min 3.00 max	
		Time from T-0 to 50.0°	X					X	sec	3.40 min 4.70 max	
BOOM CONTROL SUBSYSTEM											
CN4098W	Lower Boom Control		X						sec	0.25 ± 0.04	5037A3K1 TDPU Relay
UMBILICAL CONTROL SUBSYSTEM											
CN4099W	Aft Plate Pneumatic Eject		X						sec	1.5 ± 0.2	5037A4K1 TDPU Relay
DISCONNECT PULL TEST											
CN4670F	Interstage Adapter Heating Ducts	Straight Pull	X						lb	65 - 125	Each
CN4671F	Forward Compartment Cooling	Straight Pull	X						lb	65 - 125	
CN4672F	Umbilical Island Duct	Straight Pull	X						lb	65 - 190	
UMBILICAL POWER PNEUMATIC SYSTEM											
CN4060P	Intermediate Bulkhead vacuum switch (G-66-1)	Actuate on decreasing pressure	X						in. Hg	0.3 ± 0.03	Reset by 0.58 max on increasing pressure

TABLE 21.4-9. HANDLING AND ERECTION SYSTEMS TEST PARAMETERS

CHECKOUT NUMBER	PARAMETER	TEST CONDITION	LEVEL OF TEST: SYST	P-IN	P-OUT	TKNG	CRT	CTDN	UNIT	NOMINAL AND TOLERANCE ETR 36B	REMARKS
STRETCH SLING PNEUMATICS											
CN4058F	Atlas Stretch Force	With stretch adapter	X						lb	6,500 ±500	See Test Requirement No. 10 for relief valve settings and Test Requirement No. 11 for differential pressure switch settings
		With interstage adapter	X						lb	7,000 ±500	
CN4059F	Atlas/Centaur Stretch Force	Without encapsulated payload or nose fairing barrel	X						lb	13,500 ±500	
		With nose fairing barrel but without encapsulated payload	X						lb	14,500 ±500	
		With encapsulated payload	X						lb	19,500 ±500	

21.5 REDLINE LIMITS

A "redline" is a limit value, either maximum or minimum or both, for a specific parameter which, if exceeded during countdown, could result in failure of a planned mission. A redline condition initiates a mandatory hold in operations. Emergency procedures are then followed to return the parameter to a safe condition, to investigate, and to apply corrective action. The measurement legend is defined in Table 21.5-1. Centaur "Redlines," including certain site and GSE measurements which affect Centaur, are listed in Table 21.5-2. Current "Redline" status for Centaur and its booster is maintained for each vehicle (see Report No. 951-5-116-AC12, unpublished).

TABLE 21.5-1. REDLINE LEGEND

SYMBOL					TRANSLATION
VEHICLE	SYSTEM	L.L. or METER	MEASUREMENT NO.	TYPE	
C					Centaur
	A				Airframe
	D				Range Safety
	E				Electrical
	F				Pneumatics
	H				Hydraulics
	I				Guidance
	N				Site
	P				Propulsion
	U				Propellant Utilization
		1			Landline (Recorder)
		5			Landline (Meter or Light)
				P	Pressure
				Q	Frequency
				T	Temperature
				V	Voltage
				W	Time
				X	Event

TABLE 21.5-2. REDLINE LIMITS

VEHICLE	SYSTEM	L.L. or METER	MEASURE-MENT NO.	TYPE	DESCRIPTION	PHASE OF OPERATION	REDLINE LIMIT MIN	REDLINE LIMIT MAX	UNITS	REASON FOR REDLINE (AND NOTES)
C	A	1	399	P	Insl pnl purge fwd DP	T-120 min to T-8 sec Average wind speed Zero to 15 knots 15 to 19 knots 19 to 22 knots	 0.03 0.04 0.05		 psid psid psid	Min redline represents value of helium purge pressure required to assure that, under worst possible wind conditions, air will not leak under panels and freeze them in place
C	D	5	002	V	RSC No. 1 rcvr AGC	From rcvr No. 1 intern to upper umbilical ejection	(See Note 1)			NOTE 1: A complete loss of AGC on both receivers is a redline condition. Loss of AGC on one receiver only should be called to the attention of the test conductor and/or pad safety officer
C	D	5	007		RSC No. 2 rcvr AGC	From rcvr No. 2				
C	E	5	050	Q	Vehicle a-c pwr supply freq	Vehicle power internal	398	402	cps	Frequency of the static inverter must be maintained within indicated limits to ensure proper operation of user systems. Frequencies exceeding the redline limits indicate a faulty inverter and could result in mission failure
C	E	5	014	V	Pyro battery No. 1	From battery activation to launch	34.7		vdc	Voltages below the limits given indicate a faulty battery and could cause the failure of nose fairing jettison
C	E	5	021	V	Cent RSC No. 1 batt	Open circuit voltage prior to loading	33.2		vdc	Voltages below the limits given indicate a faulty battery, which could cause failure of the Range Safety Command system

TABLE 21.5-2. REDLINE LIMITS (Continued)

VEHICLE	SYSTEM	L.L. or METER	MEASURE-MENT NO.	TYPE	DESCRIPTION	PHASE OF OPERATION	REDLINE LIMIT MIN	REDLINE LIMIT MAX	UNITS	REASON FOR REDLINE (AND NOTES)
C (Continued)	E	5	021	V		Open circuit voltage after vehicle loading	32.0		vdc	
						Loaded voltage	30.0		vdc	
						Pulse load voltage	22.0		vdc	
C	E	5	022	V	Cent RSC No. 2 batt	Open circuit voltage prior to loading	33.2		vdc	(See CE5021V)
						Open circuit voltage after vehicle loading	32.0		vdc	
						Loaded voltage	30.0		vdc	
						Pulse load voltage	22.0		vdc	
C	E	5	028	V	Vehicle system d-c input	Internal operation	27.0		vdc	Voltages outside the limits specified indicate a faulty battery and could result in faulty operation of the user systems and subsequent mission failure
						Decrease in loaded voltage reading from 30 sec after transfer to internal power, to launch		0.5	vdc	
C	E	5	042	V	Pyro battery No. 2	From battery activation to launch	34.7		vdc	(See CE5014V)
C	E	5	051	V	400 Cycle a-c phase A	Vehicle power internal	113.8	116.2	vac	Voltages beyond redline limits indicate a faulty static inverter, which could result in faulty operation of user systems and subsequent mission failure

