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TR -4-4-2-D

JUNE 15, 1963

SATURN V SERVICE ARMS PRELIMINARY ENGINEERING REPORT Complex 39

VOLUME I

LOC-FORM 16B-1

LAUNCH OPERATIONS CENTER

TR-4-4-2-D

SATURN V SERVICE ARMS

PRELIMINARY ENGINEERING REPORT

VOLUME I

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ABSTRACT

This report presents the manufacturing requirements for fabricating Saturn V service arms and contains design and operating details of the service arms and associated equipment.

Part 1 defines the areas of responsibility necessary for the manufacture of Saturn V service arms and associated equipment. Capability requirements, manufacturing processes, special techniques, schedules, and other areas are detailed in Part 1. The manufacturer selected to fabricate the arms and related equipment must meet the requirements stated in Part 1.

Part 2 contains design and operation details of the service arms, Command Module Access Arm, and related equipment used on or in support of the Launcher-Umbilical Tower for the Saturn V Vehicle at Complex 39. The design and construction of all basic arms is similar. Eight service arms are being designed. The arms are being designed to support all umbilical lines necessary to service the various stages of all Saturn V Vehicles. The arms are also being designed to allow personnel access to the vehicle.

Some of the arms must be retracted before vehicle lift-off and others will retract following lift-off. This requirement necessitated the design of umbilical disconnect and arm retract devices which would ensure clearance between the arms and vehicle during lift-off.

The Command Module Access Arm is a separate design concept. The arm is used only for astronaut access to the Command Module.

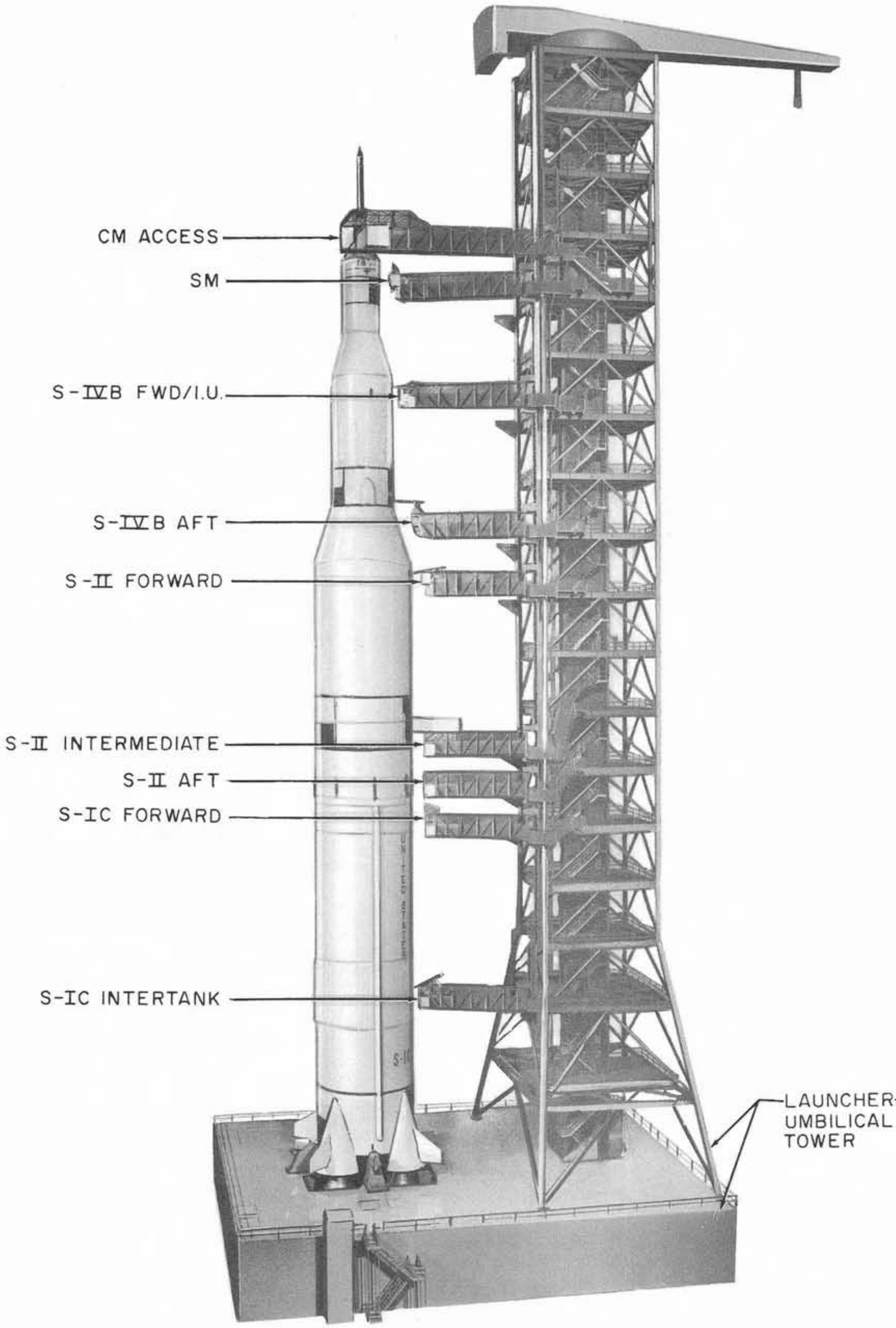
Part 2 presents the preliminary design directed toward meeting the requirements stated above.

TR-4-4-2-D
July 10, 1963

SATURN V SERVICE ARMS
PRELIMINARY
ENGINEERING REPORT
COMPLEX 39

VOLUME I

LAUNCH EQUIPMENT BRANCH
LAUNCH SUPPORT EQUIPMENT ENGINEERING DIVISION
LAUNCH OPERATIONS CENTER
HUNTSVILLE, ALABAMA



Scale Model of Proposed Launcher-Umbilical Tower (LUT)

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PART 2

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SUMMARY

This volume of the Preliminary Engineering Report presents requirements for fabricating Saturn V Service Arms and contains design and operating details of the service and access arms and associated equipment.

Part 1 defines the areas of responsibility necessary for the manufacture of Saturn V service arms and associated equipment. Capability requirements, manufacturing processes, special techniques, schedules, and other areas are detailed in Part 1. The manufacturer selected to fabricate the arms and related equipment must meet the requirements stated in Part 1.

Part 2 is primarily devoted to the design and operation of the service arms and Command Module Access Arm to be used at Launch Complex 39. Additional information included in this report describes the function of the arms in various prelaunch modes, the location of each arm with respect to the vehicle, and the design criteria. Auxiliary equipment, used in conjunction with the subject arms, is described, and the supporting function of this equipment is explained.

The major assemblies of the service arm include the first and second elements, extension elements, withdrawal mechanisms, and extension platforms. The rotation of the service arm is accomplished by a cylinder-type hydro-pneumatic system.

The major assemblies of the access arm include the basic arm structure, an extension to the arm structure, and an environmental cab. Rotation of the arm is accomplished by a hydraulic system using piston-rack type rotary actuators.

PART 1

SCOPE OF WORK

FOR

FABRICATION

OF

SATURN V SERVICE ARMS

AND

RELATED EQUIPMENT

SECTION I.
SCOPE

1-1. INTRODUCTION.

The scope of work covered in Part 1 consists of furnishing all plant facilities, labor, material, and equipment necessary for the fabrication and delivery of the Saturn V Service Arms and associated equipment, per provisions stated herein and in Part 2. Figure 1-1 illustrates a portion of the service arms and associated equipment. The arms will provide service and personnel access to the Saturn V Vehicle which will be launched from Launch Complex 39, Cape Canaveral, Florida. Some of the service arms will be retracted prior to launching of the vehicle; the remainder will retract during launch. Complete operational testing of each arm and accessories will be completed by NASA personnel before the equipment is installed on Complex 39.

1-2. DESCRIPTION OF EQUIPMENT.

The contract will include fabrication of the following components:

1-3. ARM BASIC STRUCTURE.

The arm basic structure (Figure 1-2) will be a welded truss composed of round and square tubular shapes of T-1 steel. The maximum chord member is 3 x 3 inches square, with a wall thickness of 0. 188 inch.

Each arm is made up of two structural elements. The first element will be common to all arms. The approximate dimensions for this element are 272 inches long, 60 inches wide, and 98 inches high. The second element varies in length from 146 inches to 182 inches, depending upon the vehicle stage being served. Width and depth dimensions are the same as on the first element.

1-4. EXTENSION PLATFORM.

The extension platform (Figure 1-3) is composed of five major parts as follows:

a. A basic platform support, similar in construction to the basic arm, of square tubular shapes of T-1 steel.
b. A T-head service area which is mounted to the basic platform support, and similar in construction to (a).
c. A bumper assembly which makes contact with the vehicle.
d. A coupler assembly which connects the bumper to the vehicle.
e. The drive mechanisms which position the basic platform support and the T-head.

Varying vehicle configurations require modifications to the extension platform. The modifications are detailed in Part 2.

Figure 1-1. S-IVB AFT and S-II FWD Service Arms and Associated Equipment

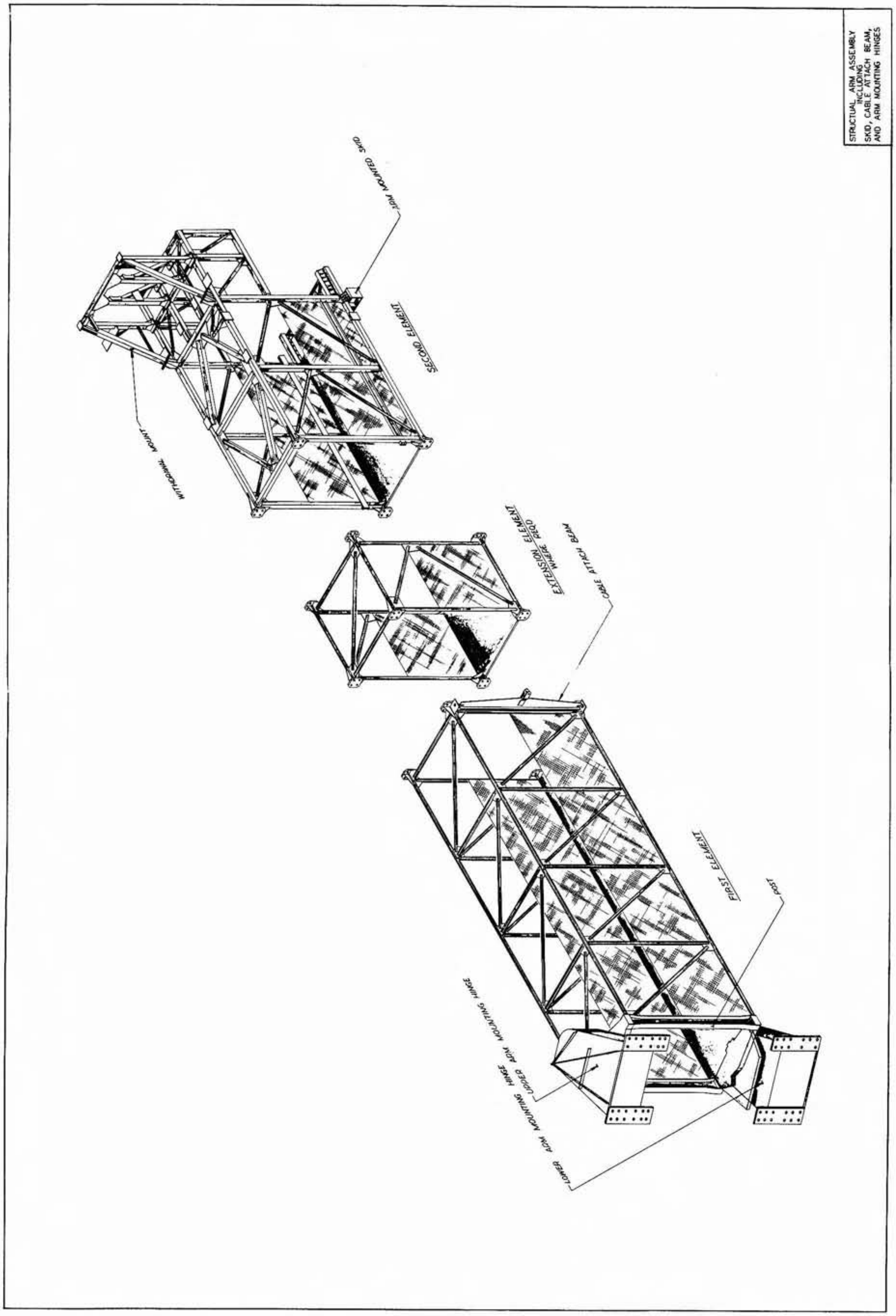

Figure 1-2. Arm Basic Structure

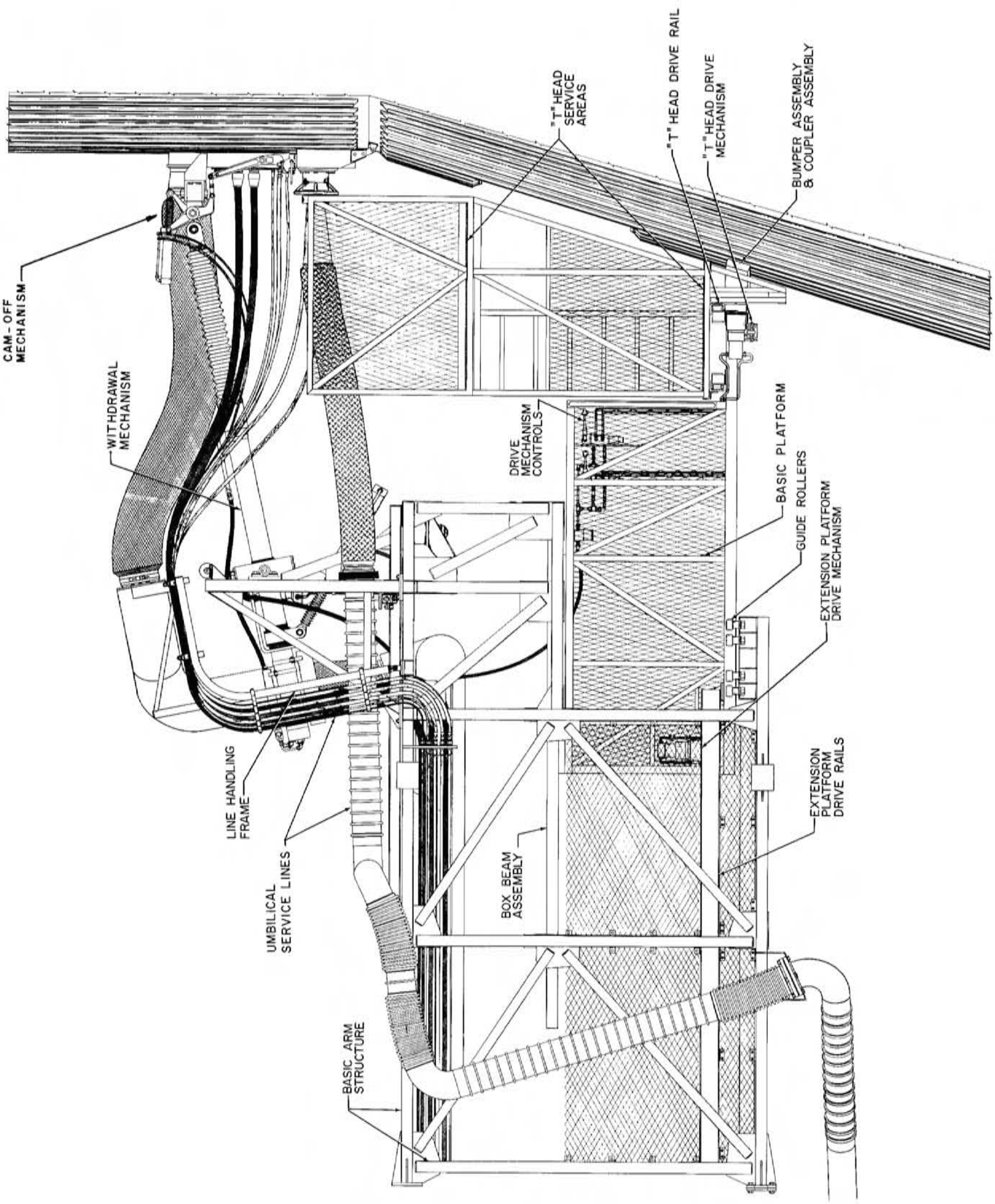

Figure 1-3. S-IVB AFT Arm Tip

1-5. TOWER MOUNTING HINGES.

Two hinges (Figure 1-4), positioned outboard of the arm at the top and bottom chords, house retraction cylinders, valves, and bearing assemblies. The hinges are plate weldments fabricated of A441 steel which varies in thickness from 0.5 to 1.5 inches. Each hinge is fastened to the tower with twenty-three 1-1/4-inch diameter high strength bolts. The hinges are standard for all the arms.

1-6. UMBILICAL SERVICE LINES.

The umbilical service lines (Figure 1-3) which connect the tower piping to the vehicle are supported on the service arms. They are composed of both hard and flex lines of various sizes and materials as follows:

a. S-IC INTERTANK ARM - two 8-inch I.D. stainless steel, vacuum-jacketed LOX lines.
b. S-IC FWD ARM - approximately 16 miscellaneous lines including 0.25-inch I.D. pneumatic lines, two 4-inch I.D. air conditioning ducts, and electrical cables.
c. S-II AFT ARM - one 1-inch corrugated stainless steel bleed line.
d. S-II INTERMEDIATE ARM - one 8-inch I.D. LOX line, one 8-inch I.D. LH_2 line, each vacuum-jacketed corrugated stainless steel. In addition there are approximately 37 miscellaneous lines ranging from 0.25-inch I.D. to 2.00-inch I.D., and electrical cables, plus two 10-inch and one 4-inch air conditioning ducts.
e. S-II FWD ARM - two 8-inch I.D. corrugated stainless steel vent lines; twelve electrical cables; six miscellaneous pneumatic lines ranging in size from 0.25-inch I.D. to 1.00-inch I.D., and a 4-inch air conditioning line.
f. S-IVB AFT ARM - one 6-inch I.D. LOX line and one 6-inch I.D. LH_2 line, each vacuum-jacketed corrugated stainless steel, with 19 miscellaneous lines, 0.25-inch to 0.75-inch I.D., and electrical cables, plus one 10-inch air conditioning line.
g. S-IVB FWD ARM - one 6-inch I.D. corrugated stainless steel vent line; 29 miscellaneous lines, 0.25 to 1.50-inch I.D. electrical cables, and one 6-inch air conditioning line. The instrument unit umbilical lines are included in this grouping.
h. Service Module ARM - 12 miscellaneous lines, 0.25 to 1.25-inch I.D., and two 6-inch air conditioning lines.

1-7. HYDRAULIC AND PNEUMATIC SYSTEMS.

The major items in the hydraulic and pneumatic systems are the arm retraction systems (Figure 1-4) and the withdrawal mechanisms (Figure 1-3).

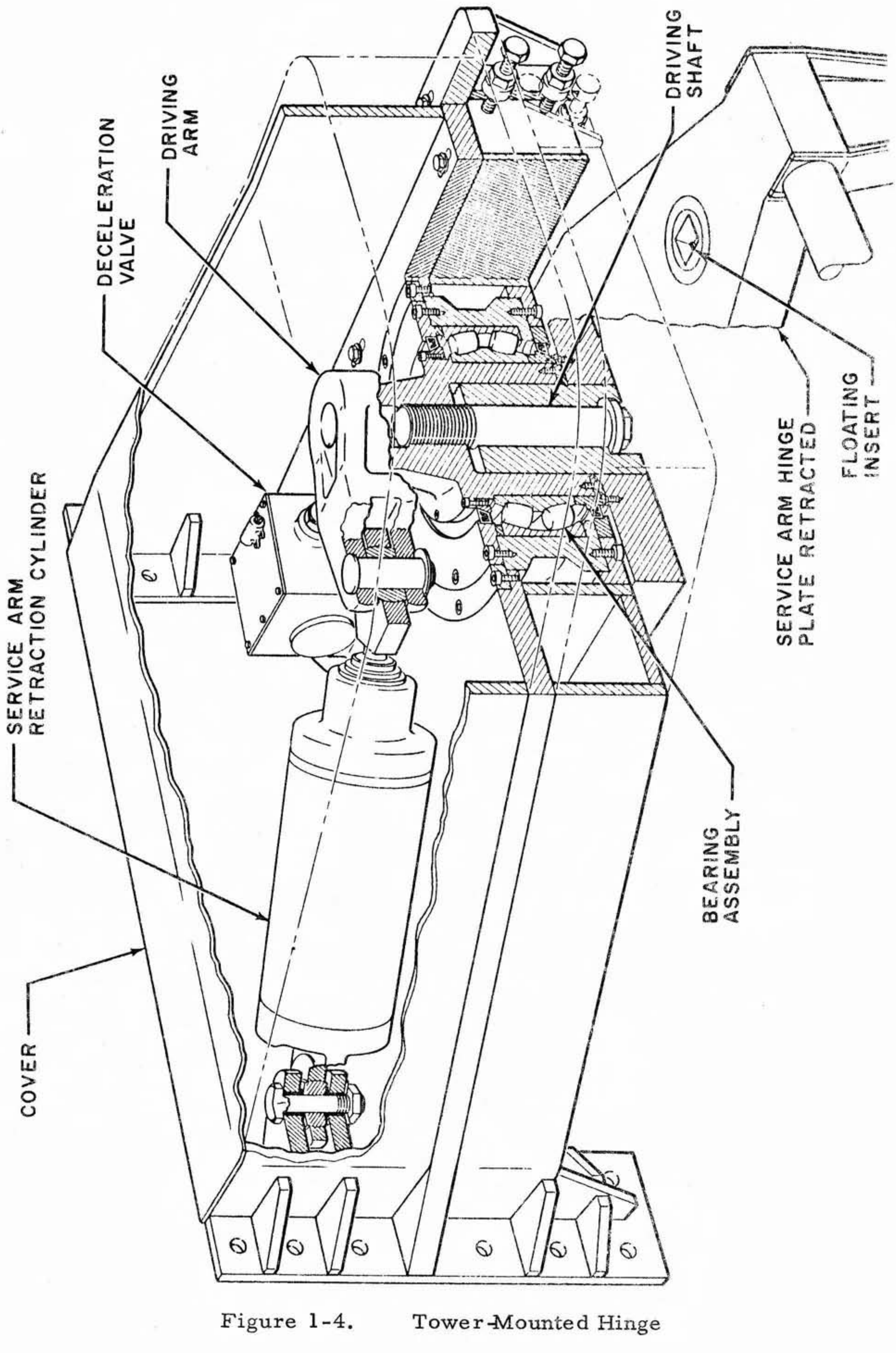

Figure 1-4. Tower-Mounted Hinge

An in-flight arm retraction system is composed of the following:

a. Two hydraulic actuators, one in the top and one in the bottom hinge (Figure 1-4). Each cylinder has an 8-inch bore, 14.87-inch stroke, and a 3.5-inch rod, and is mounted within the hinge.
b. One hydro-pneumatic cylinder, mounted on the tower deck; this cylinder has a 7-inch bore, a 52-inch stroke, with the rod end attached to a 4-pulley block (Figure 1-5).
c. Primary and secondary pressure supplies, consisting of six 10-gallon nitrogen bottles, and a piston-type 10-gallon accumulator.

The largest withdrawal mechanism is composed of:

a. A large cylinder (Figure 1-6) of special design, having a 5-inch bore, a 4-inch tubular rod, and stroke of approx. 5 feet. This cylinder is trunnion-mounted in a universal joint.
b. A small cylinder, which is a standard high-pressure actuator with a 3-inch bore, 20-inch stroke, and a 1.5-inch rod, trunnion-mounted in a universal joint.
c. A secondary device for umbilical plate disconnect, which is a small single-acting pneumatic cylinder driving a spring-loaded linkage (Figure 1-7).

A hydraulic charging unit is mounted in the base of the LUT and supplies hydraulic fluid where required for all systems. It consists of a 500-gallon reservoir with dual 5000 psi, 10 gpm pumps, filters, valving, and controls.

In addition to these items, there are numerous cables, pneumatic lines, hydraulic lines, and associated valves and controls as described in Part 2 and detailed in the engineering drawings.

1-8. ELECTRIC CONTROL AND POWER SYSTEMS.

The electrical portion of the service arm control system will consist of cabinets, panels, and components, both internal and external, at each service arm level, and interconnects between these units. These units will be used for the operational control, monitoring, and signal distribution for the respective service arms.

Lighting on each service arm will provide 20 foot-candle illumination, and receptacles will provide electrical power as required. A Class I, Group B, explosion-proof system will be provided throughout.

All electrical cables from the service arm umbilical plate to the tower distribution box will be provided with connectors at each end. Sufficient cable flexibility to assure proper operation of the withdrawal and retract mechanisms is necessary. These cables will be thermal coated for high temperature exposure.

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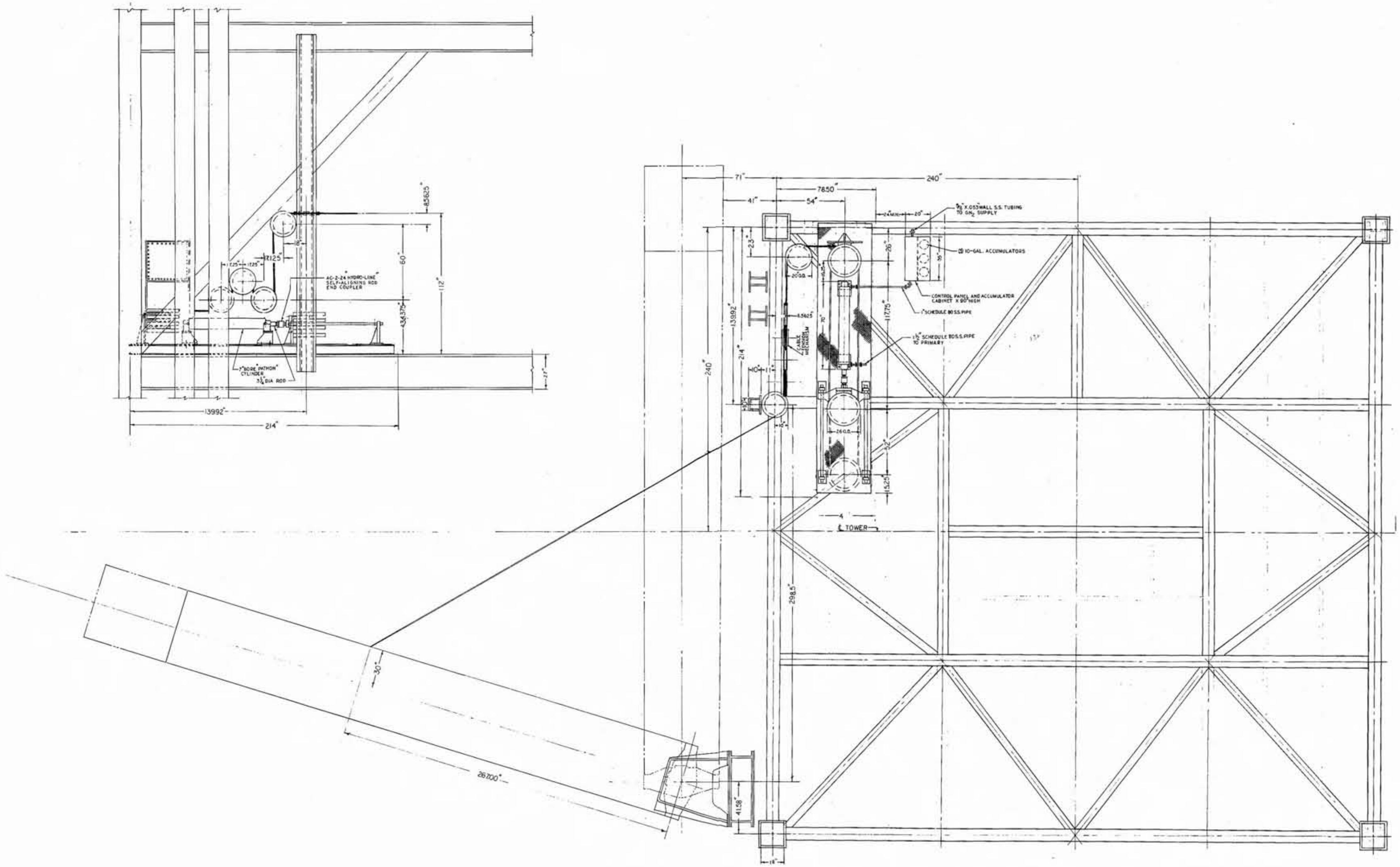

Figure 1-5. Cable Retraction System

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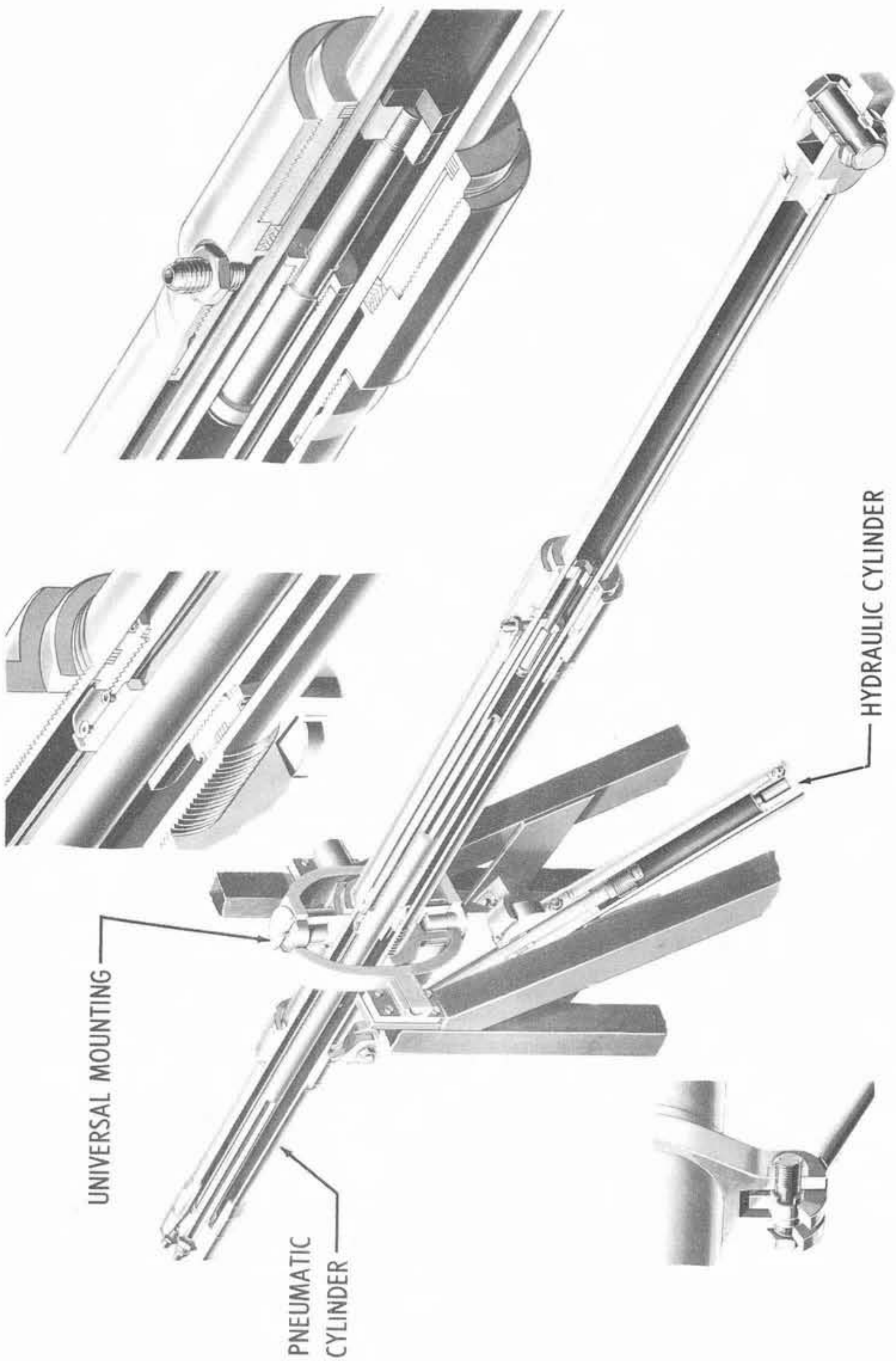

Figure 1-6. Cylinder-Type Withdrawal Mechanism

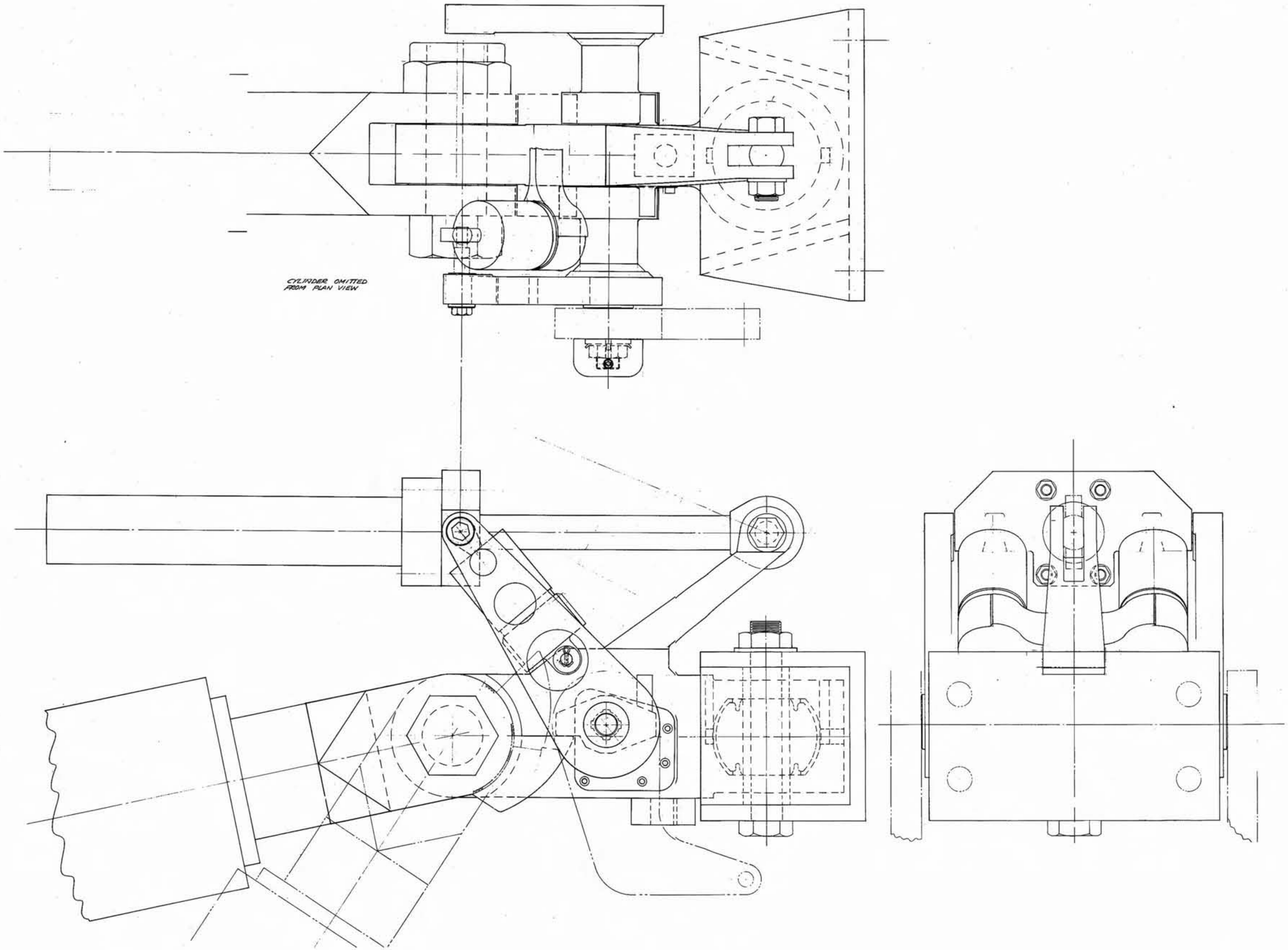

Figure 1-7. Umbilical Carrier
Cam-Off Mechanism

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Test sets and procedures for complete verification of the satisfactory operation of all units shall be provided to ensure operational reliability.

Control panels and cabinets, with associated instruments and equipment, will be required in the base of the LUT for all service arms to provide interface with the Launch Control Center and for local recording, indication and control.

1-9. WATER QUENCH SYSTEM.

The water quench system (Figure 1-8) consists of header pipe assemblies and spray nozzles mounted on the face of the tower. The spray pipes will tee off the tower headers so that each service arm is covered by two pipes, one above and one below the arm. The pipe used in this system ranges from 2-1/2-inch to 6-inch I. D. Each spray nozzle will be capable of discharging 28 gallons of water per minute, at 70 psi.

The water quench system will operate from an electrical control panel in the LUT.

1-10. TRANSPORT TRAILER UNITS.

Transport trailer units (Figure 1-9) will be of sufficient size to transport a complete service arm and accessories, and will be capable of highway travel. The drop-deck platform type units will be 10-feet wide by 56-feet long, have removable metal body panels, and will be covered with supported tarpaulin.

1-11. QUANTITIES TO BE MANUFACTURED.

The quantities to be manufactured under this scope, according to the major divisions, are as follows:

a. Service Arms - there will be four complete sets of service arms manufactured, consisting of eight arms per set. This includes one set for each of the three LUT's of Launch Complex 39, with one set of spares. In addition, there will be provided 10 percent loose spares for all components of the first three sets.
b. Water Quench System - there will be one water quench header system for each arm, making a total of four sets, eight arms per set.
c. Control panels located remotely from the service arm - this includes all control panels outlined in 1-7, 1-8, and 1-9.
d. Transport trailers - there will be eight complete transport trailer units.

Upon satisfactory completion of the items called for in this scope, the contractor will be given the opportunity to negotiate for the manufacture of four Command Module access arms and their associated equipment.

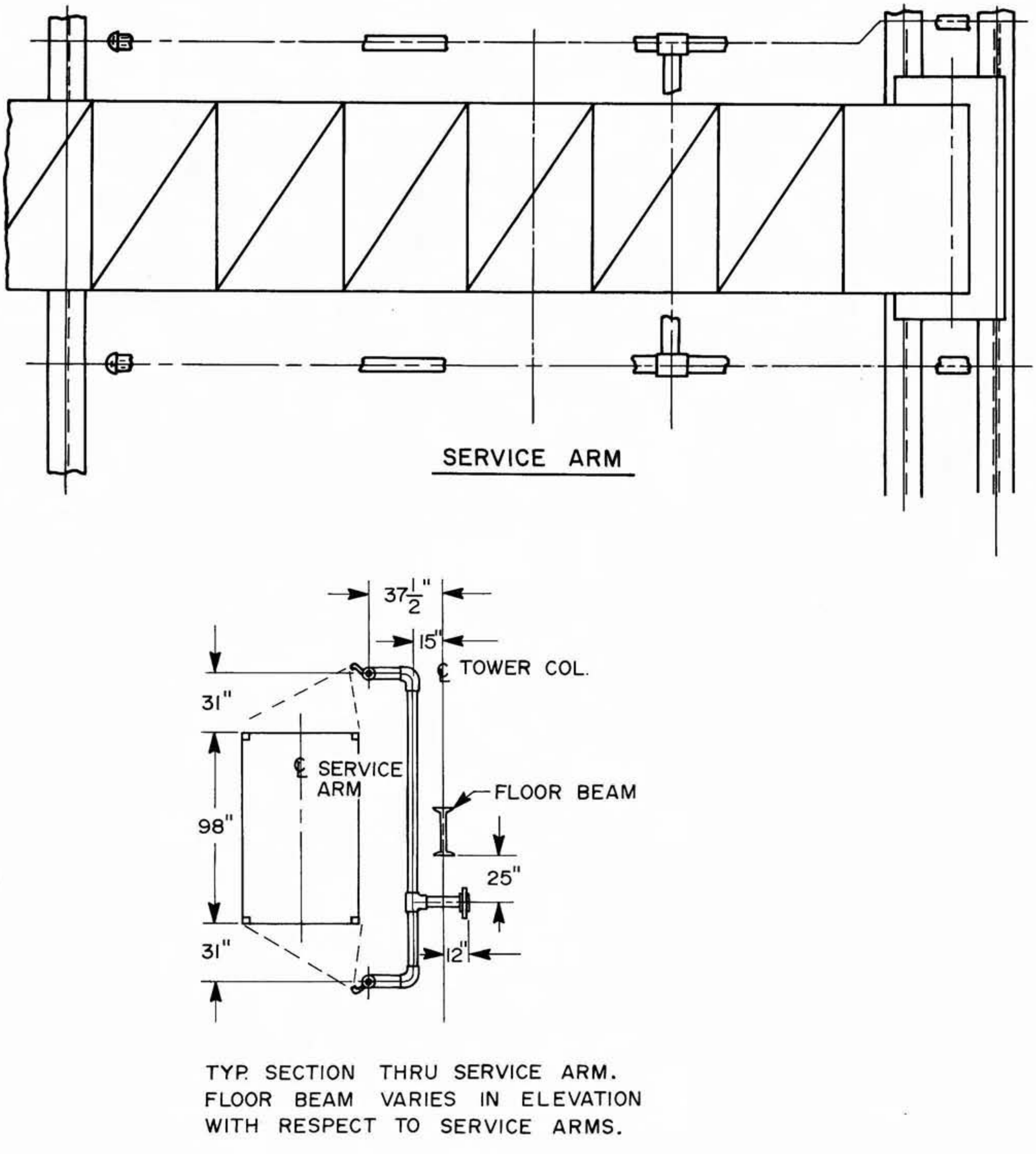

Figure 1-8. Water Quench Header Arrangement

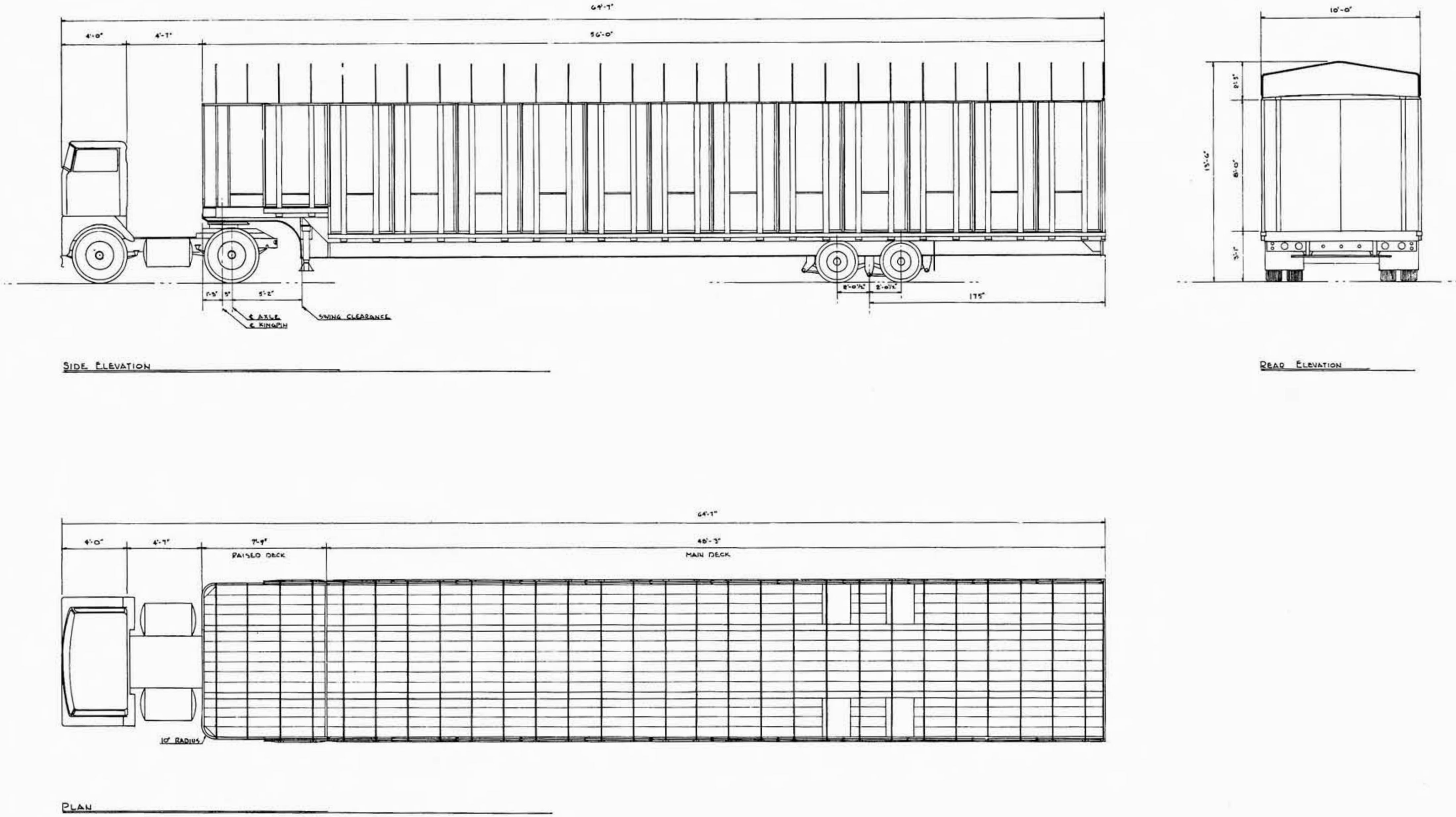

Figure 1-9. Arm Transport Trailer

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If it becomes necessary for an arm to be provided for the Lunar Excursion Module, it shall be within the scope of work to negotiate for the manufacture of four such arms and their associated equipment.

1-12. SPECIAL PROCESSES.

Propellant and pneumatic line cleaning will be required both before and after testing. Refer to Section III for fabrication and special processes details.

1-13. TIME FACTOR.

The first set of eight service arms with their associated equipment, water quench systems, and transport trailers shall be completed and delivered to NASA for operational testing at MSFC seven months after award of contract. For delivery dates of remaining items, see master schedule (Figure 1-10).

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SECTION II.
EVALUATION CRITERIA

2-1. GENERAL.

Contractors will be evaluated and selected in accordance with the criteria discussed in the subsequent paragraphs.

2-2. SCHEDULE.

The contractor shall adhere to the schedule established by LOC (Section VI), and to whatever changes that may be required to successfully complete LOC scheduling requirements. The ability and past performance of the contractor to adapt to design changes and modifications in tooling and processes with minimum schedule delay will be evaluated.

2-3. COST.

The contractor shall establish a cost figure for the manufacture of Saturn V service arms and related support equipment, with further cost breakdown as directed by the contracting officer. Although the lowest price will affect the award of the contract, the realism of the cost figures presented will indicate to some degree the experience of the contractor and his grasp of the project, and could result in rejection of a contractor for a deficiency of either.

2-4. MANAGEMENT CAPABILITIES.

Changes or modifications to the basic service arm design may require fabrication, testing, and delivery within an extremely short time. Therefore, the contractor's ability to assign additional personnel to the program and efficiently manage a close schedule is of prime importance. An organization is desired that can properly direct a project of this scope, with emphasis on schedule completion in problem areas. An organization is desired that would also provide a central contact for LOC and subcontractor personnel in obtaining schedules, reports, and project status for proper coordination and direction.

2-5. EXPERIENCE.

Work experience and past projects of the contractor shall be in the manufacturing of equipment similar to that delineated in Section I. This contractor experience should be in, or related to, the fabrication areas listed below.

a. Umbilical disconnect devices.
b. Umbilical support structures and retract mechanisms.
c. Control systems, panels, lines, and cables.
d. Large launch support equipment (hydraulic, pneumatic, electrical, mechanical).

e. Test sets to check out complex equipment and systems.
f. Trailers to transport equipment described in Section I.

2-6. FACILITIES.

Facilities of the contractor and subcontractors must be inspected and approved by LOC (Section VIII) and shall have all equipment necessary to complete the performance of the contract. Equipment and processes that shall be required are defined in Section III.

2-7. PERSONNEL.

Contractor personnel must be experienced in the manufacturing, functional testing, and shipping of equipment described in Section I. Welders shall be certified to NASA requirements as indicated in Part 2. Manufacturing personnel shall be fully capable of successfully performing all functions necessary to complete the services required.

2-8. LOCATION.

The location of the contractor's facilities, in relation to LOC and MSFC, will have a direct bearing on schedules and cost. The contractor shall be in a location to facilitate the following with minimum time and cost.

a. Transportation of service arms to MSFC for testing.
b. Return of service arms to contractor's facilities for refurbishing. (Must be located in the immediate vicinity of Huntsville, Ala.)
c. Transportation of service arms to Cape Canaveral.

2-9. SUBCONTRACTING.

The contractor shall not exceed 15 percent (paragraph 13-3) of the value of the contract in subcontracted services.

SECTION III.
CAPABILITY REQUIREMENTS

3-1. GENERAL

The contractor must show a proven capability for providing adequate fabrication facilities and manufacturing support, and must have experience in subcontracting methods and procedures. This capability and experience must have been directly related to the manufacture of umbilical disconnect devices, service structures, and related systems which have performed satisfactorily during actual launch operations. To effectively provide the required services, the following capabilities are considered necessary.

3-2. FACILITIES AND SPECIAL PROCESSES.

The contractor must be capable of providing facilities and services for the manufacture of service arms, umbilical disconnect devices, and supporting equipment to be used on Launch Complex 39 for the Saturn V Vehicle. These facilities shall be adequate to manufacture the equipment delineated in Section I. The facilities must be adaptable to changes or modifications in the basic design of the equipment. The processes and facilities necessary to manufacture Saturn V service arms and related equipment are as follows:

a. General and precision machining.
b. Welding and sheet metal working.
c. Precision welding jig and fixture fabrication.
d. Material plating, painting, and finishing.
e. LOX clean, hydraulic clean, and "clean room" (to MSFC-PROC-166 and MSFC-PROC-164).
f. Inspection (including X-ray, zyglo, magnetic particle).
g. Silkscreening.
h. Functional testing of components and subassemblies.

Element welds shall be inspected as follows:

a. Connections of the four chords to the arm hinge plates shall be 100 percent radiographically inspected.
b. Approximately 16 joints are designated as critical on the drawing 75M-05835 and shall be 100 percent radiographically inspected.
c. Five percent of the remaining welds shall be radiographically inspected.
d. The remaining welds shall be inspected by a magnetic particle method.

Adequate facilities to hoist and handle all items and assemblies must be available.