TABLE 21.5-2. REDLINE LIMITS (Continued)

VEHICLE	SYSTEM	L.I. or METER	MEASURE-MENT NO.	TYPE	DESCRIPTION	PHASE OF OPERATION	REDLINE LIMIT MIN	REDLINE LIMIT MAX	UNITS	REASON FOR REDLINE (AND NOTES)
C	E	5	052	V	400 Cycle ac phase B	Vehicle power internal	113.8	116.2	vac	
C	E	5	053	V	400 Cycle ac phase C	Vehicle power internal	113.8	116.2	vac	
C	E	5	600	V	Cent main battery	Open circuit (See Note 2)	30.0		vdc	(See CE5028V) NOTE 2: Power changeover switch must be on external
C	E	5	023	W	Cent main bat elpsd time	Time on internal		40	min	Redline limit is the max time allowable for the battery to be loaded before launch and still retain sufficient charge for inflight requirements
C	E	5	025	W	RSC 1 bat elpsd time	Time on internal		40	min	
C	E	5	026	W	RSC 2 bat elpsd time	Time on internal		40	min	
C	F	1	001	P	LO_2 tank ullage	Standby on PCU	9.6	14.0	psig	Vehicle structural integrity depends upon maintaining proper pressures in the LO_2 and LH_2 tanks, as well as proper pressure relationships between the two tanks
						LO_2 line and tank chilldown, LO_2 tanking	14.0	24.5	psig	
						LH_2 line and tank chilldown. LH_2 tanking	14.7	24.5	psig	
						No. 2 vent valve checkout/lockup	15.0	24.5	psig	

TABLE 21.5-2. REDLINE LIMITS (Continued)

VEHICLE	SYSTEM	L.L. or METER	MEASURE-MENT NO.	TYPE	DESCRIPTION	PHASE OF OPERATION	REDLINE LIMIT MIN	REDLINE LIMIT MAX	UNITS	REASON FOR REDLINE (AND NOTES)
C	F	1	001	P		Tanking complete hold	14.0	24.5	psig	
(Continued)						Prelaunch hold	14.5	17.6	psig	
						LH_2 and LO_2 detanking	14.0	24.5	psig	
C	F	5	002	P	Helium Storage Bottle	Prior to launch	2,600		psig	The max redline is based on structural limitations of the bottle. The min requirement is determined by amount of helium necessary for the mission
						Any time		2,950	psig	
C	F	1	003	P	LH_2 Tank Ullage	Standby on PCU	4.0	7.0	psig	
						LO_2 line and tank chilldown, LO_2 tanking	4.0	9.5	psig	(See CF1001P)
						LH_2 line and tank chilldown, LH_2 tanking	4.0	11.3	psig	
						No. 2 vent valve checkout/lockup	4.0	12.4	psig	
						Tanking complete hold	4.0	9.5	psig	
						Prelch hold to T-8 sec	5.0	6.6	psig	

TABLE 21.5-2. REDLINE LIMITS (Continued)

VEHICLE	SYSTEM	L.I. or METER	MEASURE-MENT NO.	TYPE	DESCRIPTION	PHASE OF OPERATION	REDLINE LIMIT MIN	REDLINE LIMIT MAX	UNITS	REASON FOR REDLINE (AND NOTES)
C (Continued)	F	1	003	P		LH_2 and LO_2 detanking	4.0	9.5	psig	
C	F	1	008	P	Engine cont reg out	Helium btl pressurized to umbilical eject	440	475	psig	Pressures outside redline limits indicate that the engine control pneumatic regulator is not operating within specified limits and could cause malfunction of engine valves
C	F	1	010	P	H_2O_2 bottle reg out	Helium btl pressurized to umbilical eject	297	315	psig	Pressures outside redline limits indicate that the H_2O_2 propellant tank pressure regulator is not supplying the proper pressure to the H_2O_2 bottle
C	F	1	012	P	H_2O_2 btl pneum pr	Start H_2O_2 tanking to detanking		360	psia	A steady or rapid increase beyond the redline limit indicates excessive peroxide decomposition and calls for immediate detanking
						Prior to launch	305	335	psia	
C	F	1	047	P	Ins panel purge dp	During ground insulation panel purge		1.95	psid	Insulation panel structural integrity depends upon maintaining the differential pressure across the panel below the redline limit
C	F	1	146	P	A/B purge btl disch	T-80 min to T-15 sec	120	300	psia	The min redline is the least pressure which will provide sufficient helium flow to assure proper insulation panel purge.
						T-15 sec, momentary spike decaying to launch	(See Note 3)			The max redline is the value above which damage to the panels could occur and is an indication of regulator problems if exceeded

TABLE 21.5-2. REDLINE LIMITS (Continued)

VEHICLE	SYSTEM	L.L. or METER	MEASURE-MENT NO.	TYPE	DESCRIPTION	PHASE OF OPERATION	REDLINE LIMIT MIN	REDLINE LIMIT MAX	UNITS	REASON FOR REDLINE (AND NOTES)
C	F	1	146 (Continued)	P						NOTE 3: Any detectable spike is acceptable. Spike indicates opening of valve
C	F	1	302	P	N/F thruster btl Q1-4	Prior to umbil eject	2,200	2,500	psig	The min redline reflects the lowest pressure which will provide sufficient force to jettison the nose fairing halves properly.
C	F	1	303	P	N/F thruster btl Q2-3	Prior to umbil eject	2,200	2,500	psig	Pressures over the maximum redline may impart excessive loads to the nose fairing hinges upon jettison
C	F	5	004	T	Helium storage bottle	Prior to flight		90	dgf	The "prior-to-flight" value is the highest temperature at which a sufficient weight of helium will be contained in the bottle at the redline minimum pressure.
						During charging (See Note 4)		152	dgf	
C	F	5	147	T	A/B helium panel purge btl	Prior to flight		90	dgf	The "during charging" redline is dictated by structural considerations of the bottle
						During charging (See Note 4)		152	dgf	NOTE 4: To read temp in applicable system bottle, "bottle select switch" must be in correct position
C	H	1	005	T	Hydraulic manifold	Start of tanking to umbilical eject	20	140	dgf	To verify that the hydraulic manifold and hydraulic oil temperatures remain within specifications

TABLE 21.5-2. REDLINE LIMITS (Continued)

VEHICLE	SYSTEM	L.L. or METER	MEASURE-MENT NO.	TYPE	DESCRIPTION	PHASE OF OPERATION	REDLINE LIMIT MIN	REDLINE LIMIT MAX	UNITS	REASON FOR REDLINE (AND NOTES)
C	I	1	034	V	In tor motor dir	Start of count to flight mode set (See Note 5)	-4.50	4.50	vdc	The platform inertial stabilization servoloop must remain stable and controlling during countdown to assure a gyro-stabilized platform. Improper operation of this loop would result in loss of the platform inertial reference
C	I	1	035	V	In mid tor motor dir	Start of count to flight mode set (See Note 5)	-3.3	3.3	vdc	NOTE 5: Transient spikes of less than 0.3 sec duration and not more than 5 volts greater than the redline value are acceptable exceptions
C	I	1	036	V	Out mid tor motor dir	Start of count to flight mode set (See Note 5)	-5.30	5.30	vdc	
C	I	1	037	V	Out tor motor dir	Start of count to flight mode set (See Note 5)	-2.2	2.2	vdc	
C	I	1	044	V	U gyro temp cont amp	Spin motor power on to flight mode set (See Note 6)	*vto +0.20	4.40	vdc	The fluorochemical fluid in which the gyro gimbal is floated must be maintained at a precise temperature to ensure proper operation of the gyro. Improper gyro operation will result in loss of platform inertial reference
C	I	1	045	V	V gyro temp cont amp	Spin motor power on to flight mode set (See Note 6)	*vto +0.20	4.40	vdc	NOTE 6: *VTO is the measured value of the temp control ampl voltage immediately after MGS power on.
C	I	1	046	V	W gyro temp cont amp	Spin motor power on to flight mode set (See Note 6)	*vto +0.20	4.40	vdc	
C	I	1	047	V	U accel temp cont amp	Spin motor power on to flight mode set (See Note 6)	*vto +0.20	4.40	vdc	The fluorochemical fluid in which the pendulous accelerometer gimbal is floated must be maintained at a precise temperature to ensure proper operation of the accelerometer.

TABLE 21.5-2. REDLINE LIMITS (Continued)

VEHICLE	SYSTEM	L.L. or METER	MEASURE-MENT NO.	TYPE	DESCRIPTION	PHASE OF OPERATION	REDLINE LIMIT		UNITS	REASON FOR REDLINE (AND NOTES)
							MIN	MAX		
C	I	1	048	V	V accel temp cont amp	Spin motor power on to flight mode set (See Note 6)	*vto +0.20	4.40	vdc	Improper accelerometer operation will result in feeding false values of delta velocities to the computer
C	I	1	049	V	W accel temp cont amp	Spin motor power on to flight mode set (See Note 6)	*vto +0.20	4.40	vdc	
C	I	1	078	V	Gyro torquing U dir	Final align mode complete to flight mode set	1.4	4.6	vdc	An improper gyro torquing voltage will result in loss of the platform inertial reference and erroneous guidance commands during flight
C	I	1	079	V	Gyro torquing V dir	Final align mode complete to flight mode set	4.8	8.0	vdc	NOTE 7: When optical acquisition is maintained
C	I	1	080	V	Gyro torquing W dir	Final align mode complete to flight mode set (See Note 7)	-7.0	0.6	vdc	
C	N	5	071	P	A/B helium pnl purge btl	At initiation of inflight purge (See Note 8)	2,600	2,950	psig	The min redline is the pressure required to assure that enough helium is in the bottle for a complete blowdown.
						Ambient tank, insul panels installed (See Note 8)		2,000	psig	The max redline is based on structural limitations of the bottle NOTE 8: CN5071P reads "purge bottle pressure only" when press syst "bottle select" switch is in purge position

TABLE 21.5-2. REDLINE LIMITS (Continued)

VEHICLE	SYSTEM	L.L. or METER	MEASUREMENT NO.	TYPE	DESCRIPTION	PHASE OF OPERATION	REDLINE LIMIT MIN	REDLINE LIMIT MAX	UNITS	REASON FOR REDLINE (AND NOTES)
C	N	5	459	P	Lower boom accumulator	Prior to launch	1,300		psig	The min redline is the min pressure required in the accumulator to assure one full retraction of the boom
C	N	5	460	P	Upper boom accumulator	Prior to launch	1,300		psig	
C	N	1	910	P	Environ GN_2 supl pr	From start of Centaur tanking to T-5	900		psig	The min redline is based on the min allowable amount of GN_2 available for air-conditioning if LH_2 detanking is necessary.
						From T-5 and counting to T-0 with Atlas thrust sect htr on GN_2	540		psig	The max value is based on structural considerations of the bottles
						Anytime		2,400	psig	
C	N	1	557	T	Thrust sect supply duct	During helium chilldown	125	135	dgf	The min redline is the lowest allowable conditioning GN_2 temperature entering the 2nd stage thrust section which will preclude overchilling of critical components in this area. The max is based on the max allowable temperatures of the H_2O_2 system and other critical components
C	P	1	014	T	P-1 fuel supply	Bottle fill to T-5 minutes		140	dgf	Marked changes in H_2O_2 temperature and pressure could indicate the presence of contaminants in the system or excessive self decomposition of H_2O_2
						T-5 minutes to umbilical eject		120	dgf	