3-3. ENGINEERING.

The contractor must have available a minimum of 10 engineering personnel to support the manufacturing, functional, and quality test efforts. These personnel must have substantial manufacturing production engineering experience. These engineering personnel must be available to either the manufacturing or test areas as required and will be required to determine if the proper fabrication tools, equipment and processes are being utilized. A minimum of three manufacturing engineers will be assigned to the NASA test area at MSFC, as required by the customer, to assist in coordinating or making changes recommended by LOC personnel.

3-4. SUBCONTRACTING.

The contractor must select subcontractors who have adequate facilities for performing the required work. The subcontractor must have experience in the manufacturing and testing of items of a nature similar to those subcontracted. Subcontractors must have facilities and personnel to accomplish the contracted work in an expeditious manner to ensure schedule compliance. The subcontractor must have the ability to quickly adapt processing tools and facilities in the event that basic design changes are necessary. Quality control procedures and methods must meet LOC requirements to facilitate in-process and end-product inspection (Section V).

SECTION IV.
NASA PERT AND COMPANION COST SYSTEM

4-1. REPORTING.

Periodic reporting to NASA by the contractor of time and cost actuals and projections will be accomplished as set forth herein. Contractor reports are required in the operation of NASA's internal project control system called "NASA PERT and Companion Cost". Contractor recognizes NASA's responsibility and authority to establish the type, content, and format of information required. Operation of the system and contractor's obligation in connection therewith are to be as described in the NASA PERT and Companion Cost System Handbook as in effect on the date of this contract.

4-2. IMPLEMENTATION.

Contract requirements under the NASA PERT and Companion Cost System shall be implemented through the operation of an implementation team consisting of representatives of the contractor and of NASA. The NASA Technical Supervisor shall: determine the NASA representatives on the team; designate from the NASA members a team Chairman; and approve contractor representatives on the team. The work breakdown structure to be used by the team as the framework for structuring of the NASA PERT fragnets and corresponding cost reporting categories shall be established by the contractor and approved by the technical supervisor.

4-3. PARTICIPATION.

Fragnets and subdivision of work cost categories (see Handbook) are to be established for each line item or group of line items as indicated by the contractor and approved by the technical supervisor. The contractor's participation, as a member of the implementation team, shall include but not be limited to the following:

a. Development of the required fragnets.
b. Interconnecting of fragnets so that data can be processed separately for each fragnet or as a group for the contractor's entire project effort.
c. Identification of events and activities comprising each of the fragnets required.
d. Definition of content of each cost reporting category.
e. Identification of activities chargeable to each subdivision of work cost category.
f. Establishment of the initial time estimate for each activity.

4-4. REQUIREMENTS.

Lower level time and cost detail, which contractor utilizes for its own management purposes to validate information reported to NASA, shall be consistent with NASA requirements hereunder.

Contractor shall exert its best efforts to ensure participation of its subcontractors in implementation and operation of the NASA PERT and Companion Cost System as appropriate.

The approximate scope of each fragnet (in terms of the number of activities) that will be required is also to be indicated by the contractor and approved by the technical supervisor. This number is an approximate estimate included in the contract primarily for purposes of estimating the cost of meeting the requirements under this clause.

Reporting against initially developed fragnets shall commence upon direction by the NASA Technical Supervisor. Frequency of reporting shall be as determined by NASA's Technical Supervisor but not more frequently than every two weeks. Reporting against all fragnets specified by the contractor will be commenced at the time the Technical Supervisor deems appropriate. Reporting against and updating of individual fragnets shall commence as soon as individual fragnets are developed and not until completion of all fragnets. The computer input data reported shall be current as of the reporting date.

Cost reports of actuals and projections shall be submitted by the contractor on NASA Form 533 in accordance with the instructions on the reverse of the form, as supplemented by the work breakdown structure, and in the number of copies set forth in the contract schedule. Reports shall be submitted at the time and in the manner designated by the NASA Contracting Officer provided, if the reporting requirements described above are changed, contractor shall be entitled to an equitable adjustment under the last paragraph hereof. The line items within the work breakdown structure will constitute the subdivisions of work to be reported. The elements of cost to be reported within each subdivision of work will be established by the contractor subject to approval by the Technical Supervisor.

In view of the character of the work under this contract, the initially developed fragnets referred to above need continual updating on a current basis to reflect to NASA a true picture of contractor work plans and status.

To ensure responsiveness and adequacy of reporting requirements, the implementation team will review total content and operation of the system annually.

During the course of this contract, if significant changes, either an increase or decrease, in NASA's information requirements specified in the work breakdown structure above, are directed by NASA's Technical Supervisor (through the NASA Contracting Officer) an equitable adjustment will be made in estimated cost, and fee to be paid to the contractor and in such other provisions of the contract as may be affected.

SECTION V.
QUALITY ASSURANCE

5-1. GENERAL.

The contractor shall provide a quality assurance system responsive to the requirements and decisions of MSFC's Quality Division. The system shall meet the requirements of "Inspection System Provisions for Suppliers of Space Materials, Parts, Components, and Services", NASA Quality Publication, National Publication Control 200-3. The system also shall meet the additional requirements specified in 5-2 through 5-17.

5-2. GOVERNMENT SOURCE INSPECTION.

Government source inspection is required on all items manufactured under this contract. The contractor shall provide facilities and other necessary provisions for 12 resident Government source inspectors during the term of the contract. Contractor-owned inspection and test equipment shall be made available to Government inspectors for product verification, if requested. The Government inspectors along with Quality Division and LOC personnel will be given at least 48 hours notice and be present during conduction of end-item subassembly acceptance tests. Inspectors and cognizant personnel also shall be notified before shipment of items.

5-3. ORGANIZATION.

The contractor shall have a quality assurance organization whose past performance proves it to be capable of operating without organizational constraints. The person responsible for directing the quality assurance organization shall have direct contact with contractor top management personnel and shall regularly report on the status and adequacy of the programs. This level of management shall be capable of ensuring compliance with all contractual commitments.

5-4. PLANNING.

The contractor's written inspection and test plan, including the product flow charts for each different end item, shall be submitted to the contracting officer, for review by NASA, within 60 days after contract award. Changes to the written plan shall be submitted at least two weeks before implementation. One-hundred percent inspection is required on all subassemblies and on each end item delivered under this contract.

5-5. DOCUMENTATION CONTROL.

The contractor shall control the distribution of drawings, change orders, control procedures, inspection and test procedures, and procurement documents within his facility. This effort shall include the controlled removal of all such documents from use as they become obsolete. The effectivity of changes, preferably by item as well as date, made to any controlled document shall be clearly defined and complete records maintained.

5-6. SUBCONTRACTOR CONTROL.

All subcontractors shall have inspection programs complying with NPC 200-3. Each subcontractor selected shall either have an acceptable previous quality record with the contractor or shall satisfactorily pass a quality survey performed by the contractor. Subcontractors engaged in this work shall be resurveyed semiannually or more often as quality histories necessitate. Subcontractors shall permit both scheduled and nonscheduled inspection access.

5-7. PROCUREMENT DOCUMENTS.

Purchase orders and subcontracts shall be reviewed by the contractor's quality engineering element to determine the adequacy of the completeness of the technical and quality requirements therein. Only those procurement documents which are approved shall be released for procurement operations. Reports, certifications, and other guarantees of compliance to requirements shall be submitted with any procured item whose important characteristics are not completely reverified by the contractor.

5-8. PRODUCTION INSPECTION AND TESTS.

The contractor's quality engineering function shall analyze all design documents to determine the factors that control the inherent reliability of the design. Based on this analysis, the characteristics to be measured in receiving, production, and shipping operations, shall be determined to assure the achievement of inherent reliability. This data shall be used, in conjunction with the manufacturing plan, to set inspection and test stations, and to comply with the requirements of paragraph 3.6 of NPC 200-3. All procedures shall be maintained current with the effective design documentation and process controls.

5-9. ACCEPTANCE TESTS AND MODIFICATIONS.

After manufacture, the completed end-item will be delivered to Test Division at MSFC for acceptance tests on the service arm and related equipment. The contractor shall supply three manufacturing engineers to MSFC Test Division during acceptance testing. After performance of the acceptance test, the equipment will be returned to the contractor for cleaning and refurbishment. Should acceptance testing indicate that modification of the equipment is required, such modifications shall be swiftly negotiated with the contractor and modified by the contractor at the test site where possible. Further testing will follow to confirm the effectiveness of the changes.

5-10. PROCESS CERTIFICATIONS.

Process certifications shall be provided on all special processes utilized in fulfilling this contract. These processes include welding, soldering, plating, anodizing, heat treating, LOX cleaning, X-ray, magnetic particle and liquid penetrant inspections, and any other processes specified in design documents. Process control procedures shall be generated and utilized. The contractor's quality organization shall conduct audits and reviews of operating processes and shall enforce compliance with the established procedures.

5-11. MATERIAL REVIEW BOARD.

The contractor shall conduct formal material review of any discrepant item that cannot be reworked to conform to design drawings. The material review board (MRB) shall consist of representatives from the quality, engineering, and production elements of the contractor's organization and of a Government representative. Acceptance of nonconforming material shall occur only with the unanimous agreement of the MRB. The contractor's MRB jurisdiction for this contract shall be limited to those discrepancies not affecting reliability, function, interchangeability, life, and safety. Requests for review of discrepancies affecting these areas, and records of all acceptance decisions made on minor discrepancies, shall be forwarded to LOC through the contracting officer.

5-12. TRACEABILITY.

A record of all operations performed on each delivered item, its components, and its sub-assemblies shall accompany each item through production, inspection, and testing. These records shall reference the applicable documents and changes, shall indicate the results of all inspections and tests performed, any MRB actions, and shall indicate operating times or expiration date of any limited-life item. The set of records defining each end item shall be used to permit compilation of all applicable certifications, inspection results, and test reports for any delivered item.

5-13. EQUIPMENT ACCURACY.

The contractor should use inspection and test equipment which has measurement capability of 10 percent of the allowable tolerance of the characteristic it measures. Similarly, the accuracy of standards used to calibrate equipment should be sufficient to measure 10 percent of the tolerance of the equipment calibrated.

5-14. CALIBRATION.

The contractor shall maintain records of the data resulting from calibration operations. Any equipment exceeding its required due date or tolerance shall be suitably isolated, tagged, or otherwise marked to prevent its use without special permission of LOC and/or NASA.

5-15. STATISTICAL TECHNIQUES.

Any sampling performed by the contractor shall be in accordance with MIL-STD-105, MIL-STD-414, or Department of Defense Inspection and Quality Control Handbooks H-106, 107, and 108. If required, other plans may be used with specific prior approval by Quality Division of MSFC. Statistical quality control charts shall be used whenever their use will increase the effective control over the article produced.

5-16. DATA AND ITEM ANALYSIS.

Inspection and test data shall be analyzed for indication of degradation of quality and reliability. If necessary, specific discrepant items shall be given an engineering failure analysis to determine the cause of the discrepancy. If analysis of the data or items indicates a design deficiency, LOC shall be notified and all applicable data, items, and other assistance shall be supplied to aid in design correction.

5-17. HOUSEKEEPING.

The contractor shall establish and maintain high standards for cleanliness and handling practices throughout the manufacturing and test facilities.

5-18. AUDITS.

The contractor's quality engineering personnel shall perform quarterly audits of the operating conformance to all quality requirements specified herein. The results of the audits, with statements of corrective actions taken, shall be submitted to the contracting officer within three weeks of the performance of the audit.

SECTION VI.
SCHEDULE

6-1. GENERAL.

The following brief definitions and discussion will make clear the intent of the accompanying schedule charts.

6-2. ENGINEERING.

The engineering required in connection with the manufacture of the service arms shall be that necessary during the manufacturing, testing, and refurbishing processes. Engineering work and guidance shall begin immediately upon award of the contract and will continue until final reprocessing or refurbishing at the manufacturer's facilities is complete.

6-3. FABRICATION.

Fabrication shall include manufacture and/or acquisition of the necessary component parts or materials and assembling these items into finished systems or structures for shipment to the test site. A general breakdown of the sub-assemblies to be fabricated is as follows:

a. Basic arm structure.
b. Withdrawal mechanisms.
c. Extension platforms.
d. Arm-mounted hydraulic and pneumatic systems and all associated tower and LUT-mounted control panels.
e. Electrical controls and power equipment mounted on the arm and control panels located on the tower and in the LUT.
f. Water quench header system and controls.
g. Arm-mounted platform and stairs.
h. Hydraulic charging unit mounted in the LUT.
i. Assembly of vehicle service lines (fuel, electrical, etc.).
j. Transport trailers.

Note: See Part II for a more detailed description of the service arms and related equipment.

Fabrication shall begin immediately after awarding of the contract. The government will submit a "letter of intent" to the selected contractor so that orders may be placed for the long-lead items required to begin manufacturing.

6-4. TRANSPORTATION.

Transportation refers to moving the service arms, related componets, and equipment as described below:

a. From the manufacturer's plant to the MSFC test site at Redstone Arsenal, Alabama.
b. From the test site to the manufacturer's refurbishing area in or near Huntsville, Ala.
c. From the refurbishing area to the AMR at Cape Canaveral.

6-5. INSPECTION.

Inspection, in this instance, refers to supervisory type inspection by NASA to ensure compliance with contractual commitments. This item, although not actually shown in the chart, will be scheduled on a continuing basis and requires of the manufacturer adequate inspection access.

6-6. TESTING.

All materials and component parts of a non-standard nature must successfully pass all acceptance tests specified in Part II. Standard stock items such as structural steel need not be tested if "Mill Test Reports" are available as specified. This is true for items such as standard valves which have previously been certified by NASA. Following fabrication, the service arm sub-assemblies shall be subjected to a functional test by the manufacturer. This item is scheduled on the chart as testing (manufacturer). Upon completion of the subassembly functional testing and final assembly, the arms will be delivered to Test Division, MSFC, for acceptance testing.

6-7. REPROCESSING OR REFURBISHING.

Upon completion of the NASA test program, the service arms will be transported to the manufacturer's facilities for refurbishing. This refurbishing or reprocessing shall include cleaning, descaling, straightening, repainting, and repairing as necessary to prepare the equipment for use. If extensive damage has been incurred, major repairs by the manufacturer will be negotiated.

6-8. DELIVERY OF HARDWARE AND DOCUMENTATION.

This refers to the presentation of the final products, as indicated in paragraph 6-3, to LOC at Cape Canaveral, Florida. At this point, after acceptance of the item by LOC, the responsibility of the contractor terminates. Hardware includes all items manufactured under the contract, generally outlined in paragraph 6-3. Also included is the required 10 percent spare components for all the above items. Documentation shall include such things as:

a. Test history log.
b. Manufacturer's shop drawings.

c. Any documents or data received with purchased materials, parts, or equipment, including all manuals.
d. Operating time, cure date, or expiration date for any limited-life items.

Traceability record, paragraph 5-12, may serve to fulfill part of the above requirements.

6-9. TOTAL CONTRACT REQUIREMENTS.

The previous information in this section on scheduling has been concerned with only the eight service arms of LUT 1; however, the total contract requirements are for the following:

a. Eight service arms - LUT 1.
b. Eight service arms - LUT 2.
c. Eight service arms - LUT 3.
d. Eight service arms - spares.

Note: The contractor will have an option to negotiate for the manufacture of four Command Module Access Arms (see Frontispiece) depending upon his performance, capabilities, and facilities to meet LOC schedule requirements.

The schedule in Figure 1-11 shows the fabrication time permitted for each of the sections of the total contract shown above. This scheduling breakdown of eight service arms, as shown in Figure 1-10, is generally typical of the scheduling for the other sections of the total contract requirements.

6-10. MAJOR MODIFICATIONS.

Any major modification requirements will be determined during the manufacturer's functional testing or during NASA's acceptance test program. This will enable modifications on future production to be carried on concurrently with the test programs so that overall schedules can be met. All major modifications so introduced will be negotiated.

6-11. SUBMISSION OF SCHEDULES.

Each bidder shall submit a detailed schedule of each section of the total contract requirements. This schedule shall be similar to that shown in Figure 1-10 and shall adhere to the general requirements of the schedule shown in Figure 1-11.

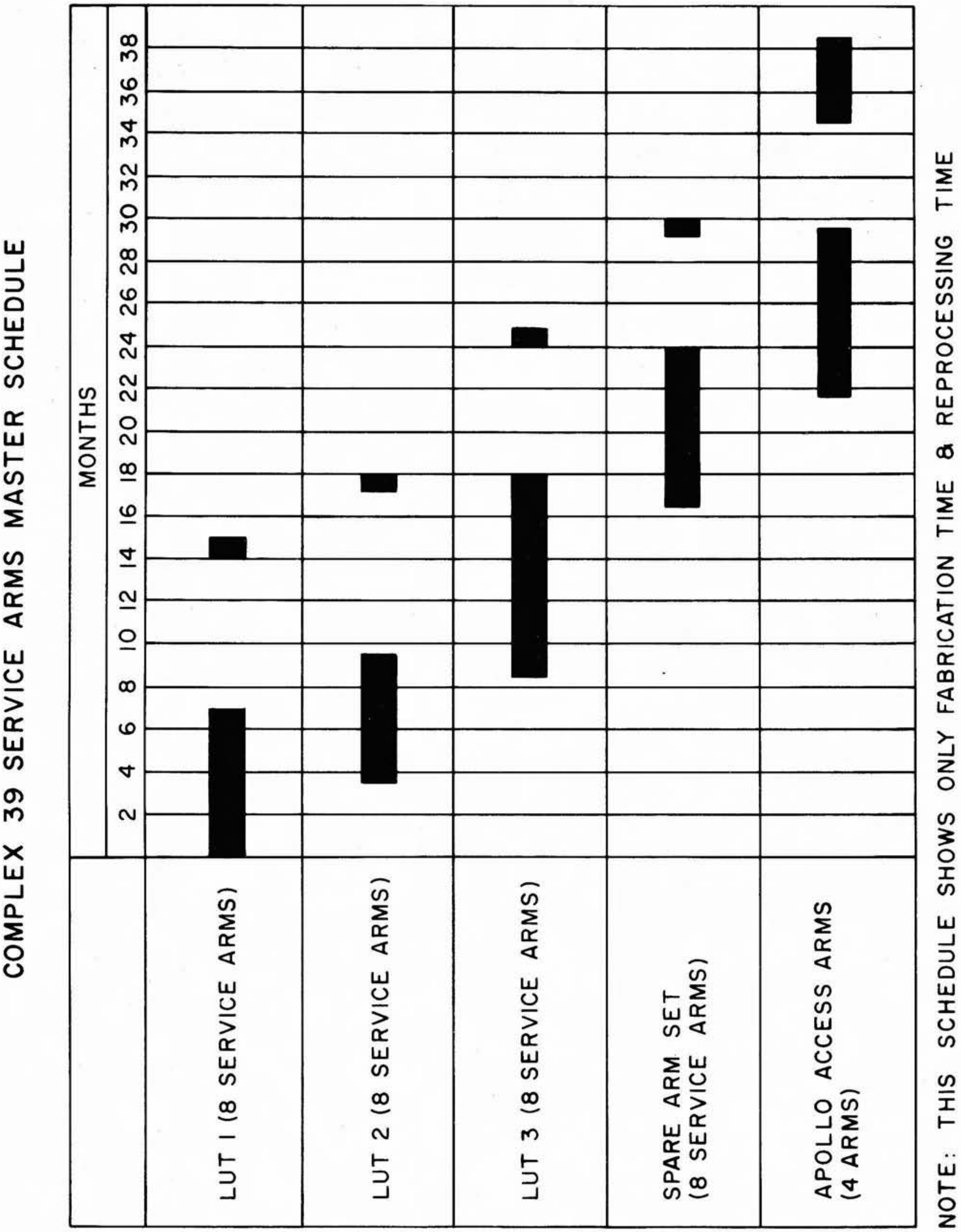

Figure 1-10. Master Schedule

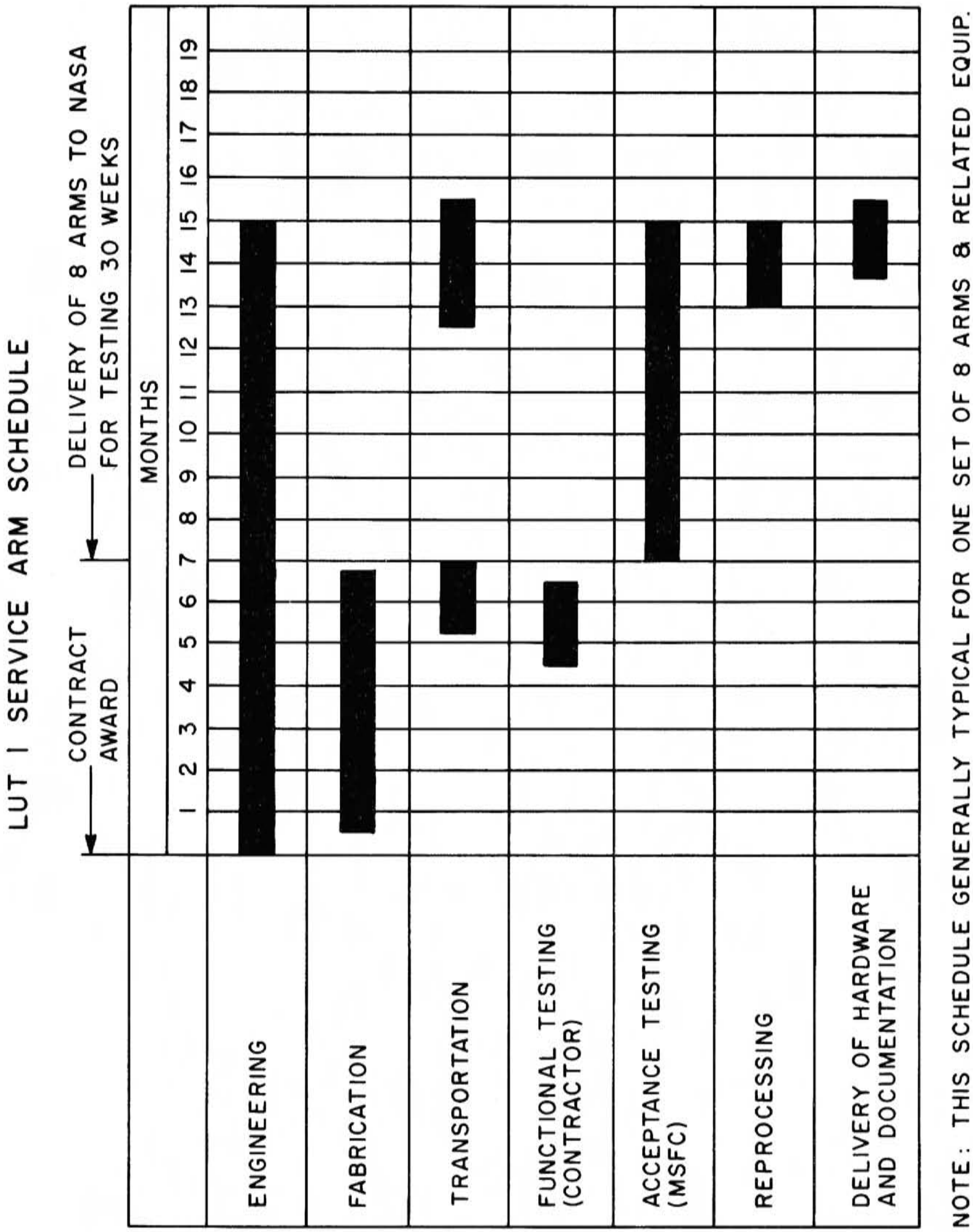

Figure 1-11. Arm Schedule

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SECTION VII.
INCENTIVE IDEAS

7-1. GENERAL.

The resultant contract will be of a cost plus incentive fee type.

7-2. OBJECTIVES.

The three prime objectives that should be considered in establishing the basis for determining incentive fee will be as follows:

a. Delivery - final delivery date for the first set of arms (8 service arms), would be the prime milestone. The delivery date for each subsequent arm, according to LOC requirements, would be the next milestones.

b. Cost - Target cost and target fee will be established. The contractor will receive an increase in fee for underrun of costs and/or a decrease in fee for an overrun of costs.

c. Performance of Contractor - All units delivered must adhere to LOC documentation and quality requirements.

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SECTION VIII.
REPORTING REQUIREMENTS AND INSPECTION ACCESS

8-1. REPORTING REQUIREMENTS.

8-2. REPORTING.

Reports will be prepared to reflect status as of the last day of the month reported and will be submitted to reach the NASA Technical Supervisor on or before the 15th of the month following the report period. They will contain the following:

a. A brief statement of the work accomplished to start of the current report period.
b. A description of the work performed during the current report period.
c. A discussion of problems encountered together with recommended resolutions.
d. A schedule showing the following:
   1. Authorized man-hours by individual Schedule Orders including corresponding dollar values.
   2. Authorized dollar amounts by Schedule Orders of material estimates.
   3. Cumulative total of hours and dollar costs used to date.
   4. Forecast of uncompleted Schedule Orders expressed in details of hours and dollars.

The contractor shall be required to submit other reports, either of a recurring or non-recurring nature, as directed by the NASA Technical Supervisor.

8-3. INTERVALS.

A weekly job status report for the preceding week shall be issued to the customer on the first work day of each week. A monthly status report and a monthly financial report shall be submitted to the customer on or before the 15th of the month following the period being reported. They will contain the following:

a. Weekly Status Report - This report shall contain daily labor expenditures for each job; weekly labor hours, labor dollars, and other expenditures by job; and weekly job status reports which compare planned expenditures to actual expenditures and indicate problem areas. The report shall contain all work performed through the last day of the previous week.

b. Monthly Status Report - This report shall contain a brief statement of work accomplished at the start of the current work period; a description of the significant work accomplishment during the current work period; and a discussion of problems encountered, with recommended solutions.

c. Monthly Financial Report - This report shall contain, in appropriate tabulation, the hours expended and dollar costs for the month reported; the cumulative hours expended, dollar costs, and materials; and a forecast to complete the job expressed in terms of hours and dollars, shown on a comparative basis with the amounts authorized, and showing discrepancies between the two as plus or minus.

8-4. INSPECTION ACCESS.

Scheduled Inspection Intervals - The customer shall notify the contractor, in advance, of intended inspections and the nature of the inspections. The contractor shall then advise the affected personnel concerned so they may be available to assist customer inspection personnel. Upon notification of an impending inspection, the contractor personnel concerned shall assemble any engineering drawings or other necessary documents that the customer may request in connection with the inspection tour.

Nonscheduled Inspection - Because the nature of the inspection tours will vary, the preparation period for the contractor will also vary in proportion. Reasonable time notification will be granted the contractor to adequately prepare for the inspection. Frequency of nonscheduled inspection and an appropriate interval of advance notice shall be stated by the contractor before the contract is awarded.

SECTION IX.
GOVERNMENT FURNISHED EQUIPMENT

9-1. TEST FACILITIES.

All service arms fabricated under this scope of work shall be given a complete acceptance test to confirm proper operation and performance as scheduled in Section VI. This test will be performed by personnel of Test Division of MSFC. The tests will be made at a Government furnished test facility located at the Marshall Space Flight Center in Huntsville, Alabama. All facilities and personnel required for the assembly, test mounting, operational testing, and disassembly of each service arm at the test site will be provided by the Government at no expense to the fabrication contractor. MSFC will provide office facilities for fabrication contractor personnel required in the test area during operational test periods.

9-2. QUICK-DISCONNECT HOUSING.

NASA will provide ground-half quick disconnect housings, either actual or prototype, for each service arm for alignment purposes and functional checks during testing at the MSFC test area.

9-3. TRANSPORT TRAILERS.

The transport trailers will become Government furnished equipment after LOC acceptance and prior to any service arm transportation by the fabrication contractor.

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SECTION X.
PARTS PROVISIONING REQUIREMENTS

10-1. GENERAL.

Spare parts will be manufactured, stocked, and maintained by the manufacturer at the rate of 10 percent. Spare parts manufacture and stocking will be accomplished concurrent with system manufacture. The spares are subject to the same quality control inspections and testing methods employed for the primary parts. In addition, a spare set of arms and equipment to outfit one LUT will be fabricated, inspected, and tested. Ten percent spares will be shipped to MSFC test area and Cape Canaveral concurrent with transportation of the first and subsequent sets of arms. The items which will require spares will be determined by LOC.

Adequate space will be provided by MSFC at the test site for storage of spare parts.

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SECTION XI.
TRANSPORTATION

11-1. GENERAL.

The contractor shall furnish transportation of the service arms as follows:

From the contractor's manufacturing area to the test facility at the Marshall Space Flight Center, Huntsville, Alabama.

From the test facility to the contractor's area for refurbishing or modification.

From the contractor's area to the Atlantic Missile Range at Cape Canaveral, Florida.

11-2. TRANSPORTATION.

Transportation of the service arms will be performed using eight semi-trailers to be manufactured by the contractor. The eight semi-trailers shall be 22-ton capacity, 10-feet wide by 56-feet long, drop-deck platform type transporters, with removable metal bodies, roof bows, and tarpaulin tops as indicated in Figure 1-9. Acceptance of the trailers will be at the manufacturing area upon completion of manufacture and trailer acceptance test.

11-3. AREAS OF RESPONSIBILITIES.

The Government shall furnish the trailers at the required location for use by the contractor for all transportation of the service arms. The contractor shall be responsible for loading and unloading the service arms from the trailers at his facility, at the test site, at MSFC and at the Atlantic Missile Range.

The contractor shall perform any packaging or dismantling of the service arms in preparation for shipment. The number of parts or assemblies removed from the service arms for transportation will be held to a minimum. The contractor shall be responsible for transportation of all items to Cape Canaveral. Packaging shall be performed in accordance with the American Trucking Association's National Motor Freight Classifications; Rules and Container Specifications. Packaging of system components and assemblies shall, in addition, be in accordance with NASA specifications.

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SECTION XII.
COST BREAKDOWN

12-1. SCOPE.

The cost totals for the manufacture of Saturn V service arms and related equipment necessary to outfit one LUT shall be determined by the fabrication contractor, and the information displayed according to Figure 1-12. The total for labor man-hours and materials shall include the contractors overhead costs.

The contractor shall also show costs for arm transportation, liaison, travel, and per diem. These costs will be affected by the location of the contractor's facilities in relation to LOC, MSFC (test area) and Cape Canaveral.

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SATURN V SERVICE ARMS AND RELATED EQUIPMENT

DATE __________
MFG __________

ITEM	S-IC INTERTANK ARM		S-IC FORWARD ARM		S-II AFT ARM		S-II INTERMEDIATE ARM		S-II FORWARD ARM		S-IVB AFT ARM		S-IVB FORWARD ARM		SERVICE MODULE ARM		TOTALS BY ITEM	
	LABOR M-HRS.	MAT'L $	LABOR M-HRS.	MAT'L $	LABOR M-HRS.	MAT'L $	LABOR M-HRS.	MAT'L $	LABOR M-HRS.	MAT'L $	LABOR M-HRS.	MAT'L $	LABOR M-HRS.	MAT'L $	LABOR M-HRS.	MAT'L $	TOTAL M-HRS.	TOTAL MAT'L $
1.0 ARM FABRICATION																		
1.1 ARM ELEMENT NO. 1																		
1.2 ARM ELEMENT NO. 2																		
1.3 EXTENSION ELEMENTS																		
1.4 WITHDRAWAL MECHANISM																		
1.4.1 DISCONNECT BRACKET																		
1.4.2 DISCONNECT CYLINDER																		
1.4.3 SECONDARY DISCONNECT CYLINDER																		
1.5 EXTENSION PLATFORM TEE HEAD																		
1.5.1 STRUCTURE																		
1.5.2 BEARING SYSTEM																		
1.5.3 POWER SYSTEM																		
1.6 EXTENSION PLATFORM																		
1.7 HINGE ASSY.																		
1.7.1 HINGE ASSY. STRUCTURE																		
1.7.2 HINGE ASSY. ACTUATORS																		
1.7.3 FLOW CONTROL VALVE																		
1.7.4 MISCELLANEOUS HARDWARE																		
1.8 SERVICE LINES AND HARDWARE																		
1.8.1 SERVICE LINE BRACKETS																		
1.8.2 HYDRAULIC																		
1.8.2.1 CLEANING																		
1.8.3 PNEUMATIC																		
1.8.3.1 CLEANING																		
1.8.4 PROPELLANT																		
1.8.5 ELECTRICAL																		
1.8.6 AIR CONDITION																		
1.8.7 DYNATHERM																		
1.9 ARM LIGHTING SYSTEM																		
2.0 TOWER HARDWARE																		
2.1 ARM SUPPORT BRACKET																		
2.2 SHOCK ABSORBER																		
2.3 LOCKING DEVICE																		
2.4 ACCESS PLATFORM																		
2.5 HYDRAULIC CONSOLES ★																		
2.5.1 HYDRAULIC CONSOLE NO. 1																		
2.5.1.1 HYDRAULIC LINES																		
2.5.1.2 CLEANING																		
2.5.2 HYDRAULIC CONSOLE NO. 2																		
2.5.2.1 HYDRAULIC LINES																		
2.5.2.2 CLEANING																		
2.5.3 TEE HEAD CONTROL																		
2.5.3.1 HYDRAULIC VALVES & LINES																		
2.5.3.2 CLEANING																		
2.6 SECONDARY RETRACT SYSTEM																		
TOTAL BY ARM																		
2.7 HYDRAULIC POWER UNIT	THIS UNIT WILL SUPPLY ALL UMBILICAL ARMS								TOTAL COST									
2.8 WATER QUENCH SYSTEM	THIS UNIT WILL SUPPLY ALL UMBILICAL ARMS																	
2.8.1 MECHANICAL									TOTAL COST									
2.8.2 ELECTRICAL									TOTAL COST									
2.9 TOWER HYDRAULIC INST.			COMPLETE INSTALLATION FOR TOWER HYDRAULIC SUPPLY						TOTAL COST									
3.0 MISCELLANEOUS																		
3.1 ARM TRANSPORTER (4 ea.)									TOTAL COST									
3.2 TOOLING FOR ARM ELEMENTS									TOTAL COST									
3.3 HINGE TOOLING									TOTAL COST									
3.4 GENERAL ELECTRICAL INST.									TOTAL COST									
													TOTAL LABOR AND MATERIALS					
													TOTAL ESTIMATE				$	
★ NOTE:																		
(1) NUMBER ONE CONSOLE IS USED ON S-II INTERMEDIATE ARM AND ALL ARMS ABOVE THIS LEVEL																		
(2) NUMBER TWO CONSOLE IS USED ON ALL ARMS																		
(3) CONTROL VALVES ARE USED ON ALL ARMS FOR TEE-HEAD OPERATION																		
(4) FOR DETAIL COST BREAKDOWN REFER TO APPENDIX A																		
SPARES AT 10% OF TOTAL ARE INCLUDED IN THE INDIVIDUAL COST ESTIMATES																		
TRANSPORTATION																		
CONTRACTOR FACILITY TO TEST SITE MSFC																		
TEST SITE MSFC TO CONTRACTOR FACILITY																		
CONTRACTOR FACILITY TO CAPE CANAVERAL																		
TRAVEL COST																		
LIAISON, TRAVEL, PER DIEM (TOTAL FOR ALL ARMS)																		

Figure 1-12. Cost Format

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SECTION XIII.
SUBCONTRACTING LIMITATIONS

13-1. APPROVAL.

The bidder shall specify any subcontractor support required or desired to complete the requirements of the contract. The work required and the estimated cost of such work must be clearly stated. Approval of subcontractors must be obtained prior to awarding of the contract.

13-2. TYPE OF COMPONENTS.

It is anticipated that some components, subassemblies, and services can be provided more advantageously through subcontractors. Typical examples of components or services which could be subcontracted are as follows:

- a. Propellant lines.
- b. Special cylinders and actuators.
- c. Pressure compensating control valve.
- d. LOX cleaning.

13-3. PERCENTAGE OF TOTAL JOB.

The prime contractor will be limited to a maximum of 15 percent on the amount of work under this contract which can be subcontracted.

Generally, the procuring of components which are vendor items will not be considered a subcontract item. Specialty items procured from outside sources, which must be manufactured and/or fabricated in accordance with drawings and specifications furnished by the contractor, shall be considered as subcontracted items. Services of any nature performed, as a part of this contract, by personnel other than regular employees shall be considered as a subcontract.

Questionable items shall be referred to the contracting officer for a decision as to whether or not they constitute a subcontract item. The decision of the contracting officer shall be final in every case.

13-4. WORKING AGREEMENTS.

The subcontractors will adhere to the contract in all respects. Any changes in the original contract by the prime contractor will be subject to immediate negotiation.

Representatives of NASA and the prime contractor will be authorized to inspect work progress at any time during the contract period. Progress reports will be kept up to date and will be presented to NASA and the prime contractor periodically, as stated in Section VIII.

All materials and parts furnished by the subcontractor will be accompanied by a written certificate.

13-5. LOCATION.

Subcontracted engineering, fabricating, and testing will be performed only by companies within the United States. All materials and parts used in fabricating will be manufactured in the United States.

13-6. GOVERNMENT SUPERVISION.

NASA installations will invoke the requirements of NASA Quality Publication 200-3 contractually to the extent needed and consistent with program planning for procurements involved. NASA space system contractors will also invoke the requirements of this publication as appropriate.

When revisions or additions to this publication are announced, the prime contractor is encouraged to authorize his subcontractors to follow the applicable portions of the revised publication. However, the contractor is not required to comply with revisions made after the effective date of the contract, except as a negotiated contract change.

SECTION I
INTRODUCTION

1-1. PURPOSE

Part 2 of this Preliminary Engineering Report presents data relative to the Saturn V Vehicle service arms and access arm. This part of the report provides detailed engineering data and drawings for use by personnel associated with the Saturn V program.

The information presented in this report reflects the design based on requirements up to 10 July 1963.

1-2. SCOPE

Part 2 contains design criteria, descriptions, and theories of operation for the service arms, access arm, and related equipment used on or in support of the Launcher-Umbilical Tower.

The information is presented according to the following arrangement:

Section II.	Presents information of a general nature. The data given in this section is intended to orient the reader regarding the Saturn V program.
Section III.	Details the criteria by which the present designs were developed.
Section IV.	Provides detailed information on each service arm and major component. Description and theories of operation are contained in this section.
Section V.	Provides the latest engineering data on the Command Module access arm.
Section VI.	Contains descriptions and uses of equipment and accessories used on the LUT. The arm transportation trailer is included in this section.
Section VII.	Presents information and detailed drawings which locate each interface between the arms and vehicle, the arms and tower, and between the arms and Vertical Assembly Building.

The appendices to this volume of the report contain documentation concerning the weight and center of gravity of the arms, the electrical schematics, the interfaces and umbilical requirements, and the drawings furnished by the stage contractors.

The references referred to in Part 2 are listed following the appendices.

SECTION II
GENERAL INFORMATION

The Saturn V is a multi-stage, liquid fueled launch vehicle which will be used in the Apollo program. In this program the launch vehicle will boost the spacecraft into the proper trajectory and orientation for lunar and planetary explorations from Launch Complex 39.

The S-IC, first stage of Saturn V, is powered by five engines which operate on a mixture of RP-1 (a kerosene base fuel), and LOX (liquid oxygen). The S-II, second stage, and S-IVB, third stage, are both powered by engines operating on a fuel mixture of LOX and LH_2 (liquid hydrogen). An unpowered instrument unit contains in-flight control and monitoring equipment and is located between the S-IVB stage and the Apollo. The payload consists of the Lunar Excursion Module (LEM), the Service Module (SM), and the Command Module (CM) (Figures 2-1 and 2-2).

2-1. UMBILICAL LOCATIONS

Fuel and oxidizer loading and venting provisions, hydraulic and pneumatic system service connections, and electrical system powering and monitoring connections are contained in vehicle-to-ground umbilical connections at nine locations on the Saturn V stages. A summary of the umbilical requirements for each stage is contained in Table 2-1. Detailed umbilical requirements, service line locations, connector sizes, flow rates, and component weights are defined in Figures A-1 through A-18, Appendix A.

2-2. LAUNCH COMPLEX 39

Launch Complex 39 consists of two or more firing sites, the Vertical Assembly Building (VAB), the Launcher-Umbilical Tower (LUT), the Mobile Arming Tower, and the Crawler Transporter. Assembly and checkout of the erected vehicle on the LUT will be accomplished inside the VAB. The assembled vehicle and the LUT are then moved to the firing site by the Crawler Transporter. After the LUT is positioned at the site, the Crawler Transporter moves the Arming Tower into position for installation of pyrotechnics. If wind in excess of vehicle capability (99.9% probability) are predicted, the vehicle will be disarmed and returned to the VAB for protection.

Placement of the LUT at the firing site will be with the tower north of the vehicle, with position I east, and fin A 45 degrees north of position I. The flame deflector will be directly below the vehicle with the flame exits north and south.

The assembled vehicle is supported on the LUT by four holddown arms during all phases of operation including prelaunch. These holddown arms are oriented north, south, east, and west. The LUT is supported on permanent foundations at the firing site; service lines located at the firing site will be mated to corresponding service lines on the LUT.

The Crawler Transporter lifts the LUT using hydraulic cylinders. The transporter, powered by four crawlers, will transport the LUT between the VAB and the firing site; and will transfer the Arming Tower between its parking area and the firing site. The Crawler Transporter maintains the base of the LUT horizontal within 10 minutes of arc at all times.

All launch operations will be monitored and controlled from the Launch Control Center (LCC) located at the VAB.

2-3. LAUNCHER-UMBILICAL TOWER OPERATIONAL SEQUENCE

The purpose of the following information is to familiarize the reader, in general, with the state of the service arms and the access arm as the LUT progresses from its erection site through lift-off of the Saturn V Vehicle.

The LUT is erected in an open area adjacent to the VAB. Installation of the service arms, access arm, and all auxiliary equipment is performed in this area prior to being transferred into the VAB by the Crawler Transporter.

The following ground rules are applicable for VAB operations:

a. The LUT enters the VAB with the umbilical carriers withdrawn, the service arms retracted against the tower face, and the access arm locked in the extended position.

b. The access arm is rotated to the side to permit stage assembly.

c. As the stages are assembled, the respective service arms are extended (umbilical carriers remain in the withdrawn position). The VAB work platforms for the stages are then positioned.

d. Extension of withdrawal mechanisms and connections of the umbilicals is accomplished from the VAB work platforms.

e. Service Arm Extension Platforms will not be used in the VAB except for fit and alignment checks.

Figure 2-1. Saturn V Vehicle

Figure 2-2. Service Arm Locations

Table 2-1. Saturn V Umbilical Requirements

Stage	VEH. Station*	Service Provided
S-IC INTERTANK	772.000	LOX Fill and Drain Couplings
S-IC FWD	1516.600	Air Conditioning, Electrical, and Pneumatic Services
S-II AFT	1606.200	LOX Pump Drain
S-II INTERMEDIATE	1767.000	Instrument Cooling and Purge
	1771.000	LOX Coupling, Engine Compartment Purge, Electrical and Pneumatic Services
	1905.000	LH_2 Coupling
S-II FWD	2506.000	GH_2 Vent, Electrical and Pneumatic Services
S-IVB AFT	2760.000	LH_2 and LOX Coupling, Electrical and Pneumatic Services
	2794.312	Air Conditioning
S-IVB FWD	3203.555	GH_2 Vent
	3214.992	Air Conditioning, Electrical and Pneumatic Services
SM	3721.555	Air Conditioning, Vent Lines, Electrical and Pneumatic Services

*Stations defined are center lines of umbilical housing.

f. Umbilical carrier disconnect, withdrawal mechanism retraction, and arm rotation for all service arms will have complete functional tests prior to leaving the VAB.

g. Any tests performed on the access arm in the VAB will be limited by the space available for arm rotation.

h. A complete functional test will be performed on the access arm after removal from the VAB and prior to transportation to the firing site.

i. The LUT leaves the VAB, pauses for access arm retraction, and continues to the firing site.

During transportation to the firing site, the service arms remain extended and locked, all withdrawal mechanisms stay extended with the umbilical carriers connected to the vehicle, and all extension platforms are withdrawn and locked. The access arm is in the retracted position locked to the tower.

After the crawler positions the LUT at the firing site, it will then transport the Arming Tower to the firing site and position it on the south side of the LUT. The access arm will be extended and the cab positioned adjacent to the CM hatch. The Arming Tower work platforms will then be moved into position to provide arming service to the vehicle.

After pyrotechnics are installed and other arming services are completed, the crawler will remove the Arming Tower so that propellant loading and final checkout operations can begin. During final checkout, an astronaut crew will enter the Apollo via the access arm and check out the payload. The CM hatch will be closed and the access arm retracted and latched to the tower during this period to allow emergency escape of the CM. After propellant loading is completed, the access arm will be extended for removal of the checkout crew and loading of the flight crew.

The access arm will be retracted at T minus 60 seconds. The S-IC INTERTANK, S-IC FWD and S-II AFT Service Arms will be retracted at T minus 10 seconds.

The S-II INTERMEDIATE, S-II FWD, S-IVB AFT, S-IVB FWD and SM arms will retract at lift-off after receiving a command signal from lift-off switches located on the holddown arms. These switches are activated by the vertical motion of the vehicle.

Inspections will be performed on the arms after each launch to determine the extent of damage due to pressure and heat. All major refurbishment will be performed after removing the arms from the tower and transferring them to a separate Refurbish Building.

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SECTION III
DESIGN CRITERIA

Design criteria for the service arms and access arm are established by ground operations and by ground and launch environments during which the Saturn V Vehicle will function.

Wind conditions are expressed in terms of a percentage. This percentage represents the probability that winds not exceeding a certain magnitude will occur during the month when the strongest winds are expected. For example, a 99% probability wind is a wind velocity which will not be exceeded 99% of the time during the strongest wind month.

The Saturn V Ground Rules (Reference 1) state that the Saturn V Vehicle shall have a free standing capability for the 99.9% probability wind. The Saturn V Vehicle shall be capable of launch for the 99% probability wind and capable of flight for the 95% probability wind.

The Crawler Transporter will be capable of transferring the LUT and the Saturn V Vehicle in winds up to 99% probability wind; the LUT must have a free standing capability, without the vehicle, in hurricane winds.

The wind conditions mentioned above establish the vehicle deflections and frequencies that will affect service arm and access arm design.

Prior to launch, the vehicle size and shape will be affected by the prevailing ambient temperatures and by the weight of propellants.

The initial flight path will be determined by the wind velocity and direction and the booster thrust variation. This is one of the criteria which establishes the retraction time for service arms.

Vehicle drift toward the tower will subject all tower mounted components to severe impingement pressures and temperatures. These conditions necessitate the use of high strength steels and a water quench system for the service arms.

Additional criteria are established by maintenance, checkout, and access required into the vehicle at each umbilical area.

Each of the criteria mentioned above will be discussed in more detail in the paragraphs to follow.

General design criteria for each major arm component are discussed in paragraphs 3-13 through 3-18, while detailed criteria and design conditions for each component will be presented in their applicable sections of the report.

3-1. SATURN V VEHICLE DEFLECTIONS ON THE LUT

3-2. VEHICLE DEFLECTIONS DUE TO WIND

The Saturn V Vehicle deflections on the LUT due to wind are presented in Reference 2. This data is presented for the 99.9%, 99% and 95% probability wind conditions for both a fueled and unfueled vehicle. Deflection of the vehicle base caused by flexibility of the holddown arms, the launcher deck, and the LUT foundation are also included in this data. The horizontal translation of the launcher will be subtracted from the total deflection presented for a given station since it has no effect on the net deflection between the vehicle and the service arms.

The Saturn V Vehicle frequencies, as given in Reference 2, are 0.80 cps and 0.33 cps for the unfueled and fueled vehicle respectively.

3-3. VEHICLE DEFLECTIONS DUE TO WIND-INDUCED OSCILLATIONS

The Saturn V Vehicle deflections on the LUT due to wind-induced oscillations are presented in Reference 3. This data is applicable to the 99.9%, 99% and 95% probability wind conditions for both a fueled and unfueled vehicle. Effects of the vehicle base flexibility are included in this data.

These deflections are caused by vortex shedding of wind after the vehicle has undergone its maximum displacement due to steady state wind pressure. The oscillations form an elliptical pattern in the horizontal plane. The major axis of this ellipse lies normal to the steady state wind direction. The elliptical pattern will be contained within the maximum vehicle motion envelope.

3-4. VEHICLE DEFLECTIONS DUE TO THERMAL BENDING

The Saturn V Vehicle deflections on the LUT due to thermal bending are given in Reference 4. This data is based on a 25°F temperature differential between diametrically opposed points on the vehicle skin.

3-5. VEHICLE DEFLECTIONS DUE TO PROPELLANT AND STRUCTURAL DEAD WEIGHT

The Saturn V Vehicle deflections on the LUT due to propellant and structural dead weight are given in Reference 4. This data is presented for the most severe conditions that occur simultaneously to produce maximum vertical deflections. The vertical deflections of the LUT and its foundation relative to the vehicle are negligible.

3-6. VEHICLE SHOCK AND VIBRATION CRITERIA

The Saturn V Vehicle shock and vibration criteria are given in Reference 5. The data is presented for the propellant couplings and electrical umbilical connectors of the S-II, S-IVB, Instrument Unit, and SM. The environments considered are:

a. Transient vibration during ignition, lift-off, maximum dynamic pressure, Mach one, cutoff, separation, ignition of second stage, etc.

b. Steady state vibration during the "mainstage" portion of flight.

c. Short time mechanical or electrical shock environment.

3-7. TOWER DEFLECTIONS DUE TO WIND AND TRANSPORTATION

Tower deflections due to wind and transportation are presented in Reference 6. The deflections are given for the following conditions:

a. LUT transporting the vehicle in a 99% probability wind.

b. LUT stationary with the vehicle at the firing site in a 99.9% probability wind.

c. LUT stationary with fixed supports during hurricane conditions.

d. Crawler transporting the LUT and Saturn V Vehicle with a power pulse of 2.6 ft/sec^2. The combined loads induced in the vehicle due to crawler acceleration and wind will not exceed those induced at the firing site during a 99.9% probability wind condition.

Tower wind deflections will not be combined with vehicle wind deflections for net deflections between the service arms and the vehicle. This is due to frequency conditions and shielding of one structure by the other for the more critical north-south winds.

3-8. SATURN V VEHICLE DRIFT CONDITIONS

The vehicle drift is given in Reference 7. This reference gives the drift of the vehicle nose and base with respect to the tower versus time in seconds and vehicle rise in feet. Curves are presented giving the combined effect of thrust misalignment and variation with 95% and 99% wind probabilities.