TABLE 21.5-2. REDLINE LIMITS (Continued)

VEHICLE	SYSTEM	L.L. or METER	MEASURE-MENT NO.	TYPE	DESCRIPTION	PHASE OF OPERATION	REDLINE LIMIT MIN	REDLINE LIMIT MAX	UNITS	REASON FOR REDLINE (AND NOTES)
C	P	1	033	T	LO_2 B pump inlet	End of LO_2 topping to umbilical eject	-285		dgf	If LO_2 is loaded which is too cold, and is below the min redline, the liquid will not be saturated and pressure in the LO_2 tank may fall below levels required for structural integrity of the tank and intermediate bulkhead
C	P	1	036	T	LO_2 BP turb bear	Prior to umbil eject	-25		dgf	At temperatures below this level, freezing of the bearing lubricant may occur
C	P	1	040	T	P-2 fuel supply	Bottle fill to T-5 minutes		140	dgf	(See CP1014T)
						T-5 minutes to umbilical eject		120	dgf	
C	P	1	059	T	C1 LO_2 pump inlet	From T-5 minutes to umbilical eject		-277	dgf	To verify that there is liquid at engine inlets prior to launch; this condition is required to assure a satisfactory engine start
C	P	1	060	T	C1 LH_2 pump inlet	From T-5 minutes to umbilical eject		-418	dgf	
C	P	1	061	T	C2 LO_2 pump inlet	From T-5 minutes to umbilical eject		-277	dgf	
C	P	1	062	T	C2 LH_2 pump inlet	From T-5 minutes to umbilical eject		-418	dgf	
C	P	1	093	T	H_2O_2 bottle temp	Bottle fill to T-5 minutes		140	dgf	(See CP1014T)
						T-5 minutes to launch		120	dgf	

TABLE 21.5-2. REDLINE LIMITS (Continued)

VEHICLE	SYSTEM	L.L. or METER	MEASURE-MENT NO.	TYPE	DESCRIPTION	PHASE OF OPERATION	REDLINE LIMIT MIN	REDLINE LIMIT MAX	UNITS	REASON FOR REDLINE (AND NOTES)
C	P	1	127	T	LH_2 bstpump turb bear	Prior to umbil eject	-25		dgf	(See CP1036T)
C	P	1	143	T	C1 engine comp amb	Prior to umbil eject		200	dgf	Temperatures above the max indicate air-conditioning system malfunction, or fire
C	P	1	144	T	C2 engine comp amb	Prior to umbil eject		200	dgf	
C	P	1	336	T	LH_2 boostpump varobox	Prior to umbil eject	0		dgf	Critical boost pump components must be above the min redline to assure proper inflight operation
C	P	1	337	T	LH_2 bstpump cont valve	Prior to umbil eject	0		dgf	
C	P	1	613	T	Helium chill-down line	Launch - 15.1 minutes to launch - 8 seconds		-390	dgf	Satisfactory inflight engine start requires pump cooldown, with the liquid helium system, to temperatures below the max redline
C	P	5	602	X	C1 ignitor box pr sw	Start of count to umbilical eject		green light out		Proper operation of engine ignition system requires that ignitor boxes remain pressurized at all times
C	P	5	603	X	C2 ignitor box pr sw	Start of count to umbilical eject		green light out		Light out indicates loss of pressure
C	U	5	160	X	LH_2 level 95 pc wet	From LH_2 tank 95 pc probe activation to launch	20		min	LH_2 venting is not permitted from launch to T+30 sec because of combustion hazard. To minimize LH_2 tank pressure rise rate, insulation panels must be chilled for this min time

TABLE 21.5-2. REDLINE LIMITS (Continued)

VEHICLE	SYSTEM	L.L. or METER	MEASURE-MENT NO.	TYPE	DESCRIPTION	PHASE OF OPERATION	REDLINE LIMIT MIN	REDLINE LIMIT MAX	UNITS	REASON FOR REDLINE (AND NOTES)
C	U	5	161	X	LO_2 100.2 pc wet light	T-90 seconds	100.2 wet light must be on			LO_2 must be loaded above this level to keep sloshing to a min, because of elimination of the slosh baffles
C	U	5	164	X	LH_2 99.8 pc wet light	T-90 seconds	99.8 wet light must be on			To assure sufficient LH_2 for successful mission accomplishment

SECTION XXII

GROUND SYSTEMS CRITERIA

22.1 STRUCTURAL CRITERIA

Report Number 55-00210, "Structural Design Critera Centaur Ground Support Equipment," defines the criteria for determining loads and establishing the load factors to be used for the design of Ground Support Equipment (GSE). Winds, handling, transportation, stretch, captive firing, internal pressure, and dynamic testing are considered.

22.2 ENVIRONMENTAL CRITERIA

Report Number 55-00200E, "Environmental Design and Test Requirements for Project Centaur Equipment," defines the criteria for establishing the operating conditions, non-operating conditions, and qualification provisions for the design of GSE. Temperature, altitude, humidity, shock, vibration, acoustic noise, electromagnetic interference, explosive atmosphere, and equipment life are considered.

SECTION XXIII

INDEX

23.1 SCOPE: This index is compiled to serve as a key to source information that may be known under several different nomenclatures in past and present documents describing the Centaur Systems. Nomenclatures were obtained from Contract NAS3-3228, Task order 6; Contract NAS3-3232, Task order 567; the applicable documents; the bibliography; and the drawings listed in the following paragraphs.

23.2 APPLICABLE DOCUMENTS: The documents listed as follows supplement the information in this report and are required to obtain a complete system's description.

1. Centaur Complex 36B Environmental Control System Operation and Maintenance Manual Volume 2, Convair Report 63-1005, 1 April 1965.

2. Centaur Complex 36B Environmental Control System Operation and Maintenance Manual Volume 3, Convair Report 63-1005, 1 April 1965.

3. Centaur Complex 36B, Propellant Loading System Operation and Maintenance Manual, Convair Report 63-1011, 1 July 1965.

4. Centaur Complex 36B Stretch System Operation and Maintenance Manual, Convair Report 63-1008, 10 July 1964.

5. Centaur Complex 36B Umbilical Boom System Operation and Maintenance Manual, Convair Report 63-1013, 1 April 1965.

6. Environmental Design and Test Requirements for Project Centaur Equipment, Convair Report 55-00200E, 11 September 1964.

7. Ground Pneumatic System Operation and Maintenance Manual Complex 36B ETR, Convair Report 63-1012, 15 June 1965.

8. Operation and Maintenance Manual Landline Instrumentation System ETR, Complex 36A and 36B, Convair Report BYH64-002, 15 October 1965.

9. Structural Design Criteria, Centaur Ground Support Equipment, Convair Report BTD65-165, 10 February 1966.

23.3 BIBLIOGRAPHY: The documents listed as follows were utilized to prepare this report and can be used to amplify the information on any specific system.

1. Appendix A Facilities Design Criteria for Fifth AMR Launch Site, Convair Report ZL-7-074, 20 July 1959 (Confidential).

2. Atlas-Centaur Flight Evaluation Report Vehicle AC2, Convair Report GDA63-1237, 9 January 1964 (Confidential).

3. Atlas-Centaur Flight Evaluation Report Vehicle AC3, Convair Report GDA-BNZ64-022 (Confidential), 15 August 1964.

4. Atlas-Centaur Flight Evaluation Report Vehicle AC4, Convair Report GDA-BNZ64-045, 1 February 1965 (Confidential).

5. Atlas-Centaur Flight Evaluation Report Vehicle AC5, Convair Report BNZ65-019, 1 April 1965 (Confidential).

6. Atlas-Centaur Flight Evaluation Report Vehicle AC6, Convair Report BNZ65-037, 22 October 1965 (Confidential).

7. Atlas/Centaur Launch on Time Study, Convair Report ACY65-001-4, 7 July 1965.

8. Centaur Monthly Configuration Performance and Weight Status Report, Convair Report GDC63-0495, 21 August 1965 (Confidential).

9. Centaur Operational Configuration Data Task Order 6. Convair letters to L. C. Perry, NASA/LeRC.

955-63-670	2 May 1963
955-63-666	29 April 1963
955-63-560	8 May 1963
955-63-654	13 May 1963
955-63-1060	12 June 1963

10. Centaur Redlines, Convair Report 951-5-116-AC12, (Unpublished).

11. Centaur Technical Handbook, Report No. GD/A-BPM64-001-1, 1 October 1964.

12. Centaur Unified Test Plan Section 9 Test Parameters, Convair Report AY62-0047, 23 September 1965.

13. Facilities Design Criteria for Fifth AMR Launch Site, Convair Report ZL-7-074, 27 April 1959 (Confidential).

14. Ground Support Specification for Centaur Checkout Equipment, Convair Report 55-01416A, 15 May 1965.

15. Ground Support Specification for Centaur Electrical (L/C) System, Convair Report 55-01412A, 15 May 1965.

16. Ground Support Specification for Centaur Ground Instrumentation System, Convair Report 55-01415A, 15 May 1965.

17. Ground Support Specification for Centaur Handling, Erecting, and Servicing Equipment, Convair Report 55-01411 revision A, 3 March 1965.

18. Ground Support Specification for Centaur Inertial Guidance System, Convair Report 55-01417A, 15 May 1965.

19. Ground Support Specification for Centaur Pressurization System, Convair Report 55-01414, Revision B, 15 May 1965.

20. Ground Support Specification for Centaur Propellant Loading System, Convair Report 55-01413A, 15 May 1965.

21. Ground-Wind Restrictions Procedure for Atlas/Centaur/Surveyor AC6 and AC7, Convair Report GD/C-BTD65-061, dated 1 June 1965.

22. Interface Requirements for Atlas/Centaur AC8, Convair Report 65/952-3/75, 30 November 1965.

23. NASA Centaur 6D Model Specification, Convair Report 55-01508, 13 October 1965.

24. Trajectory Data Book AC6, Convair Report BTD65-002, 19 April 1965.

23.4 DRAWINGS: The drawing numbers listed as follows are referenced in the text of the report and may be used to amplify information on hardware that is a component of any specific system.

Index code (F3.2-2 is Figure 3.2-2)
(T9.3-1 is Table 9.3-1)
(8.2.4 is Paragraph 8.2.4)

DRAWING NO.	REF.	DRAWING NO.	REF.
AD319600MK2	F3.2-2	DUG8283A1	F14.3-1
D920544	F14.3-1	DUG8284A1	F14.3-1
DM923203	F14.3-1	DUG8285A1	F14.3-1
DM923511	F14.3-1	MS25269-D1	F9.4-6
DM924541	F14.3-1	PWA15241	8.2.4
DM925514	F14.3-1	PWA15256	8.2.4
DM925540	F14.3-1	PWA15416	8.2.4
DM925541	F14.3-1	PWA15428	8.2.4
DM925542	F14.3-1	PWA15429	8.2.4
DM925544	F14.3-1	PWA15430	8.2.4
DM925545	F14.3-1	RL10A-3-3	F3.2-2,
DM925546	F14.3-1		F8.2-1
DM925547	F14.3-1	TPISS-7437	6.5
DM925548	F14.3-1	0-00036	T16.3-3
DM925758	F14.3-1	7-02329	T9.3-1
DM926067	F14.3-1,	7-05203	15.1.2
	F14.5-6	27-06162	F19.2-1
DUG8029	F14.3-1,	27-06600	F19.2-1
	F14.5-6	27-06601	F19.2-1
DUG8034	F14.3-1,	27-91303	F19.2-1
	F14.5-6	55-01222	F3.2-2
DUG8035	F14.3-1,	55-01276	F3.2-2
	F14.5-6	55-02012	T18.3-1
DUG8038	F14.5-6	55-02013	F12.1-12
DUG8041	F14.3-1,	55-02016	F12.1-12
	F14.5-6	55-02106	T9.3-1,
DUG8198	F14.3-1		F20.1-2
DUG8199	F14.3-1	55-02109	T9.3-1,
DUG8204	F14.3-1		F9.3-2
DUG8205C1	F14.3-1	55-02136	T9.3-1
DUG8220	F14.3-1	55-02141	F3.2-2
DUG8282A1	F14.3-1		