3-9. LUT TEMPERATURES AND PRESSURES DURING SATURN V VEHICLE LIFT-OFF

The LUT and all attached components will be subjected to extremely high impingement pressures and temperatures for critical vehicle drift conditions. The stagnation pressures and temperatures versus distance from nozzle exit and engine centerline are given in reference 8.

The vehicle may be committed to flight during a 95% probability wind and can correct for drift with engine gimbal angles up to 5°-9'. A combination of the above conditions can place a given service arm in the exhaust stream, thus subjecting it to the temperatures and pressures indicated in Reference 8. These values can approach 4000°F and 85 psig respectively.

Several temperature versus time curves for various locations on the face and top of the tower are presented in Reference 9. These curves indicate the soak time required to stabilize temperatures of 1/4, 1/2, and 1-inch steel plates. The data considered most applicable for design criteria are for a 1/4-inch steel plate located at the south edge of the top of the tower. A stable temperature of 1200°F is accomplished in a soak time of 15 to 20 seconds.

3-10. ASPIRATION EFFECTS INDUCED BY THE SATURN V ENGINE EXHAUST

Data from the Complex 34 Umbilical Tower, obtained during the SA-4 launch, indicated under-pressures of significant magnitude occurred at tower elevations. These under-pressure levels are caused by the jet pump effect of the exhaust gases as they exit from the engine nozzles. Wind velocities developed across the various decks by this under-pressure can slow or prevent retraction of the service arms. Investigation and analysis of this phenomenon has been requested; however, no positive data is presently available for design criteria.

To provide some relief from the aspirated wind effects, all arms are retracted and latched to the tower before the engine nozzle exits are level with the top of the arm.

3-11. CRITERIA BASED ON PERSONNEL AND MAINTENANCE CONSIDERATIONS

Personnel access into the vehicle will be required from service arms. This access is required for installation, checkout, and maintenance of vehicle components and instrumentation.

The anticipated maximum package weight to be carried across the arms is 200 pounds.

Personnel access to each umbilical carrier will be required for routine and emergency maintenance.

Personnel will not be allowed on the extension platforms during winds greater than 30 knots, except for emergency operations.

3-12. DESIGN LOAD FACTORS

The following load factors will be used:

a. Wind Loads = 2

b. Dead Loads = 2

c. Live Loads = 3

d. Inertia Loads = 2

e. Impact Loads = 2

3-13. DESIGN CRITERIA FOR MAJOR SERVICE ARM COMPONENTS

3-14. ARM STRUCTURE

The truss shall be capable of remaining extended and locked during a 99.9% wind condition and must be capable of being retracted during a 99% wind condition.

The truss shall be capable of withstanding loads induced by an angular deceleration equivalent to an eight "g" side load at the arm tip. No load factor will be used for this condition. Design shall be based on ultimate strengths.

Design loads for the vertical direction shall be determined by combining the maximum dead loads with a maximum live load of 1000 pounds.

All major structural members that are critical when exposed to exhaust pressures shall be designed to the yield strength of the material at $1000^{\circ}F$. For all other conditions, the major members will be designed to the yield strength of the material at normal ambient temperature. Minor structure such as flooring, personnel safety screen, handrails, etc., will be designed for normal ambient temperature.

Engine exhaust pressures applied to the arm are a function of drift and engine gimbal angle. The maximum drift condition will give intolerable pressures for design purposes. The arm structure will be designed for the following loads:

a. Carry a net pressure of 10 psig on the projected area of the arms.

b. The floor panels can carry 3.5 psig.

c. If the floor panels have failed, the truss members will withstand up to 35 psig before yield.

3-15. EXTENSION PLATFORMS

The S-IC INTERTANK, S-IC FWD and the S-II AFT Extension Platforms do not couple to the vehicle but make contact only through a rubber bumper. The platforms are withdrawn if wind velocities exceed a 95% probability wind. The maximum live load for these platforms will be 1000 pounds. Loads induced by arm retraction will be negligible.

The S-II FWD, S-IVB AFT, S-IVB FWD and SM Extension Platforms are mechanically coupled to the vehicle in wind conditions not to exceed 30 knots. They must remain attached during the 95% probability wind. While coupled, the extension platforms must track the vehicle through an envelope established by combining the effects of a 95% wind, thermal bending, vehicle deflection due to weight, wind-induced oscillations, etc. The detailed criteria is given in Table 3-1. These platforms are withdrawn after vehicle service and prior to lift-off. The platform designs are subject to criteria established by service arm acceleration. The maximum live load will be 1000 pounds.

All extension platforms will be designed to the same criteria for temperature and pressure as stated for arm structure.

Table 3-1. Vehicle and Tower Deflections For Extension Platform Design

ARM	VEHICLE STATION	HORIZONTAL DEFL. (IN.)	VERTICAL DEFL. (IN.)	HORIZONTAL OSCILL. (IN.)	HORIZONTAL ACCELERATION (IN / SEC^2)
S-IC INTER'K	692	± .65	+ .65 − .35	± .10	2.54
S-IC FWD	1415	± 2.60	+ 1.30 − 3.60	± .55	14.00
S-II AFT	1590	± 3.20	+ 1.35 − 3.60	± .65	16.50
S-II INT	—	—	—	—	—
S-II FWD	2437	± 7.00	+ 2.40 − 5.60	± 1.40	35.60
S-IVB AFT	2644	± 8.30	+ 2.50 − 5.65	± 1.65	42.00
S-IVB FWD	3169	± 12.50	+ 3.00 − 7.00	± 2.10	53.40
S. M.	3614	± 16.80	+ 3.30 − 7.40	± 2.70	68.50

INCLUDES SOLAR WARPAGE AT 95% WIND CONDITION. DOES NOT INCLUDE TOWER DEFLECTIONS.

INCLUDES TOWER DEFLECTIONS, 120° F. TEMP., AND FUELED VEHICLE CONDITIONS.

RESULT OF VORTEX SHEDDING AT 95% WIND, EMPTY VEHICLE, f = .80

PLATFORM DOES NOT FOLLOW VEHICLE MOTION.

DEFLECTIONS FOR THIS LOCATION ARE APPROX. DEFINITE INFORMATION NOT AVAILABLE.

3-16. WITHDRAWAL MECHANISMS

The withdrawal mechanism shall be capable of tracking the vehicle through an envelope established by the 99.9% wind condition, vehicle deflection due to propellant weight, and wind-induced oscillations. Thermal bending is excluded from this summation because it will not be coincident with a 99.9% wind condition. Detailed design data for each withdrawal mechanism is presented in Tables 3-2 and 3-3.

The withdrawal mechanisms shall be capable of retracting the umbilical carrier to the service arm tip from any point within an envelope established by the 99% wind condition, thermal bending, vehicle deflection due to propellant weight, wind-induced oscillations, and vertical motion of the vehicle during the first few inches of flight. This criteria is presented in Table 3-3.

The withdrawal mechanism shall function while subjected to inertia loads induced by service arm retraction and shall be capable of surviving the following conditions:

a. Impact loads that were described for the service arm structure. Design will be based on the ultimate strength of the material at normal temperature.

b. External design pressure of 35 psig with the design based on yield strength of the material at 1000°F.

c. Inertia loads induced when withdrawing in one second. Design will be based on yield strength of the material at normal temperature.

During LUT transport the withdrawal mechanisms will be extended and attached to the vehicle and must accommodate this motion envelope which shall not exceed the 99.9% condition previously stated.

3-17. ARM RETRACTION SYSTEM

The arm retraction system shall be designed to retract the arm in a 99% probability wind for the most severe vehicle drift condition, and each arm must arrive and latch to the tower face before the bottom of the booster nozzles are level with the top of each service arm. The most critical retraction times for the service arms are given in Table 3-4.

Table 3-2. Vehicle Motion Envelope Prior To Lift-Off

Service Arm	Vehicle Station	Lateral Displacement (Reference 2 & 4)	Vehicle Vertical Deflections	
			+	-
S-IC INTERTANK	772	2.5	.46	1.15
S-IC FWD	1516	6.8	1.03	3.34
S-II AFT	1606	7.3	1.06	3.36
S-II INTERMEDIATE (Lox & Umb.)	1771	8.3	1.27	3.46
S-II INTERMEDIATE (LH_2 Line)	1905	9.3	1.25	3.54
S-II FWD	2506	13.5	2.12	5.45
S-IVB AFT	2777	15.8	2.18	5.67
S-IVB FWD	3222	20.3	2.64	6.64
SM [3]	3721	26.6	2.98	7.16

Notes:

(1) Horizontal Translations given in References 2 and 3 have been subtracted. Reference Design Criteria, Section III.

(2) Lateral Displacements are the maximum of the two following conditions:

(a) 99.9% wind and fueled vehicle.
(b) 99% wind and unfueled vehicle plus thermal bending.

(3) Deflections for this location are approximate. No definite information available.

Table 3-3. Vehicle Motion Envelope at Lift-Off

Service Arm	Vehicle Station	Lateral Displacement (Reference 2 & 4)	Vehicle Vertical Defelctions	
			+	-
S-IC INTERTANK	772	1.6	0	1.15
S-IC FWD	1516	4.0	0	3.34
S-II AFT	1606	4.5	0	3.36
S-II INTERMEDIATE (LOX & Umb.)	1771	5.2	0	3.46
S-II INTERMEDIATE (LH_2 Line)	1905	5.7	0	3.54
S-II FWD	2506	8.4	0	5.45
S-IVB AFT	2777	9.5	0	5.67
S-IVB FWD	3222	11.9	0	6.64
SM[3]	3721	14.5	0	7.16

Notes:

(1) Horizontal translations given in References 2 and 3 have been subtracted. Reference Design Criteria, Section III.

(2) Lateral Displacements are for the 99% wind, fueled vehicle condition.

(3) Deflections for this location are approximate. No definite information available.

Table 3-4. Maximum Retraction Times for In-flight Arms

Arm	Tower Station	Retraction Time (Sec)
S-II INTERMEDIATE	1739.25	6.38
S-II FWD	2391.25	7.37
S-IVB AFT	2630.47	7.70
S-IVB FWD	3155.55	8.38
SM	3634.80	8.96

Note: Retraction times are based on the travel time required for the bottom of the nozzle (station 115.0) to reach the top of each service arm.

3-18. DESIGN CRITERIA FOR THE COMMAND MODULE ACCESS ARM

The access arm will be latched to the tower during transportation to the firing site.

At the firing site, the access arm can be extended and coupled to the vehicle in wind velocities up to the 95% probability wind (Table 3-5).

The access arm cab must be capable of tracking the vehicle envelope established by a 99% probability wind, thermal bending, vehicle deflection due to propellant loads, and wind-induced oscillations (Table 3-5).

The design temperature for the access arm will be the same as specified for the service arms. The access arm will be retracted approximately 60 seconds prior to lift-off in wind velocities up to 99% probability wind.

More detailed criteria is presented in Section VI for each of the major access arm components.

Table 3-5. Command Module Access Arm Design Criteria

DESIGN CRITERIA ITEMS	WIND PROBABILITY CONDITIONS					
	95%		99%		99.9%	
	Fueled	Unfueled	Fueled	Unfueled	Fueled	Unfueled
Steady state wind velocity (knots)	29.4	29.4	38.7	38.7	48.3	48.3
Peak wind velocity (knots)	41.2	41.2	54.2	54.2	67.6	67.6
Displacement of C.M. induced by wind (in.)	5.7	5.4	15.8	15.5	26.0	24.4
Thermal bending envelope (in.)	-	13.3	-	13.3	-	-
Maximum C.M. displacement (in.)	5.7	18.7*	15.8	28.8*	26.0	24.4
Amplitude of wind induced oscillations (cps)	3.9	3.8	7.0	6.3	10.2	9.8
Freq. of wind induced oscillations (in./sec)	.33	.80	.33	.80	.33	.80
Velocity of wind induced oscillation (in./sec)	8.1	18.9	14.6	34.2	21.2	49.3
Acceleration of wind induced oscillations	16.9	95.0	30.3	173.0	44.1	247.2
"G" loading wind induced oscillations	0.044	0.246	.078	.0446	0.114	0.639

*Displacement figures based on thermal and wind induced displacements. Wind induced oscillations occur within the maximum displacement envelope.

SECTION IV
SERVICE ARMS

There are eight service arms (S-IC INTERTANK, S-IC FWD, S-II AFT, S-II INTERMEDIATE, S-II FWD, S-IVB AFT, S-IVB FWD, and SM) attached to the LUT mounting beam and extending to within approximately 5 feet of the vehicle (Figure 2-2).

These arms support service lines that are required to sustain the vehicle at the firing site prior to launch. The dimensions of the arms are sufficient to permit personnel passage through the arm to an extension platform. The extension platform provides for personnel entrance into the vehicle and allows access to the various umbilical service areas.

There are two general classifications or types of service arms: preflight and in-flight. The preflight arms are retracted and locked against the tower face prior to vehicle lift-off. The in-flight arms remain extended until the vehicle is launched and are then rotated to the tower before the engine nozzles reach the arm elevation. The S-IC INTERTANK arm must be capable of reconnecting if the launch is aborted during the last 10 seconds of countdown.

The weight and center of gravity has been determined for each arm except the SM and CM arms. This data is presented in Appendix B.

For convenience of presentation, the discussion of the service arms is separated into the arm structure; the withdrawal mechanism and line handling devices; the extension platforms; the arm retraction system; the electrical system; and the service lines. The detail operational sequence is presented in paragraph 4-83.

4-1. ARM STRUCTURE

The complete structural arm assembly consists of either two or three elements (Figure 4-1). The element nearest the tower is designated as the first element and the one nearest the vehicle as the second element. On two arms (S-IVB FWD and SM), the first and second elements are connected by another section designated as an extension element. All elements are of truss type construction employing tubular members and gusset plates.

The S-IC FWD, S-II AFT, S-II INTERMEDIATE, and the S-II FWD arms are approximately 420 inches long. The S-IC INTERTANK arm is 13 inches shorter due to tower geometry. The S-IVB AFT, S-IVB FWD, and the SM arms range from 455 inches to 541 inches in length. This additional length is required because of reduced vehicle diameter.

The outside arm dimensions are 60 inches wide and 98 inches high and provide an unobstructed area of 42 by 78 inches for personnel passage. The floor of the arm is constructed of panels which are bolted to angles installed parallel and adjacent to the lower chords. A 1-1/2 inch diameter handrail is provided 42 inches above the floor level for personnel safety.

4-2. MATERIAL SELECTION CRITERIA

During adverse launch conditions, the upper surface of a 1/4 inch thick plate located at the top south edge of the tower will be heated to approximately 1800°F for two to three seconds. This temperature will stabilize at approximately 1200°F for 15 to 20 seconds.

Because of the transient nature of this high temperature, a lesser temperature of 1000°F was chosen as optimum for the accompanying blast loading (paragraph 3-14). To satisfy this requirement, T-1 Type A steel is used for all material thicknesses of one inch or less. For material over one inch thick, T-1 steel is used because T-1 Type A is not available.

T-1 and T-1 Type A steels have yield strengths of 100,000 psi at normal temperatures for plates up to 2-1/2 inches thick and 1 inch thick respectively. For T-1 steel plates over 2-1/2 inches thick and for square tubes, the yield strength is 90,000 psi. At 1000°F the yield strengths decrease to 73,000 psi. These steels will, upon cooling, regain their original yield strength and modulus of elasticity unless the tempering temperature is exceeded.

As a collateral benefit to the high strengths, T-1 has a resistance to atmospheric corrosion four times that of structural carbon steel while T-1 Type A has a resistance equal to twice that of structural carbon steel. The addition of nickel and copper accounts for the increased corrosion resistance of T-1.

4-3. FIRST ELEMENT

The first element (Figure 4-2) is a truss approximately 272 inches long and is common to all service arms. The interchangeability of this element requires that it be designed for the arm with the most severe loading conditions. It is supported at the tower face by the upper and lower arm hinges. Splice plates are provided on the vehicle end for connection of an extension element or a second element. This element, in elevation, is a Pratt truss with the upper and lower chords connected by members designed for load reversals.

Two wide-flange beams with coverplates, connect the upper and lower hinge plates. These beams transfer the individual bending loads caused by the rotational tendency of the self-aligning bearings. Arm locking devices are incorporated into the hinge plates. For personnel safety and protection of the locking mechanisms, the lower hinge plate is covered with a removable floor grating. The first element is also equipped with a secondary arm lock which is actuated by the movement of a manually operated safety gate (Figure 4-3). The gate occupies a position in the floor, near the hinge plate, and operates a lock to prevent arm rotation. When the gate is in a raised position, barricading the arm, the lock is disengaged.

4-4. SECOND ELEMENT

The second element (Figures 4-4 through 4-7) is the vehicle end of the structural arm assembly. This element, in elevation, is a K-truss design with the lower half of the last panel omitted to accommodate the retracted extension platform and "T" head. The element is of welded construction and framed predominately of square tubular members which furnish additional strength in areas of local bending. Splice plates are mounted on the tower end of the second element for connection to the first element or extension element.

The second element contains brackets for supporting the extension platform box beams. These brackets are pinned longitudinally to prevent transfer of bending loads, caused by deflection of the box beam, into the vertical arm truss. However, the truss does support, in bending, the eccentric vertical shear and the side load induced by the box beams.

4-5. WITHDRAWAL MECHANISM MOUNT

Withdrawal mechanism mounts (Figures 4-8 and 4-9) are provided on the arms to support the mechanisms. The mounts also transfer the withdrawal mechanism loads to the arm structure.

4-6. EXTENSION ELEMENT

The two extension elements (Figure 4-10) are K-trusses fabricated from round tubing and gusset plates. The extension element for the S-IVB FWD arm is 68 inches long; the element for the SM arm is 121 inches long.

4-7. CABLE ATTACH BEAM

The arm mounted cable attach beams (Figure 4-11) are weldments of T-1 Type A steel plate and are supported ~~by self~~-aligning bearings to allow rotation as the arm is retracted. The beam is mounted at the vehicle end of the first element and transfers the cable tension produced by the tower mounted cylinder into the arm structure. These beams are identical for all arms except the S-IVB AFT. This arm has a special beam to provide clearance for the propellant lines.

4-8. SERVICE ARM MOUNTING HINGE

Two tower mounted hinges (Figures 4-12 and 4-13) located above and below the arm hinge plates support the service arm. Each hinge weighs approximately 2500 pounds and is designed to support the service arms structure under a blast load of 35 psi with the arm in the retracted position.

The hinges are fabricated of welded ASTM A441 steel plate, 1/2 to 2 inches thick, and are bolted to the tower structure with high strength steel bolts.

Each hinge contains a bearing assembly, drive shaft, hydraulic cylinder, and associated piping. The upper and lower hinge assemblies are protected by dust covers which pivot at one corner for access to the equipment. The hydraulic cylinder is clevis mounted to the hinge structure. The piston rod of the cylinder is pinned to a driving arm which transmits torque through the drive shaft to the service arm hinge plate (Figure 4-14).

The differences in the upper and lower hinges are the opposite hand mounting of the hinge components, the secondary lock bracket located only on the lower hinge, and the deceleration valve located only in the upper hinge.

Two adjustable lock mechanisms will hold the service arm in the extended position and are located on the east side of the hinge assemblies. The locking dog is driven by a linkage and a hydraulic cylinder. The dog contacts a floating insert located in the service arm hinge plate ensuring full surface contact.

A secondary locking device prevents inadvertent arm rotation while personnel are on the arm. A floating insert, located in the lower tower-mounted hinge, receives a key that is pivoted from the arm hinge plate. Personnel entering the arm lower the safety gate, thus engaging the lock.

The upper surface of the lower hinge serves as a continuation of the access platform and is covered with a nonskid coating to provide a safe walking surface.

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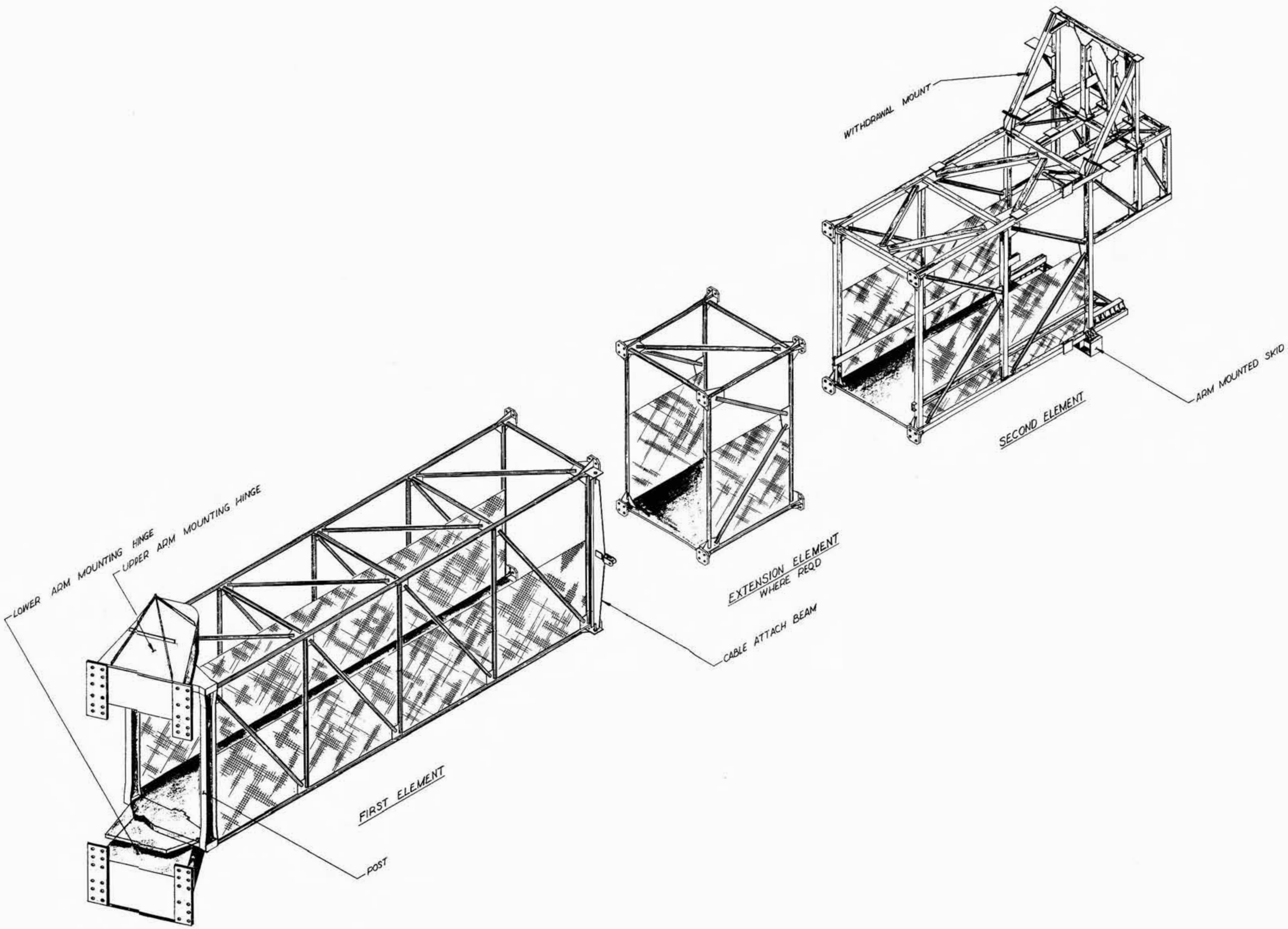


Figure 4-1. Structural Arm
Assembly

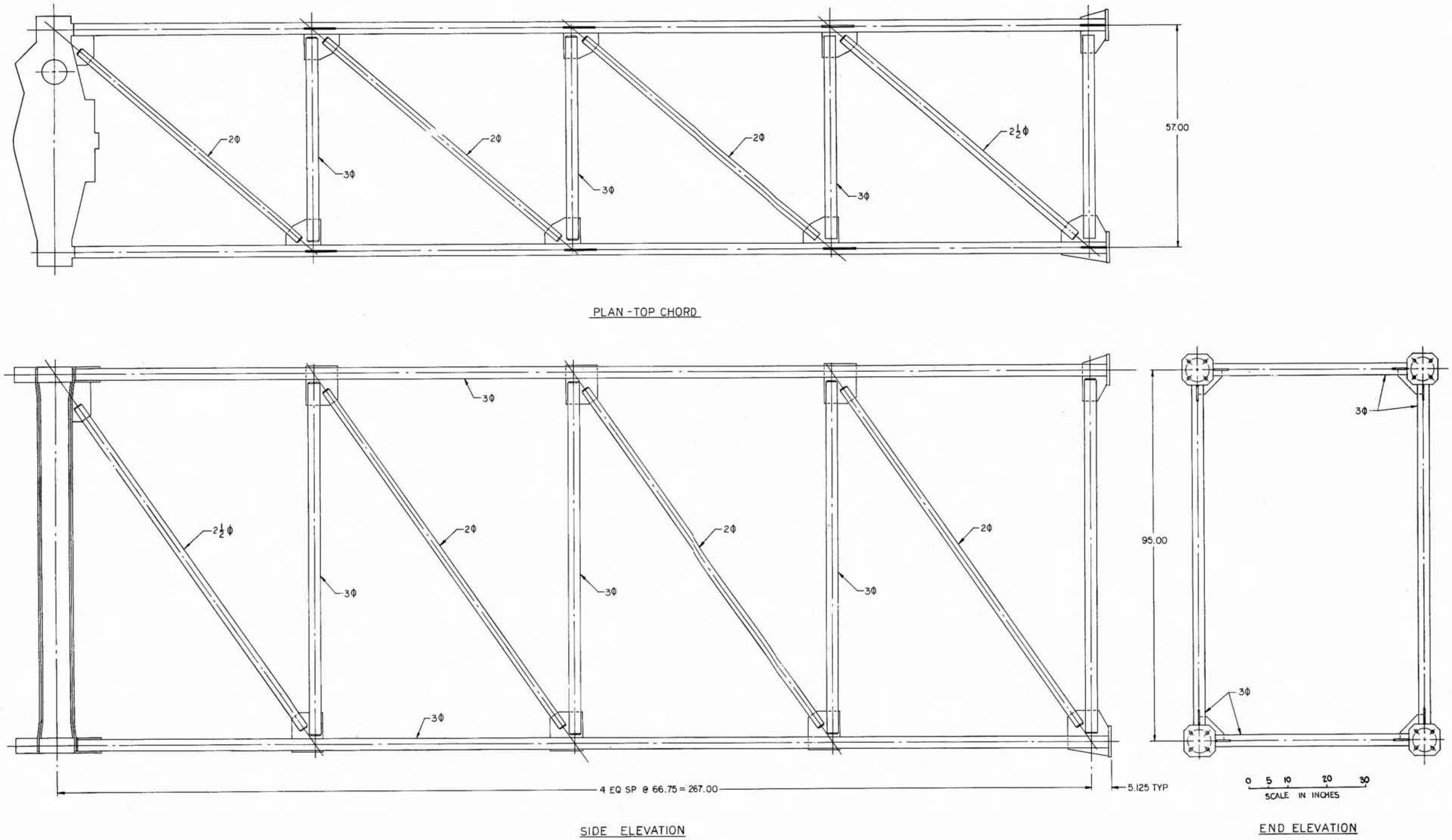


Figure 4-2. First Element

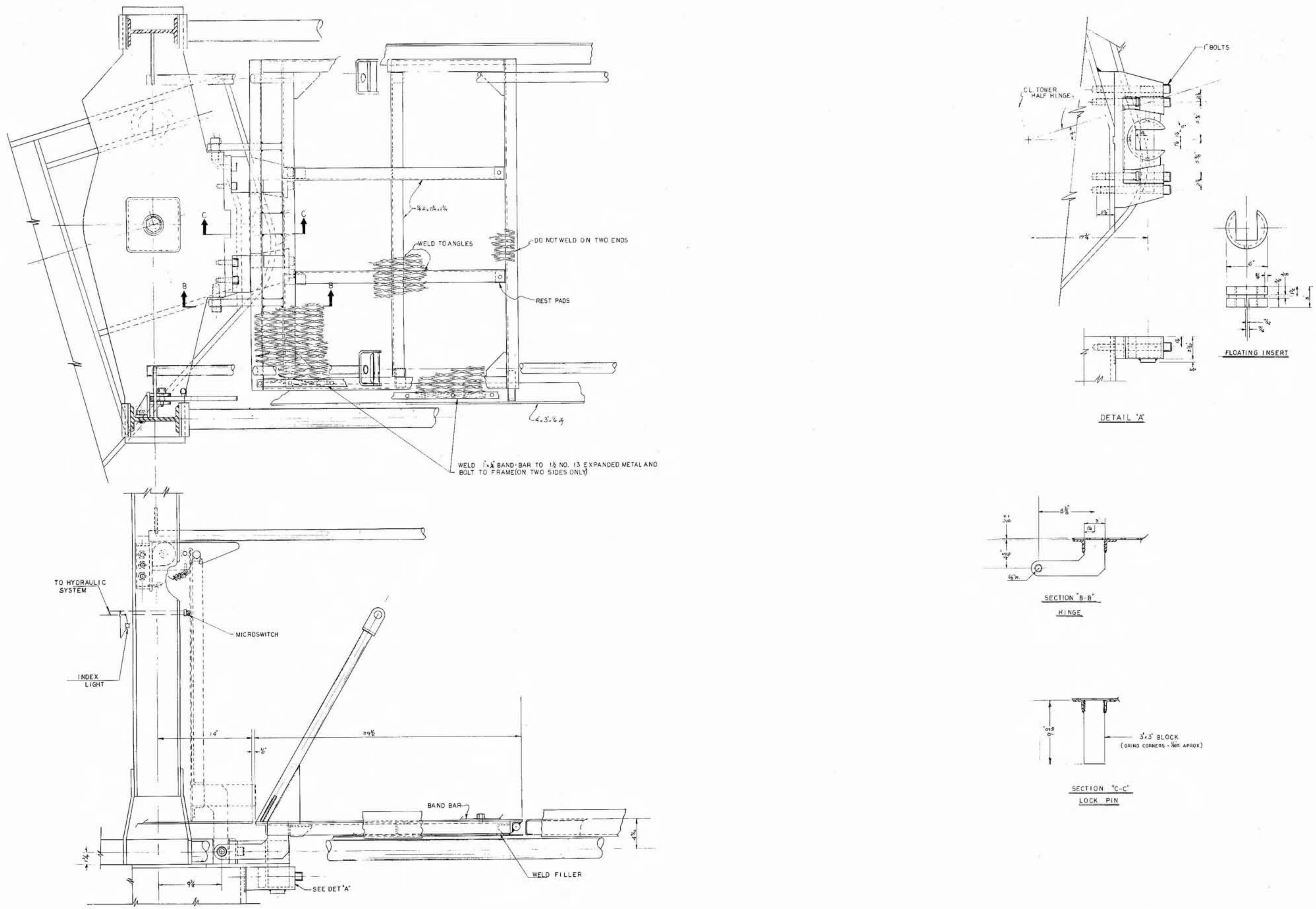


Figure 4-3. Safety Gate

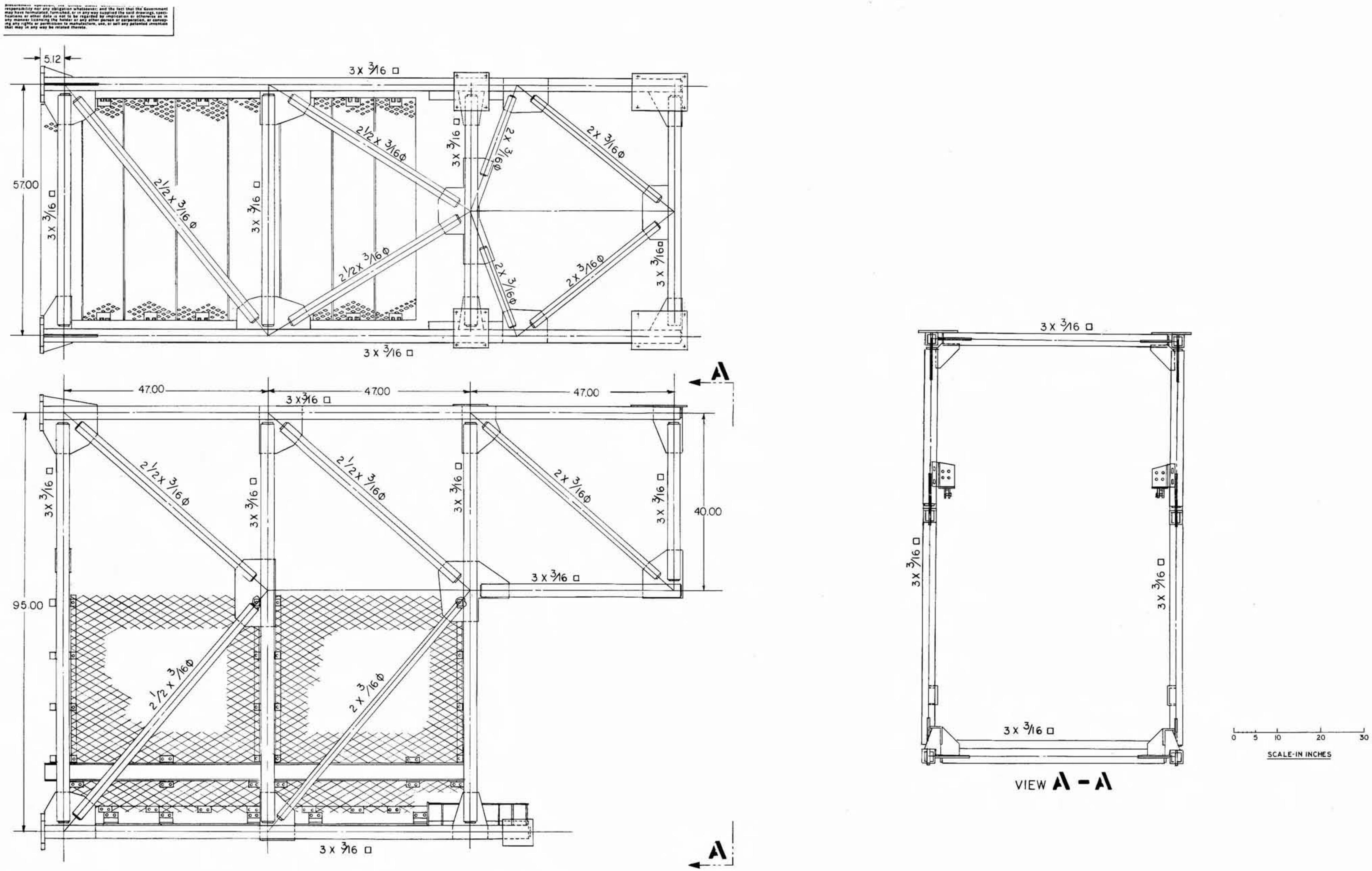


Figure 4-4. S-IC FWD Second Element

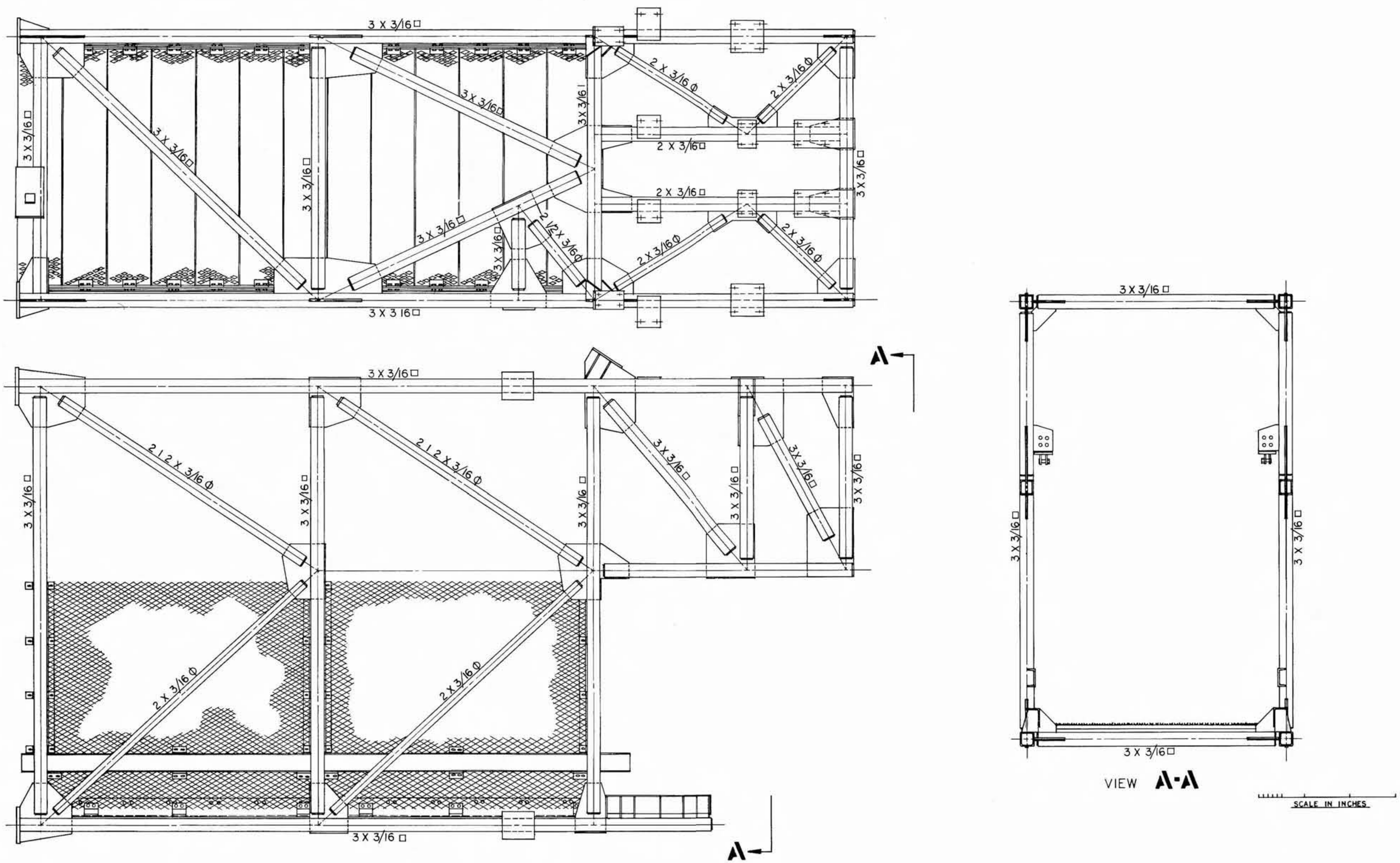


Figure 4-5. S-IVB AFT
Second Element

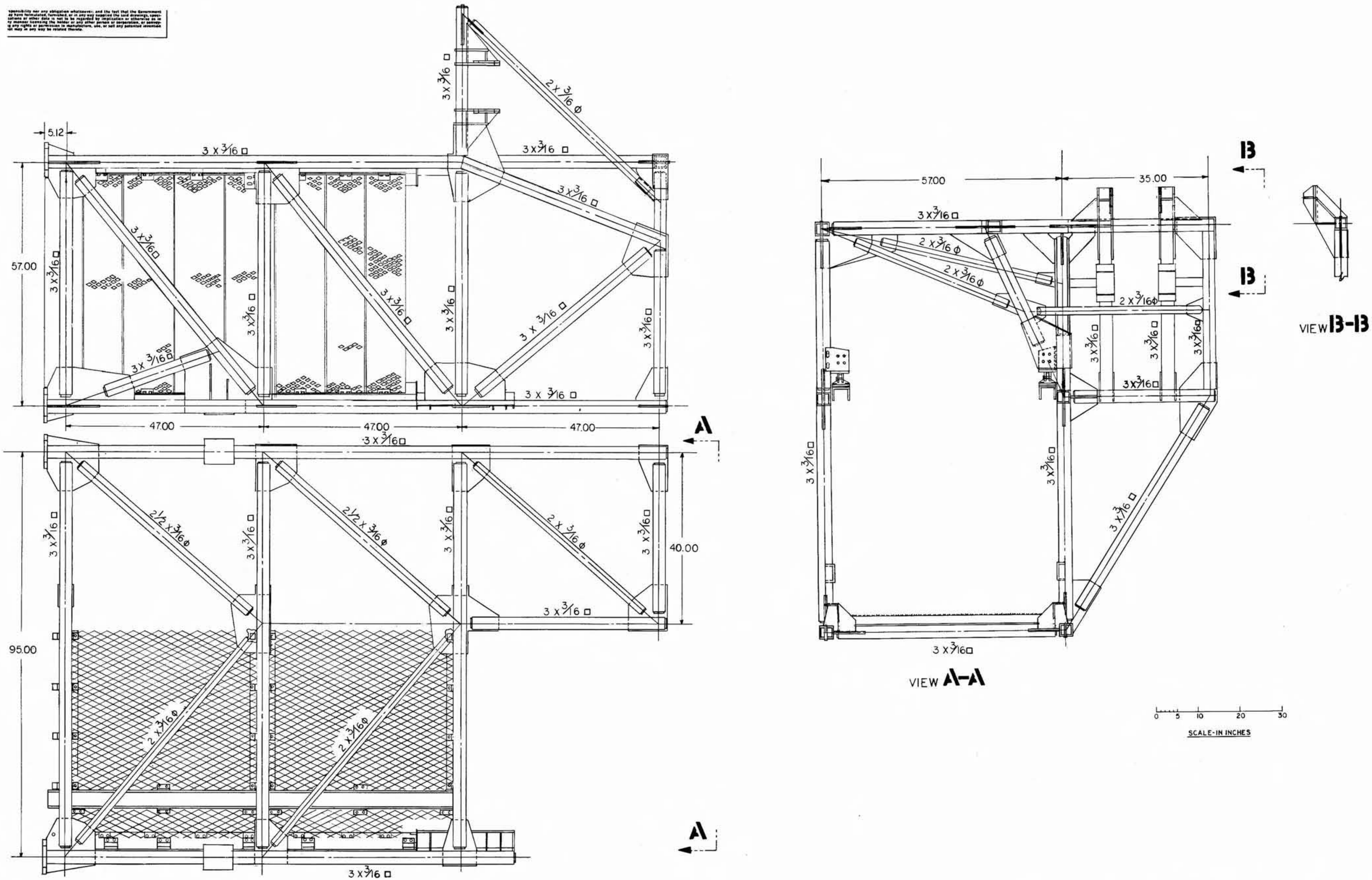


Figure 4-6. S-IVB FWD Second Element

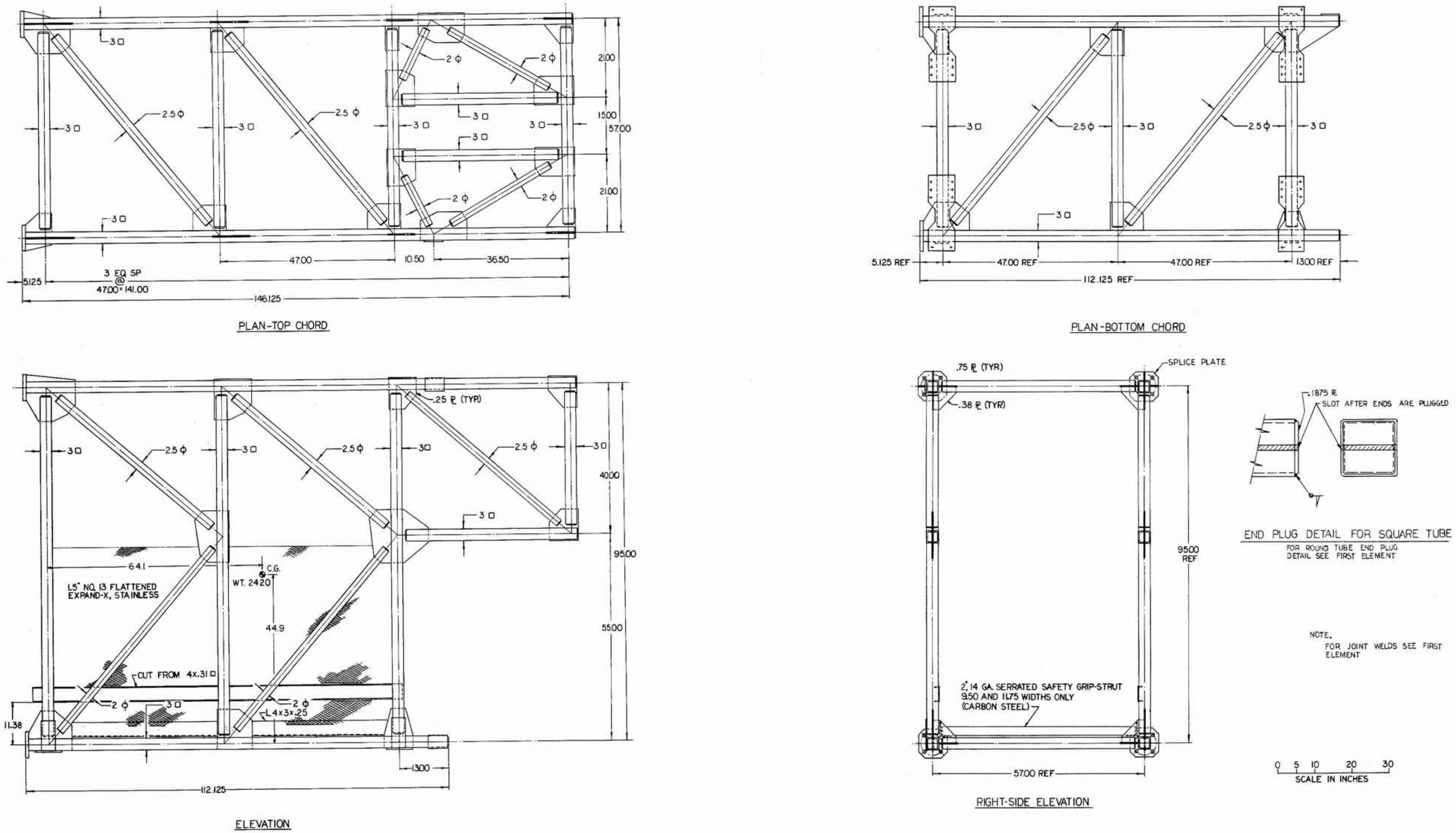


Figure 4-7. Service Module
Second Element

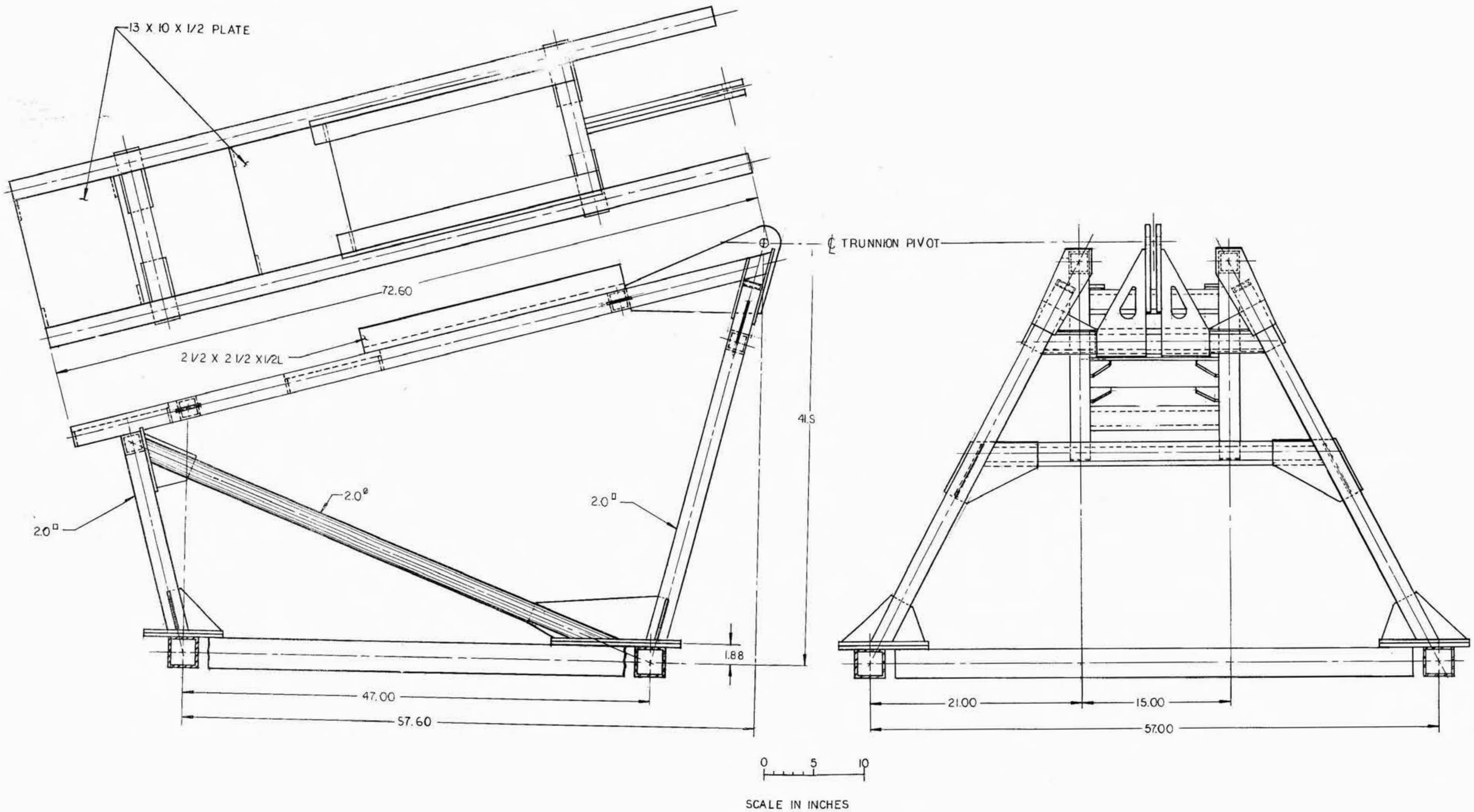


Figure 4-8. S-IC FWD Withdrawal Mount

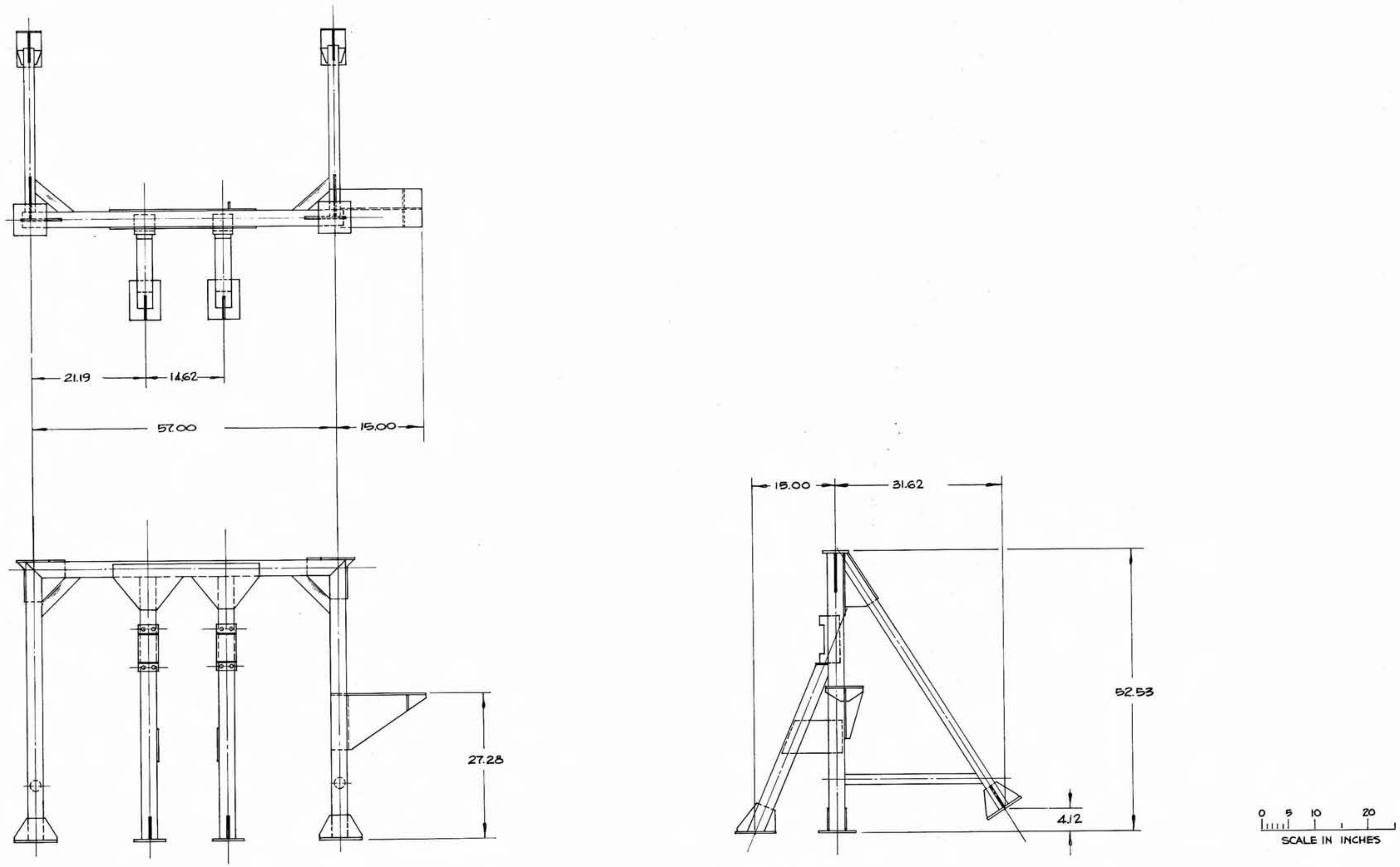


Figure 4-9. S-IVB AFT Withdrawal Mount

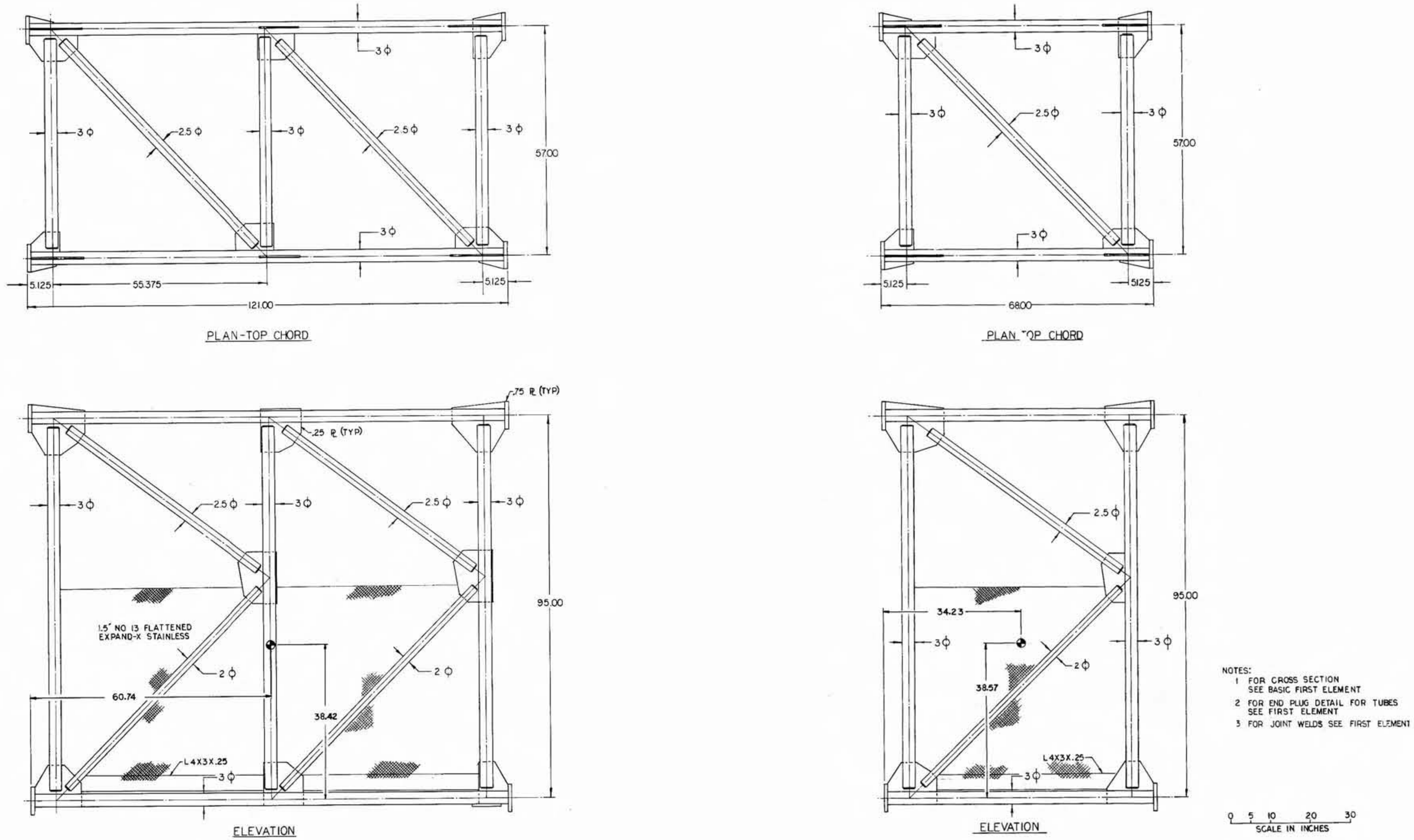


Figure 4-10. Extension Elements

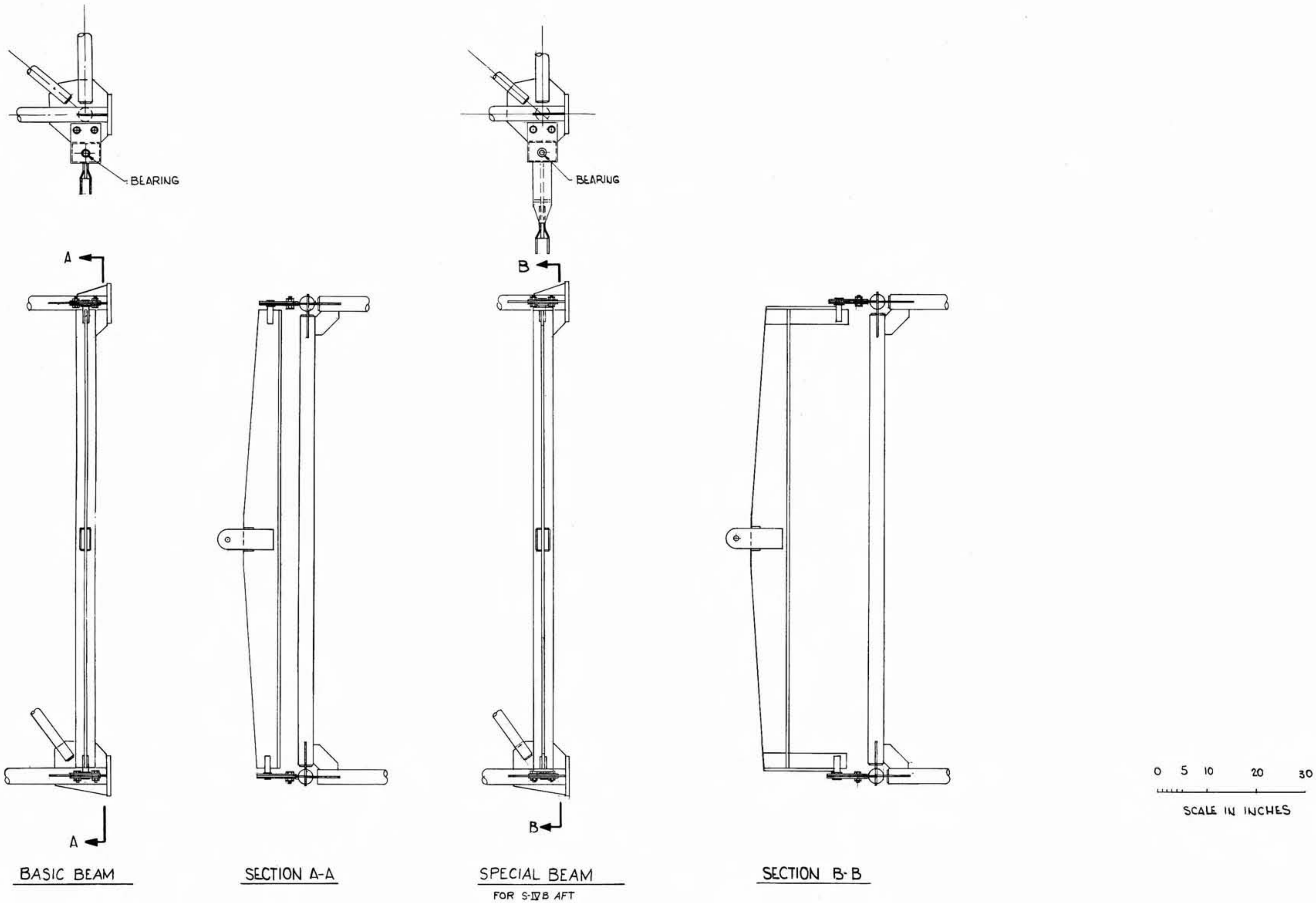
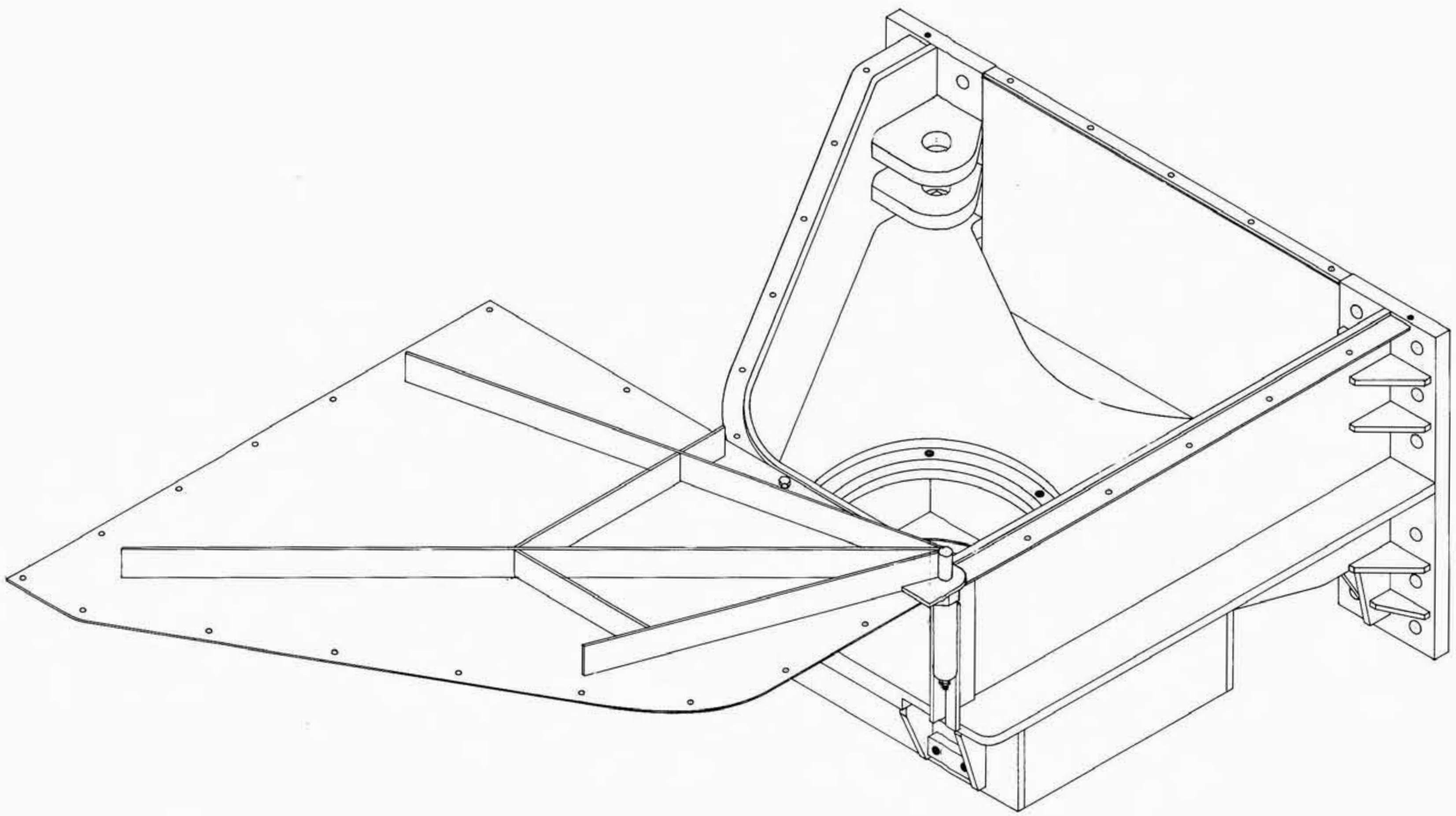
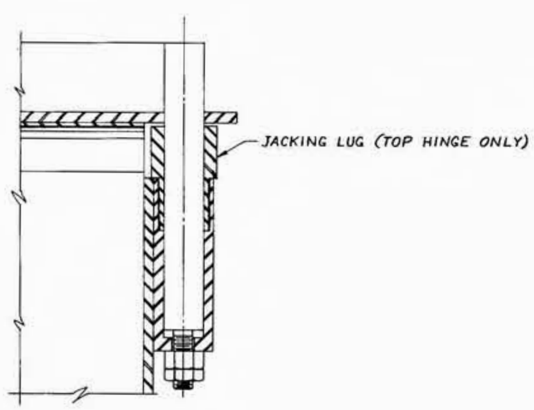


Figure 4-11. Cable Attach Beam





PIVOT DETAIL

Figure 4-12. Arm Mounting Hinge

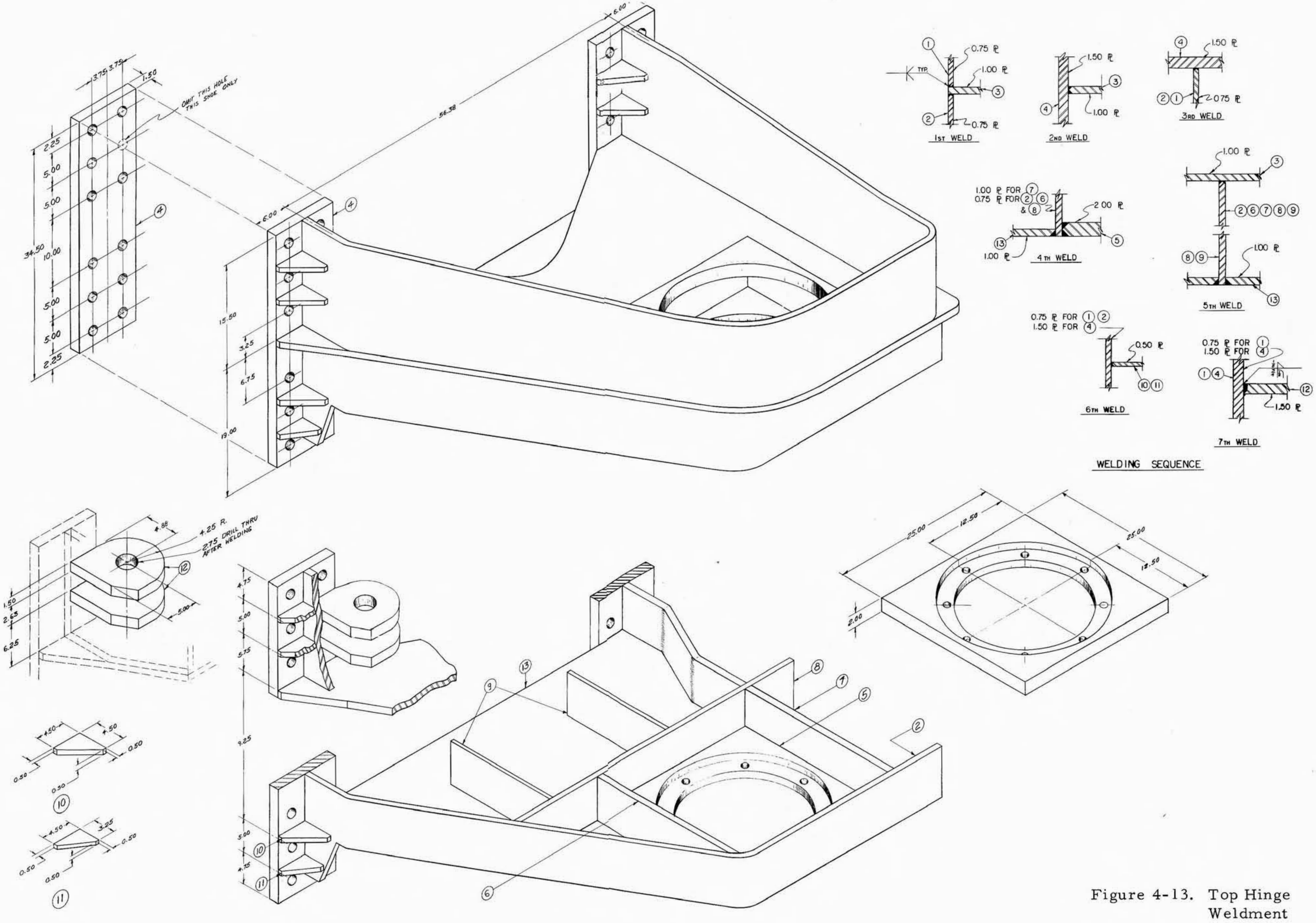


Figure 4-13. Top Hinge Weldment

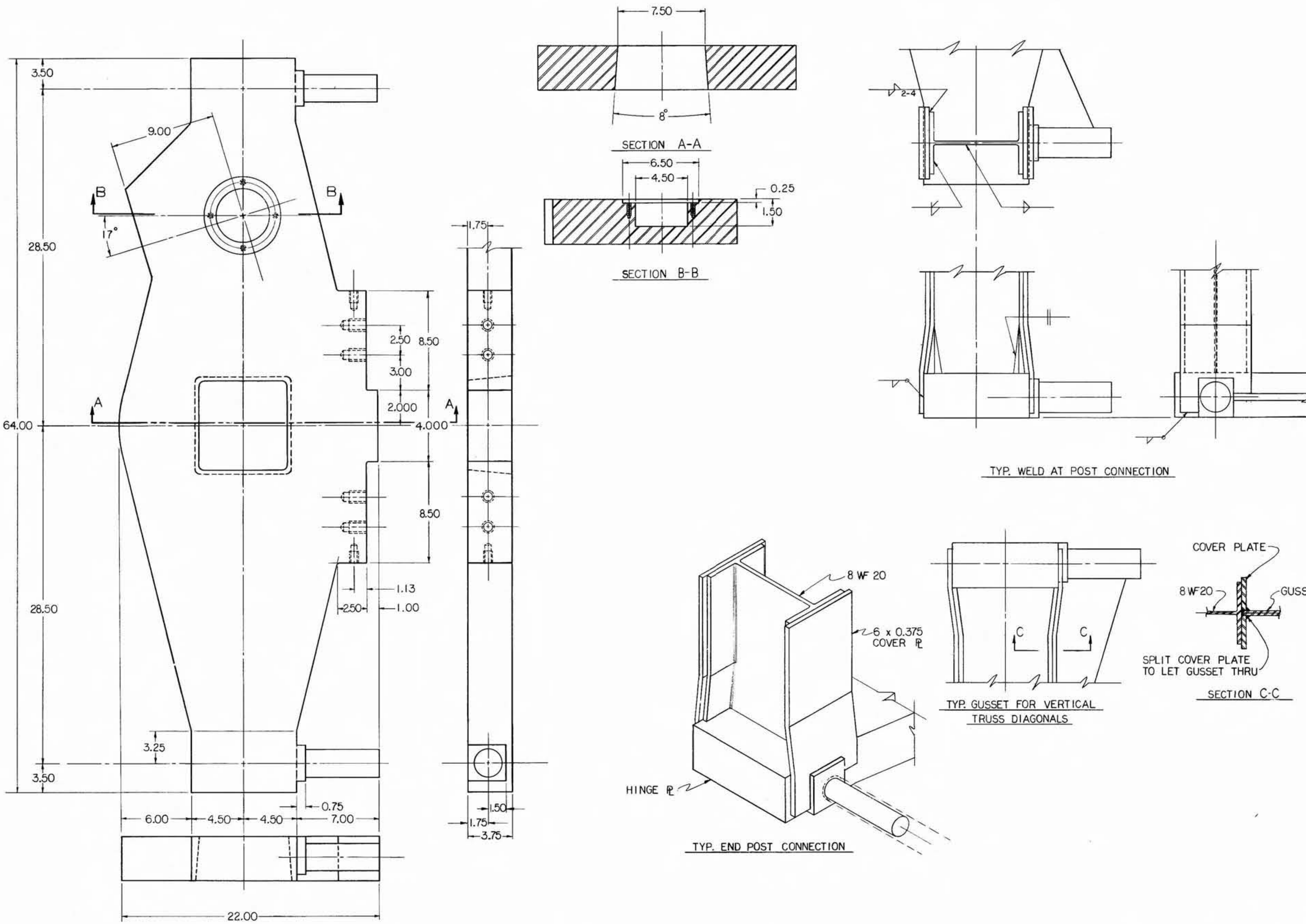


Figure 4-14. Hinge Plate

4-9. WITHDRAWAL MECHANISM AND LINE HANDLING DEVICES

The mechanisms (Figure 4-15) discussed in this section are divided into three general categories: umbilical carrier withdrawal mechanisms, cam-off mechanisms, and line handling devices. The basic function of the withdrawal mechanism is to provide rapid withdrawal of the umbilical carrier from the disconnected position adjacent to the vehicle skin to a stored position near the end of the service arm. The purpose of the cam-off (or disconnect) mechanism is to provide a redundant method of unlocking and separating the umbilical carrier from the vehicle plate. The line handling device operates in conjunction with the withdrawal mechanism to ensure that the line slack developed during withdrawal is accommodated without excessive bending of the lines and without interference with adjacent structures or mechanisms.

The withdrawal mechanism is mounted on the vehicle end of the service arm and is bolted to the umbilical carrier. The mechanism must be capable of following the relative displacement of the vehicle caused by wind loading, thermal bending, fuel weight compression, and thermal contraction due to subzero temperatures of the cryogenic propellants (Tables 4-1 and 4-2).

The "Description of Components" and the "Operational Description" (paragraphs 4-10 and 4-17) are generally applicable to the S-II INTERMEDIATE, S-II FWD, S-IVB AFT and S-IVB FWD Service Arms.

Some of the detailed descriptions and illustrations used are peculiar to the S-IVB AFT arm. The differences between the mechanisms for S-IVB AFT arm and those for the other service arms are clarified in paragraph 4-19.

4-10. DESCRIPTION OF COMPONENTS

4-11. Umbilical Carrier. The umbilical carrier for the S-IVB AFT (Figure 4-16) is essentially a rectangular housing containing the various line connectors which mate with counter-parts in the vehicle plate. The carrier and vehicle plate are held together until released by a ball-lock assembly. Umbilical carriers for all stages are shown in Figures 7-3 through 7-8.

Primary disconnect is accomplished by energizing small pneumatic push-off pistons which are contained within the housing. These pistons and the ball lock are energized simultaneously. Hockey stick type cam levers are pivoted on each side of the housing and linked to the ball-lock assembly. The levers are driven by the cam-off mechanism and will provide a secondary means of umbilical carrier unlock and separation in case of primary disconnect failure. As the levers are revolved, the ball lock is mechanically disengaged. The lower surfaces of the levers then contact the vehicle to produce

Table 4-1. Vehicle Motion Envelope at Lift-Off

Service Arm	Vehicle Station	Lateral Displacement (Reference 2 & 4)	Vehicle Vertical Deflections	
			+	-
S-IC INTERTANK	772	1.6	0	1.15
S-IC FWD	1516	4.0	0	3.34
S-II AFT	1606	4.5	0	3.36
S-II INTERMEDIATE (LOX & Umb.)	1771	5.2	0	3.46
S-II INTERMEDIATE (LH_2 Line)	1905	5.7	0	3.54
S-II FWD	2506	8.4	0	5.45
S-IVB AFT	2777	9.5	0	5.67
S-IVB FWD	3222	11.9	0	6.64
SM[3]	3721	14.5	0	7.16

Notes:

(1) Horizontal translations given in References 2 and 3 have been subtracted. Reference Design Criteria, Section III.

(2) Lateral Displacements are for the 99% wind, fueled vehicle condition.

(3) Deflections for this location are approximate. No definite information available.

Table 4-2. Vehicle Motion Envelope Prior to Lift-Off

Service Arm	Vehicle Station	Lateral Displacement (Reference 2 & 4)	Vehicle Vertical Deflections	
			+	-
S-IC INTERTANK	772	2.5	.46	1.15
S-IC FWD	1516	6.8	1.03	3.34
S-II AFT	1606	7.3	1.06	3.36
S-II INTERMEDIATE (LOX & Umb.)	1771	8.3	1.27	3.46
S-II INTERMEDIATE (LH_2 Line)	1905	9.3	1.25	3.54
S-II FWD	2506	13.5	2.12	5.45
S-IVB AFT	2777	15.8	2.18	5.67
S-IVB FWD	3222	20.3	2.64	6.64
SM[3]	3721	26.6	2.98	7.16

Notes:

(1) Horizontal Translations given in References 2 and 3 have been subtracted. Reference Design Criteria, Section III.

(2) Lateral Displacements are the maximum of the two following conditions:

(a) 99.9% wind and fueled vehicle.
(b) 99% wind and unfueled vehicle plus thermal bending.

(3) Deflections for this location are approximate. No definite information available.

a prying action which rotates the umbilical carrier about its support feet. The support feet release completely before an 11° rotation angle is attained.

4-12. Cam-off Mechanism. The cam-off mechanism (Figure 4-17) is located on a short link at the vehicle end of the withdrawal mechanism. This mechanism consists of a pneumatic cylinder (2-inch bore and 6-inch stroke), a pair of driving arms, a pair of over-center springs, a splined output shaft, and two small cams. The two small cams are attached to the large clevis at the end of the withdrawal mechanism pneumatic cylinder.

The cam-off cylinder body is trunnion mounted to the driving arms; the piston rod is pinned to a clevis which is part of the support link; and the over-center springs are arranged to prevent inadvertent actuation of the mechanism. When the cylinder is pressurized, the arms are rotated toward the vehicle driving the springs over center and producing a torque at the output shaft. The torque is transmitted through a simple linkage to the cam levers on the sides of the umbilical carrier. The torque and angle are given in Figure 7-1.

A third method of disconnecting the umbilical carrier is produced by the vertical lift-off motion of the vehicle. This phenomenon is known as "Vehicle Motion Cam-off" and is available in case of complete failure of all electrical and pneumatic systems. The method has no effect on normal cam-off operations. When the vehicle has risen past a predetermined level, the angular change between the umbilical carrier and the withdrawal mechanism pneumatic cylinder causes engagement of cam surfaces to drive the cam-off mechanism output shaft. The driving cams are splined to the clevis of the pneumatic cylinder to allow proper adjustment. The driven cams are integral parts of the arms which rotate the output shaft.

4-13. Withdrawal Mechanism. The major component of the withdrawal mechanism is a high pressure pneumatic cylinder (Figure 4-18) of special design which has a 5-inch bore, 4-inch rod, and a stroke of approximately 60 inches. The piston rod is constrained against rotation by a feather key mounted near the piston. The feather key rides in a milled slot in the piston guide rod. The guide rod is keyed to the blind-end cylinder head, extends through the barrel, and telescopes inside the piston rod. The forward end of the piston guide rod serves as a barrel for a 1-1/2 inch bore x 7-inch stroke hydraulic shock absorber. The fluid column contained within the piston guide rod discharges through a metering orifice to provide deceleration during the last five inches of cylinder stroke. The pneumatic cylinder is trunnion mounted in a universal joint located at the cylinder midpoint. A ring-mounted clevis is also threaded to the cylinder barrel to receive a self-aligning bearing on the rod end of the hydraulic cylinder.

The withdrawal mechanism hydraulic cylinder is a standard high pressure hydraulic actuator with a 3-inch bore, 1-1/2 inch rod, and a modified rod-end head which receives a large spherical bushing. The bushing is housed directly below the pneumatic cylinder universal joint and is supported by a common structure which ties the withdrawal mechanism to the service arm.

This dual cylinder combination and arrangement of universal joints allows tracking of vehicle motion while the umbilical carrier is connected. The arrangement also provides a self-centering feature during retraction. Vehicle loading is minimized by the introduction of balancing pressures in both cylinders. The retraction motion is a combination of straight line displacement along the axis of the pneumatic cylinder and simultaneous rotation of this axis is due to the torque applied by the hydraulic cylinder.

4-14. Line Handling Devices. Two types of line handling devices are required on the service arms: propellant line handling devices; and electrical cable, air conditioning duct, and pressure line handling devices. Descriptions of these devices are given in the following paragraphs.

Figure 4-19 shows the propellant line installation on the S-IVB AFT Service Arm. Vacuum-jacketed flex-line assemblies extend from the couplers in the umbilical carrier to flanged joints at the forward ends of the hard line assemblies. The portions of the hard line assemblies on the top of the arm are supported on trolleys which roll along I-beams. Three vacuum-jacketed hinge joints are contained in sections of the hard line assemblies which are suspended on the sides of the service arm. During vehicle motion and umbilical carrier retraction, the hinged joints deflect to allow straight line motion along the I-beams. This arrangement ensures positive drain of propellants throughout the range of vehicle motion. The installation must have enough free motion to extend 16 inches out and 30 inches up from nominal position and yet not allow pockets to form in the lines when the umbilical carrier is 16 inches in and 6 inches down from the nominal position.

A propellant line retract system is installed on top of the arm behind the lines. This system consists of a pneumatic cylinder which drives a 4 to 1 ratio block and tackle. The output cable is connected to a beam which joins the two hard line assemblies. This system provides a pull on the propellant lines during retraction to prevent destructive compressive bending of the flex lines. A second use of the retract system is to provide an adjustment of the tension in the flex line during vehicle tracking.

The remaining service lines for the S-IVB AFT arm are handled by a pivoted frame (Figure 4-15) located directly behind the support structure for the withdrawal mechanism. The various lines are clamped to the tubular members of the frame and are arranged to provide proper bend configurations at both ends. The frame follows vehicle motion to some extent since any increase in line tension, as the vehicle moves out, tends to rotate the frame forward. A cable connects the frame to the beam across the aft end of the propellant lines. Thus, as the vehicle moves in and the propellant lines move away from the vehicle, the line handling frame is rotated back. When the umbilical carrier is withdrawn, the frame is rapidly revolved backward by the propellant line retract system. When in final position, the frame is locked in place and is restrained against motion induced by service arm acceleration.

4-15. OPERATIONAL DESCRIPTION

Three possible modes of operation are briefly outlined below. These descriptions are intended to give only a general understanding of the chronological sequence of events. Refer to paragraph 4-83 for detail operational description of the isolated redundant mechanical and electrical systems.

4-16. Primary Disconnect and Withdrawal. Initial vertical motion of the vehicle closes the primary lift-off switch. The closing of this switch completes a circuit to energize a valve which supplies pressure to the umbilical carrier ball lock and push-off pistons. The umbilical carrier is unlocked and ejected from the vehicle. This action closes a switch in the umbilical carrier to confirm release. When this switch is closed, a circuit is completed to energize the valves which supply pressure to the withdrawal mechanism pneumatic and hydraulic cylinders. The umbilical carrier release confirm switch also completes a circuit to energize the service arm retract system. Thus, service arm retraction and umbilical carrier withdrawal occur simultaneously.

Figure 4-20 is a presentation of the combined motions which produce relative displacement of the S-IVB AFT umbilical carrier with respect to the vehicle skin at lift-off. The following phenomena were examined separately as functions of time: pneumatic ejection of the umbilical carrier, withdrawal action of the dual cylinders, retraction of the service arm, rise of the vehicle, and drift of the vehicle toward the tower. The "T" referred to in the figure represents the instant when vehicle rise begins. Many simplifying assumptions were necessary in the preparation of this study. Some of these assumptions were constant accelerations of the withdrawal mechanism cylinders, valve delays, velocity of umbilical carrier acquired by ejection, etc.

4-17. Secondary Disconnect. A few milliseconds after application of pressure to the umbilical carrier pneumatic system, pressure is applied to the cam-off mechanism pneumatic cylinder. Therefore, if the ball lock or push-off pistons within the carrier fail, release and separation will be accomplished almost immediately by the cam-off mechanism. The sequence of operation after closure of the umbilical carrier release confirm switch is the same as that for primary disconnect.

4-18. Vehicle Motion Cam-off. If both modes of operation described above fail, the vehicle will continue to rise until the cams on the end of the pneumatic cylinder engage the cam surfaces on the driving arms (Figure 4-17). This causes enough rotation of the cam-off mechanism output shaft to unlock the umbilical carrier. Further vehicle rise rotates the withdrawal mechanism pneumatic cylinder away from the vehicle and fully extends the piston rod. When the piston bottoms, the umbilical carrier continues to rotate until all connections are broken and the carrier is free of the vehicle. At this point, the pneumatic cylinder is constrained against rotation toward the vehicle by a ratchet at the trunnion. The pressures in this cylinder are no longer equal due to the increase in the force component along the barrel. Therefore, the pneumatic cylinder will collapse and the carrier will fall away from the vehicle.

4-19. ARM PECULIAR CHARACTERISTICS

As a result of efforts toward standardization, a dual cylinder type withdrawal mechanism (similar to the one described) is used on four of the eight service arms. The large pneumatic cylinder for each of these mechanisms is identical except for the location of the attach point for the hydraulic cylinder. The trunnions for the pneumatic cylinders are identical. The hydraulic cylinders differ only in stroke. The adjustment feature inherent in the cam-off mechanism allows its application to all dual-cylinder type withdrawal mechanisms. A brief description of the mechanisms carried by each service arm is given below.

4-20. S-IC INTERTANK. Addition of a remote connect capability to the S-IC INTERTANK arm allows arm retraction before lift-off and classification as a preflight arm. The exact configuration of the LOX couplers to be handled from this arm is yet to be determined. Present plans call for two 6-inch couplers. The propellants will be carried by two 8-inch lines from the M-P&VE/LOC interface on the arm back to the tower interface. A compound parallel linkage device has been proposed to handle the carrier which contains the couplers. This device is spring loaded to the neutral position and is driven by a single pneumatic cylinder. Two concentric pneumatic devices are provided in the carrier for actuation of the couplers and control of the probe which seats in a funnel in the vehicle. This arrangement provides guidance for remote reconnect of the couplers.

The design of the remote reconnect mechanism has not progressed sufficiently to warrant inclusion of an illustration in this report other than the sketch in Appendix F.

4-21. S-IC FWD. Since the S-IC FWD is a preflight arm, a simple disconnect and withdrawal mechanism is used. Figure 4-21 shows a pivoted device similar to those used on Complex 37. A lanyard is connected to the bar between the umbilical carrier cam levers. This lanyard is routed over pulleys on the boom to a block and tackle retraction device which is driven by a pneumatic cylinder. Initial lanyard travel cams the umbilical carrier from the vehicle (if the push-off pistons have failed) and withdraws the carrier to the end of the boom. Additional lanyard travel rotates the boom away from the vehicle and back to a small structure on top of the service arm where the boom is latched. The service lines are clamped to the pivoted boom thereby obtaining limited guidance during withdrawal.

An alternate mechanism is shown in Figure 4-22. The operation of this device is similar to the one just described except that the pivoted boom is replaced with a simple rigid structure. This mechanism is arranged to prevent the retracted umbilical carrier from contacting the skin of the vehicle as it deflects toward the tower.

4-22. S-II AFT. The S-II AFT disconnect and withdrawal mechanism (Figure 4-23) will handle a single 1-inch diameter flex line. Therefore, a very simple lanyard retract device is mounted on the side of the service arm truss. This device consists of a pneumatic cylinder which reels cable through a block and tackle to disconnect and withdraw the coupler to the service arm.

4-23. S-II INTERMEDIATE. The unique spacing of two propellant lines in addition to a relatively large umbilical carrier dictates the need for three separate withdrawal mechanisms on the special second element of the S-II INTERMEDIATE service arm (Figure 4-24). The arrangement of the mechanisms has been somewhat simplified by placement of an extension platform on the S-II AFT arm for service of the lower umbilicals at the S-II INTERMEDIATE arm.

A dual cylinder type withdrawal mechanism is mounted inside the arm on the bottom cord members to handle the umbilical carrier at vehicle station 1771. The operation and arrangement of the cylinders is similar to that previously described for the S-IVB AFT service arm. All the umbilical lines except the 14-inch air conditioning duct are clamped near the mechanism mount and allowed to sag in the retracted position. Thus, no special handling devices are required.

The 8-inch LOX line at vehicle station 1771 is retracted by a lanyard type withdrawal device mounted at the upper left side of the arm. The lanyard is connected directly to the ball-lock pin in the coupler to provide a secondary means of release. The flex line section of the propellant line is supported by rollers to reduce vehicle loading. The propellant line slack generated by vehicle motion is taken up by an arrangement of two hinged joints and a pressure compensated expansion joint. These components are set in their neutral positions at full retraction. Thus, the spring forces generated in the system cause impending motion away from the vehicle. An additional lanyard is connected to the ball-lock pin and anchored to the arm such that vehicle rise past a predetermined level will cause release of the coupler. This corresponds to the vehicle motion cam-off condition previously explained for the umbilical carriers.

The 8-inch LH_2 line at station 1905 is handled by a second lanyard type mechanism. A hard line section rides on a trolley between two sections of flex line. The flex line into the coupler is supported by a band to reduce vehicle loading. The aft flex section is directed down the side of the arm and deflects to allow approximately 40 inches of translation along the trolley. Both the coupler, with attached flex line, and the hard line section are retracted by a single pneumatic cylinder as follows. The cylinder is connected to the hard line section by a 2 to 1 lanyard-pulley arrangement. The lanyard from the coupler is connected to the hard line support by another 2 to 1 pulley system. Thus, one unit of motion by the cylinder produces two units of motion by the hard line and four units by the coupler. This action produces the required bending in the aft section of flex line and simultaneous retraction of the fwd flex line without violating the minimum bend radius of either section.

The systems described above will meet the requirement for positive drain of propellants during vehicle tracking.

4-24. <u>S-II FWD.</u> A dual-cylinder type withdrawal mechanism (Figure 4-25) is mounted off center on the top of the S-II FWD arm to handle the umbilical carrier at vehicle station 2506. The hydraulic cylinder is located above the pneumatic cylinder and is attached to the barrel forward of the main trunnion. The hydrogen vent lines are routed through rollers on the side of the service arm. The remainder of the service lines are routed such that the retraction slack may be accommodated inside the arm structure.

4-25. <u>S-IVB AFT.</u> The withdrawal mechanism for the S-IVB AFT arm (Figure 4-15) has been completely described in "Description of Components" and "Operational Description."

4-26. S-IVB FWD. A dual cylinder type withdrawal mechanism (Figure 4-26) is mounted on the side of the S-IVB FWD arm. This mechanism handles the Instrument Unit and S-IVB FWD umbilical carriers which are held within a common frame. The mechanism employs the "hydraulic cylinder above" configuration and a special bent clevis at the end of the piston rod of the pneumatic cylinder. The special clevis compensates for the geometrical conditions imposed by the off-set location and radial orientation of the umbilical carriers. A pivoted frame similar to the one on the S-IVB AFT is used to handle the service lines. This frame is pulled during retraction by a lanyard connected to the blind end head of the pneumatic cylinder.

4-27. SM. A modified pivoted boom type disconnect and withdrawal mechanism (Figure 4-27) is mounted on top of the SM arm to handle the umbilical carrier at station 3721.555. The boom for this device has a central pivot that allows the boom to collapse as the umbilical carrier is withdrawn. This feature ensures impending motion away from the vehicle skin. A lanyard clamping device is included at the end of the boom to accomplish vehicle motion cam-off within a reasonable amount of vehicle rise. The magnitude of horizontal vehicle displacement at this station prohibits the use of an ordinary cable tension cam-off device. The special device senses the vertical motion of the vehicle and clamps the lanyard so that additional vehicle motion releases the umbilical carrier.

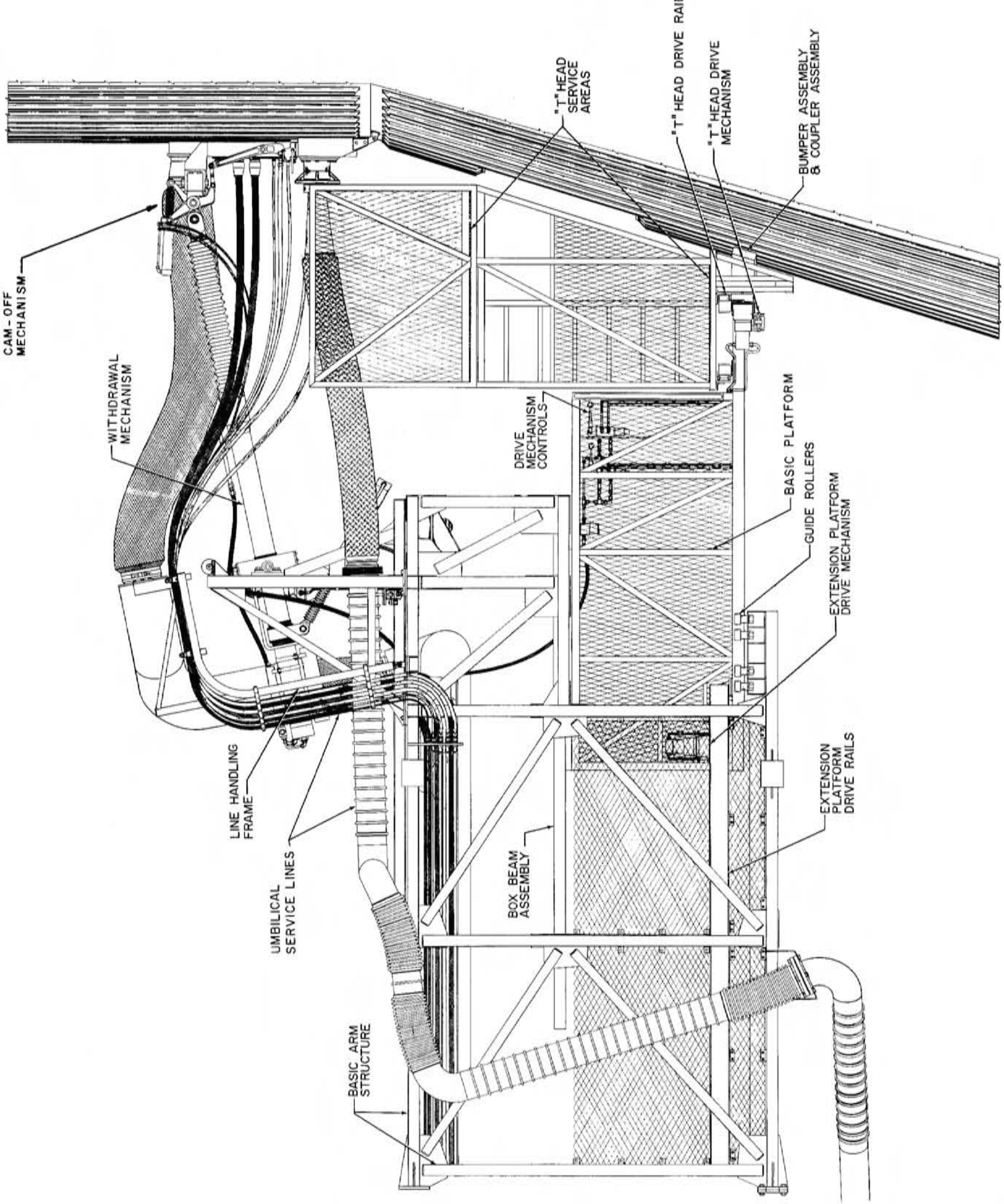


Figure 4-15. S-IVB AFT Arm Tip

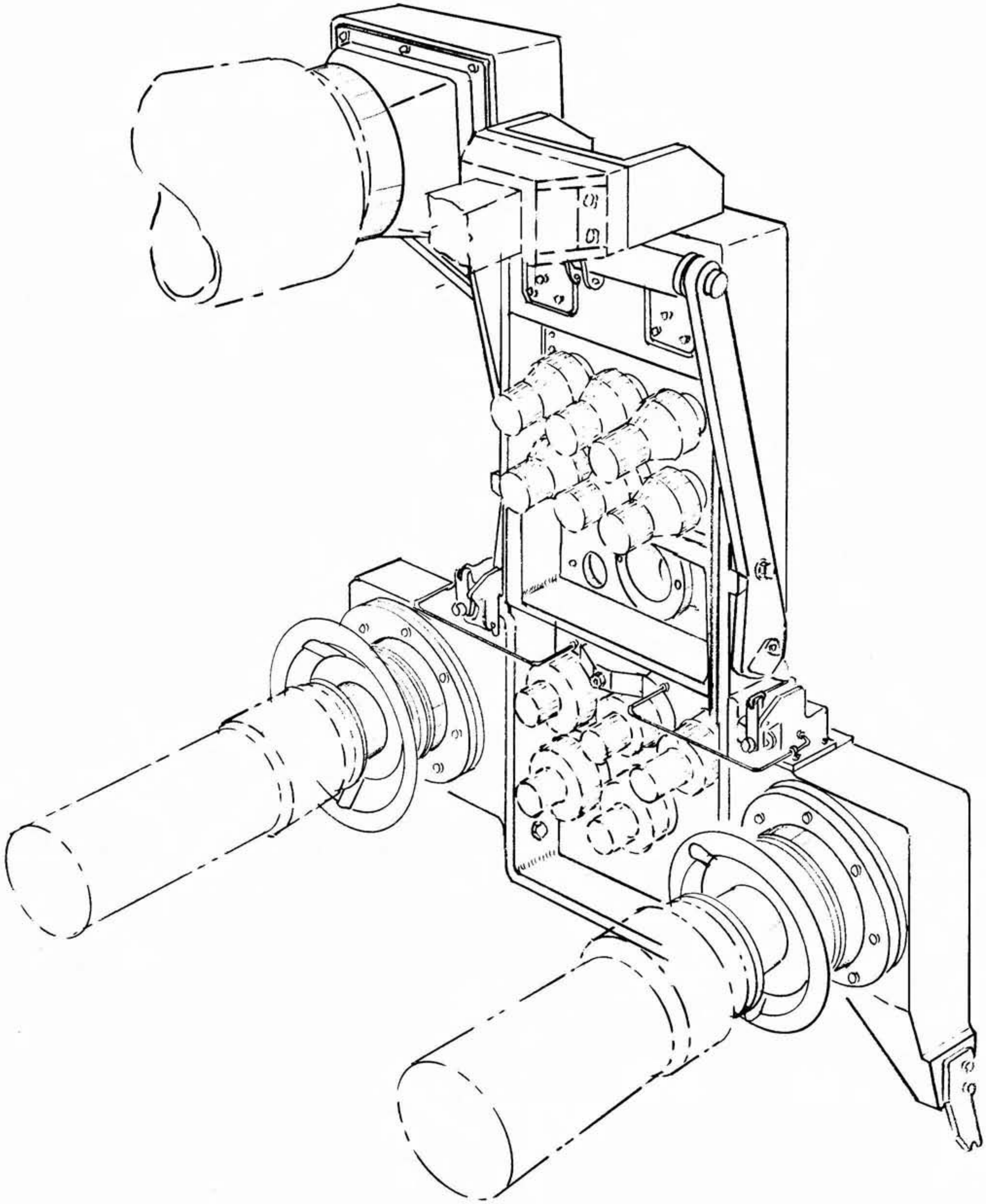


Figure 4-16. S-IVB AFT Umbilical Carrier

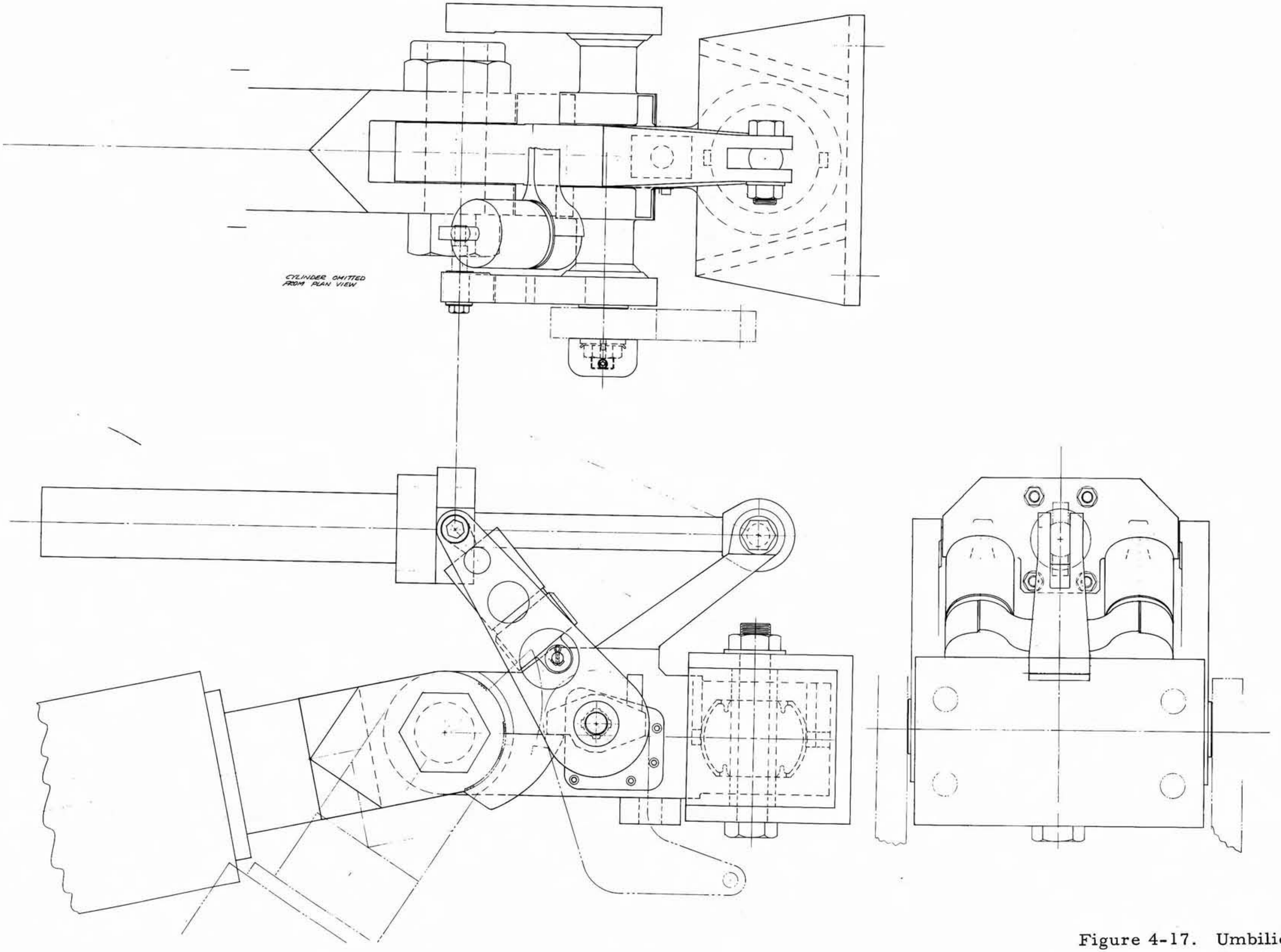


Figure 4-17. Umbilical Carrier Cam-off Mechanism

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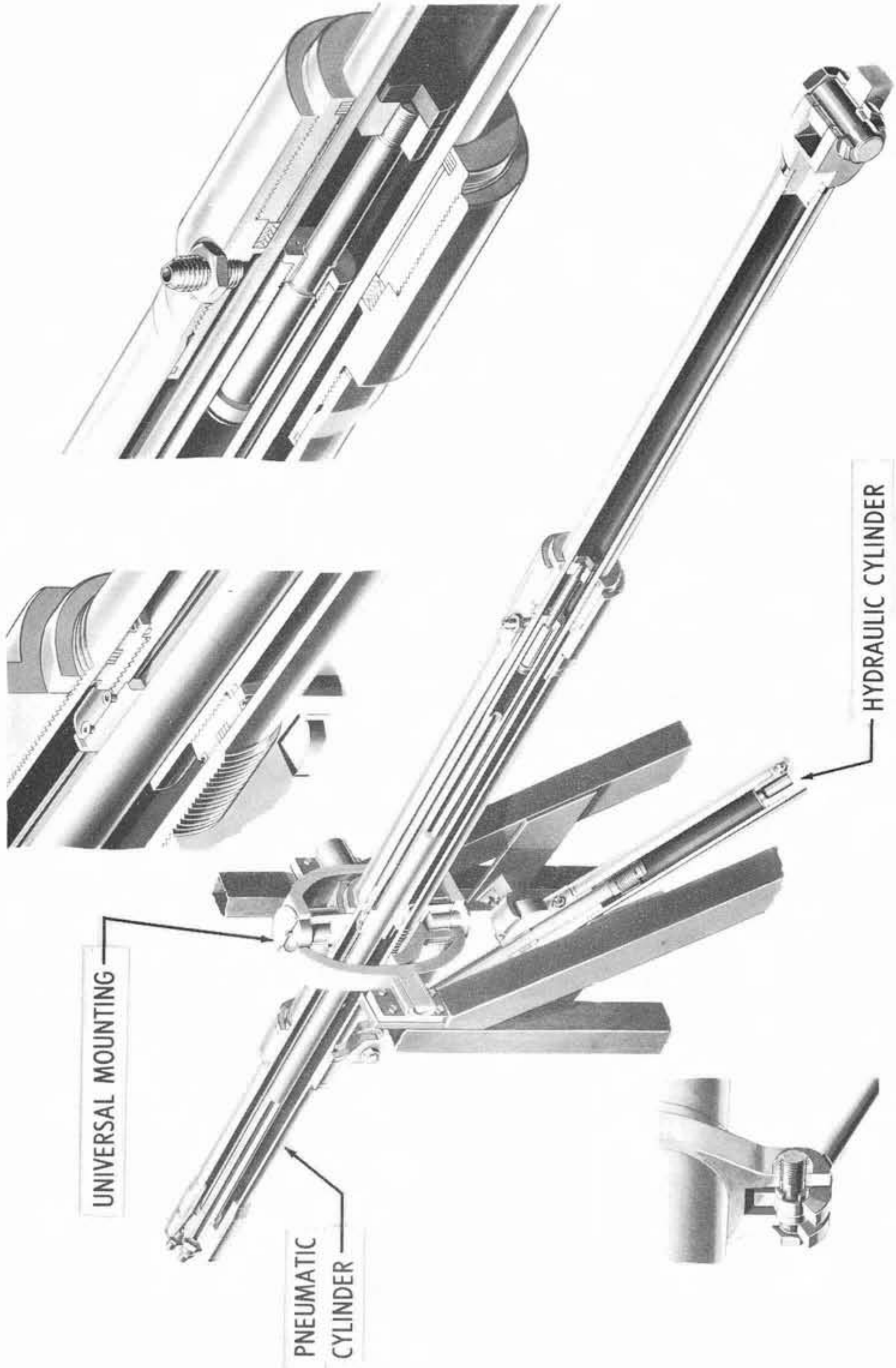