DRAWING NO.	REF.	DRAWING NO.	REF.
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55-02153	T9.3-1	55-05203	F15.1-7
55-02154	T9.3-1	55-05320	15.2.2
55-02157	T9.3-1	55-05349	15.2.2
55-02172	T9.3-1	55-05350	15.2.2
55-02176	F9.4-3,	55-05351	15.2.2
	F20.1-3	55-06265	F3.2-2
55-02183	F9.4-6	55-06266	F3.2-2
55-02400	F3.2-2	55-08102	F3.2-2
55-02412	8.2.4	55-08111	T18.3-2
55-02424	F9.5-9,	55-08128	T9.3-1
	9.5.4	55-08140	T9.3-1
55-02430	F20.2-1	55-08151	F7.1-1,
55-02602	T9.3-1		F20.1-3
55-02603	T9.3-1	55-08153	F20.1-3,
55-02604	T9.3-1		F7.1-1,
55-02716	F9.4-6		F20.2-1
55-02911	T9.3-1	55-08155	F20.1-3
55-02912	T9.3-1	55-08158	F20.1-3
55-02913	T9.3-1	55-08159	F10.3-3,
55-02925	T9.3-1		F20.1-3,
55-02929	T9.3-1		F20.2-1
55-02930	T9.3-1	55-08160	T9.3-1
55-02940	T9.3-1	55-08163	T9.3-1
55-02943	T9.3-1	55-08166	F7.1-1,
55-02946	T9.3-1		F20.1-3
55-02951	T9.3-1	55-08194	T9.3-1
55-02957	T9.3-1	55-08196	T9.3-1
55-02961	T9.3-1	55-08301	T18.3-1
55-02964	T9.3-1	55-08311	T18.3-1
55-02962	T9.3-1	55-08513	F7.2-1
55-02971	T9.3-1	55-08607	F11.1-1
55-02972	T9.3-1	55-08607	F11.3-1
55-02976	T9.3-1	55-08622	F11.1-1,
55-02984	T9.3-1		F11.3-1,
55-02990	T9.3-1		F20.1-6
55-02992	T9.3-1	55-09001	T19.2-1,
55-02996	T9.3-1		F19.2-2,
55-02997	T9.3-1		F19.2-6,
55-02999	T9.3-1		F19.3-1
55-04218	F12.2-2,	55-09029	F19.4-9
	F12.2-6	55-12507	F3.2-2

DRAWING NO.	REF.
55-13506	F3.2-2
55-13508	F3.2-2
55-16261	F20.1-2
55-17257	T18.2-2
55-17519	17.1.2
55-17520	17.1.2
55-21131	F3.2-2
55-23001	F9.3-2,
	T18.3-2
55-23025	T9.3-1
55-24019	8.2.4
55-24023	9.5.4
55-24045	9.5.4
55-24047	F9.5-13,
	9.5.4
55-24071	9.5.4
55-24074	F9.5-16,
	F20.1-7
55-24090	F3.2-2
55-24102	9.5.4
55-29018	T9.3-1
55-29051	T9.3-1
55-29064	T9.3-1
55-29082	T9.3-1
55-29083	T9.3-1
55-29086	T9.3-1
55-29092	T9.3-1
55-29110	T9.3-1
55-29117	T9.3-1
55-29131	F20.2-1
55-29138	F20.2-1
55-29159	T9.3-1,
	F20.2-1
55-29160	T9.3-1,
	F9.3-2
55-29161	T9.3-1
55-29171	T9.3-1
55-29172	T9.3-1,
	F9.3-2
55-29178	T9.3-1
55-29181	T9.3-1
55-29189	T9.3-1
55-29190	T9.3-1
55-29191	T9.3-1
55-29192	T9.3-1,
	F9.3-2,
	F9.4-3
55-29235	F20.1-7,
	9.5.4
55-29273	F9.5-16,
	9.5.4
55-29275	F20.1-2,
	F9.4-3
55-29277	F20.1-6
55-29282	F20.2-1
55-29285	9.5.4
55-30974	T9.3-1
55-36073	4.3.2,
	F4.3-2
55-36080	F3.2-2
55-40001	F3.2-2
55-40002	F3.2-2
55-43210	F3.2-2
55-43248	F3.2-2
55-46130	F3.2-2
55-46131	F3.2-2
55-46132	F3.2-2
55-46133	F3.2-2
55-49033	T9.3-1
55-49046	T9.3-1
55-49182	F14.3-1,
	F14.5-6,
	F14.6-1
55-51222	12.1.5
55-51221	12.1.5
55-53117	T18.5-1
	15.2.2
55-54119	18.6
55-54165	F15.1-7
55-54172	15.1.2
55-54402	F12.2-6,
	F15.1-4

DRAWING NO.	REF.
55-54403	F12.2-6, F16.2-3
55-54404	F8.2-4, F9.4-3, F9.4-6, F12.2-2, F12.2-6
55-54406	F12.2-2
55-54407	F9.2-2, F12.2-2
55-54409	F9.2-2, F9.3-2, F9.6-2, F12.2-6
55-54410	F10.2-3, F10.3-3, F12.2-2, F12.2-6
55-54411	F8.2-4, F9.2-2, F9.3-2, F12.2-2, F12.2-3, F12.2-6, F15.1-4, F16.2-3
55-54412	F12.2-2
55-54416	F8.2-4, F12.2-2
55-54419	F8.2-4, F9.2-2, F9.3-2, F12.2-2, F12.2-3, F12.2-6, F15.1-4
55-54424	F12.1-12
55-54427	F8.2-4, F9.2-2, F9.4-3, F9.6-2, F12.1-12, F12.2-2,
55-54427 (continued)	F12.2-3, F12.2-6, F12.1-8, F13.2-6, F13.2-8, F16.2-3, F15.1-4
55-54428	F12.2-2, F12.2-6
55-54429	F12.2-2, F12.2-6
55-54439	F12.1-12
55-54448	F8.2-4, F9.2-2, F9.4-3, F9.4-6, F12.2-3, F12.2-6
55-54502	F9.4-3
55-54514	F12.1-12
55-54542	12.1.5
55-54550	T18.5-1
55-54551	T18.5-1
55-54552	T18.5-1
55-54553	T18.5-1
55-54554	T18.5-1
55-54555	T18.5-1
55-54556	T18.5-1
55-54568	F9.4-3
55-54590	F12.1-12, F12.2-3
55-54595	F9.2-2, F9.3-2, F9.4-3, F9.4-6, F9.6-2, F12.1-12, F12.2-2, F15.1-4
55-54603	F9.4-3
55-54606	F8.2-4, F12.1-12

DRAWING NO.	REF.
55-54612	F13.2-6,
	F13.2-8
55-54618	F9.2-2,
	F9.4-3,
	F9.4-6,
	F12.1-12,
	F12.2-2,
	F15.1-4
55-54626	F9.4-3
55-54629	F12.1-12
55-54635	F13.2-6,
	F13.2-8
55-54648	F13.2-6,
	F13.2-8
55-54649	F12.1-12,
	F12.2-6
55-54672	F9.2-2
55-54679	F10.3-3
55-54683	F10.2-3
55-54686	F9.2-2,
	F9.3-2,
	F9.6-2
55-54694	F9.2-2,
	F9.3-2,
	F9.6-2
55-54696	F9.2-2
55-54698	F12.2-7
55-54700	F12.2-2
55-54702	F12.2-2
55-54704	F12.2-3
55-54710	F12.2-6
55-54712	F12.2-2
55-54714	F9.2-2
55-54716	F10.2-3
55-54718	F10.2-3
55-54720	F10.2-3
55-54722	F10.3-3
55-54736	F9.3-2
55-54737	F9.3-2,
	F9.6-2

DRAWING NO.	REF.
55-54738	F8.2-4,
	F9.2-2,
	F9.6-2,
	F10.2-3,
	F10.3-3
55-54739	F12.2-2
55-54746	F9.3-2
55-54755	F16.2-3
55-54757	F16.2-3
55-54761	F15.1-4
55-54763	F8.2-4
55-54773	F15.1-4
55-54780	F13.2-8
55-54781	F15.1-4
55-54783	F15.1-4
55-54783	F15.1-4
55-54784	F16.2-3
55-54785	F16.2-3
55-54789	F8.2-4
55-54790	F12.2-2
55-54791	13.2.2,
	F13.1-4,
	F13.2-6,
	12.2-2,
	F8.2-4,
	F12.2-6
55-54792	F13.2-8
55-54793	F12.2-2,
	F12.2-6
55-54794	F13.2-8
55-54796	F8.2-4
	F13.2-6
	F12.2-6,
	13.2.2
55-54797	F13.2-8
55-54798	F8.2-4,
	F12.2-2,
	F12.2-6
55-54799	F15.1-4,
	F16.2-3,
	F12.2-6,
	F12.2-2

DRAWING NO.	REF.
55-54805	13.2.2, F13.1-5, F13.2-8
55-54811	F13.1-5
55-54821	13.2.2, F13.1-5, F13.1-4, F13.2-6, F13.2-8
55-54823	F13.2-8
55-54831	13.2.2, F13.1- , F13.2-8, F13.2-6
55-54833	F13.2-6, 13.2.2, F13.1-4
55-54835	F13.1-5, 13.2.2, F13.2-8
55-54837	13.2.2, F13.2-8, F13.1-5
55-54839	F13.2-8, F13.1-5, 13.2.2
55-54841	F13.2-8, F13.1-5, 13.2.2
55-54843	F13.2-8, F13.1-5, 13.2.2
55-54853	F13.1-4, F13.2-6
55-54855	F11.3-1, F11.3-5, F13.1-4, F13.2-6
55-54857	F13.2-8, 13.2.2, F13.1-5
55-54859	F13.2-8, 13.2.2, F13.1-5
55-54861	F13.1-5, 13.2.2, F13.2-8
55-54873	F9.2-2, F9.3-2
55-54881	13.2.2 F13.2-8
55-54897	F13.1-5, 13.2.2, F13.2-8
55-55065	F9.2-2, F9.6-2
55-55067	F9.4-6
55-55068	F9.4-6
55-55513	F9.6-2, F12.1-12
55-55630	13.2.2, F13.2-6, F13.2-8
55-55730	T18.2-1
55-55731	T18.2-1
55-55732	T18.2-1
55-55733	T18.2-1
55-55734	T18.2-1
55-55735	T18.2-1
55-55736	T18.2-1
55-55737	T18.2-2
55-56319	F6.4-1
55-56320	6.4.2
55-56322	6.4.2
55-56042	15.1.2, F15.1-7
55-56101	15.1.2
55-56403	F15.1-4