Figure 4-18. Cylinder-Type Withdrawal Mechanism

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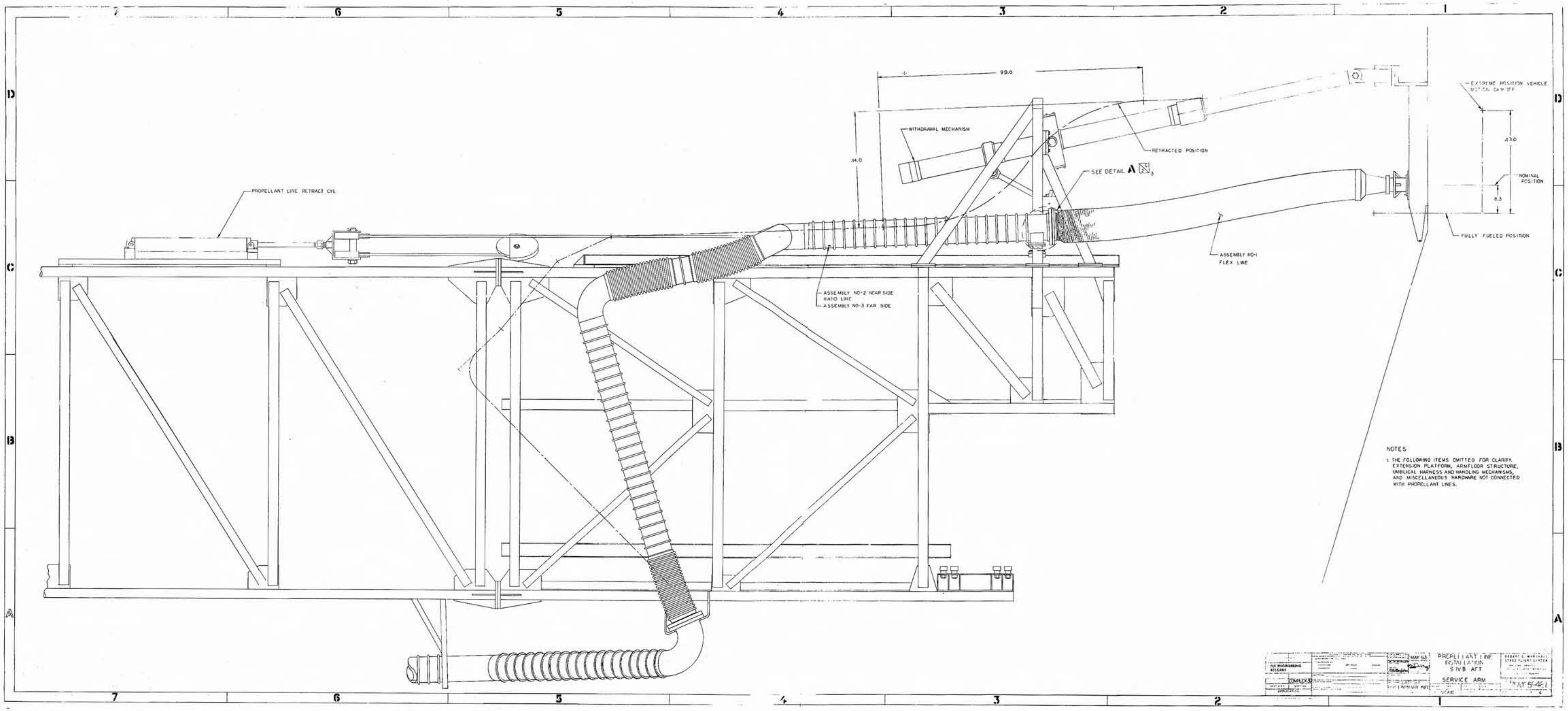


Figure 4-19. Propellant Line Installation - S-IVB AFT (Sheet 1 of 4)

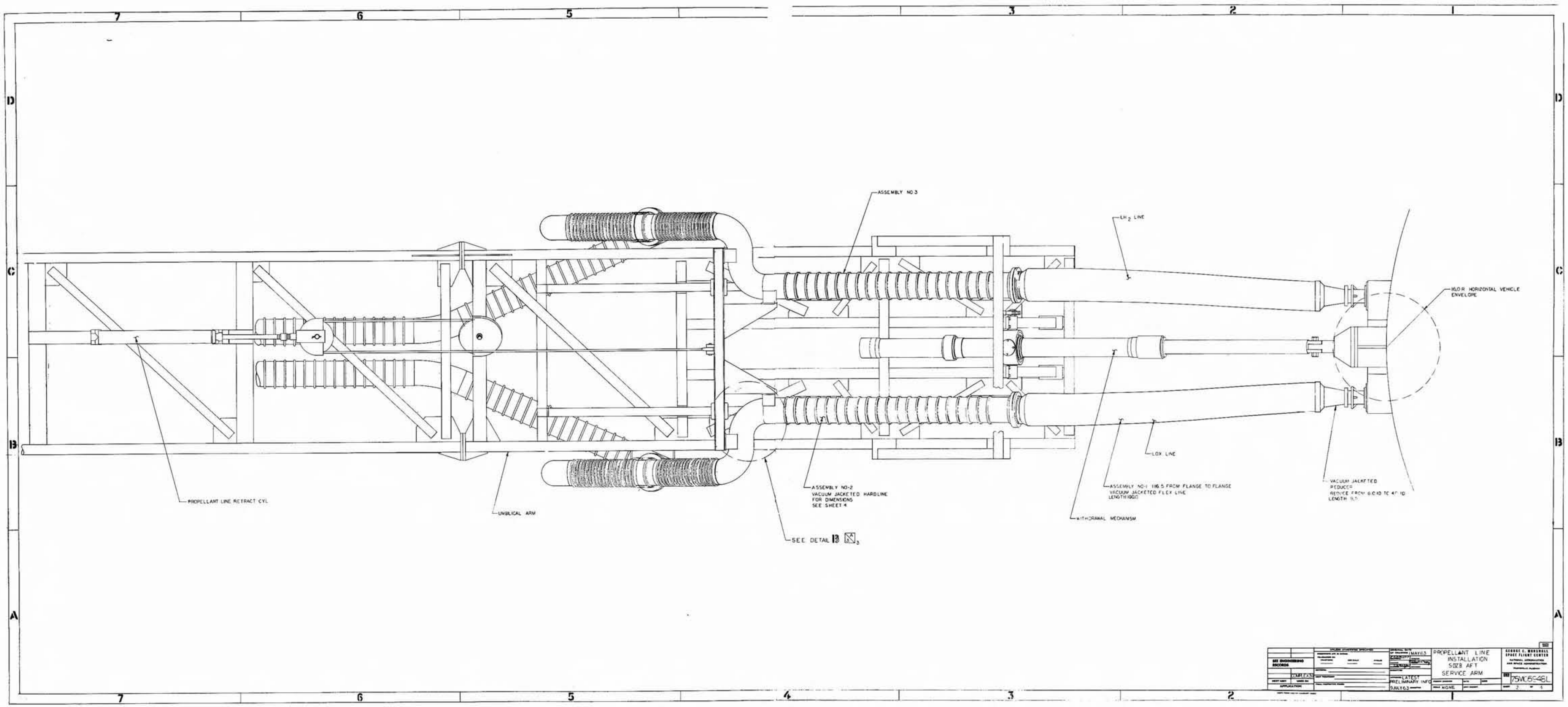


Figure 4-19. Propellant Line Installation - S-IVB AFT (Sheet 2 of 4)

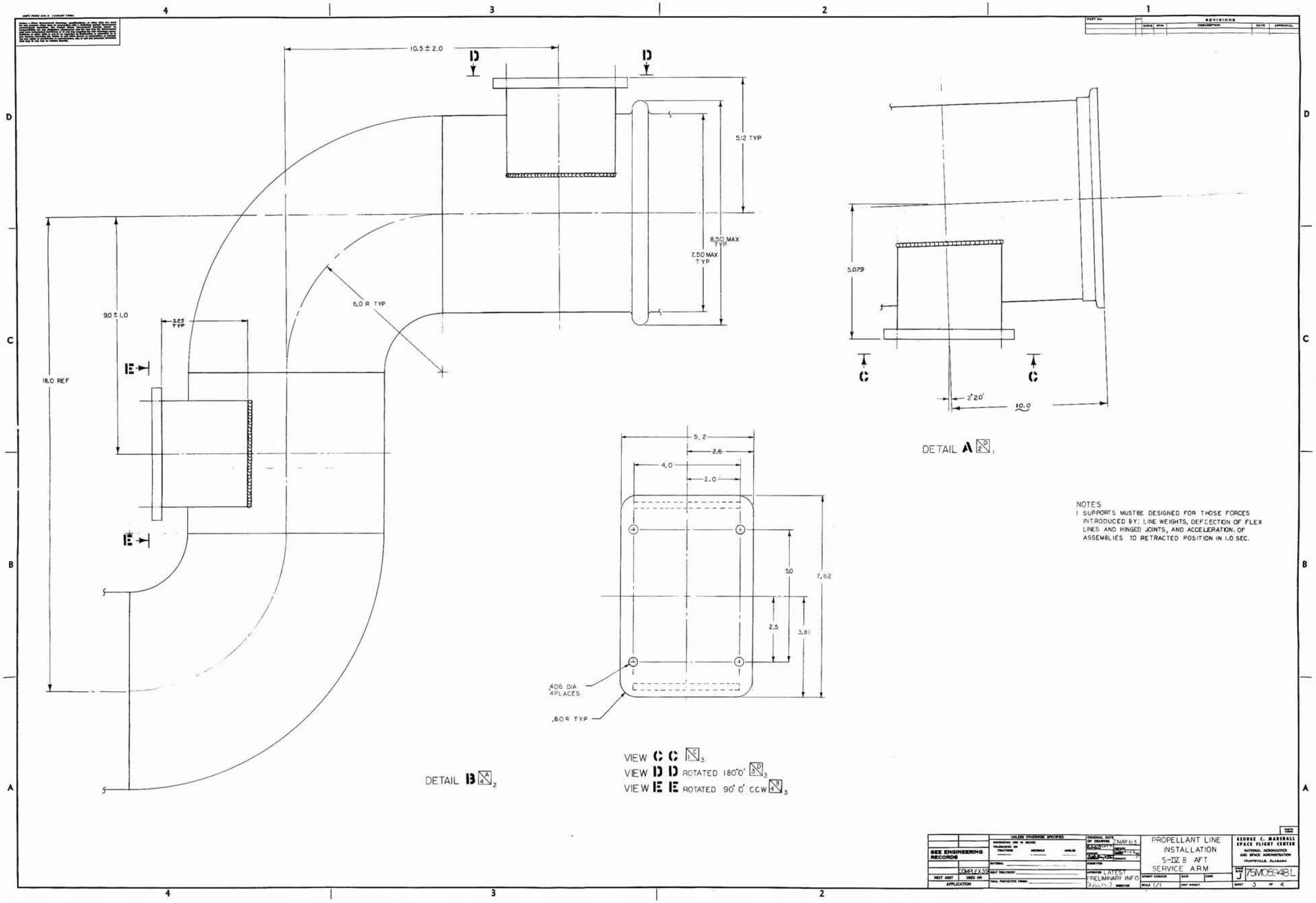
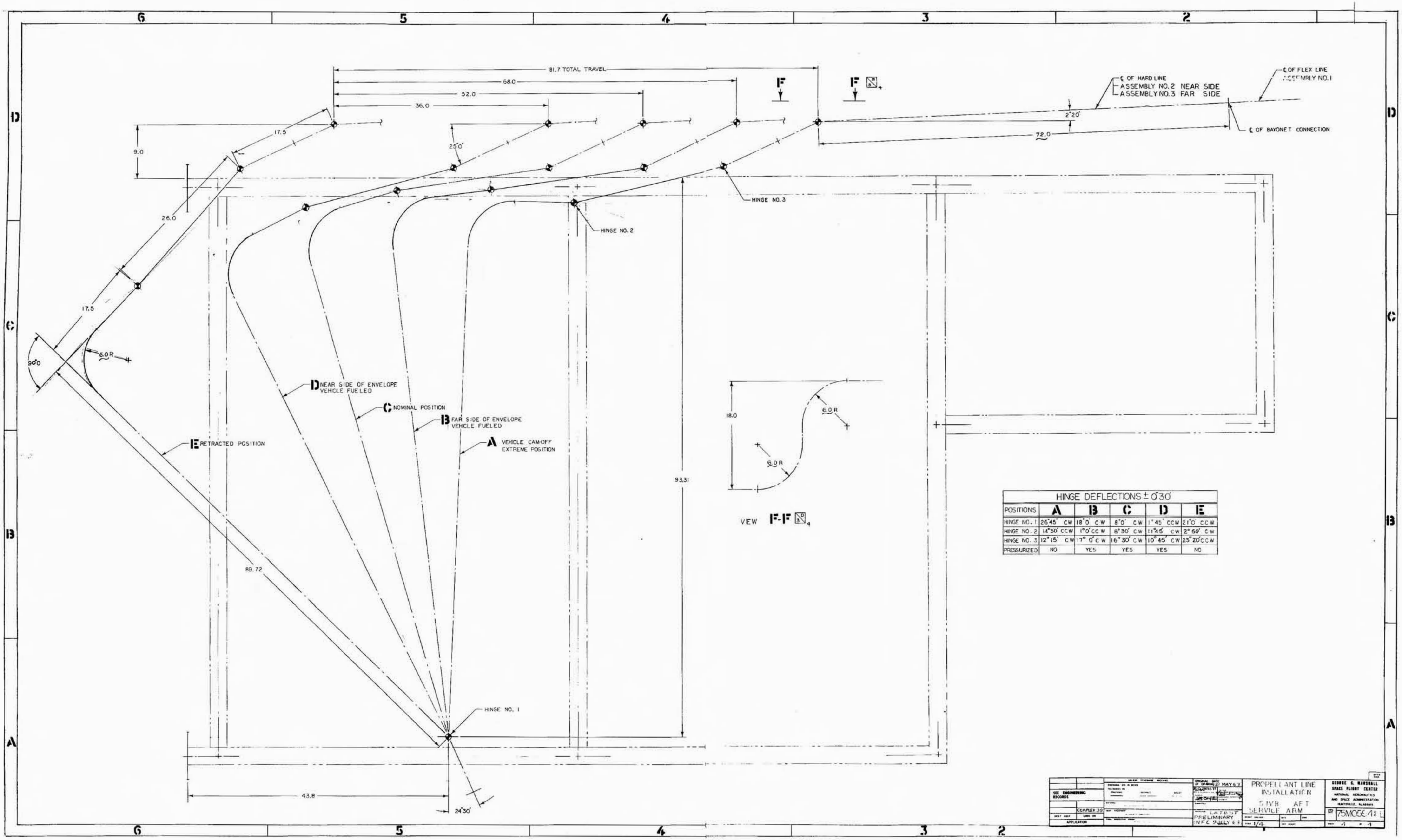


Figure 4-19. Propellant Line Installation - S-IVB AFT (Sheet 3 of 4)



HINGE DEFLECTIONS ± 0°30'					
POSITIONS	A	B	C	D	E
HINGE NO. 1	26°45' CW	18°0' CW	8°0' CW	1°45' CCW	21°0' CCW
HINGE NO. 2	14°30' CCW	1°0' CCW	8°30' CW	11°45' CW	2°50' CW
HINGE NO. 3	12°15' CW	17°0' CW	16°30' CW	10°45' CW	23°20' CCW
PRESSURIZED	NO	YES	YES	YES	NO

Figure 4-19. Propellant Line Installation - S-IVB AFT (Sheet 4 of 4)

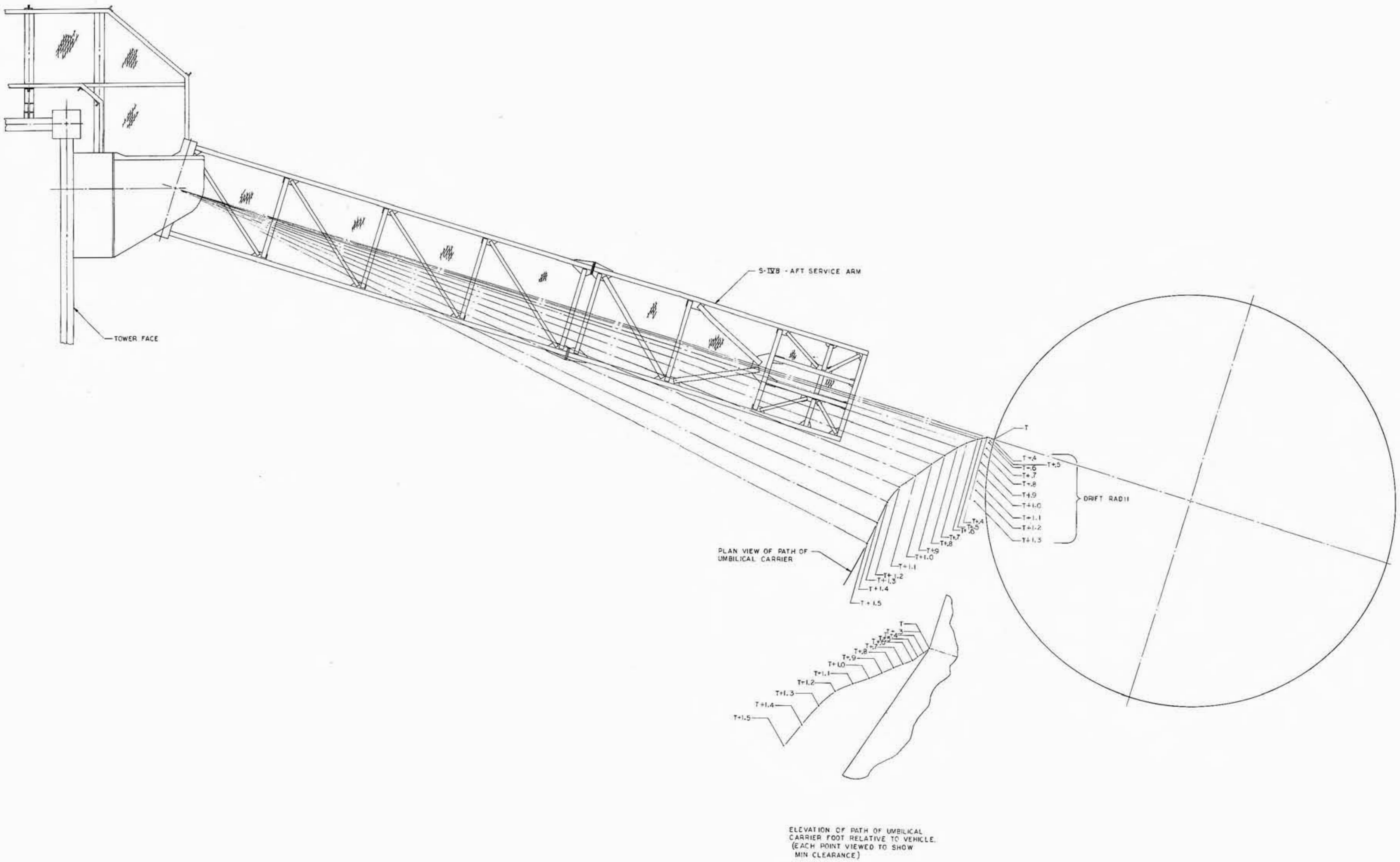


Figure 4-20. Umbilical Carrier Withdrawal Path

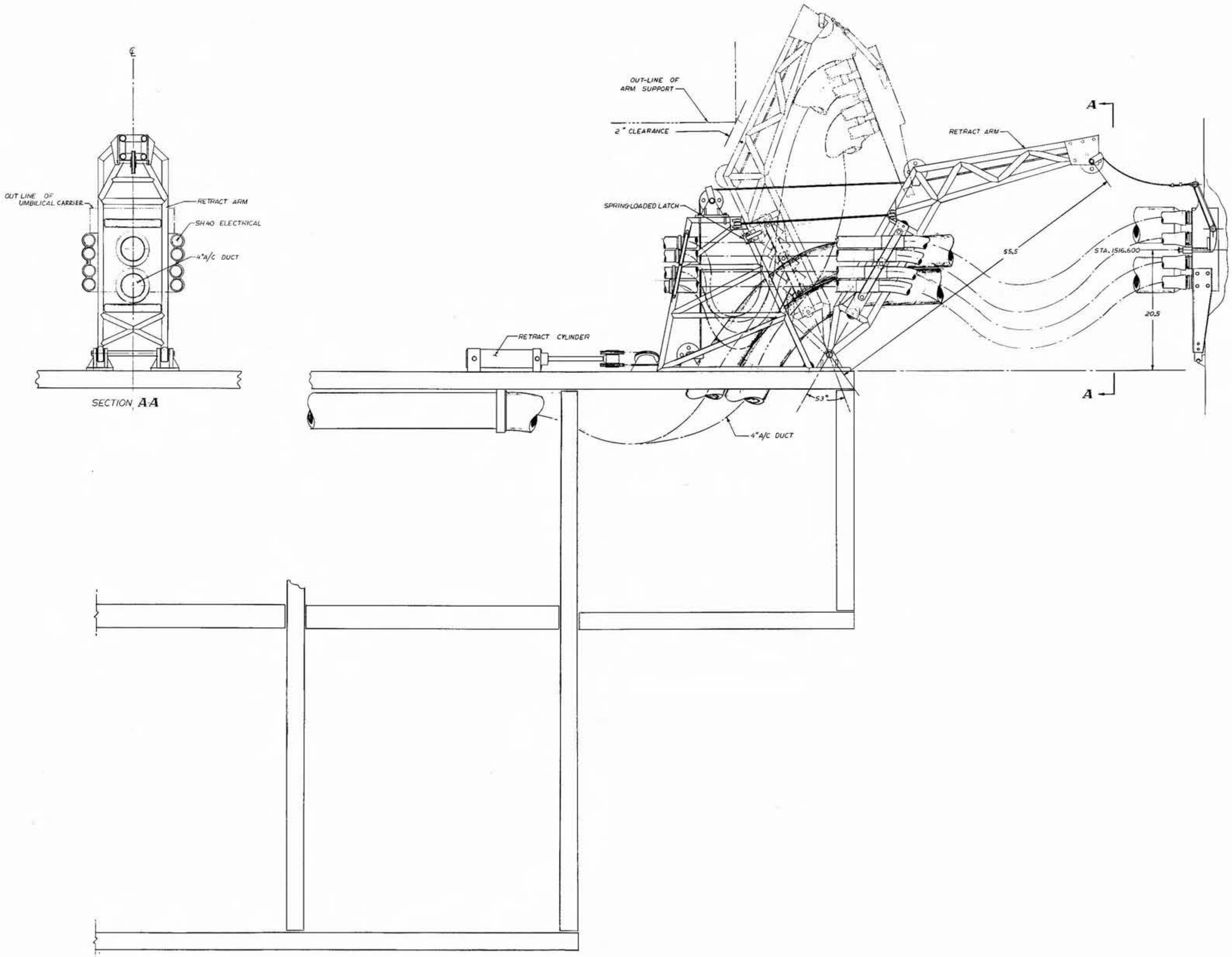


Figure 4-21. S-IC FWD Withdrawal Mechanism

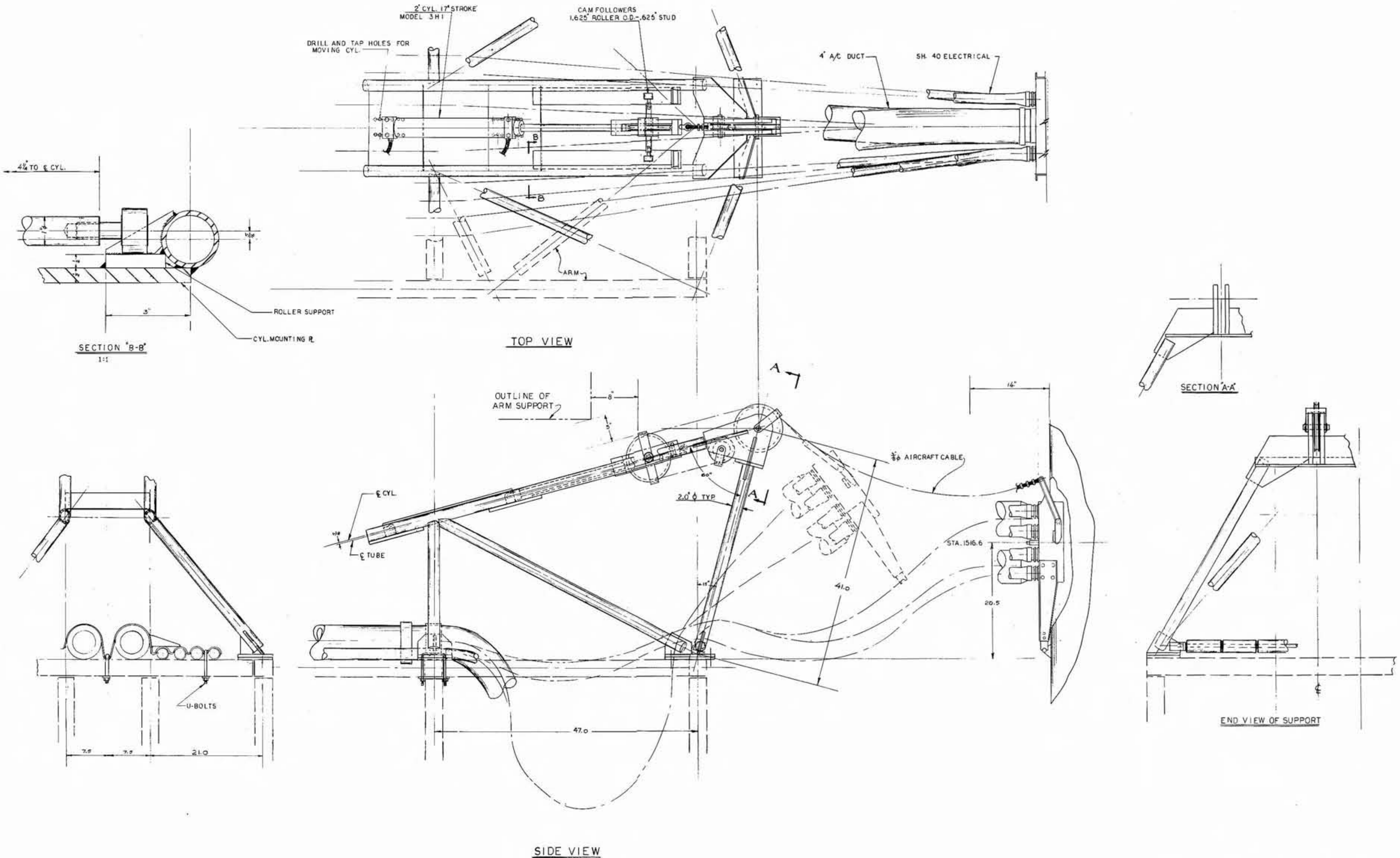


Figure 4-22. S-IC FWD Withdrawal Mechanism - Alternate

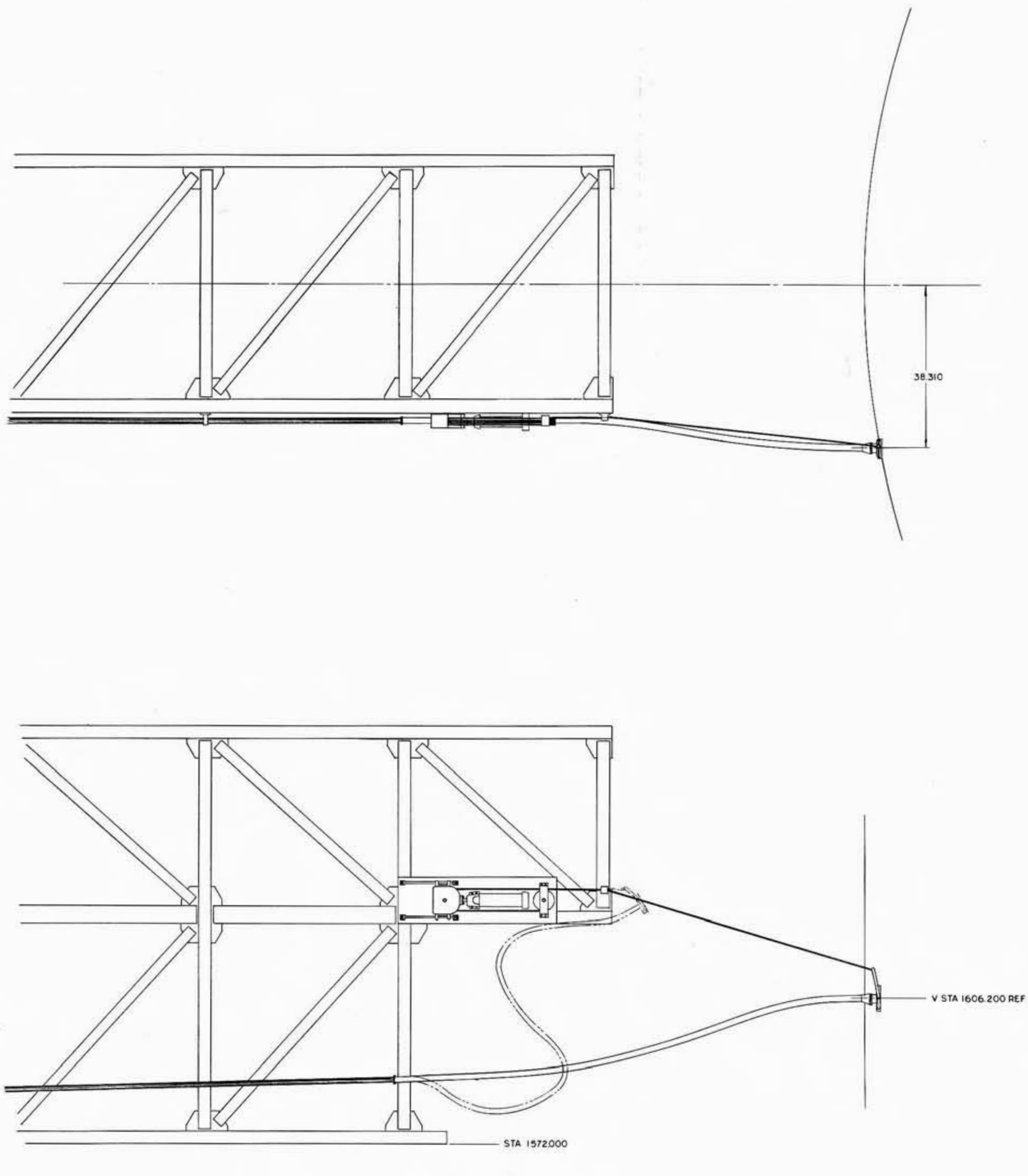
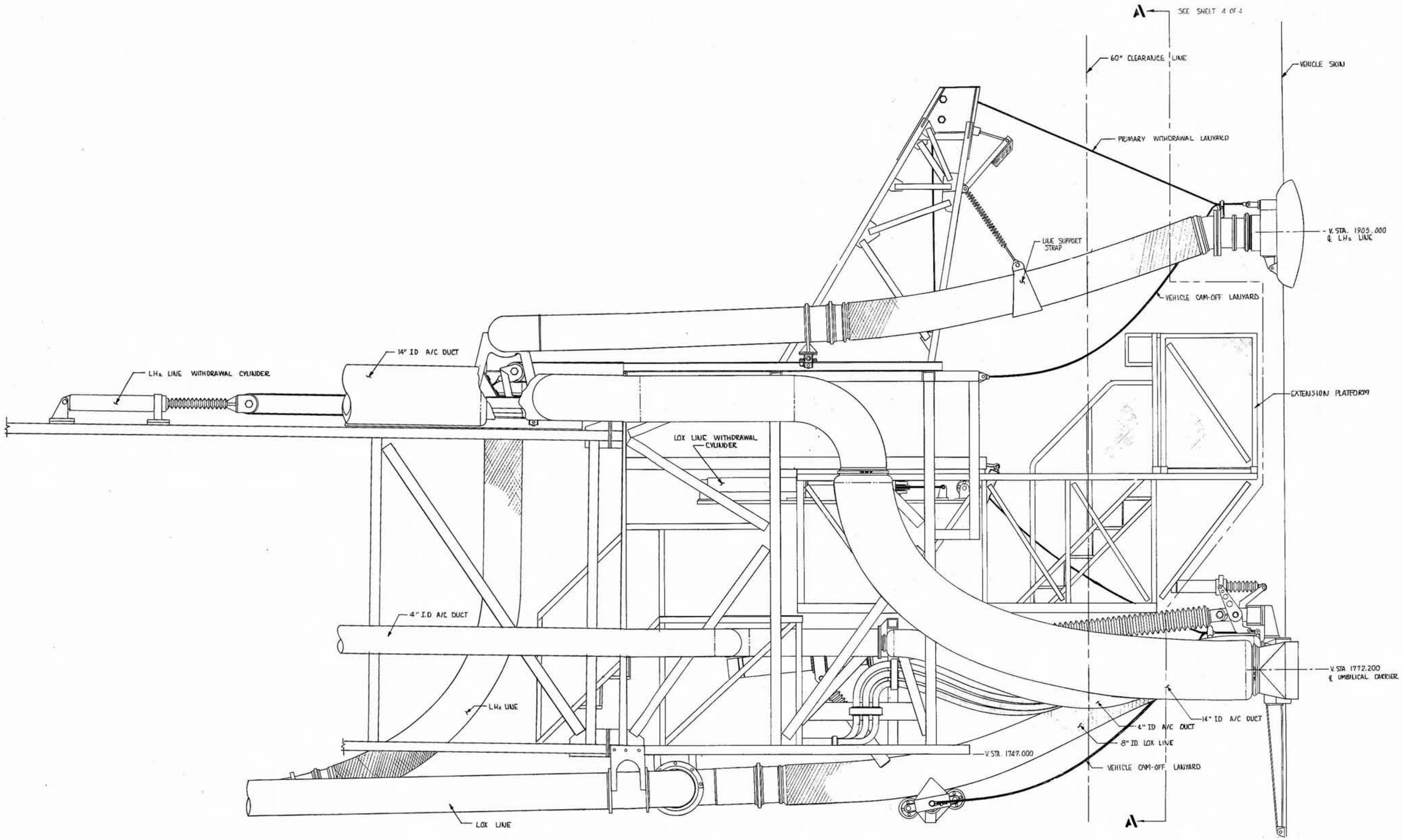


Figure 4-23. S-II AFT Withdrawal Mechanism



WEST SIDE ELEVATION

Figure 4-24. S-II INTERMEDIATE Withdrawal Mechanisms (Sheet 1 of 4)

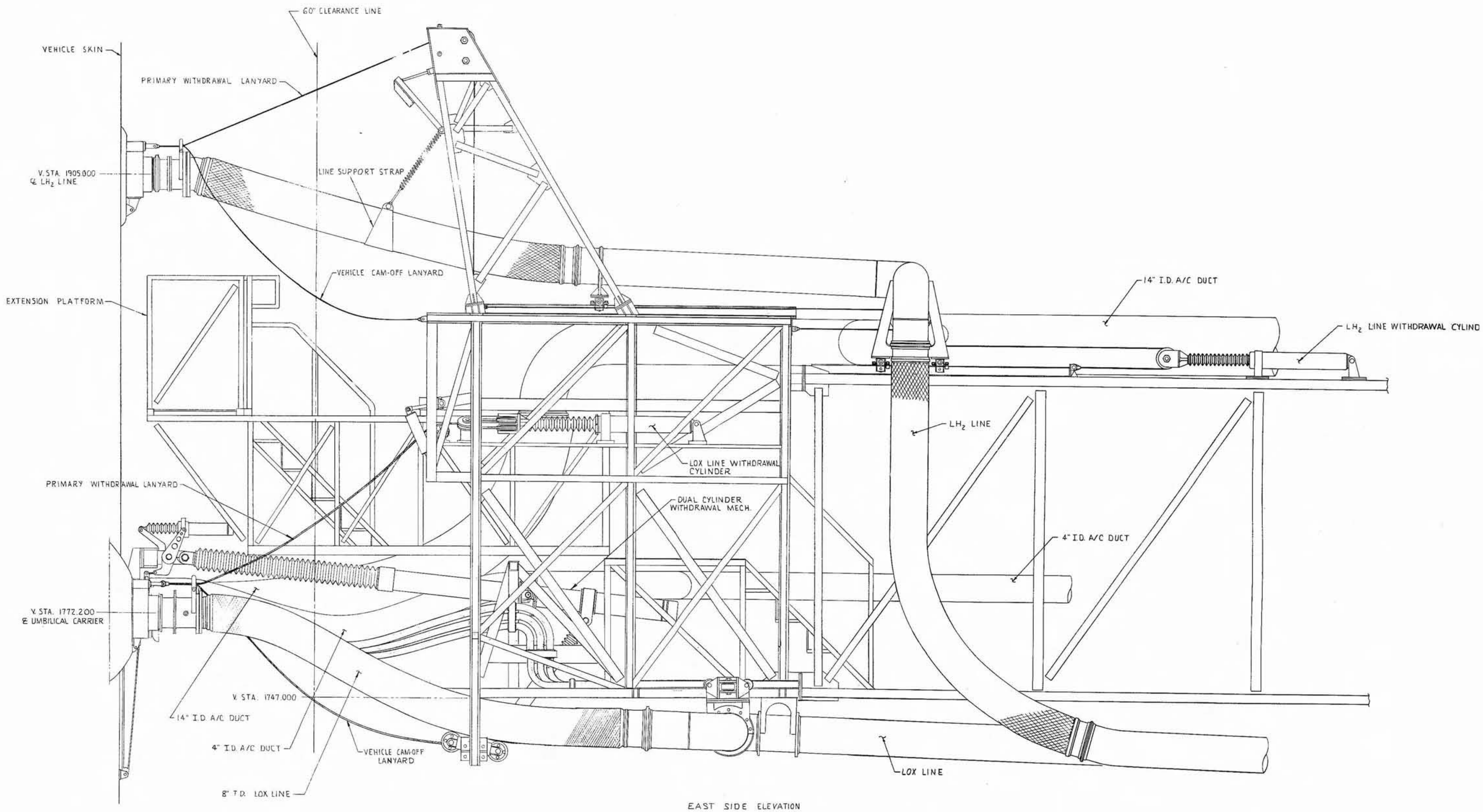


Figure 4-24. S-II INTERMEDIATE Withdrawal Mechanisms (Sheet 2 of 4)

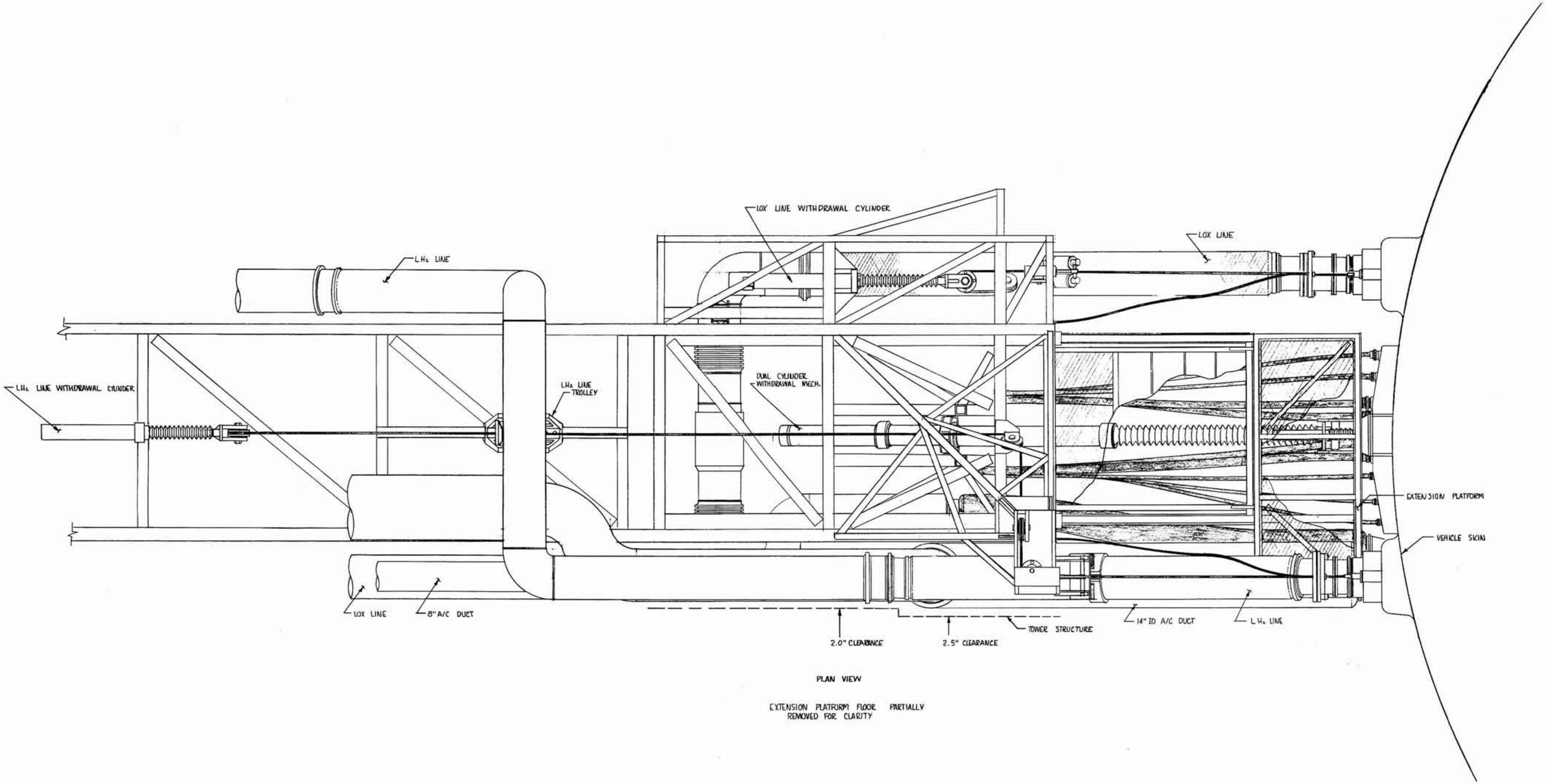


Figure 4-24. S-II INTERMEDIATE Withdrawal Mechanisms (Sheet 3 of 4)

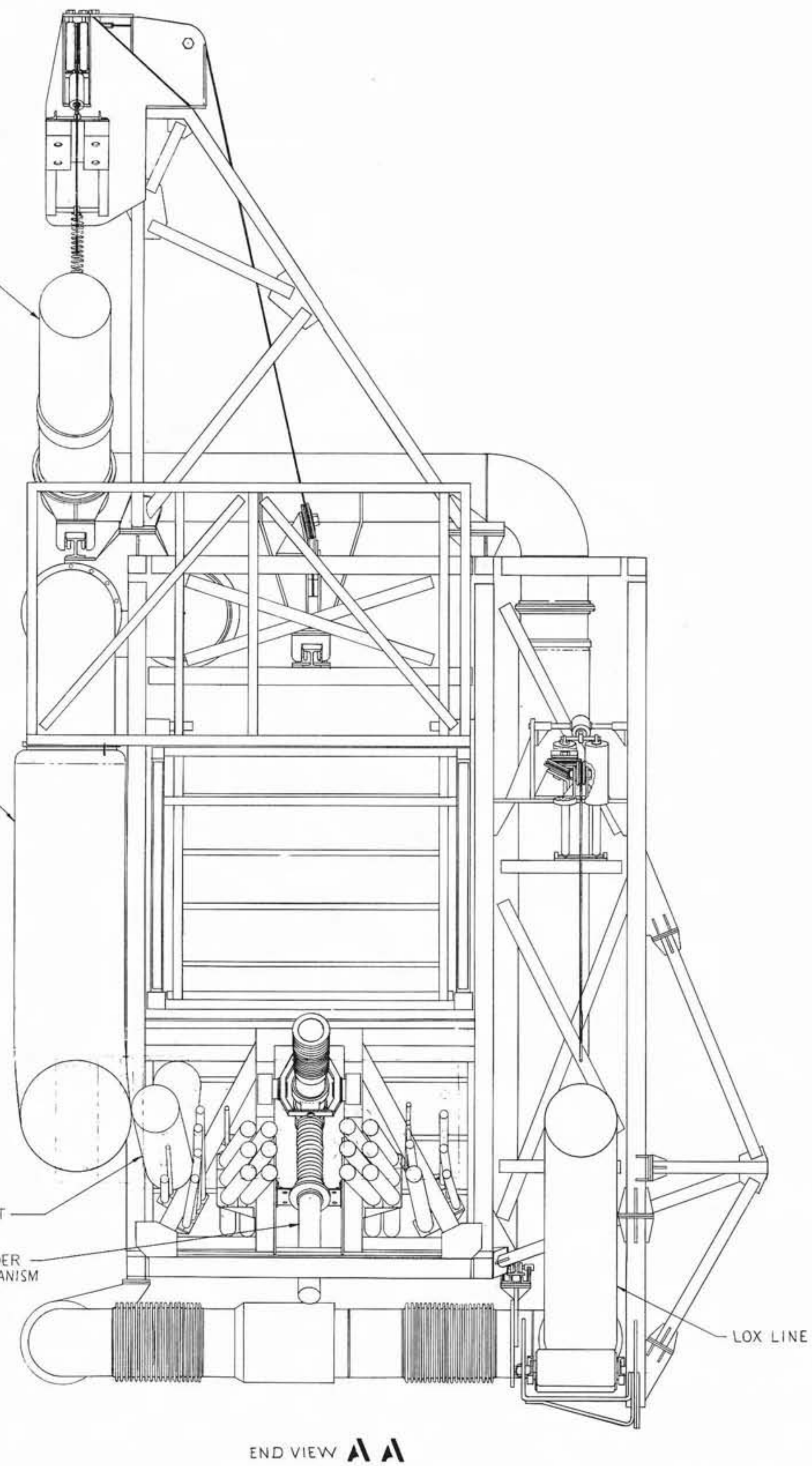


Figure 4-24. S-II INTERMEDIATE Withdrawal Mechanisms (Sheet 4 of 4)

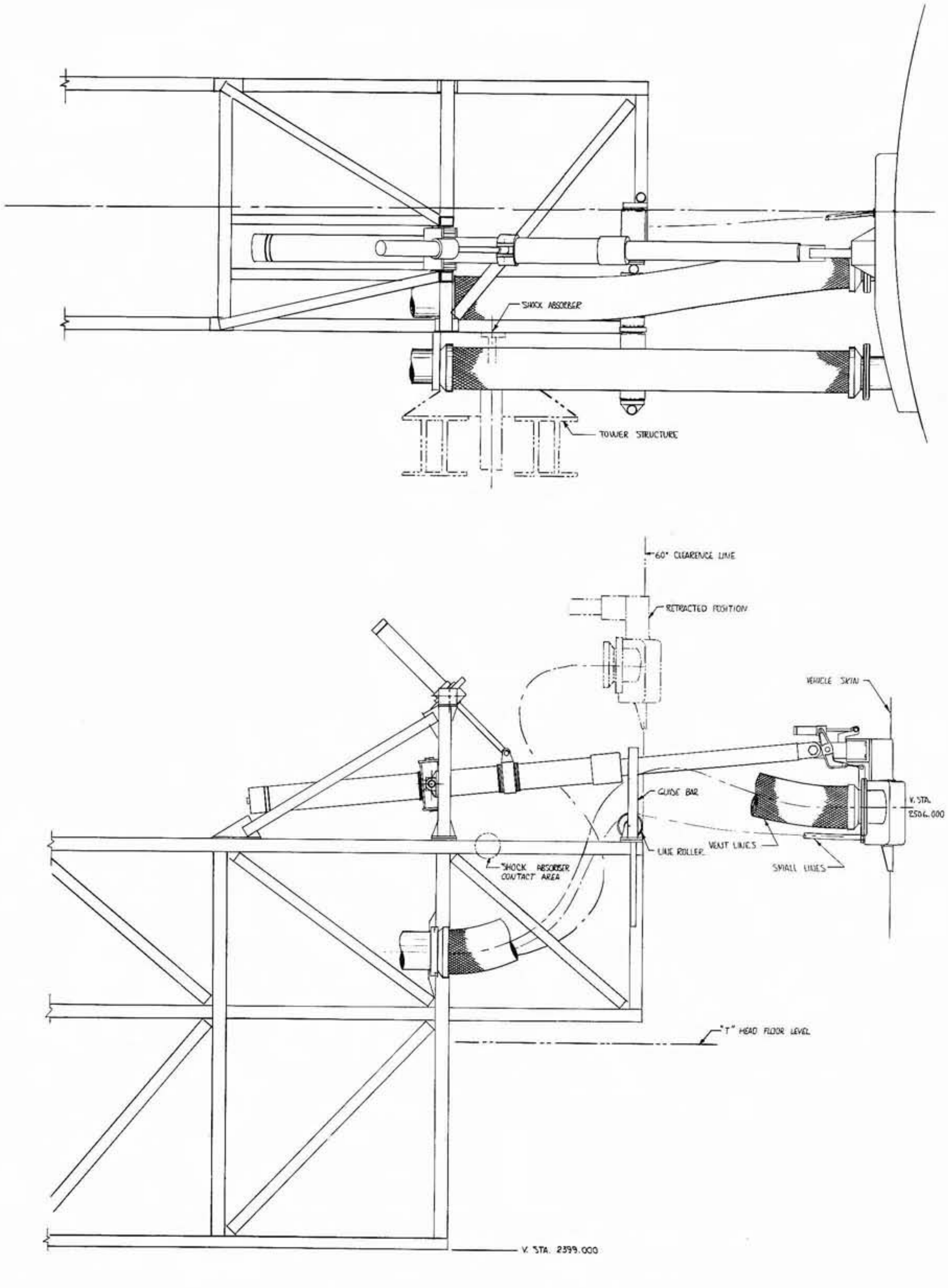


Figure 4-25. S-II FWD Withdrawal Mechanism

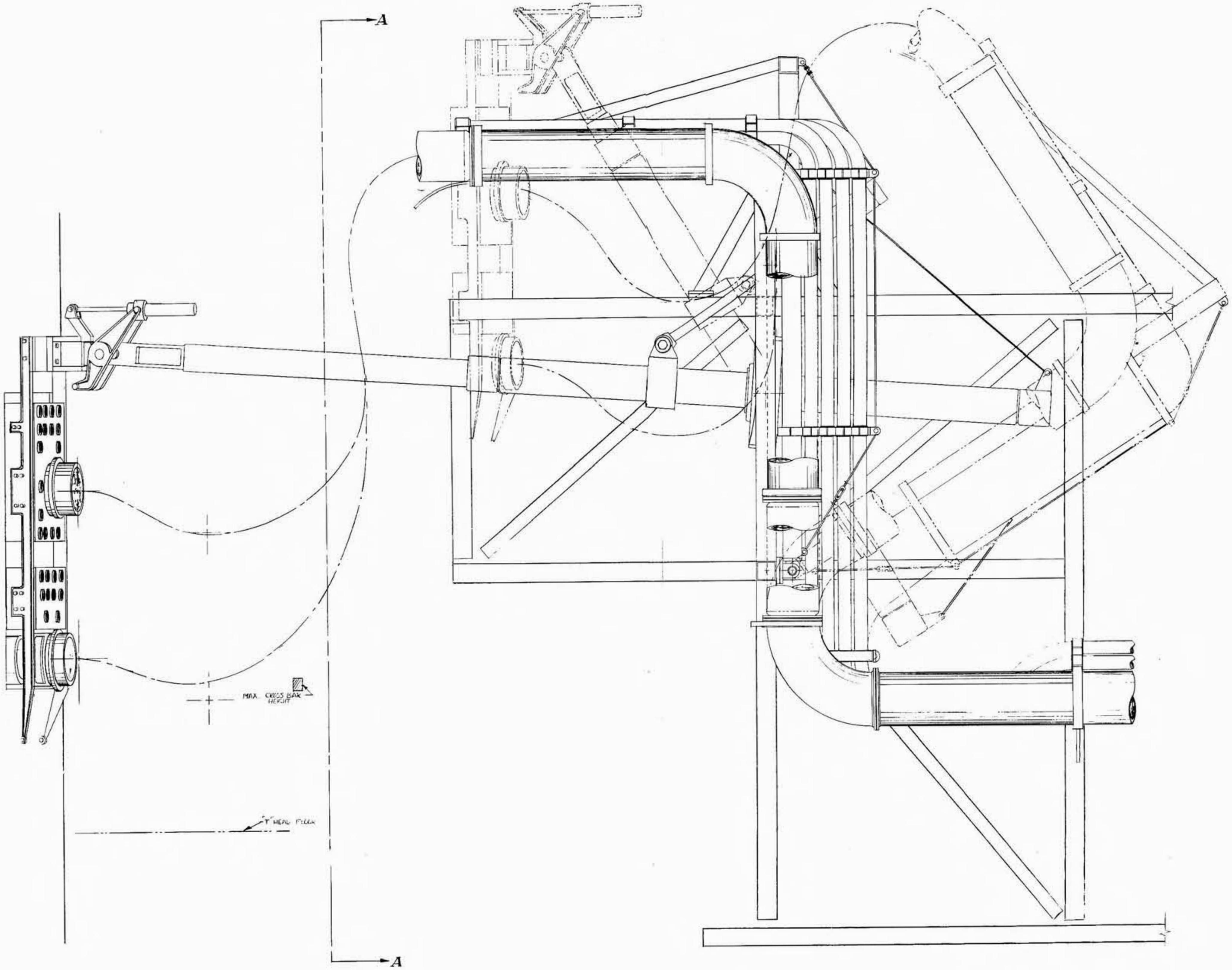


Figure 4-26. S-IVB FWD Withdrawal Mechanism (Sheet 1 of 3)

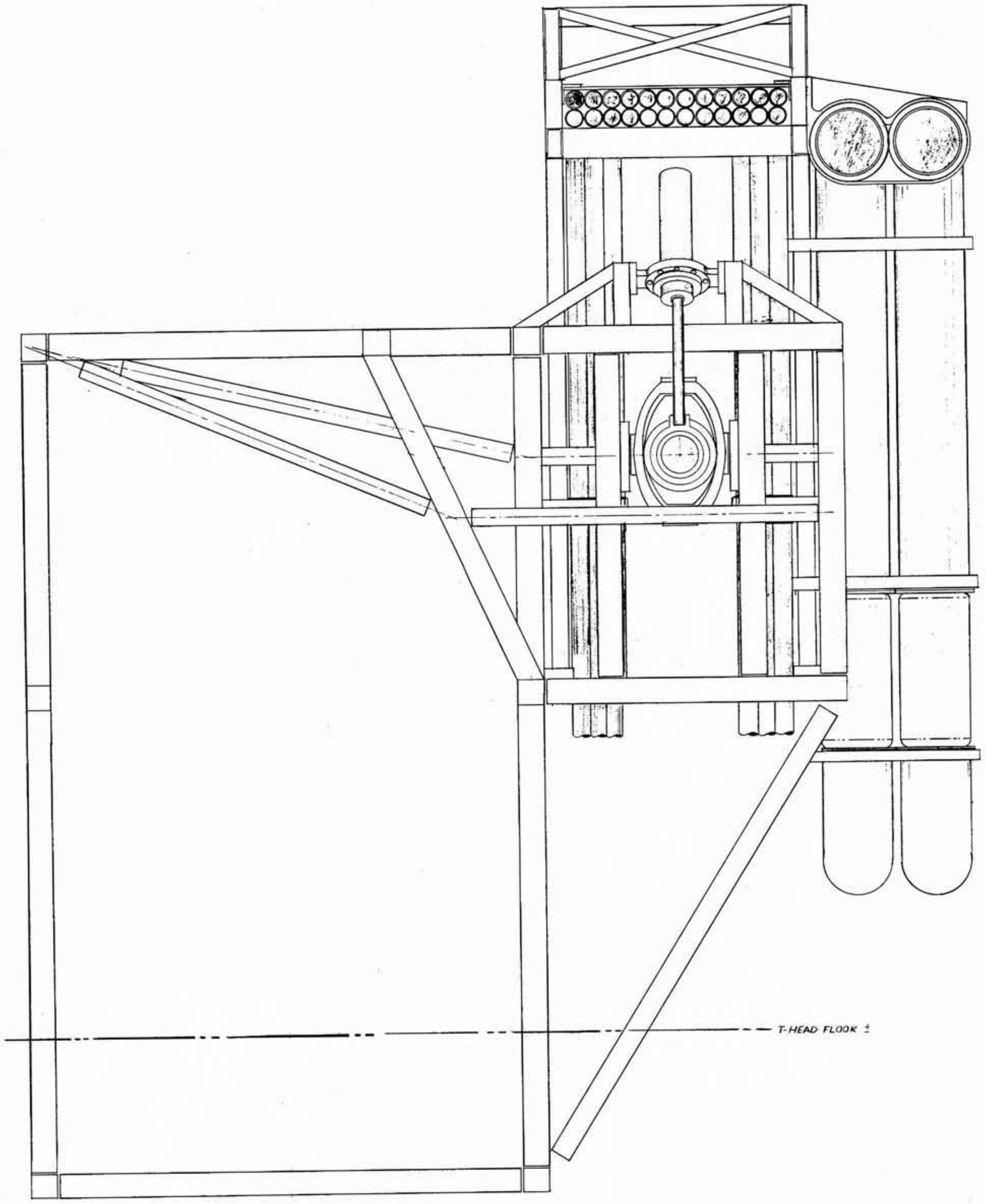


Figure 4-26. S-IVB FWD Withdrawal Mechanism (Sheet 2 of 3)

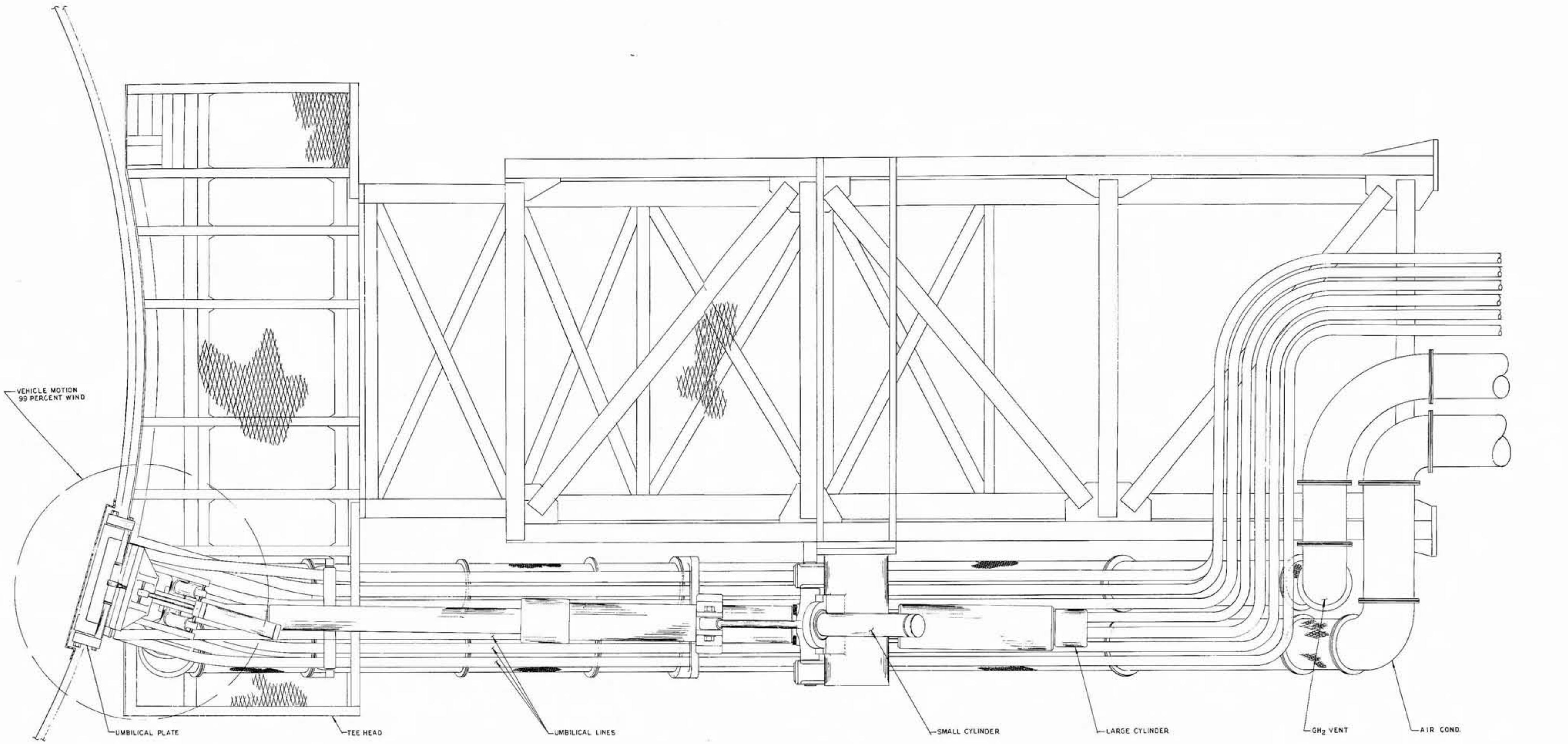


Figure 4-26. S-IVB FWD Withdrawal Mechanism (Sheet 3 of 3)

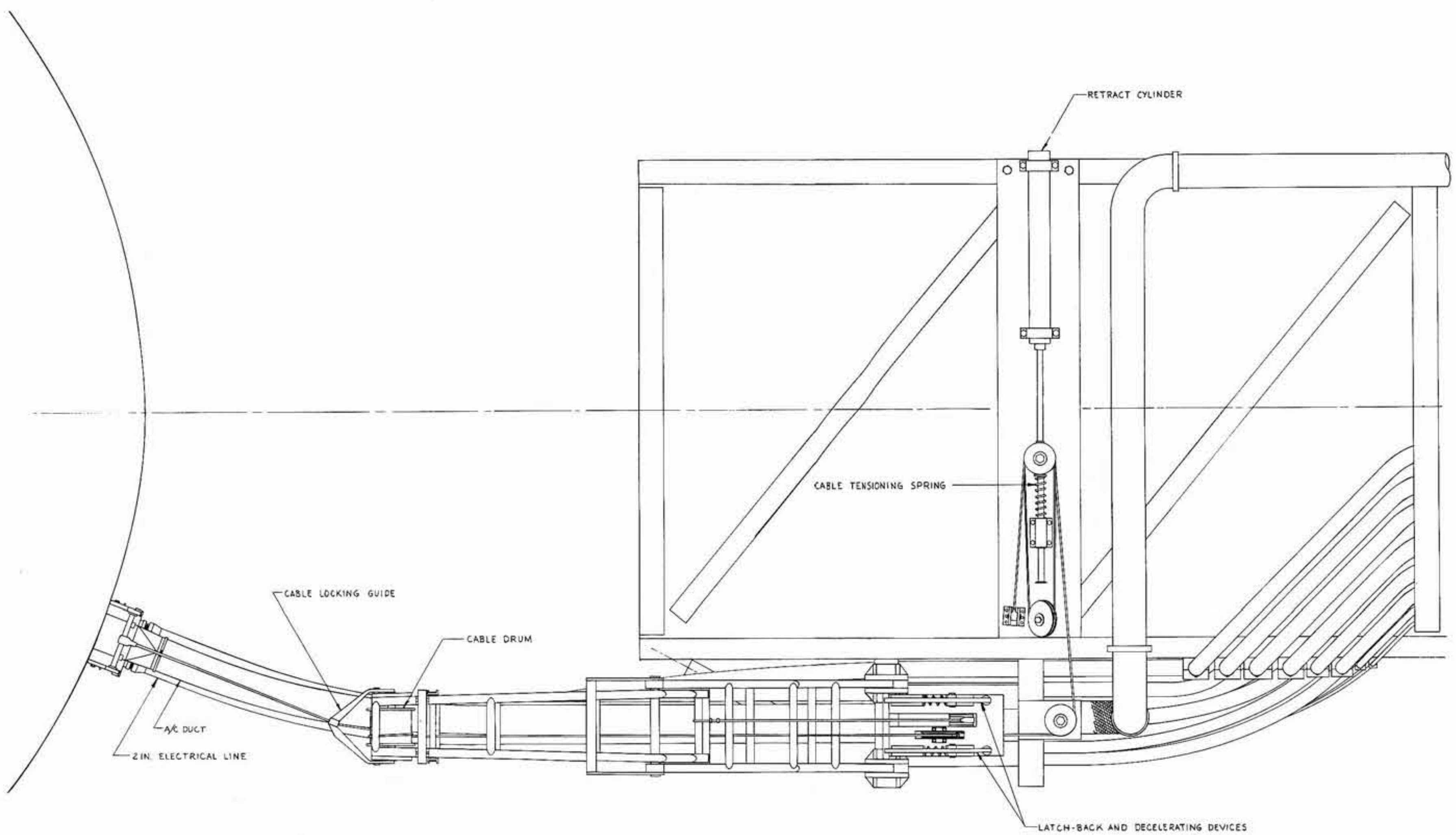


Figure 4-27. Service Module Withdrawal Mechanism (Sheet 1 of 2)

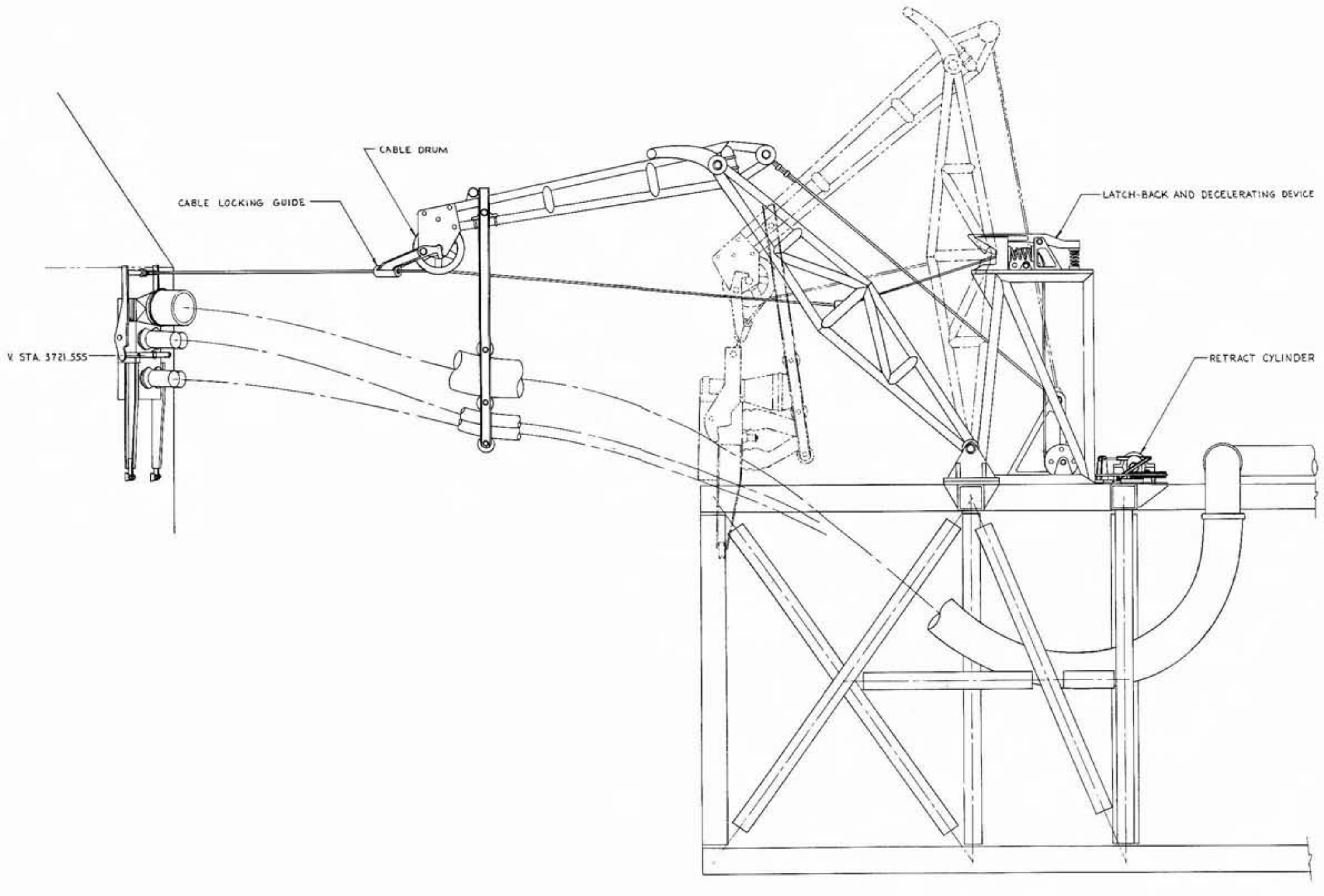


Figure 4-27. Service Module Withdrawal Mechanism (Sheet 2 of 2)

4-28. SERVICE ARM EXTENSION PLATFORMS

The extension platforms are located at the vehicle end of each service arm. These platforms provide a walkway across the space between the end of the service arm and the vehicle. This distance has been established at 60 inches for all arms except the S-IC INTERTANK which is 45 inches and the S-II AFT which is 36 inches. In addition, the portion of the platform adjacent to the vehicle provides a landing from which personnel can enter the vehicle or service the umbilical areas outside the vehicle.

4-29. DESIGN CRITERIA AND OPERATIONAL REQUIREMENTS

Design criteria established during concept studies and preliminary design of the extension platforms include:

a. All vertical and horizontal motion during prelaunch conditions including a maximum 95% wind condition (Table 4-3) must be accommodated by the platform.

b. The platform must be light enough to minimize the acceleration forces imparted to the vehicle during tracking operations.

c. The platform must retract into the service arm sufficiently to maintain the required clearance between the platform and the vehicle skin.

d. An open structure with good blast survival characteristics is required.

e. The coupling operation must be capable of being performed during winds up to 30 knots.

f. Personnel will not be permitted on the platforms during winds exceeding 30 knots.

g. Vertical movement of the vehicle relative to the platform must be accommodated with minimum forces imparted to the vehicle.

h. The platform structure must allow clearance for all service lines.

i. The maximum acceleration forces exerted on the vehicle by the platform are a result of vortex shedding oscillations (Table 4-3).

Table 4-3 Vehicle and Tower Deflections For Extension Platform Design

ARM	VEHICLE STATION	HORIZONTAL DEFL. (IN.)	VERTICAL DEFL. (IN.)	HORIZONTAL OSCILL. (IN.)	HORIZONTAL ACCELERATION (IN / SEC^2)
S-IC INTER'K	692	± .65	+ .65 – .35	± .10	2,54
S-IC FWD	1415	± 2.60	+ 1.30 – 3.60	± .55	14.00
S-II AFT	1590	± 3.20	+ 1.35 – 3.60	± .65	16.50
S-II INT	—	—	—	—	—
S-II FWD	2437	± 7.00	+ 2.40 – 5.60	± 1.40	35.60
S-IVB AFT	2644	± 8.30	+ 2.50 – 5.65	± 1.65	42.00
S-IVB FWD	3169	± 12.50	+ 3.00 – 7.00	± 2.10	53.40
S. M.	3614	± 16.80	+ 3.30 – 7.40	± 2.70	68.50

INCLUDES SOLAR WARPAGE AT 95% WIND CONDITION. DOES NOT INCLUDE TOWER DEFLECTIONS.

INCLUDES TOWER DEFLECTIONS, 120° F. TEMP., AND FUELED VEHICLE CONDITIONS.

RESULT OF VORTEX SHEDDING AT 95% WIND, EMPTY VEHICLE, f = .80

PLATFORM DOES NOT FOLLOW VEHICLE MOTION.

DEFLECTIONS FOR THIS LOCATION ARE APPROX. DEFINITE INFORMATION NOT AVAILABLE.

The service arm extension platforms fulfill all the above design criteria and in addition provide practical personnel safety measures and personnel access to the vehicle.

4-30. DESCRIPTION OF COMPONENTS

The basic design of the extension platforms (Figures 4-28 through 4-34) consists of a welded construction of square tubular members, serrated flooring, and expanded metal side screening. The main elements of the platforms are listed below with a brief description of each (Figure 4-15).

4-31. Box Beam Assembly. A box beam assembly (Figure 4-35) is mounted on each side of the service arm just inside the basic structure and approximately 50 inches above the bottom chord of the arm. These two assemblies support the entire extension platform and provide longitudinal motion of the platform with respect to the arm.

Each box beam contains a bearing carrier assembly consisting of recirculating roller bearings mounted on a "T" shaped carrier. The extension platform is suspended from the carriers. Recirculating roller bearings ride on hardened race ways inside the box beam housing and provide low friction movement of the extension platform. The bearings on the carrier assembly must be arranged to react the large moment resulting from the cantilevered extension platform. In addition, a single set of bearings are provided to react reverse loads which may occur during arm retraction.

4-32. Basic Platform. The basic platform, with minor variations, is common to all service arms. This portion of the extension platform provides a walkway across the space between the vehicle and the arm and forms the support structure for the landing outside the vehicle. The "U" shaped structure of the basic platform consists of square steel tubing of welded construction. The approximate dimensions of the platform are: 124 inches long, 52 inches wide, and 45 inches high.

4-33. "T" Head. A "T" head is located at the vehicle end of the basic platform and mounted on ball bearing rollers. The "T" head moves perpendicular to the basic platform on the rollers to accommodate vehicle motion in the lateral direction. A landing for access to the vehicle and/or service areas is provided on all "T" heads. Handrails and screening are an integral part of all "T" heads where personnel are permitted while servicing the vehicle.

The "T" head described above is required only on the S-II FWD, S-IVB AFT, S-IVB FWD, and SM arms. A small service platform, to be described later, is used on the remaining arms where access into the vehicle is required.

4-34. Bumper Assembly. The bumper assembly (Figure 4-36) is mounted on ball bushings which move vertically on shafts attached to the "T" head structure. This arrangement permits vertical movement of the vehicle and bumper assembly relative to the "T" head. A rubber bumper is bonded to the bumper assembly structure to protect the vehicle skin while the extension platform is connected. Structure is provided in the center of the bumper assembly for mounting the coupler.

4-35. Coupler. A coupler (Figure 4-37) is mounted on the bumper assembly of each "T" head. The coupler connects to a hard point on the vehicle to form a link between the vehicle and the extension platform. The coupler permits connection to an oscillating vehicle while the extension platform remains a sufficient distance away to prevent a collision. Once the coupler is connected, the platform may be moved out until it is in phase with the oscillatory motion of the vehicle.

4-36. Drive Mechanisms. All extension platforms which require "T" heads are equipped with air motors for positioning both the extension platform and the "T" head. Torque from the air motors is transmitted through a friction wheel to a drive rail. This power moves the extension platform relative to the basic arm or the "T" head relative to the extension platform. The air motors will be powered by pneumatics and will be controlled through manually operated valves located on the extension platform control panel directly behind the "T" head.

4-37. Guide Rollers. Guide rollers are mounted on the bottom chord of the basic arm and bear against the lower members of the extension platform. These rollers transfer wind loads directly to the main structural members of the service arms.

4-38. Uncoupled Warning System. A warning buzzer and flashing red light are mounted on the vehicle end of the basic arm. These devices are electrically connected to a switch located on the coupling mechanism and give visual and audible signals should the extension platform inadvertently disconnect from the vehicle.

4-39. Safety Panels. Safety panels are installed across the vehicle end of the extension platform when the platform is not connected to the vehicle.

4-40. Service Work Platform. A small service platform (Figure 4-38) replaces the "T" head where horizontal vehicle deflections do not exceed four inches. This occurs on the S-IC INTERTANK, S-IC FWD, and S-II AFT arms. On these extension platforms, the service platform forms a part of the bumper assembly. No hard point on the vehicle is required at these locations. The bumper assembly is spring loaded to maintain pressure against the vehicle skin during all oscillations. The forces imparted to the rubber bumper by the vehicle skin are sufficient to cause the bumper assembly and the attached service platform to follow vehicle oscillations.

4-41. S-II INTERMEDIATE PLATFORMS

The location of umbilical areas at the S-II INTERMEDIATE arm requires two special extension platforms. One platform is located on the S-II INTERMEDIATE arm and provides a service area for the LH_2 umbilical (Figure 4-39). This platform consists of the components described in paragraphs 4-31, 4-32 and 4-37. The platform floor is located approximately 36 inches above the basic arm floor to provide clearance for the withdrawal mechanism.

A second platform is located on top of the S-II AFT arm and provides a service area for the S-II INTERMEDIATE umbilical carrier and LOX umbilical (Figure 4-30). Because of special requirements for this platform, none of the components described in paragraphs 4-31 through 4-40 could be utilized.

There is no contact between either of these platforms and the vehicle since access into the vehicle is not required. Both platforms are extended and locked in position when service is required at the umbilical area.

4-42. PLATFORM OPERATIONAL DESCRIPTIONS

a. Extension and retraction of platforms which do not connect to the vehicle (S-IC INTERTANK, S-IC FWD, S-II AFT).

1. Two men are required for extension. Operator A takes a position on the vehicle end of the platform to move and position the bumper assembly laterally against the vehicle as the platform is extended.

2. Operator B unlocks the extension platform by depressing a foot pedal located at the tower end of the platform and pushes the platform toward the vehicle. Movement of the platform can be controlled by actuating a lever which will apply braking action through two friction blocks pressed against rails on either side of the basic arm.

3. When operator A has positioned the bumper assembly against the side of the vehicle, operator B pushes the platform against a preset stop and locks it in position with the friction blocks.

4. Safety panels across the end of the platform are removed to permit entry to the vehicle.

5. Only one operator is required to retract the extension platform. He releases the friction blocks and pulls the platform into the arm until it locks in the retracted position.

b. Extension and retraction of S-II INTERMEDIATE umbilical service platforms.

The platforms described in paragraph 4-41 will be extended by unlocking the platform retract lock and pushing the platform to a preset stop. The platforms are then locked in the extended position. The platforms are retracted by reversing the above procedure.

c. Extension and retraction of platforms which connect to hard points on the vehicle (S-II FWD, S-IVB AFT, S-IVB FWD, SM):

1. Two men are required for extension and retraction operations. Operator A will assume a position at the air motor controls located on the platform behind the "T" head. Operator B will assume a position on the "T" head above the coupler mechanism.

2. Operator B will remove a section of the "T" head floor to permit access to the coupler and attach the coupler positioning device.

3. Operator A will open the main pneumatic supply valve. This will pressurize both sides of the air motors to provide braking for the platform and "T" head. Next, operator A will move the positioning cylinder valve to "drive" and both friction wheels will be forced against the drive rails.

4. Operator A then moves the lock-pin valve to "unlock" and the extension platform extend-retract valve to "extend". With initial movement of the platform, the lock-pin valve may be released to return to "lock". Platform extension continues until the "T" head clears the basic arm structure. Then operator A unlocks the "T" head lock-pin and moves the platform toward the vehicle while adjusting the "T" head laterally. This operation continues

until the coupler and vehicle mounted hard point are in correct position for connecting. Operator A performs these movements by positioning the manual valves which operate the two air motors. One valve extends, retracts, or brakes the platform while the other valve moves the "T" head left and right or brakes it in the desired position. A space of two or four inches now exists between the platform bumper and the vehicle.

5. Operator B actuates the coupler positioning device extending the coupler across the space between the platform bumper and the vehicle and closing the jaws around the hard point. Operator A extends the platform until the bumper is seated against the skin. Operator B locks the coupler. The coupler positioning device is removed and the floor section replaced.

6. When coupling is complete, operator A moves the cylinder valve to "floating". This pulls the friction wheels away from the drive rails, and the platform and "T" head are released to follow the vehicle movement. Safety panels across the end of the "T" head are removed to permit access into the vehicle.

7. Retraction is performed in the reverse order and the platform and "T" head are locked in position after retraction.

For detail operation of the pneumatic system, refer to paragraph 4-108.

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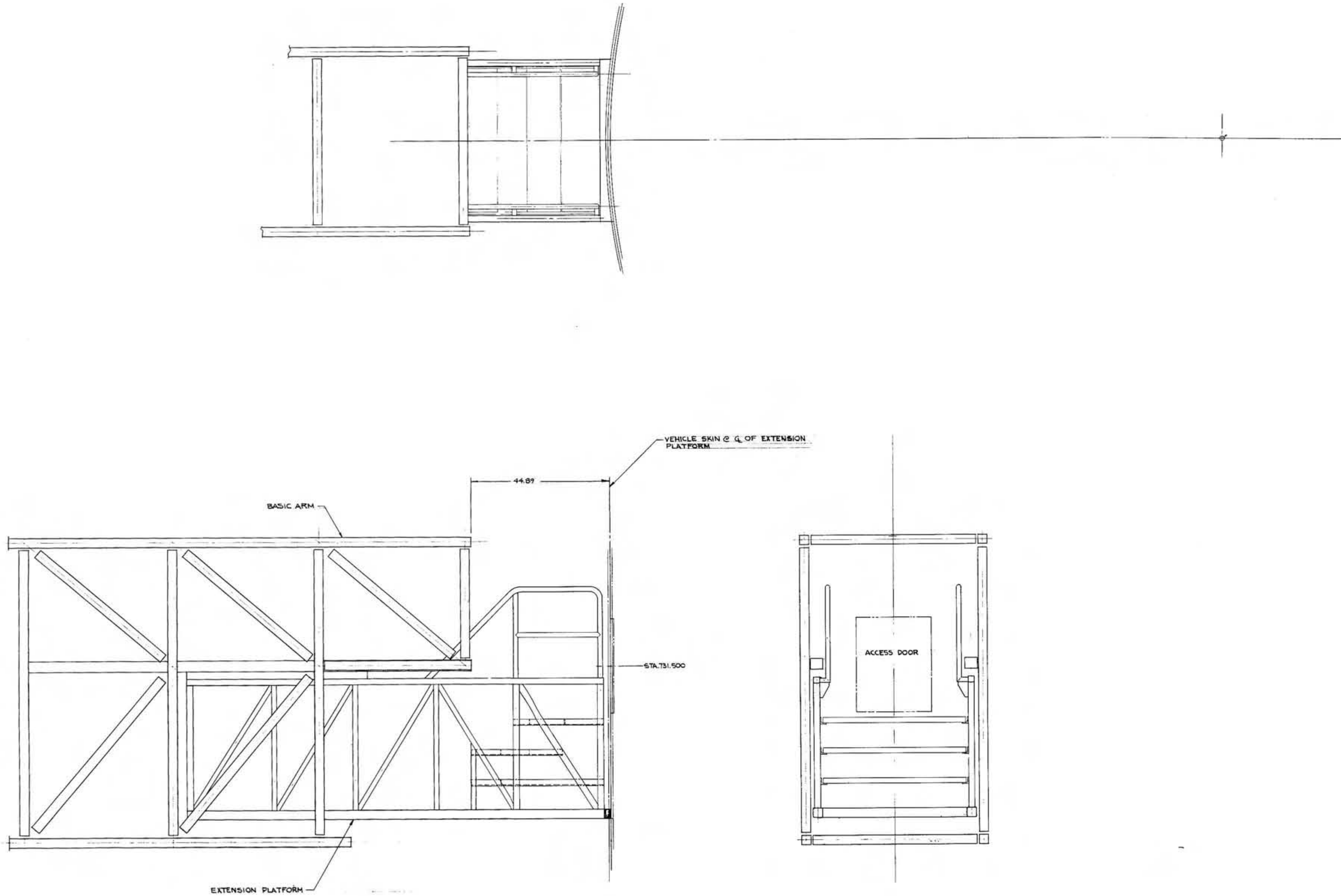