DRAWING NO.	REF.	DRAWING NO.	REF.
55-58873	F9.6-2	55-73802	F5.2-1
55-60231	12.1.6	55-74029	F3.2-2
55-60494	9.6.4	55-74036	F3.2-2
55-61012	F3.2-2	55-74042	F3.2-2
55-61019	F3.2-2	55-74053	F3.2-2
55-61040	F3.2-2	55-74203	F19.3-1
55-61081	F9.2-2,	55-74204	F19.3-1
	F9.6-2	55-74205	F19.3-1
55-61093	F3.2-2	55-74206	F19.3-1
55-61329	F9.4-3	55-75000	F19.3-1
55-61348	F3.2-2	55-75030	F5.2-1
55-61365	F3.2-2	55-75037	F5.2-1
55-61368	F3.2-2	55-75061	F5.2-1
55-61427	F3.2-2	55-75063	F5.2-1
55-61499	F6.4-1	55-75068	F5.2-1
55-61502	F3.2-2	55-80072	F3.2-2
55-61813	F3.2-2	55-81030	9.5.4
55-61814	F3.2-2	55-81033	F3.2-2
55-63128	9.6.4	55-81034	F7.1-1,
55-63130	9.6.4		F20.1-3
55-63131	9.6.4	55-81037	9.5.4
55-63132	9.6.4	55-83062	F20.1-4
55-63133	9.6.4	55-83063	F20.1-8
55-63134	9.6.4	55-83065	F20.1-4
55-64007	F5.2-1	55-83066	F20.1-3
55-64506	F5.2-1	55-83087	F20.1-8
55-65621	F9.6-2,	55-83089	F20.1-3
	F9.3-2	55-83157	F10.2-5
55-65972	T18.2-2	55-83158	F10.2-5
55-71141	T19.4-1	55-85025	F11.1-1,
55-71146	T19.4-1		F11.3-1,
55-71170	F4.3-2		F11.3-5
55-72007	F19.4-8,	55-85400	F3.2-2,
	F19.4-9,		F11.3-1
	F19.3-14,	55-85413	F11.1-1
	F19.4-7,	55-87031	F11.1-1,
	F19.4-4,		F11.2-4,
	F19.4-3		F11.3-1
55-72466	F3.2-2	55-87151	F20.1-4
55-72980	F5.2-1	55-87200	F11.3-5
55-73304	F5.2-1	55-87205	F11.1-1,
			F11.3-5

DRAWING NO.	REF.
55-90060	F19.4-7, F19.4-6, F19.4-5, F19.4-8, T19.5-1, T19.4-1, F19.3-1, F19.3-14
55-90061	T19.4-1, F19.4-7, F19.4-5, F19.4-8, F19.4-9
55-90062	F19.4-7, 19.4.3, F19.4-5 F19.3-1, T19.3-1, 19.3.8 F19.3-14, T19.4-1
55-90063	T19.4-1
55-90063	F19.4-7, F19.4-6, F19.4-8, F19.4-9
55-90064	T19.4-1, F19.4-4
55-90065	F19.4-5, T19.4-1
55-90066	F19.4-7, 19.4.3, F19.4-5
55-90067	F19.4-7, 19.4.3, F19.4-5
55-90068	F19.4-6, F19.4-5
55-90072	F19.4-5
55-90073	F19.4-5
55-90075	F19.4-5

DRAWING NO.	REF.
55-90076	F19.4-7, 19.4.3, F19.4-5
55-90077	F19.4-7, 19.4.3
55-90081	T19.5-1
55-90094	T19.5-1
55-90095	F19.3-1, 19.3.8, T19.3-1, F19.3-13
55-91003	T19.2-1
55-91004	F19.2-1
55-91005	F19.2-1
55-91006	F19.2-1
55-91022	F19.2-1
55-91032	F19.2-1
55-91043	T19.5-1
55-91101	T19.2-1, F19.2-6
55-91102	T19.2-1, F19.2-2, F19.3-1 T19.5-1
55-91103	T19.2-1, F19.2-2, F19.2-5, F19.3-1
55-91104	T19.2-1, F19.2-2, F19.3-1
55-91105	T19.2-1, F19.2-2, F19.3-1
55-91106	F19.2-1, F19.2-2, F19.2-6
55-91108	F19.3-1, 19.3.8, T19.3-1
55-91112	F19.2-1, F19.2-2

DRAWING NO.	REF.
55-91113	F19.2-1, F19.2-2
55-91117	T19.5-1
55-91128	F19.3-11
55-91138	F19.2-1
55-91140	F19.2-1
55-93000	F19.4-1, F19.4-3
55-93001	T19.2-1
55-93004	F19.3-1, 19.3-8, T19.3-1
55-96097	T9.3-1
55-96118	19.3.3, 19.3.8, T19.3-1
55-97002	9.5.4
55-97050	T19.5-1
55-97058	F19.3-1
55-97063	19.3.8, T19.3-1
55-98003	12.1.5
55-98004	12.1.5, F12.1-8
55-98006	F12.1-8, 12.2.1, F13.2-6
55-98029	12.1.5
55-98030	12.1.5
55-98037	F12.1-8, F13.2-6
55-98038	F12.1-8, 16.2.2
55-98039	F12.1-8, F13.2-6
55-98040	F13.2-6
55-98042	13.2.4
55-98072	F16.2-3, 15.2.2, 16.2.2
57-29024	T9.3-1
57-29025	T9.3-1
57-29026	T9.3-1
57-29027	T9.3-1
80-09900	15.1.2
80-09901	15.2.2
80-09908	15.1.2
81-40975	F12.1-12
81-65903	F3.2-2
83-65900	T9.3-1
86-21901	12.1.6
86-73900	F9.4-6, T12.1-2
86-73901	T12.1-2
86-73903	T12.1-2
87-44933	15.1.2
99-35004	F9.4-6

23.5 SUBJECT INDEX: Areas of interest which do not appear in the table of contents were selected for the following subject index. A cross reference for different nomenclatures for the same items and for items of equipment that might have a specific interest is thereby established.

Index Code (F3.2-2 is Figure 3.2-2)
(T9.3-1 is Table 9.3-1)
(8.2.4 is Paragraph 8.2.4)