Figure 4-28. S-IC INTERTANK
Extension Platform

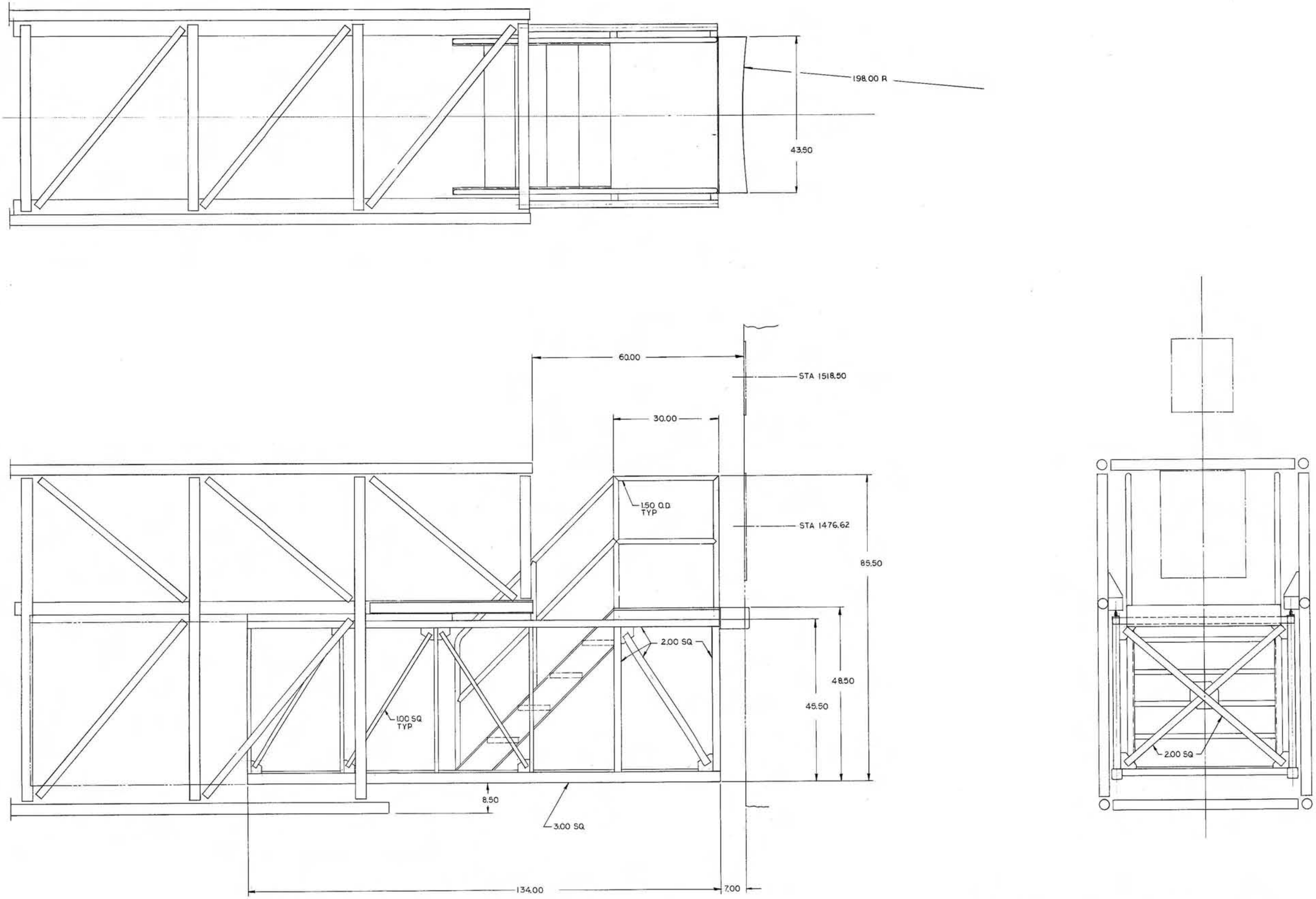


Figure 4-29. S-IC FWD Extension Platform

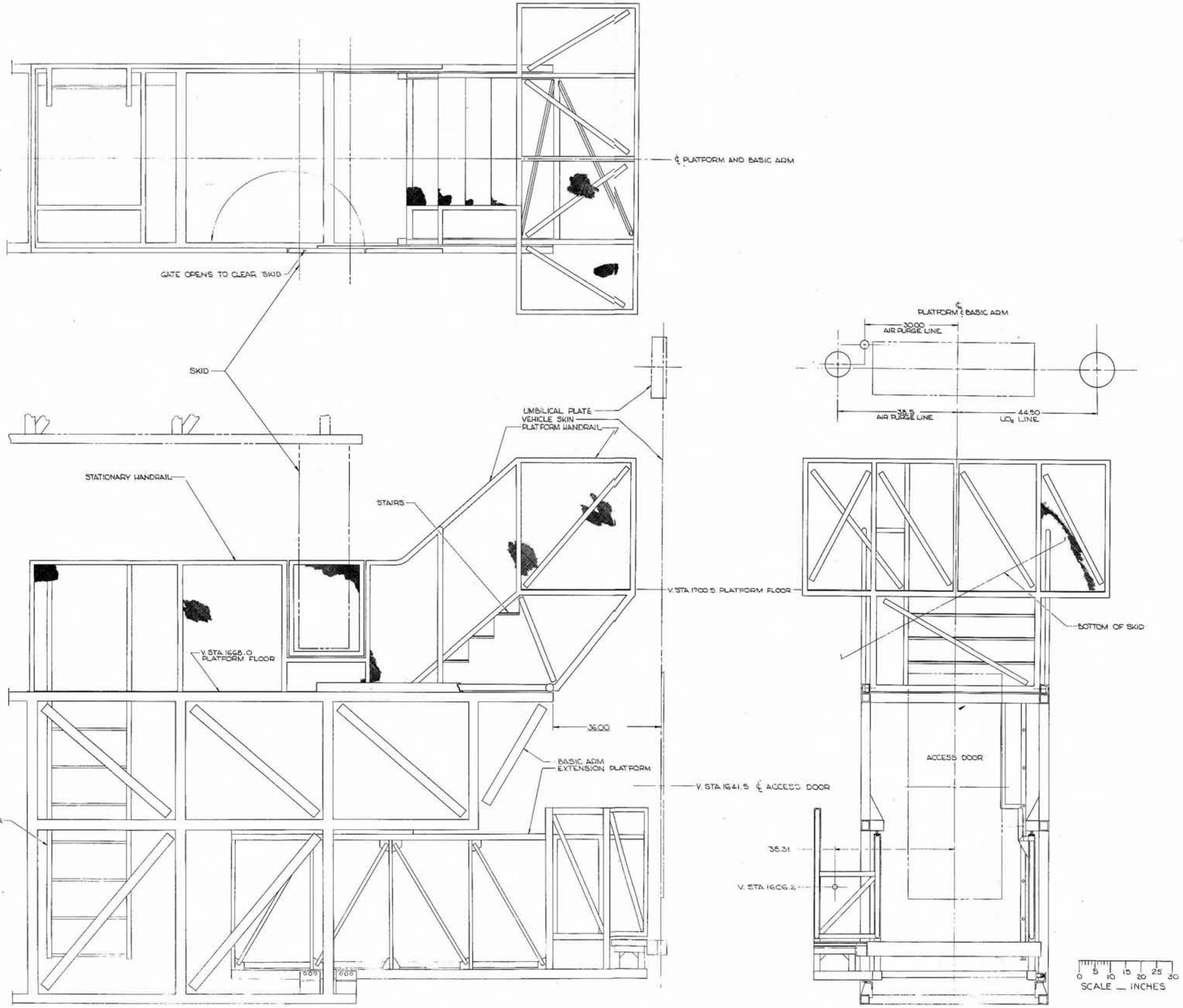


Figure 4-30. S-II AFT Extension Platform

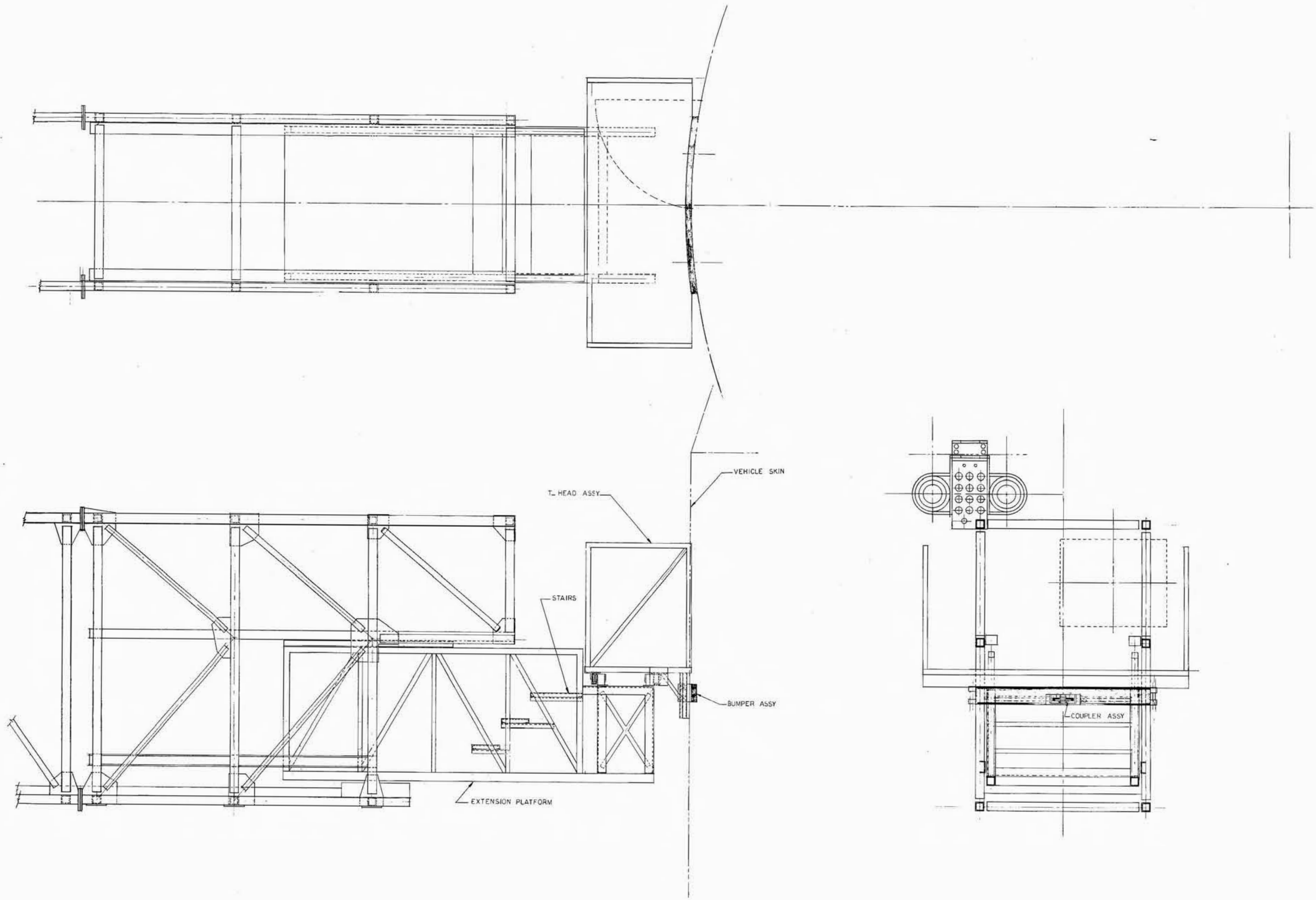


Figure 4-31. S-II FWD Extension Platform

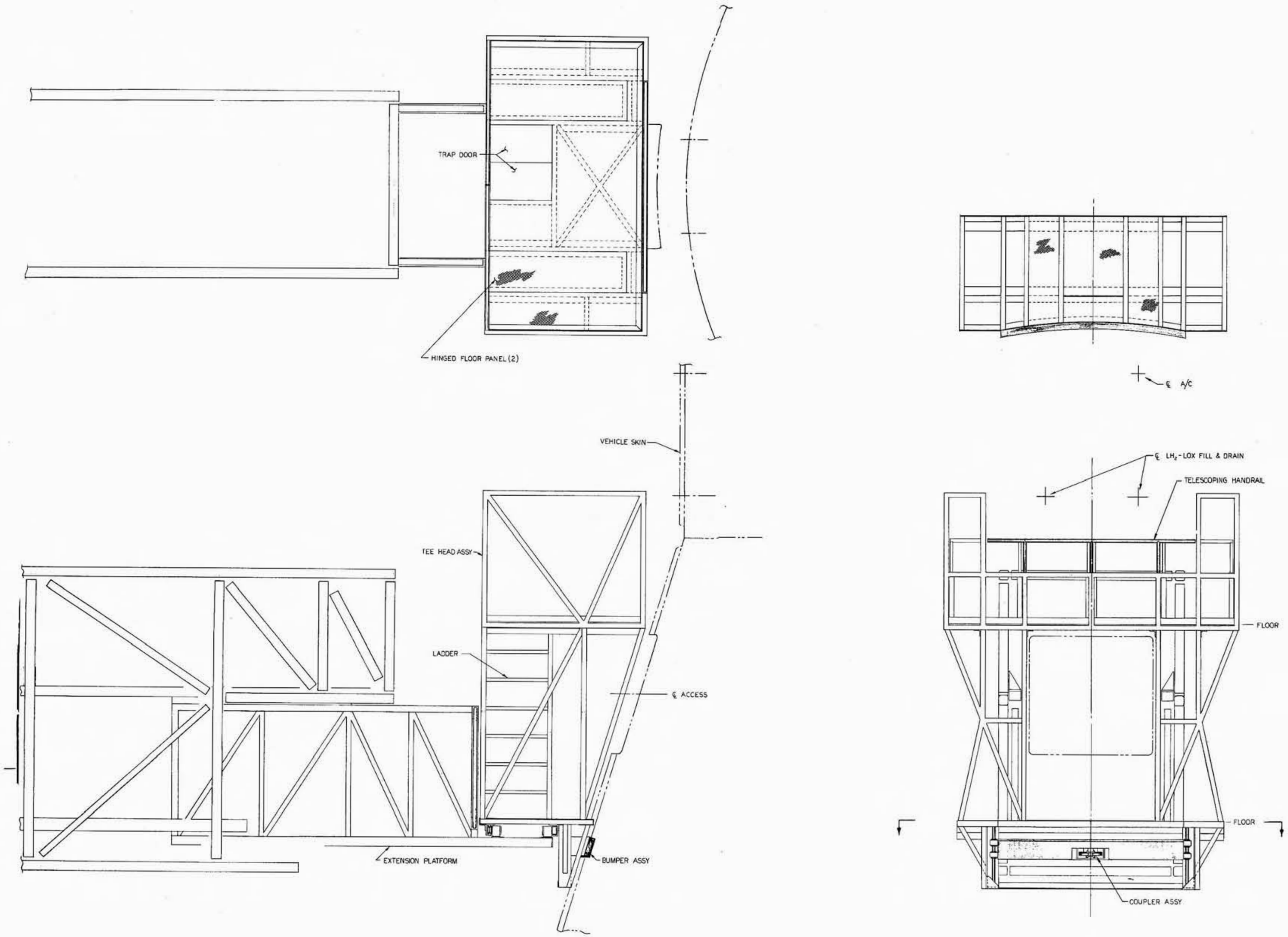


Figure 4-32. S-IVB AFT Extension Platform

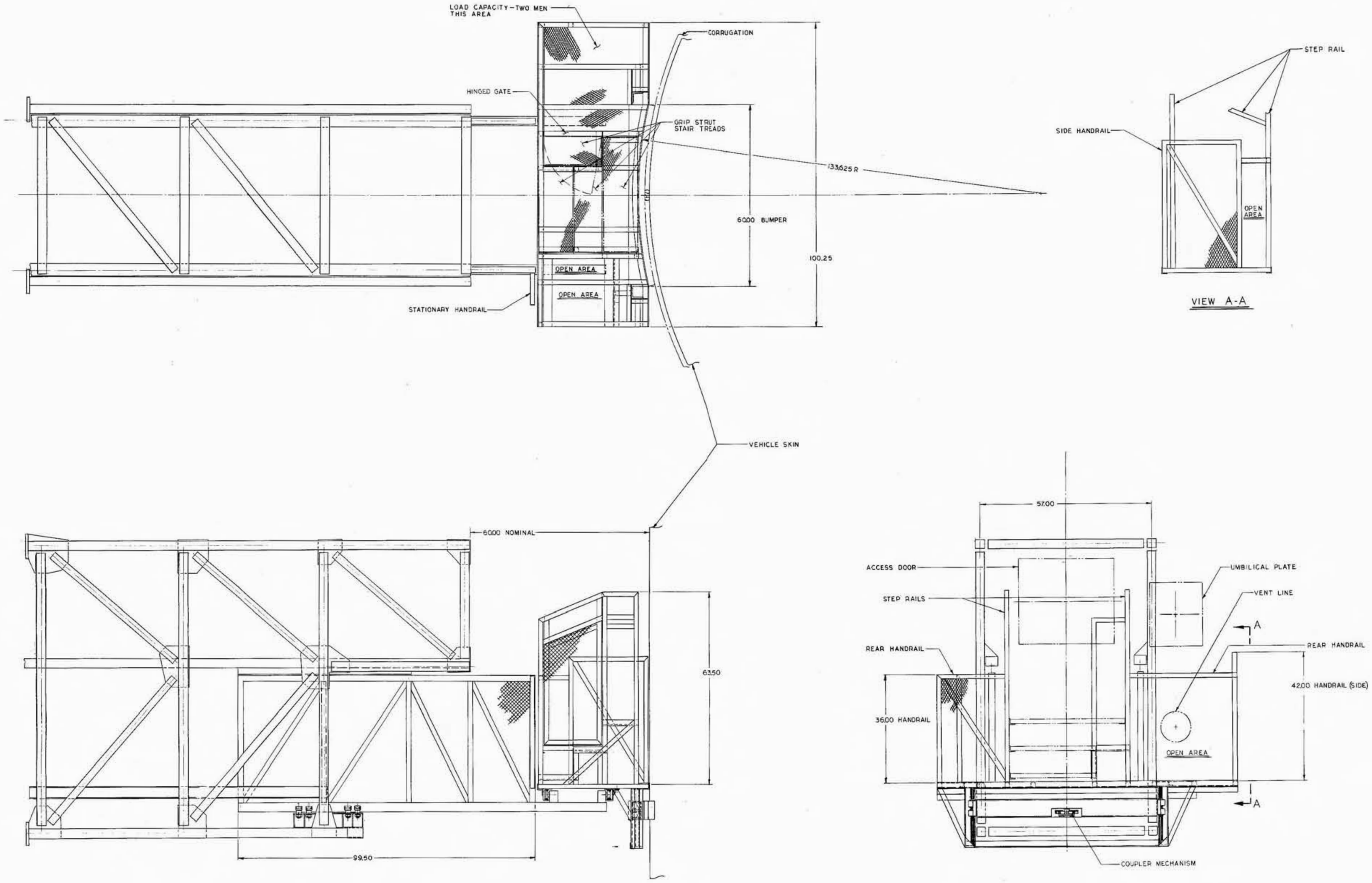


Figure 4-33. S-IVB FWD Extension Platform

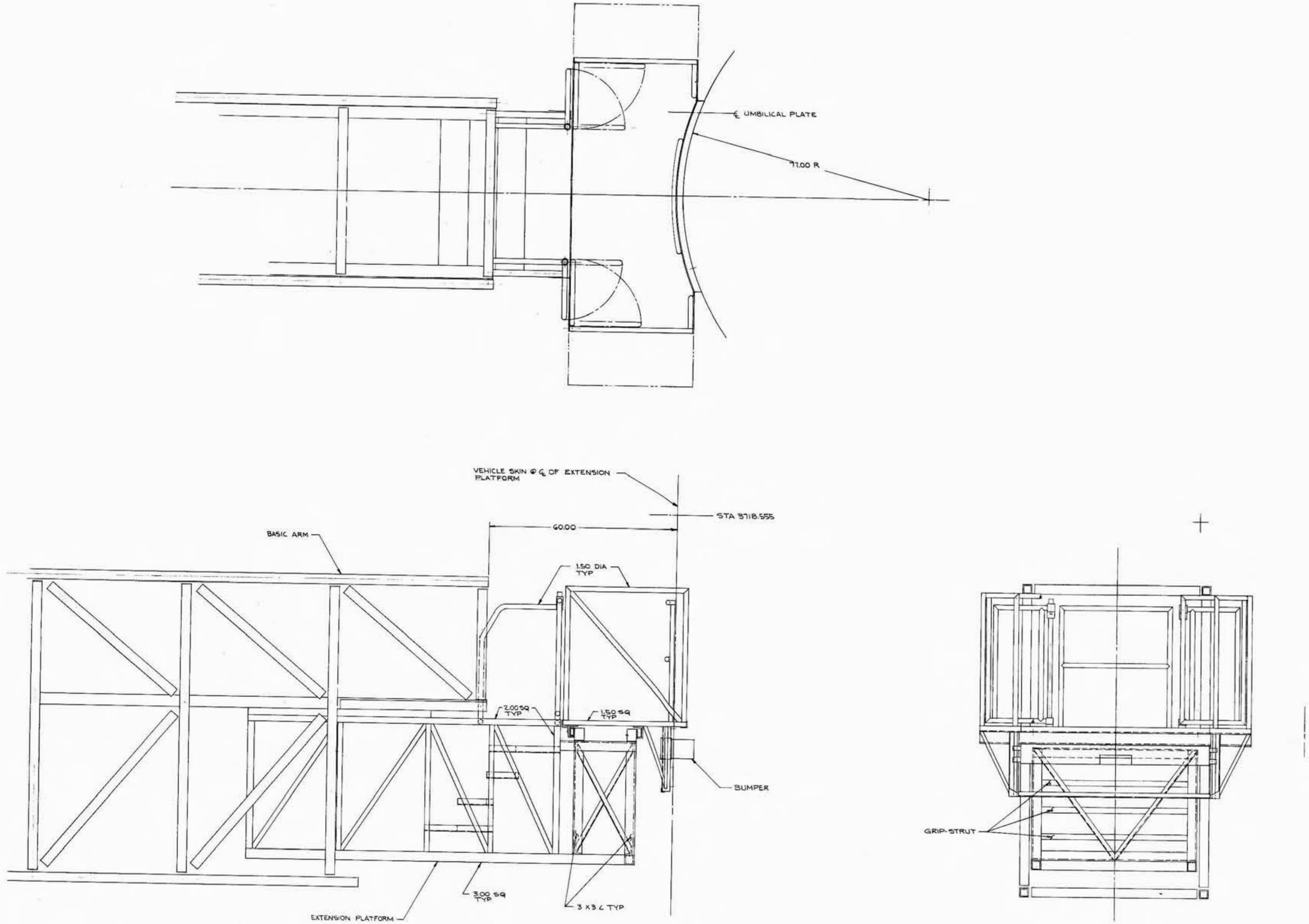
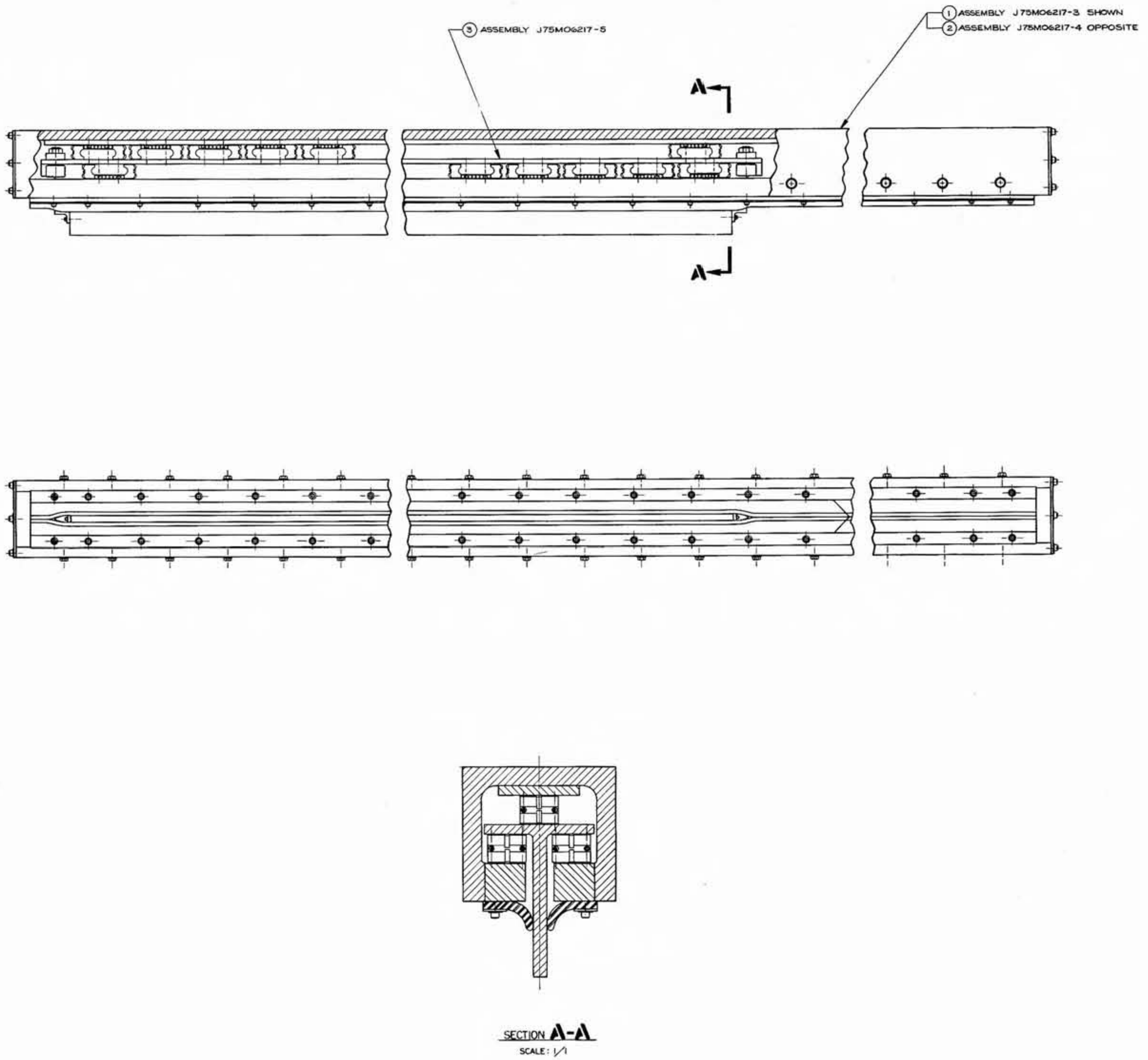


Figure 4-34. Service Module Extension Platform



-5	-4	-3	-2	-1	ZONE	FIND NO	CODE	PART OR STOCK NO / DRAWING NO	DESCRIPTION	UNIT WT
18					3B	34	537-24	21100	BEARING	.50
4					4A	33	925-63	CF-1-S	CAM FOLLOWER	
	22	22			2C	32		AN960C416L	WASHER	.0012
4					2A	31		AN960C4	WASHER	.0005
4					4A	30		AN960C716L	WASHER	
	14	14			4D	29		AN960C10	WASHER	.0021
	74	74			4C	28		AN960C416	WASHER	.0025
	A/R	A/R			4C	27		MS20995C32	LOCKWIRE	
	96	96			3C	26		AN960C6	WASHER	.0008
72					3B	25		MS16997-13	SCREW	.0046
4					4B2	24		MS21040-7	NUT	.0195
4					2A2	23		MS16997-12	SCREW	.0046
	96	96			3C2	22		MS16998-11	SCREW	.0046
	14	14			4D2	21		MS16998-28	SCREW	.006
	74	74			4C2	20		LC1004-9H	BOLT	
	4	4			2C2	19		MS16998-74	SCREW	.053
	53	53			2C2	18		LC333A-5	SCREW	
	22	22			2C2	17		LC1004-6	BOLT	
	2	2			2C2	16		D75M06221-1	BAR	
	2	2			2C2	15		D75M06218-1	PLATE	1.476
	1	1			2C2	14		J75M06226-2	SEAL ASSY	
	1	1			2C2	13		J75M06226-1	SEAL ASSY	
2					2B2	12		C75M06225-1	SPACER	.252
	1	1			3D2	11		J75M06214-1	BEARING WAY ASSY	20.77
	1	1			2D2	10		J75M06214-4	BEARING WAY ASSY	41.60
	1	1			3C2	9		J75M06214-3	BEARING WAY ASSY	41.60
2					2A2	8		C75M06224-1	BAR	.075
	2	2			4C2	7		D75M06219-1	PLATE	.457
1					3A2	6		J75M06215-1	CARRIER	
	1				4D2	5		J75M06216-2	BOX BEAM	
		1			4D2	4		J75M06216-1	BOX BEAM	
			1	1	3D	3		J75M06217-5	BEARING CARRIER ASSY	
			1		2D	2		-4	BOX BEAM ASSEMBLY	
				1	2D	1		-3	BOX BEAM ASSEMBLY	
								-2	BOX BEAM & CARRIER ASSEMBLY	
								J75M06217-1	BOX BEAM & CARRIER ASSEMBLY	

ASSY DASH NO

LIST OF MATERIAL

SEE ENGINEERING RECORDS

COMPLEX 39 — NEXT ASSY / USED ON — APPLICATION

UNLESS OTHERWISE SPECIFIED — TOLERANCES ON DECIMALS XXX ±.010

ORIGINAL DATE OF DRAWING 7 JUNE 63

BOX BEAM & CARRIER ASSEMBLY S-IVB AFT SERVICE ARM

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE, ALABAMA

J 75M06217 L

SCALE 1/2 & NOTED — UNIT WEIGHT NOTED — SHEET 1 OF 2

LO-DE

Figure 4-35. Box Beam Assembly (Sheet 1 of 2)

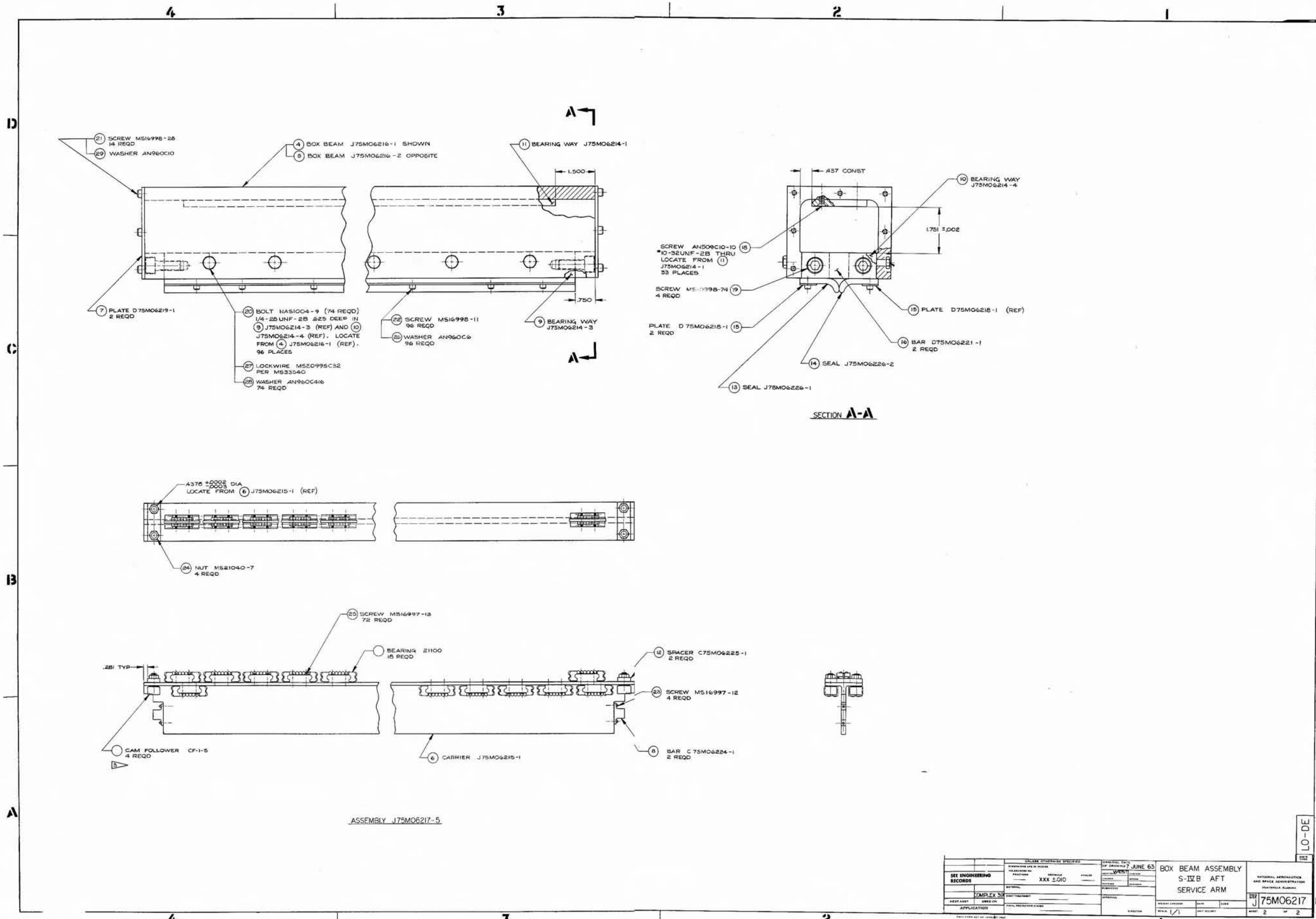
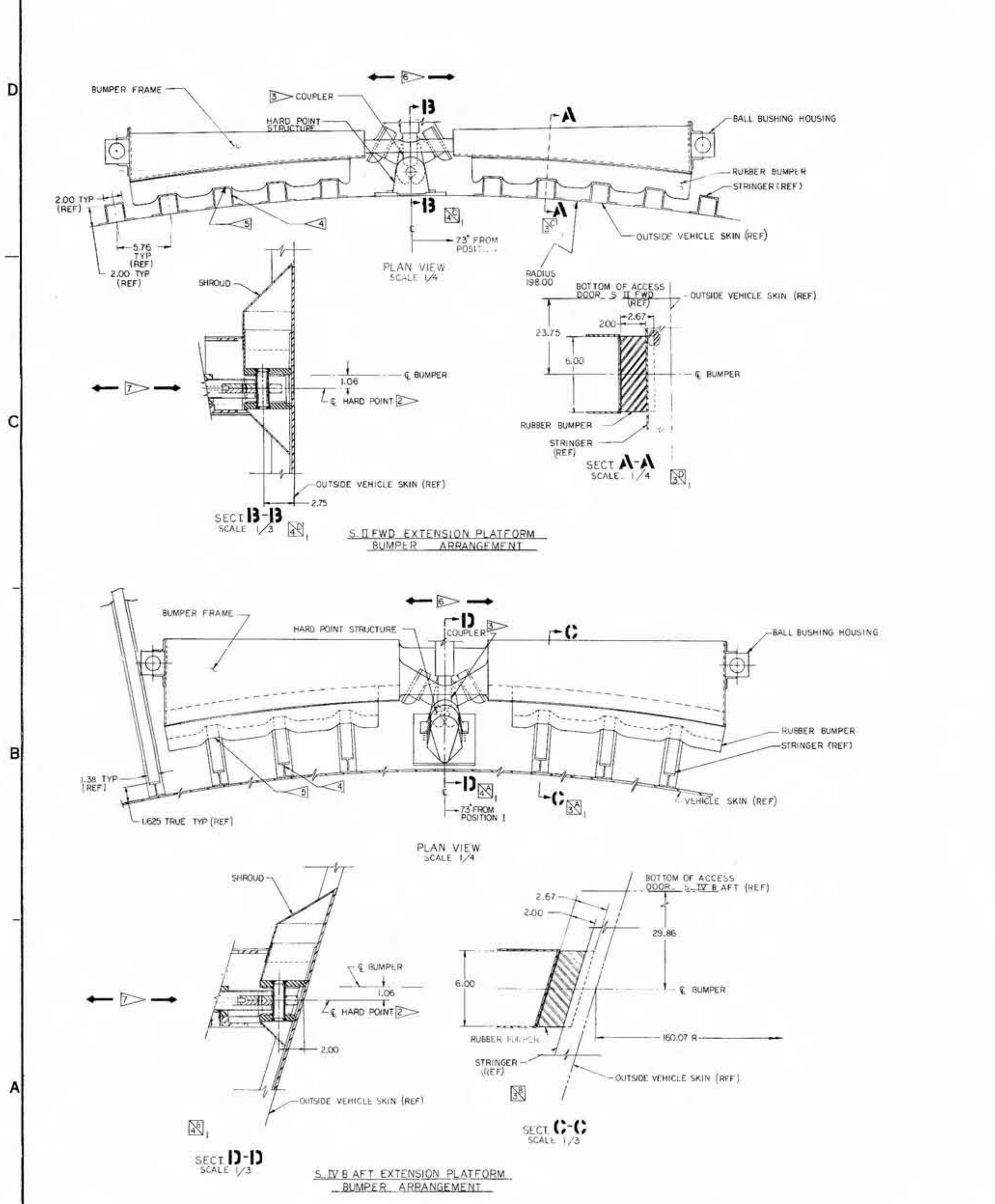
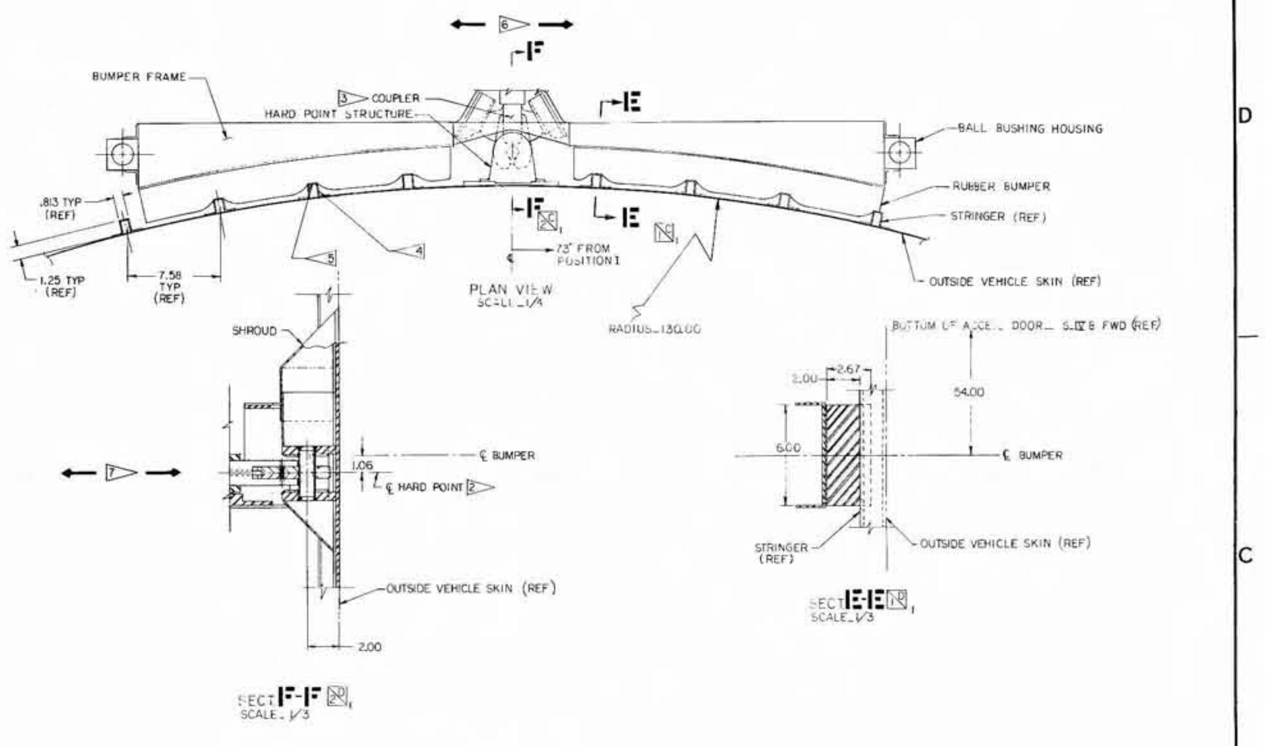


Figure 4-35. Box Beam Assy. (Sheet 2 of 2)





S-IV B FWD EXTENSION PLATFORM
BUMPER ARRANGEMENT

NOTES:

1 BUMPERS SHOWN IN MAX COMPRESSED CONDITION.

2 HARD POINT TO BE ADJUSTABLE 1.50 FWD AND AFT OF POSITION SHOWN. ATTACHMENT BAR TO BE 1.00 DIA.

3 OPENING IN COUPLER JAWS TO BE 1.12 DIA.

EXTENSION PLATFORM	4 NO. OF STRINGERS SUPPORTING BUMPER	5 MAX. PRESS. ON STRINGERS (NO LOAD FACTOR)	DEFLECTION 95% WIND	6 TANGENTIAL FORCE MAX. (NO LOAD FACTOR)	7 RADIAL FORCE MAX. (NO LOAD FACTOR)
S-I C INTERTANK	10	0.32 PSI	0.65 IN		34.26 LBS
S-I C FWD	10	0.62	2.60		58.60
S-II AFT	10	0.72	3.20		62.80
S-II INTER					
S-II FWD	8	2.59	7.00	187.60 LBS	316.43
S-IV B AFT	6	8.80	8.30	249.60	395.43
S-IV B FWD	6	26.90	12.50	278.60	471.43
SM			16.80		
CM			17.80		

GROUND RULES – SATURN V EXTENSION PLATFORM OPERATION

1 MAX. WIND CONDITION WHILE CONNECTED TO THE VEHICLE = 95%
2 MAX WIND CONDITION FOR PERSONNEL ON PLATFORMS = 30 KNOTS.
3 TOWER DEFLECTIONS ARE NOT CONSIDERED FOR PLATFORM DEFLECTIONS.
4 NATURAL FREQUENCY OF VEHICLE = .80 DRY AND .33 FUELED.

LIST OF MATERIAL

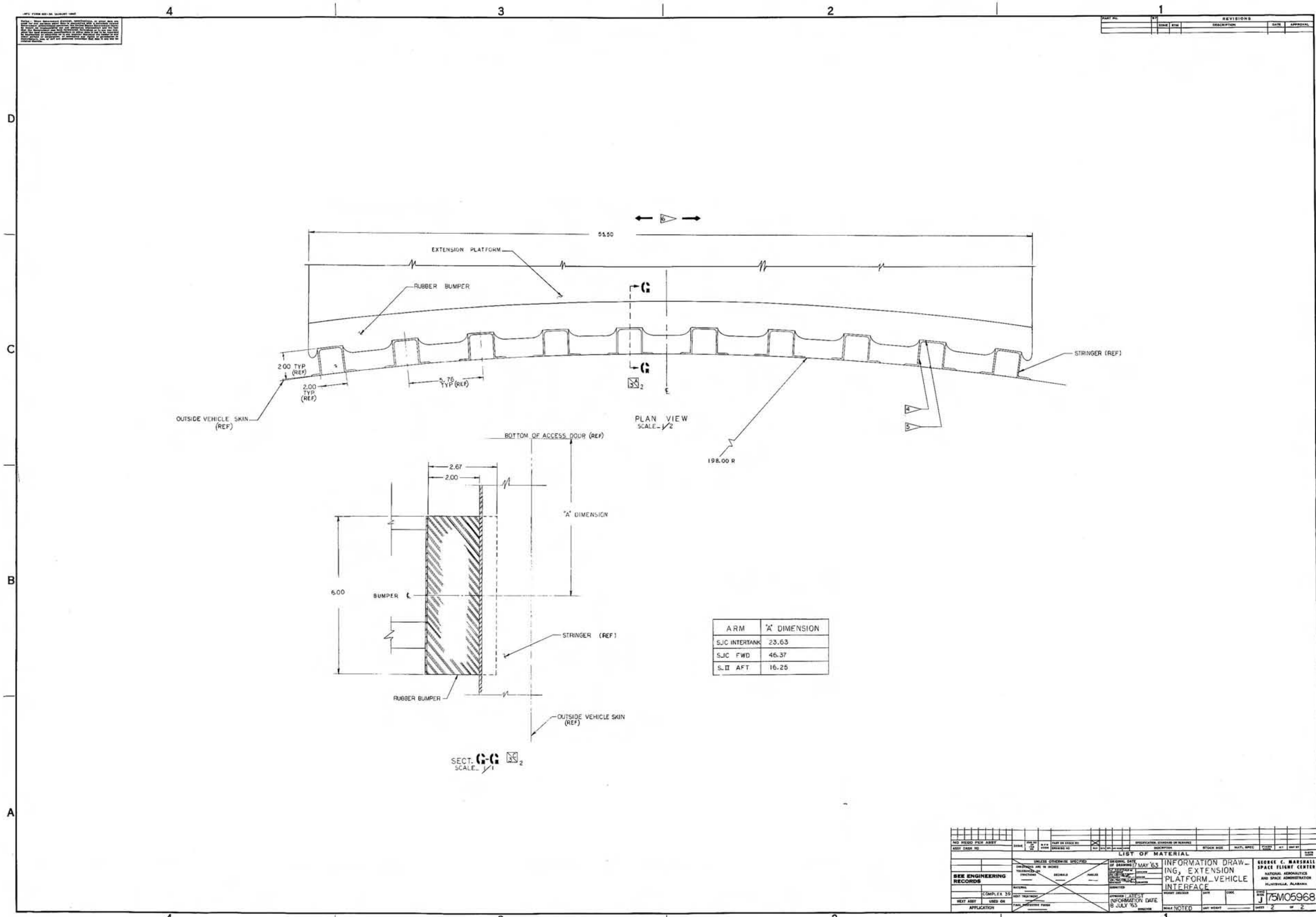
SEE ENGINEERING RECORDS

INFORMATION DRAWING, EXTENSION PLATFORM - VEHICLE INTERFACE

GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

ORIGINAL DATE OF DRAWING 17 MAY '63
LATEST INFORMATION DATE 8 JULY '63
SCALE NOTED
J 75M05968
SHEET 1 OF 2

Figure 4-36. Extension Platform - Vehicle Interface (Sheet 1 of 2)



ARM	"A" DIMENSION
SJC INTERTANK	23.63
SJC FWD	46.37
S-II AFT	16.25

Figure 4-36. Extension Platform - Vehicle Interface (Sheet 2 of 2)

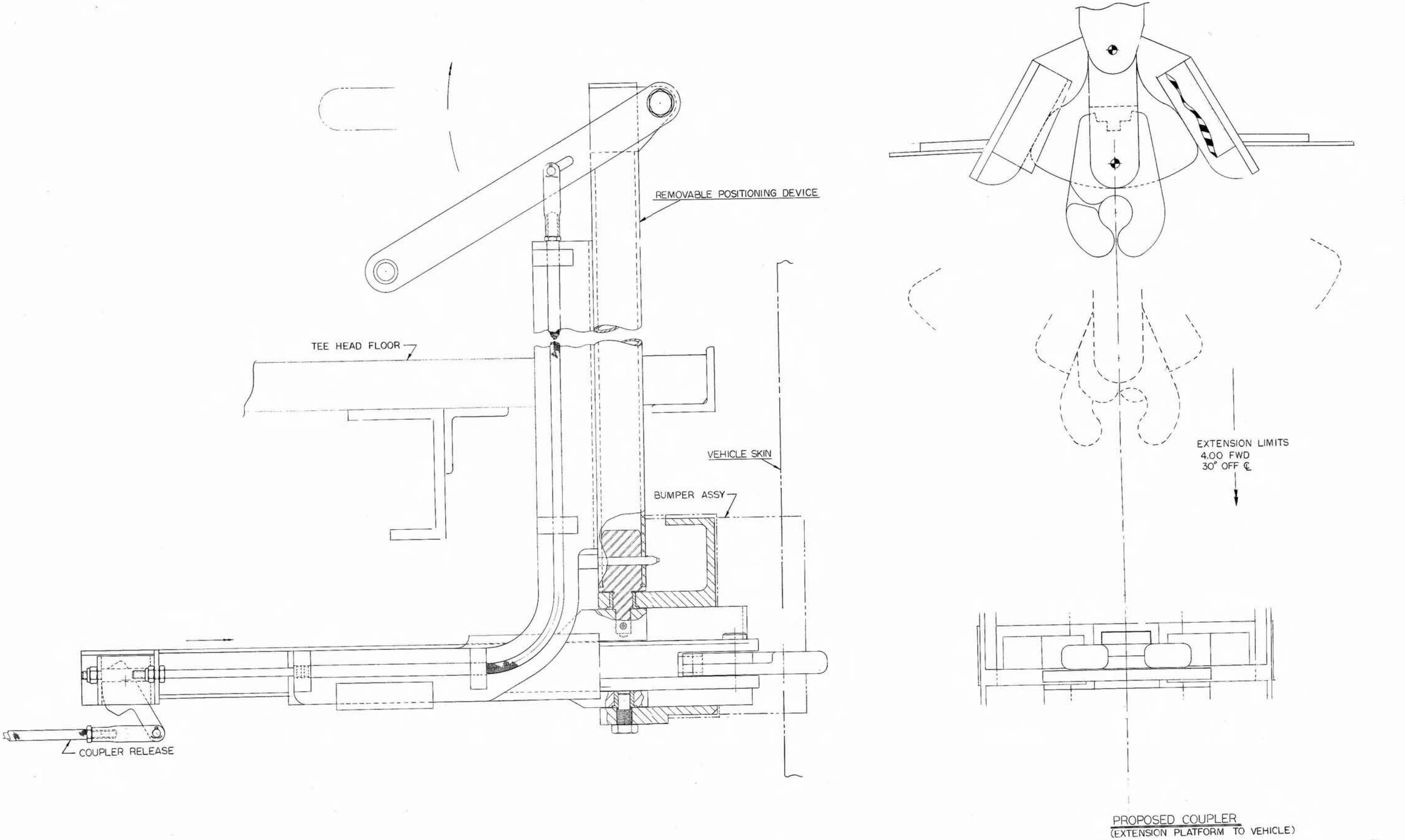


Figure 4-37. Coupler

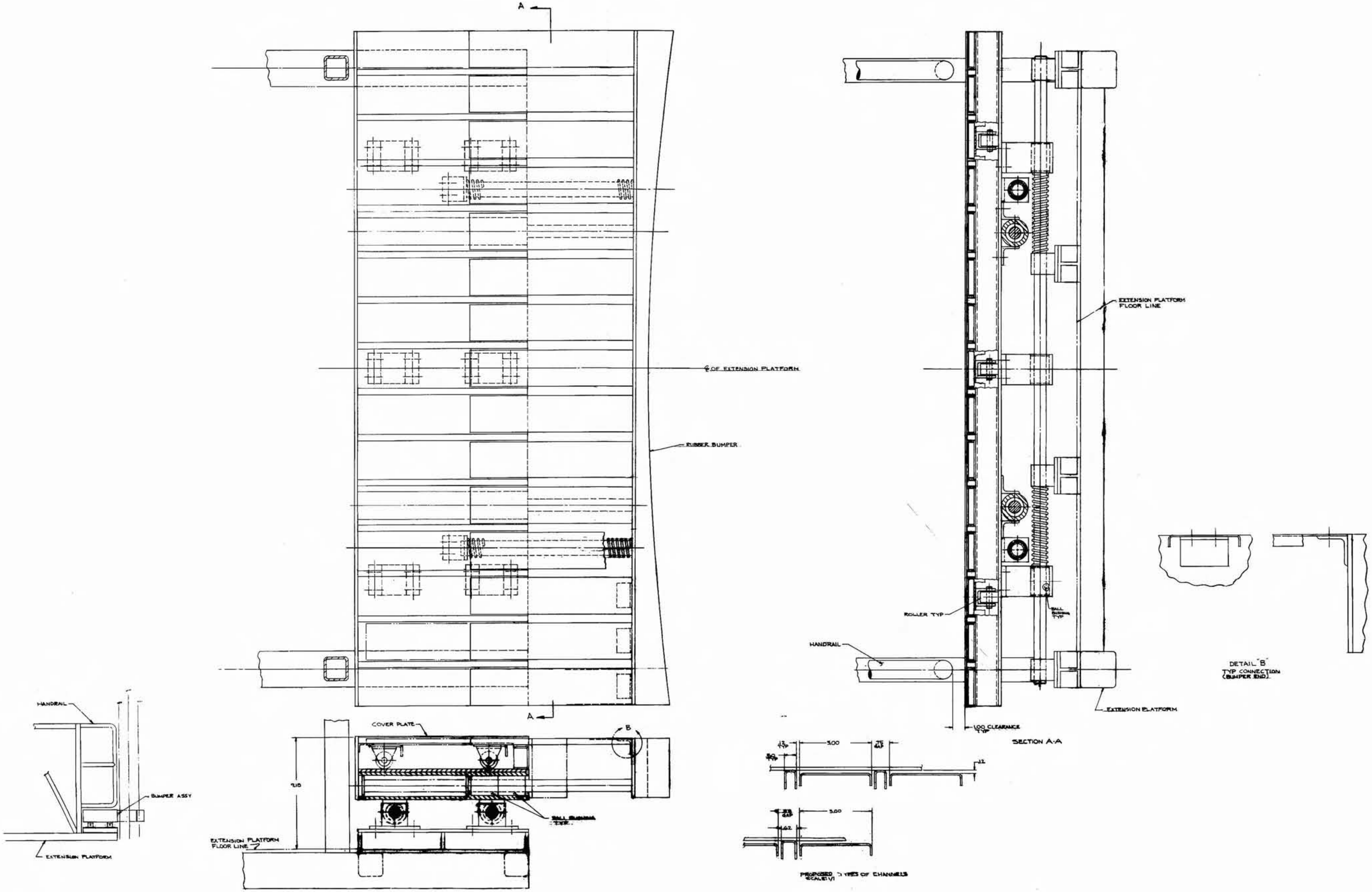


Figure 4-38. Service Work Platform

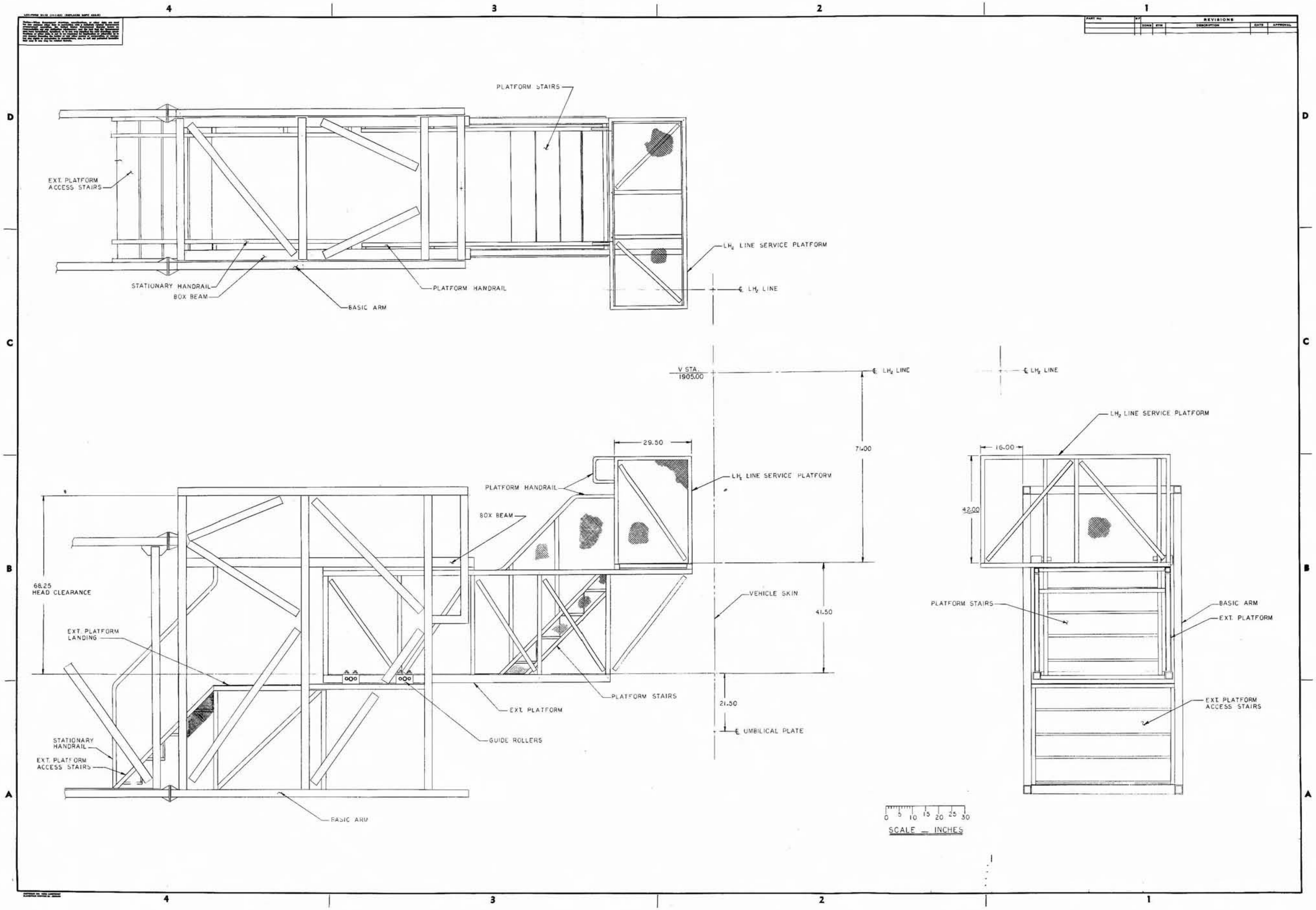


Figure 4-39. S-II INTERMEDIATE Extension Platform

4-43. ARM RETRACTION SYSTEM

A series of mechanical, hydraulic, and pneumatic features designed into each of the service arms provides a means for rotating the arm horizontally through a 73 degree arc and locking the arm at the extreme positions.

Timing and performance of all components are critical for in-flight arm retraction. The retraction system is capable of unlocking the arm, accelerating it against various wind loads, and decelerating it to a smooth stop.

The arm retraction system differs for preflight arms and in-flight arms. The preflight arms are retracted hydraulically only and do not have the cable retraction system; the in-flight arms are retracted by a hydro-pneumatic combination system. The hinge-mounted cylinders and associated actuating mechanisms for preflight arms and in-flight arms are the same. The subsequent description is applicable to in-flight arm retraction.

The hydro-pneumatic part of the retraction system is composed of the primary and secondary pressure supplies, valving, and actuators described in the following paragraphs.

The primary pressure supply consists of three 10-gallon nitrogen bottles having a precharge pressure of 2000 psi. The secondary pressure supply is a combination of three 10-gallon nitrogen bottles precharged to 2100 psi, and a piston type 10-gallon hydraulic accumulator. The primary pressure supply and its valving is mounted inside control cabinet No. 2 and the secondary pressure supply in control cabinet No. 1.

4-44. DESCRIPTION OF COMPONENTS

Two tower-mounted hinges (Figure 4-40), positioned outboard of the arm at the top and the bottom chords, house the retraction cylinders, the arm lock, and the bearing assembly. Drive shafts, seven inches in diameter, transmit the torque through the arm hinge plates.

4-45. Hydraulic Retraction Cylinder. Hydraulic cylinders, one in the top and one in the bottom hinge, are connected parallel in the hydraulic circuit. Each cylinder has an 8-inch bore, 14.875-inch stroke, 3.5-inch diameter rod, and is clevis mounted within the hinge. The force developed on the pull stroke of the cylinder is transmitted through a 12-inch driving lever to the drive shaft which rotates the service arm. Two bell-crank type, hydraulically operated arm locks are encased in the hinges. The top hinge contains a special cam-operated decelerating valve and the required valve and cylinder piping.

4-46. Tower-Mounted Hydro-pneumatic Cylinder. One hydro-pneumatic cylinder, mounted on the tower, operates a cable retraction mechanism (Figure 4-41). This cylinder has a 7-inch bore, a 52-inch stroke, and has the rod end attached to a block carrying four pulleys. Four other pulleys are mounted at the rear of the cylinder to form an 8 to 1 block and tackle system. The cable is routed from the system through a tensioning device to a swivel connection 267 inches from the arm pivot (Figure 4-41).

4-47. Control Cabinets. Control cabinets contain hydraulic and pneumatic accumulators and control valves for the arm retraction and withdrawal mechanism systems. The cabinets are made of stainless steel and are located on the tower deck adjacent to the arm. Each in-flight service arm has two control cabinets, No. 1 and No. 2; the prelaunch arms have only control cabinet No. 1. The size of control cabinet No. 1 will be approximately 7 feet long, 5 feet deep, and 7 feet high. The size of control cabinet No. 2 is approximately 2-1/2 feet long, 2 feet wide, and 7 feet high. Each control cabinet contains an electrical distributor box and control cables to the solenoid valves and the position indicator lights.

4-48. Latch-Back Mechanism. Arm supports, mounted on the tower, house the latch-back mechanism. This mechanism must be designed to withstand the load induced on the arm by the aspiratory wind back through the tower (Figure 4-42).

4-49. Linear Shock Absorbers. Two linear type shock absorbers (Figure 4-43) are bolted to the tower-mounted beams at the same level as the top and bottom service arm chords. These shock absorbers have a 4-inch bore, an 18-inch stroke, and are orificed such that a uniform stopping force is provided to decelerate the arm in event of a dual failure of the flow control valve.

4-50. OPERATIONAL DESCRIPTION

The prerequisite for reliable retraction of the service arm dictates the duplication of retraction means and minimum response time between modes of operation. Prior to vehicle launch, the arms are mechanically locked in the extended position. At T minus 10 seconds during the countdown, the preflight service arms are retracted. At T minus 15 seconds, the locks of the in-flight service arms are released; however, the arms are held in position by hydraulically-locked, hinge-mounted cylinders.

Lift-off initiates a rapid but chronological sequence of operations. First, the primary lift-off switch closes and completes the circuit to the umbilical carrier ball-lock release and ejection pistons. When the carrier is unlocked and separated from the vehicle, a limit switch located in the umbilical carrier, closes to initiate action of both the withdrawal mechanism and arm retraction system. The resulting sequential operation of the hydro-pneumatic retraction system can be described as follows:

NOTE

This system is completely duplicated for redundancy, electrically and mechanically (paragraph 4-96 through 4-100).

The limit switch completes a circuit to open valves located in the supply lines and return line. These valves release the primary and the secondary pressure supplies and open a hydraulic return line from the hinge-mounted cylinders through the flow control valve to the reservoir.

During normal operation of the system, the primary pressure supply delivers nitrogen into the blind end of the tower-mounted cylinder. The nitrogen intensifies the hydraulic pressure on the rod end and forces the flow into the rod ends of the two hinge-mounted cylinders. In effect, the pistons of the hinge-mounted cylinders retract the service arm, and the idling cable is automatically reeled at 8 times the rate of the tower-mounted cylinder motion. Although blocked by a check valve, the secondary pressure supply is available if the intensified pressure drops below the secondary supply pressure.

The geometry of the hinge cylinder and the cable mechanism is such that for the same angular increments of service arm motion, displacement patterns for hinge and tower cylinders are different. Cable slack is approximately constant for the first 50 degrees of rotation; however, the slack increases in the remaining 23 degrees. A cable tensioner provided at the tower mounted cylinder controls the cable slack and idling tension.

The hydro-pneumatic system (Figure 4-44) offers automatic protection against the consequences of the following types of failure:

a. Gradual or total loss of hydraulic oil in the hinge-mounted supply lines. If a gradual hydraulic leakage develops at the hinge-mounted cylinder, the tower-mounted cylinder, while automatically compensating for oil loss, will extend further and tighten the cable. At the same time, the intensified pressure to the hinge-mounted cylinder will decrease until the secondary supply (hydraulic accumulator) begins to compensate for oil loss. Depending on the leakage intensity, either the cable tension will continue to increase or secondary pressure supply will take over and complete the arm retraction. Sudden loss of all oil due to line failure relieves the pressure in the hydraulic line between the hinge-mounted and tower-mounted cylinders and results in retraction of the arm solely by the cable system. Thus, any loss in torque developed by the hinge-mounted cylinder is automatically supplied through the cable by the tower-mounted cylinder.

b. Loss of Nitrogen Pressure. If there is a complete pressure loss in the GN_2 primary supply, the tower-mounted cylinder will not move and the cable will not be reeled. However, a secondary supply (hydraulic accumulator) will provide pressure and full oil flow to the hinge-mounted cylinders instantaneously. Partial loss of GN_2 pressure will result in either an immediate and complete switch to the secondary supply or a momentary input from the GN_2 primary supply until the secondary supply takes over.

4-51. PRESSURE-COMPENSATED FLOW CONTROL VALVE

For deceleration control of the service arm, a cam-operated, pressure-compensated flow control valve (Figure 4-45) of unique design is located in the return lines from the hinge mounted cylinders. This valve incorporates special features such that it will fail only in the full-flow condition to ensure complete arm retraction within the critical time interval. This valve maintains accurate and reliable speed control of the arm, independent of wind loading conditions, by use of a pressure-compensating unit and a cam-controlled variable orifice. Different retraction times and functions of angular velocity versus displacement may be obtained by changing the shape or angular orientation of the cam or by adjusting the compensator spring setting.

The principle of the pressure-compensator can be summarized as follows: the pressure drop across the compensator is equal to the force exerted by the compensator spring.

The internal design of the flow control valve was dictated by the necessity that the control system must always move the arm from the path of the ascending vehicle; consequently, there must be no valve failure that results in additional flow restriction or in complete closure of the line.

Two types of failure are possible which could jeopardize arm retraction: failure of the compensator spring, or clogging of the cam-controlled variable orifice.

Failure of the compensator spring results in a shifting of the compensator spool to the flow cutoff position. Addition of a sequence valve which, after spring failure shifts the spool to the fully open position, converts the unit into a nonpressure-compensating deceleration valve.

Clogging of the cam controlled variable orifice would close the return line and decelerate the service arm which could result in collision with the vehicle. Orifice clogging causes a rapid pressure buildup that opens a latch-type relief valve allowing full flow through the return line.

Incorporation of the two special features satisfies the requirement for a fail-safe deceleration system. However, the failures outlined above could result in the service arm approaching the tower with sufficient momentum to destroy the arm or cause the arm to rebound into the vehicle. The shock absorbers previously described reduce damage from these possibilities.

For detail operational description of hydro-pneumatic system, see paragraph 4-92 through 4-107.

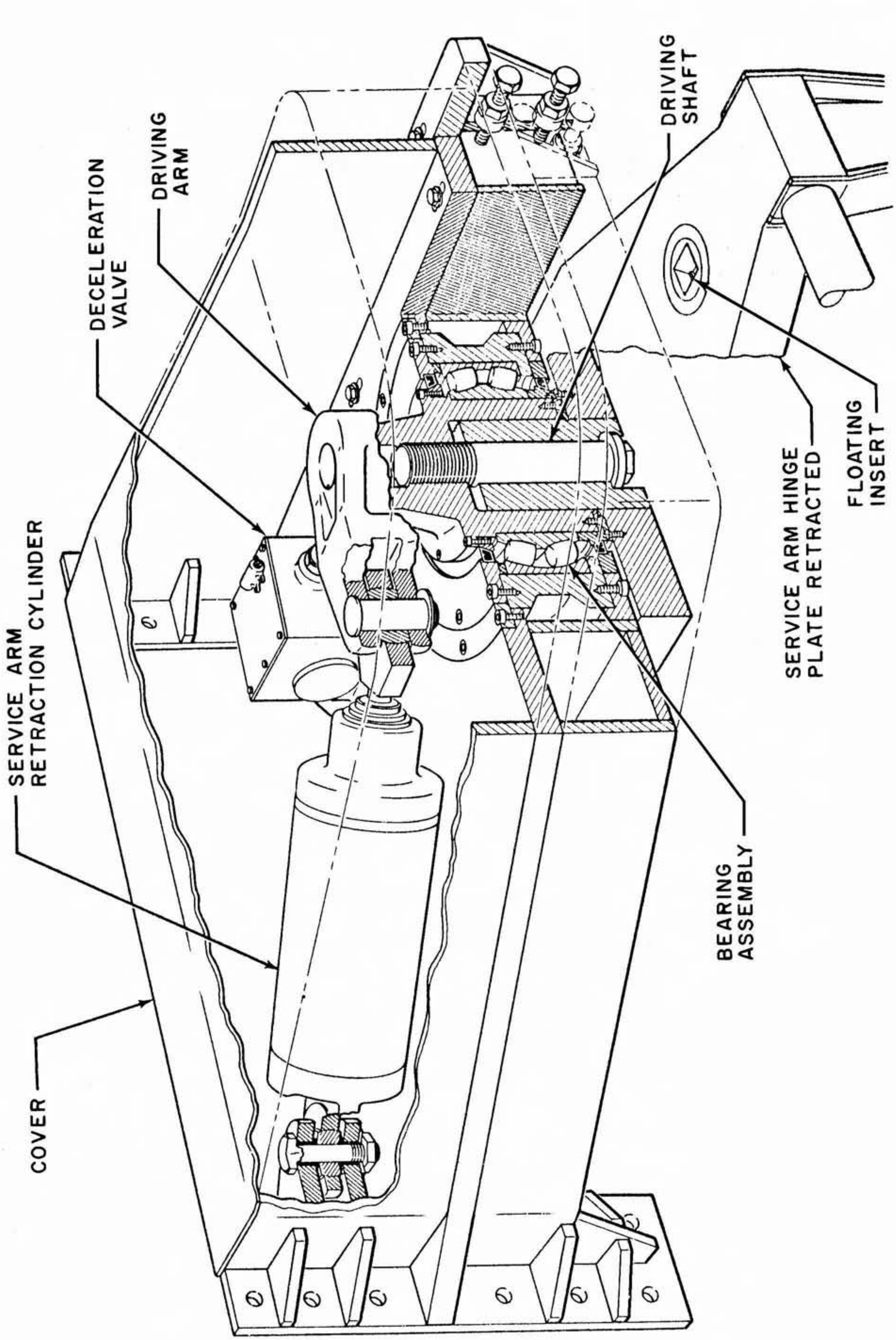


Figure 4-40. Tower-Mounted Hinge

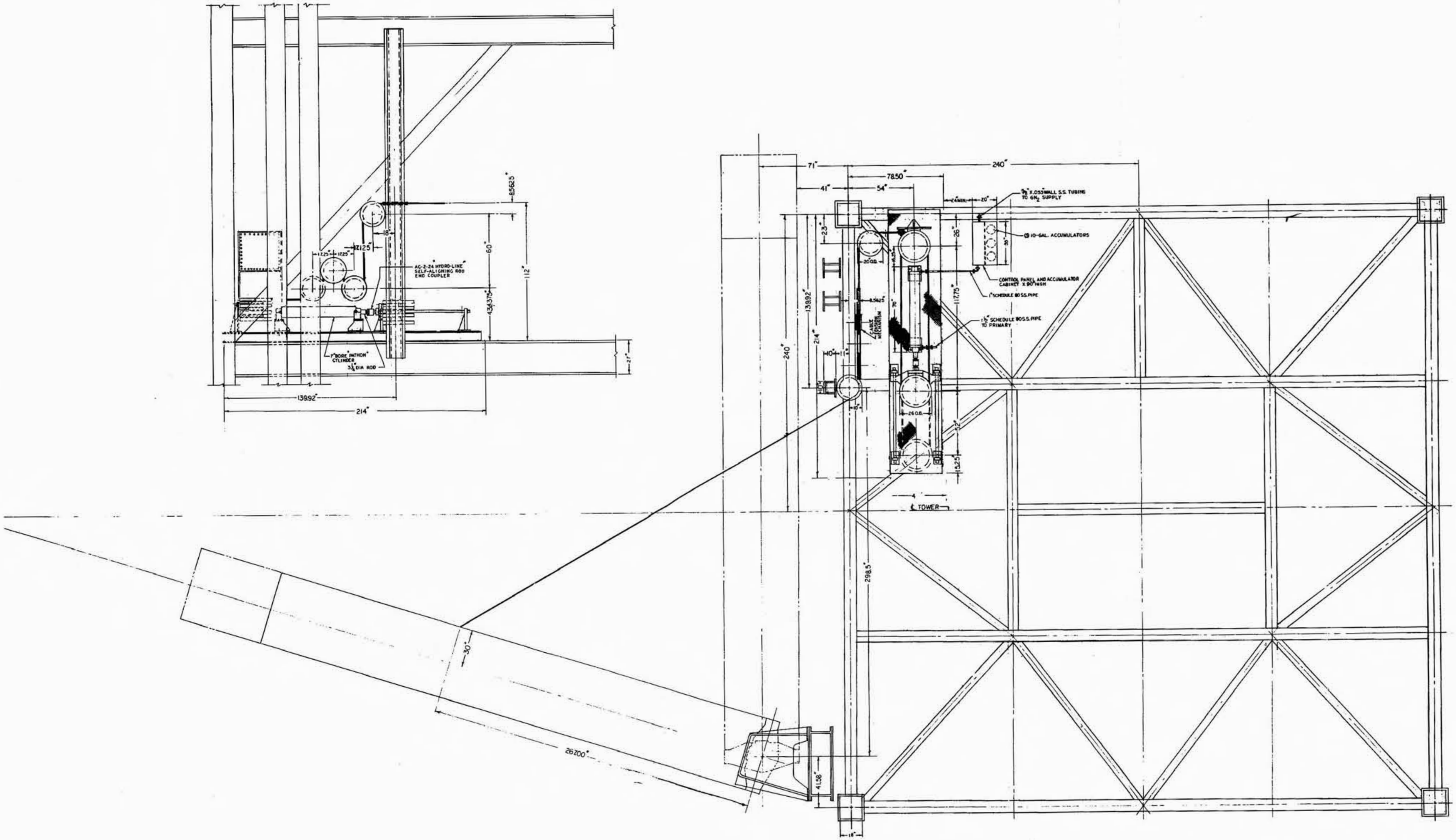


Figure 4-41. Cable Retraction System

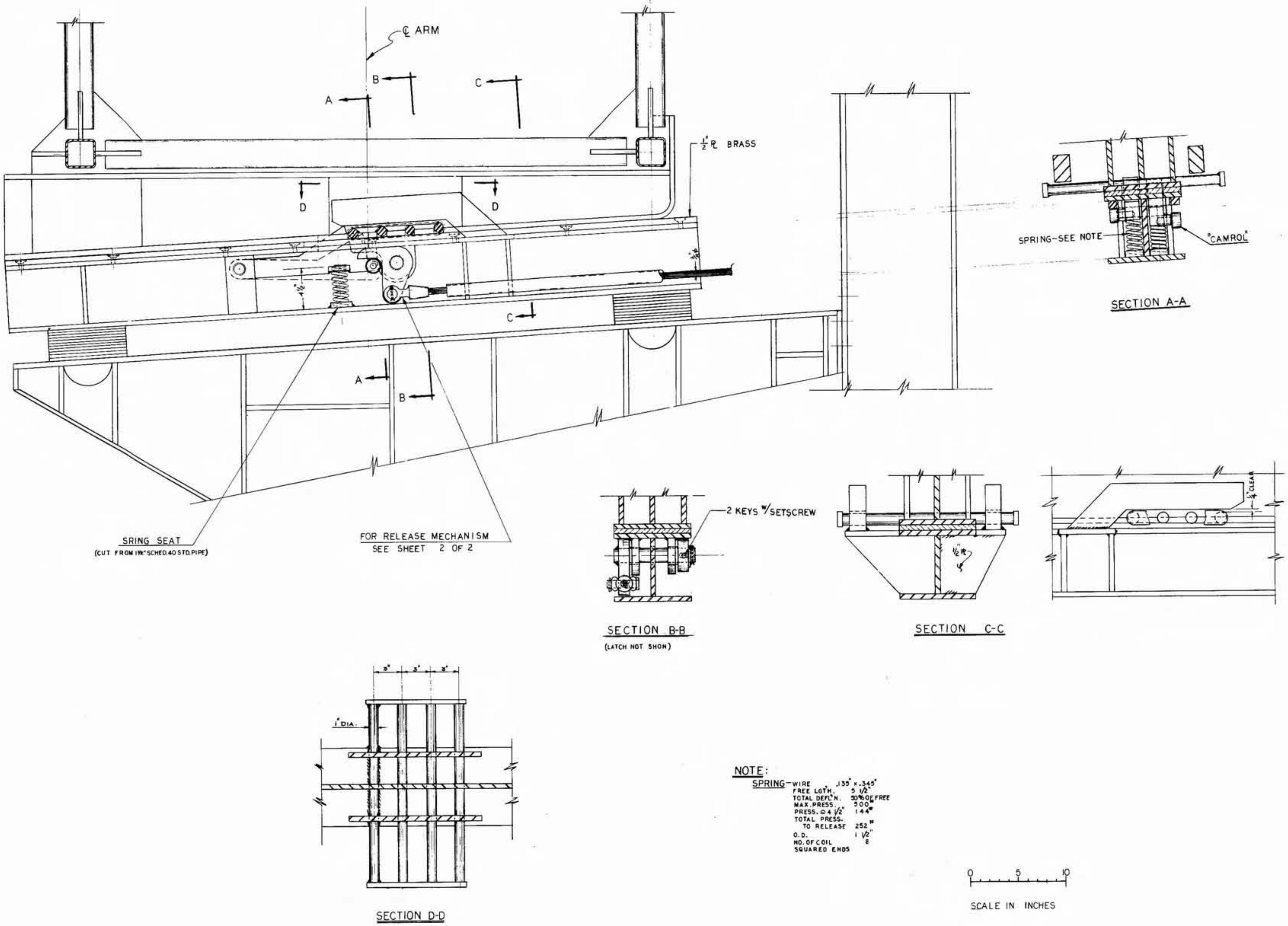


Figure 4-42. Latch-Back Mechanism (Sheet 1 of 2)

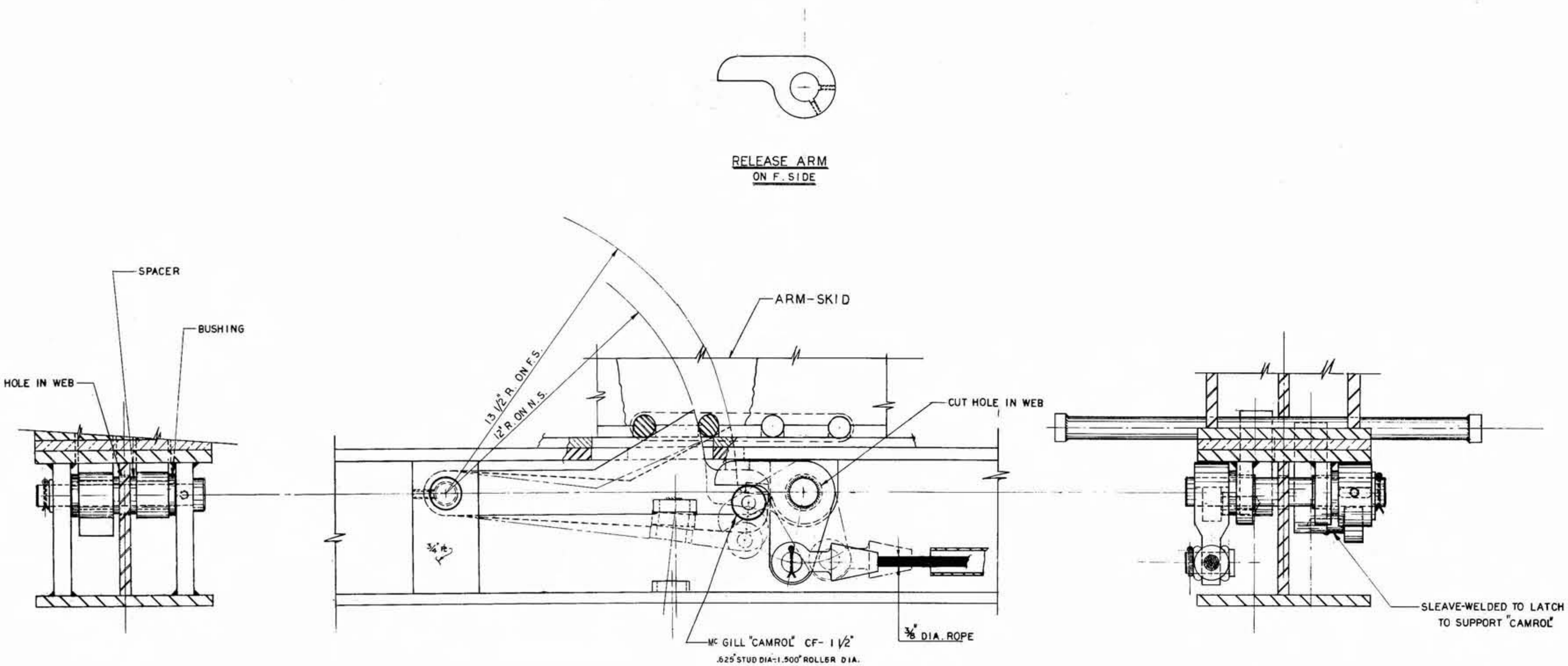


Figure 4-42. Latch-Back Mechanism (Sheet 2 of 2)

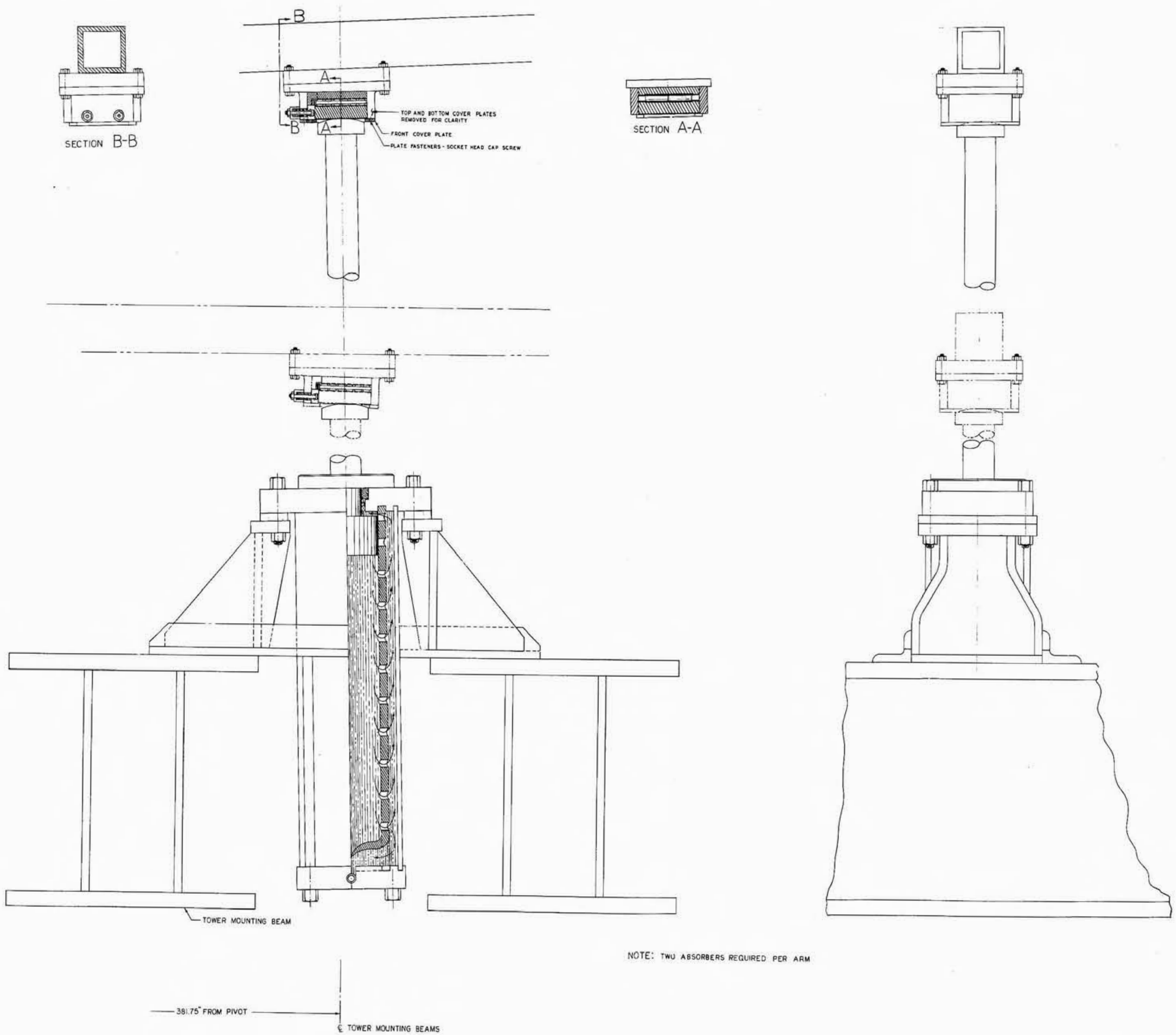
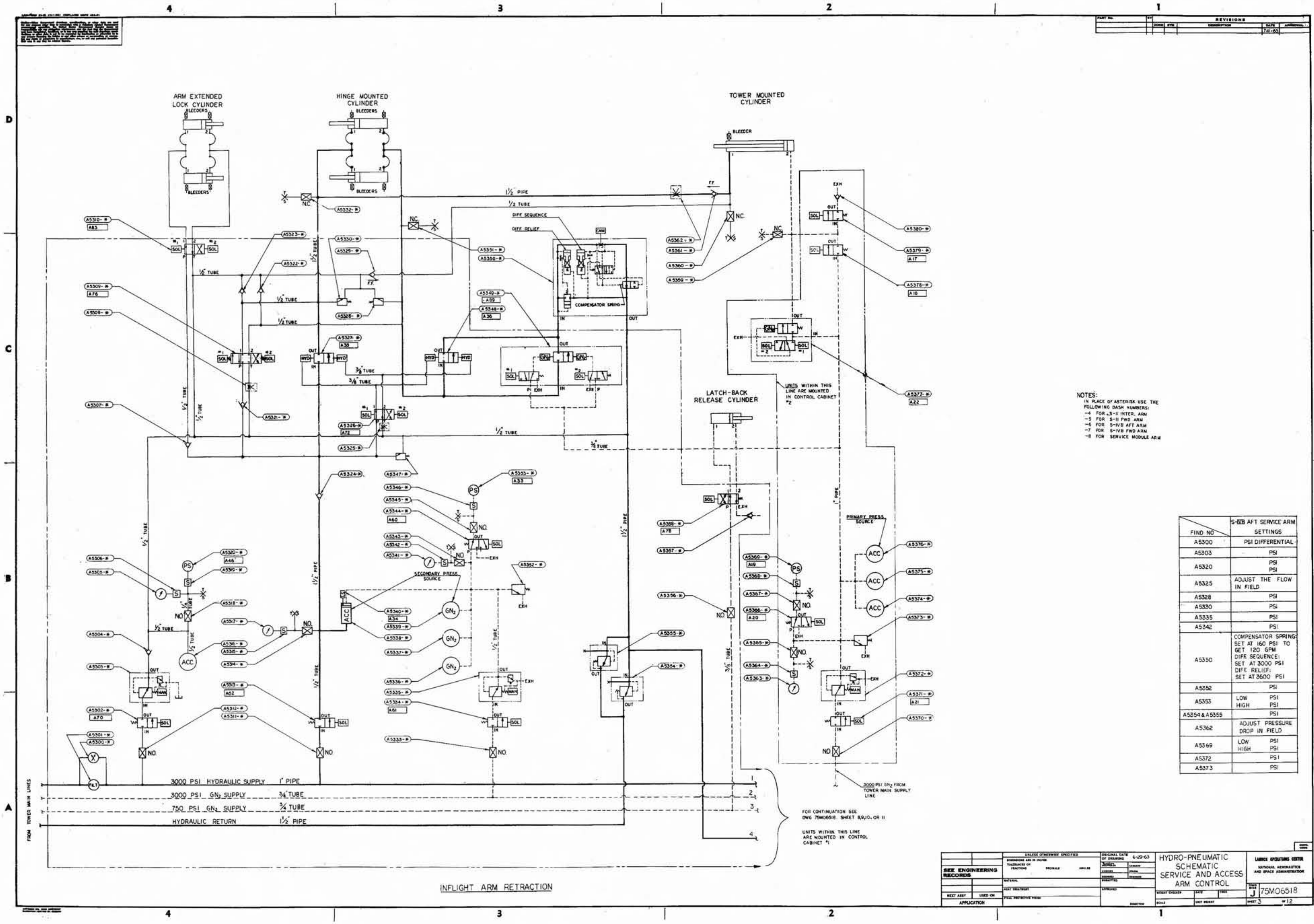


Figure 4-43. Linear Shock Absorber



FIND NO	S-IVB AFT SERVICE ARM SETTINGS
A5300	PSI DIFFERENTIAL
A5303	PSI
A5320	PSI PSI
A5325	ADJUST THE FLOW IN FIELD
A5328	PSI
A5330	PSI
A5335	PSI
A5342	PSI
A5350	COMPENSATOR SPRING: SET AT 160 PSI TO GET 120 GPM DIFF SEQUENCE: SET AT 3000 PSI DIFF RELIEF: SET AT 3600 PSI
A5352	PSI
A5353	LOW PSI HIGH PSI
A5354 & A5355	PSI
A5362	ADJUST PRESSURE DROP IN FIELD
A5369	LOW PSI HIGH PSI
A5372	PSI
A5373	PSI

Figure 4-44. Hydro-Pneumatic System Schematic

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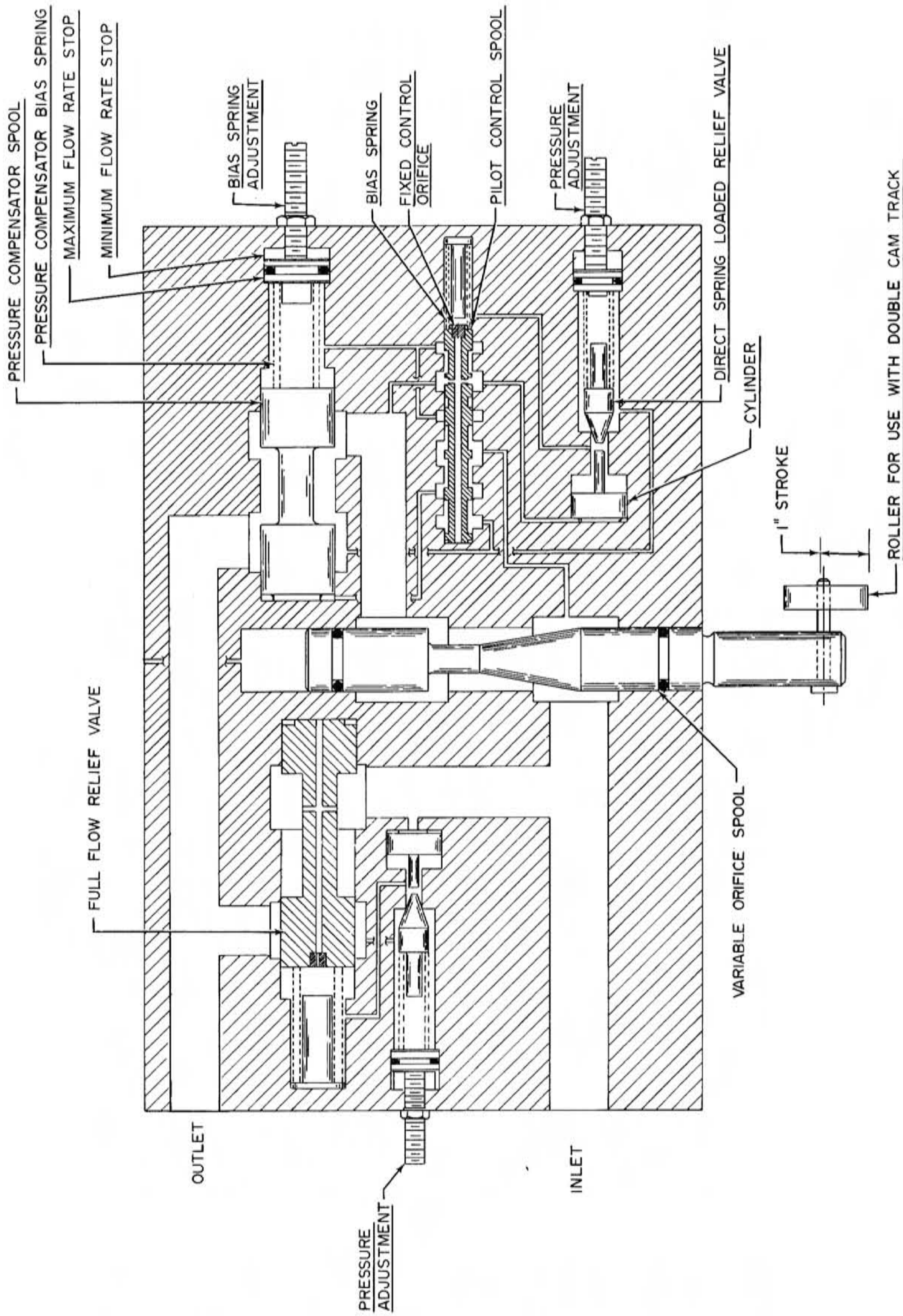

Figure 4. 45. Pressure-Compensated Flow Control Valve

4-52. ELECTRICAL SYSTEMS (Appendix C)

4-53. OPERATIONAL DESCRIPTION

4-54. In-flight Service Arms Automatic Operation (Figures 4-55 and 4-56). The automatic operation of the service arms has the firing circuits isolated from the remainder of the system. There are two 28-volt d.c. power sources, two primary lift-off switches, two secondary lift-off switches, and two carrier release switches. Each power source is used in a similar manner through its respective primary, secondary, and carrier release switch. There is no electrical connection between the two systems, thereby ensuring complete isolation and redundancy.

The primary lift-off signals originate from the two switches located on the vehicle holddown arms which sense vehicle motion. The signal from the primary lift-off switch number one simultaneously energizes solenoid No. 1 of valve number A5520 for all in-flight service arms. The signal from the primary lift-off switch number two simultaneously energizes the solenoid of valve A5524 for all in-flight service arms. When the valves have shifted, the position indicator switches close and energize relays in the relay distributor. Contacts of the relays will close light circuits on the LUT service arm monitor panel to confirm operation. Other contacts of the relays will energize recorder circuits to record the operations of the valves. These valves open pneumatic lines that supply pressure to unlock and eject the umbilical carrier from the vehicle. When the umbilical carrier is disengaged, two carrier release switches are closed to initiate withdrawal and retraction of the respective service arm for each d.c. power source. Carrier release switch No. 1 energizes solenoid No. 2 of valve A5500, solenoid No. 2 of valve A5462, solenoid No. 2 of valve A5451, and solenoid No. 2 of valve A5326. Carrier release switch No. 2 energizes solenoid of valve A5508, solenoid No. 2 of valve A5463, solenoid No. 2 of valve A5413, solenoid No. 1 of valve A5349, and solenoid No. 2 of valve A5377. As the above valves shift, the position indicators of each will close and energize their respective relay in the relay distributor. Contacts of the relays will close a light circuit on the LUT service arm monitor panels to confirm operation of each valve. Other contacts of the relay will energize recorder circuits to record the operation of the valves. Due to the delay in shifting of the valves, the withdraw will begin operation approximately 100 milliseconds before retraction begins.

The secondary lift-off switches are closed by vehicle motion at a position of vehicle travel where any umbilical carrier will have been mechanically disengaged from the vehicle by vehicle motion if any umbilical carrier had failed to be disengaged electrically. Closure of the secondary lift-off switches supplies power to the withdrawal and retraction valves for all service arms without the need for umbilical carrier switches having to close.

When the service arm locks to the tower and the arm has bottomed out on the shock absorber, a retraction-complete switch will close and energize a relay in the relay distributor. Contacts of the relay will energize a light circuit on the LUT service arm monitor panels. Other contacts of the relay will energize a recorder circuit.

The electrical wiring schematics for the service arm control system are shown in Figures C-1 through C-19 and C-23. Figure C-24 depicts this operational sequence. The operational times were based on the best information available from the mechanical, hydraulic, pneumatic, and analysis groups.

4-55. In-flight Service Arms Semiautomatic Operation. This operation is discussed in paragraph 4-83 (Figures C-20 through C-23).

4-56. Preflight Service Arms Automatic Operation. The automatic operation of the preflight service arms will be similar to the in-flight arms. The signal to retract the arms will be given approximately 10 seconds before engine ignition from the countdown programmer; whereas, the primary lift-off switches give the retract signal on the in-flight arms. This will allow the arms time to be retracted and locked against the tower before engine ignition. When all the preflight arms are locked against the tower, a signal will confirm the retracted condition. If any one of the preflight arms is not retracted, the countdown will hold.

The preflight arms will have no redundancy in the carrier kickoff, withdrawal, and retraction systems; whereas the in-flight arms use redundancy throughout. There will be no cable retraction system, and the withdrawal and carrier kickoff valves will be reduced in number; for example, there will only be one supply and return valve for the pneumatic cylinder.

There will be one battery supply and one carrier release switch; whereas, the in-flight has two battery supplies and two carrier release switches. Figure C-31 depicts this operational sequence.

4-57. Preflight Service Arms Semiautomatic Operation. The preflight semiautomatic operation will be the same as for the in-flight arms except for solenoid valves A5377, A5378, A5379, and A5349 of Figure 4-55. These valves will not be in the system since there is no cable retraction system for the preflight arms.

4-58. SERVICE ARM LIGHTING

The lighting system will provide a minimum of 20 footcandles of illumination on each service arm (Figures C-32 through C-36). The system components are hydrogen explosion proof; thus, should the need arise, the lights could remain on during fueling operations. Refer to Figures C-32 and C-33 for an arrangement of overhead lighting for those service arms for which preliminary design is complete. The first element, as shown on the S-II AFT Service Arm, will be typical for every service arm (Figure C-32). The placement of the lights on the second elements and extension elements will vary for each arm (Figures C-32 and C-33). All service arms will also be provided with three-wire, 120/208 voltage explosion proof receptacles.

4-59. DOCUMENTATION

The complete service arm electrical documentation for Complex 39, which includes arm installation, tower installation and LUT base installation in more detail, is shown by the family trees in Figure C-37 and C-38.

4-60. COMPONENT DESCRIPTION (Figure C-29)

4-61. Control Distributor. The primary function of the control distributor is to channel the individual cables from pressure switches, valves, junction boxes, etc., into 60 conductor cables for distribution to patch racks in the base of the LUT. Each distributor is supplied with the same 28 volts d.c. power used in the patch racks to provide a common positive and negative return bus; this reduces the number of 60 conductor cables required to supply indication and controls to the base of LUT.

The distributor will be 10.50 inches high and is designed to mount in a standard 24-inch rack. There will be top and bottom covers which are sealed to provide easy accessibility to the terminal boards and connectors. The front plate will be sealed in order for the distributor to be used in areas that will require sealing. The distributor is versatile and can be used in other GSE.

The control distributor will be used on all service arm levels and will be mounted in valve console No. 1 since the majority of valves are located in this console. The six-pin connectors on the rear (Figure C-30) are connected to components in the console with cables which have a six-pin plug on one end and the required plug on the other end. This allows the distributor to be used on all service arms without special modifications for the exact number of 2, 3, 4, 5, and 6-pin connectors required.

The front of the distributor has two 60-pin and one 4-pin connectors. The 4-pin connector is 4-conductor number 1/0 and is used for d. c. power. One of the 60-pin connectors is used for control and indication circuits feeding to the patchracks in the base of the LUT, and one is used for control and indication circuits from valve console No. 2 or circuits from the service arms.

There are two assembly-types of terminal boards inside the distributor: One assembly numbered TB1 and TB2 which will be wired number to number to the 60-pin connectors J1 and J2 on the front of the distributor; and the other assembly numbered TBA, TBB, TBC, and TBD, each wired in groups of six terminals to their respective 6-pin connector, letter to letter. For example, TBA1 wires letter to letter to connector JA1 on the rear. Other terminals will be used for d. c. buses and will be supplied from connector J3 on the front.

The terminal board nomenclature of TBA1, A2 "A10"; TBB1 "B10", D1 "D10" is used in lieu of TB1, 2, 3 . . . . . 40. It has been common practice to wire each connector pin to a terminal and to keep the terminal nomenclature consistent with that of its connector pin; four mechanically interchangeable terminal boards are used in the distributor for this purpose. Had connectors numbered 1 through 40 been used, then four separate boards which only differ in silk screen markings (i. e., 1-10, 11-20, 21-30, and 31-40) would have to be produced and stocked. By engraving the position of the four terminal boards TBA, TBB, TBC, and TBD, each board only needs to be marked 1-10, thus reducing stocking and manufacturing expense.

4-62. Test Set. The firing system portion of the test set will have four switches. One switch will be used for a lift-off simulator. The other three switches will be used to either arm or disarm the carrier release switch, withdrawal, and retraction circuits, respectively.

The firing test set will have three modes of operation:

a. Operation of the kickoff cylinders only. This can be done by disarming the carrier release switch, withdrawal, and retraction switches. Then close the lift-off simulator to the firing position.

b. Operation of the withdrawal mechanism. This can be done by arming the carrier release switch and withdrawal switch, and disarming the retraction switch. Then close the lift-off simulator switch.

c. Operation of the retraction mechanism. This can be done by arming the carrier release switch, withdrawal and retraction switches. Then close the lift-off simulator switch.

For safety purposes the operator checking the firing circuit operations must unplug the firing cable feeding the firing junction box from the other LUT firing circuits and then plug the cable from the firing test set into the firing junction box.

Also included in this test set will be the capability of controlling all valves and verifying all component feedback indications, thereby providing complete individual arm checkout capability while isolated from all other systems. This test set is identical for all arms and has switches and lights to command and monitor all functions. When used on an arm not containing certain functions, the switches and lights not used may be noted on checkout procedures and panel overlays.

This test set will be used to check out a single arm at the manufacturer, at MSFC Huntsville Service Arms Test Site, at the completion of installation of an arm on the LUT, at any time a single arm is to be checked out, or for troubleshooting components of an arm.

The test set will have a separate d. c. power connector to enable operation from portable or fixed power sources.

A parallel connector will be provided to allow recording, if required, while testing, or to allow monitoring of checkout in the LUT.

The test set is the suitcase weatherproof type similar to the LO-DE test sets supplied for the Saturn C1.

All arm test sets are identical and interchangeable. There is only one test set checkout procedure and only one spare test set per LUT. Six test sets will provide one for every other arm plus the one spare per LUT.

4-63. Portable Arm Control Box. The portable arm control box is used to extend or retract each service arm individually. The operator can take a position near the arm with the control box and visually check the arm as it extends or retracts.

There will be six indicator lights and a single-pole double-throw, center off, spring return switch on the top panel. Internally there will be a terminal board and a relay. A 60-pin connector will terminate the control cable from the control box to control console No. 1. Schematics showing the controls for the extension and retraction are shown in Figures C-20 through C-22.

4-64. Umbilical Crossover Distributor. The umbilical crossover distributor will be approximately 6 by 3 by 6 feet and will be used only on the service arms that have umbilical cables.

Approximately 70 electrical cables will be required from the vehicle to crossover distributors and approximately 100 cables from the crossover distributors to facility umbilical (U. B.) terminal distributors. The majority of these cables will be 60 conductor No. 16 with overall shields and with certain individual shield requirements. Choices of standard cable configurations will be made when requirements are available from the stage contractors.

The arm cables will be delivered, installed on the arms and tested at MSFC Huntsville. The crossover to U. B. distributor cables will be delivered with the arms so that they can be installed on the LUT as a complete package

4-65. Control Console No. 1. Control Console No. 1 will have most of the hydraulic and pneumatic components, and will be located on each service arm control level. The control distributor, portable arm control box and test set will be either mounted in or attached to the console. There will be approximately seventy-five, two to six conductor component cables from the pressure switches, valves, etc., to the control distributor, portable arm control junction box, and test set which will be installed with clamps, etc.

4-66. Control Console No. 2. Control Console No. 2 will have the hydraulic-pneumatic cylinder controls. This console will only be used on the in-flight arms. This console will have a junction box for portable arm control. There will be approximately fifteen, two to six conductor component cables from the pressure switches, valves, etc., to the junction box which will be installed with clamps, etc.

4-67. Lighting and Power Distributor. The lighting and power distributor will be approximately 8 by 8 by 8 inches, and will supply three-wire 120/208 volts, 60-cycle power for lighting and receptacles for each service arm. The facilities installation will be phased to provide a balanced load to all service arms, and it will be on a switched circuit similar to that for the tower lighting.

4-68. Service Arm Patch Racks. These racks are used to distribute the control command and feedback signals of each service arm to remote locations such as the Launch Control Center (LCC).

There will be patchboard terminations for all incoming and outgoing lines. In addition, relay and diode modules have patchboard terminations for each relay and diode terminal. These modules are plugged into connectors identical to those which accept the cables on the back of the patchboard assembly. The racks will be 24 inches wide by 86.25 inches high and radio frequency interference shielded. There will be a requirement for seven racks (Figures C-25 and C-26).

Pre-programmed patchboards can be readily installed or existing board re-programmed for several different operations. This will offer versatility with a minimum of wiring changes.

4-69. Service Arm Monitor and Recorder Panel Racks. The service arm monitor and recorder panels will be used to monitor and record operations for each service arm. The panels will monitor the systems at the vertical assembly building, during transit, and during prelaunch and launch operations.

There will be two monitor panels per service arm, each being 24 inches wide and 8.75 inches high. Panels for each service arm are laid out by location of equipment, pneumatic charging, hydraulic charging, and firing systems. The pneumatic charging circuits for each service arm are summed up with relay contacts to a green pneumatic charging "OK" light. The pneumatic charging "OK" light will remain energized until the pressure drops in one of the pneumatic air bottles at which time the respective pressure switch closes and energizes a charging valve. The "OK" light will be de-energized. This will tell the operator the location of the system being charged. This same procedure is performed for the hydraulic charging systems. The firing feedback circuits are summed up with relays to a green firing system "OK" light. This light will remain energized as long as the firing valves are in the proper position.

Another light is provided to indicate the firing systems are ready for launch. This light will be energized when the charging systems are blocked, the extension platform locked, and the arm extended-lock unlocked. As the firing valves shift after being energized, relays will be energized and will energize their respective light and recorders circuits.

There probably will be three 100-channel, R. F. I. shielded event recorders used to record charging events and firing events.

The monitor panels will require four 24-inch wide by 86.25-inch high R. F. I. shielded racks. The layout of the monitor panels and racks are shown in Figures C-25, C-27, and C-28.

4-70. VEHICLE SERVICE LINES

Service lines described in this section are the cryogenic, air conditioning, pneumatic, and electrical lines servicing the S-IC, S-II, S-IVB, IU, and the SM stages of the Saturn V Vehicle. Electrical lines are described in paragraph 4-52. The lines run from an interface at each tower level, along the service arm, to another interface at the vehicle, either in a combined housing or a single coupling. All lines other than electrical, which are continuous between the vehicle and the tower junction box, consist of a section of flex line at each end of the arm with a section of hard line between. All pneumatic flex lines are extruded teflon tubes wrapped with a stainless steel wire braid. All cryogenic flex lines are corrugated stainless steel wrapped with a stainless steel wire braid. Air conditioning flex lines are silicone and fiberglas supported by a wire helix with the 4-inch, 6-inch, and 10-inch sizes being insulated. The hard line for the air conditioning is an aluminum spiral duct with an external insulation. Propellant fill and drain lines will be vacuum jacketed with a vacuum probe, valve, and burst disk supplied with each assembly. In addition, expansion joints are used to accommodate movement of the propellant lines. The S-IVB AFT propellant fill lines are discussed in paragraph 4-14. A detailed tabulation on function, media, pressure, temperature, flex hose weight, size, etc., and hard line data along with each umbilical carrier location is included in Appendix A.

4-71. S-IC INTERTANK

This arm will carry the S-IC LOX fill and drain lines. The size and number of the lines leading from the remote reconnect mechanism has not been determined. Two 8-inch ID lines carry the propellants from the tower interface onto the arm.

4-72. S-IC FWD

All of the S-IC FWD service lines are terminated in a common umbilical carrier (Figure 4-46) at the vehicle. The lines include two 4-inch air conditioning lines, eight electrical lines, and four pneumatic lines (Figure A-3, Appendix A). Each line consists of a flex section at the arm tip, a section of hard line along the arm, and another section of flex line at the hinge point. The umbilical carrier and the lines are handled by a lanyard withdrawal mechanism (Figures 4-21 and 4-22).

4-73. S-II AFT

A one-inch LOX bleed line will be located on the S-II AFT arm (Figure A-5). Corrugated stainless steel flex lines will be used at the arm tip and hinge point with a section of tubing between. A lanyard attached to a collar on the coupling and actuated by a pneumatic cylinder is used to withdraw the line, (Figure 4-23).

4-74. S-II INTERMEDIATE

The three main groupings of service lines on this arm are as follows.

4-75. LOX Fill and Drain Line. An 8-inch ID, 10-inch OD, vacuum jacketed line interfaces with a lift-off type ball and cone propellant coupling (Figure 4-47) and is retracted by a lanyard withdrawal mechanism. Two hinged joints and a pressure compensated expansion joint is used in conjunction with a corrugated flex hose to aid in retraction.

Another flex hose (Figures 4-48 and 4-49) is used at the hinge point in a traveling loop supported below the arm. Six pneumatic lines will furnish GN_2 and He_2 to purge the line and coupling and to actuate the shut-off valve located between the coupling and flex hose.

4-76. LH_2 Fill and Drain Line. An 8-inch ID, 10-inch OD, vacuum jacketed line (Figures A-7, A-8, and A-9, Appendix A) will interface with a coupling similar to the one used for the LOX line. Six small pneumatic lines will be routed out to the interface between the coupling and the flex hose. The LH_2 line is handled by a lanyard-type withdrawal mechanism as shown in Figure 4-24.

4-77. Umbilical Carrier. All electric lines, air conditioning and purge lines, small cryogenic lines, and pneumatic lines interface in a common carrier (Figure 4-50). The carrier and lines are handled by a cylinder-type withdrawal mechanism. The cryogenic and pneumatic lines vary from 3/8 inch to 2 inches in diameter and conditioning ducts vary from 4 inches to 14 inches in diameter.

4-78. S-II FWD

All the lines on this arm interface at the vehicle in a common umbilical carrier. These lines (Figure A-10, Appendix A) include two 8-inch hydrogen vent lines, a one-inch cryogenic line, six pneumatic lines, eight electrical lines, and one 4-inch air conditioning line. These lines are handled by a cylinder withdrawal mechanism.

4-79. S-IVB AFT

All the service lines on this arm interface in a common umbilical carrier (Figure 4-51) handled by a cylinder withdrawal mechanism.

The vacuum jacketed propellant fill and drain lines, a 6-inch ID, 8-inch OD LOX line and a 6-inch ID, 8-inch OD LH_2 line are located symmetrically on either side of the arm (Figure 4-52). Hinged expansion joints are used in conjunction with flex hose at the tip of the arm, and flex hose is used at the hinge point. Another mechanism is used to eliminate pockets in the LOX and LH_2 lines and aid in withdrawal of the propellant lines, 10-inch air conditioning line, six electrical lines, and eleven pneumatic and small cryogenic lines. The line handling mechanism is shown in Figure 4-15. The layout of these lines around the hinge point is shown in Figure 4-19.

4-80. S-IVB FWD AND INSTRUMENT UNIT

The lines on this arm service both the S-IVB FWD and the Instrument Unit (IU). All of the lines interface with two umbilical carriers supported in a common frame (Figure 4-53). Each line is defined in Figure A-14, Appendix A. A cylinder withdrawal mechanism is used to handle the common frame and lines (Figure 4-26).

a. S-IVB. The S-IVB portion consists of a 6-inch hydrogen vent line and eight electrical lines.

b. IU. The IU portion consists of a 6-inch air conditioning line, sixteen electrical lines, a pneumatic line, and two lines for water/methanol conditioning.

4-81. SERVICE MODULE

The requirements of this arm have not been definitely established at this time. However, all lines will interface in a common umbilical carrier (Figure 4-54). This carrier will be retracted with a lanyard withdrawal mechanism (Figure 4-27) and the tentative lines are shown in Figure A-16 and A-17, Appendix A. The lines include a 6-inch air conditioning line, three electrical lines, five pneumatic and small cryogenic lines, and two coolant lines.

4-82. COMMAND MODULE

At present, a 6-inch air conditioning line will supply the environmental cab at the tip of the access arm.

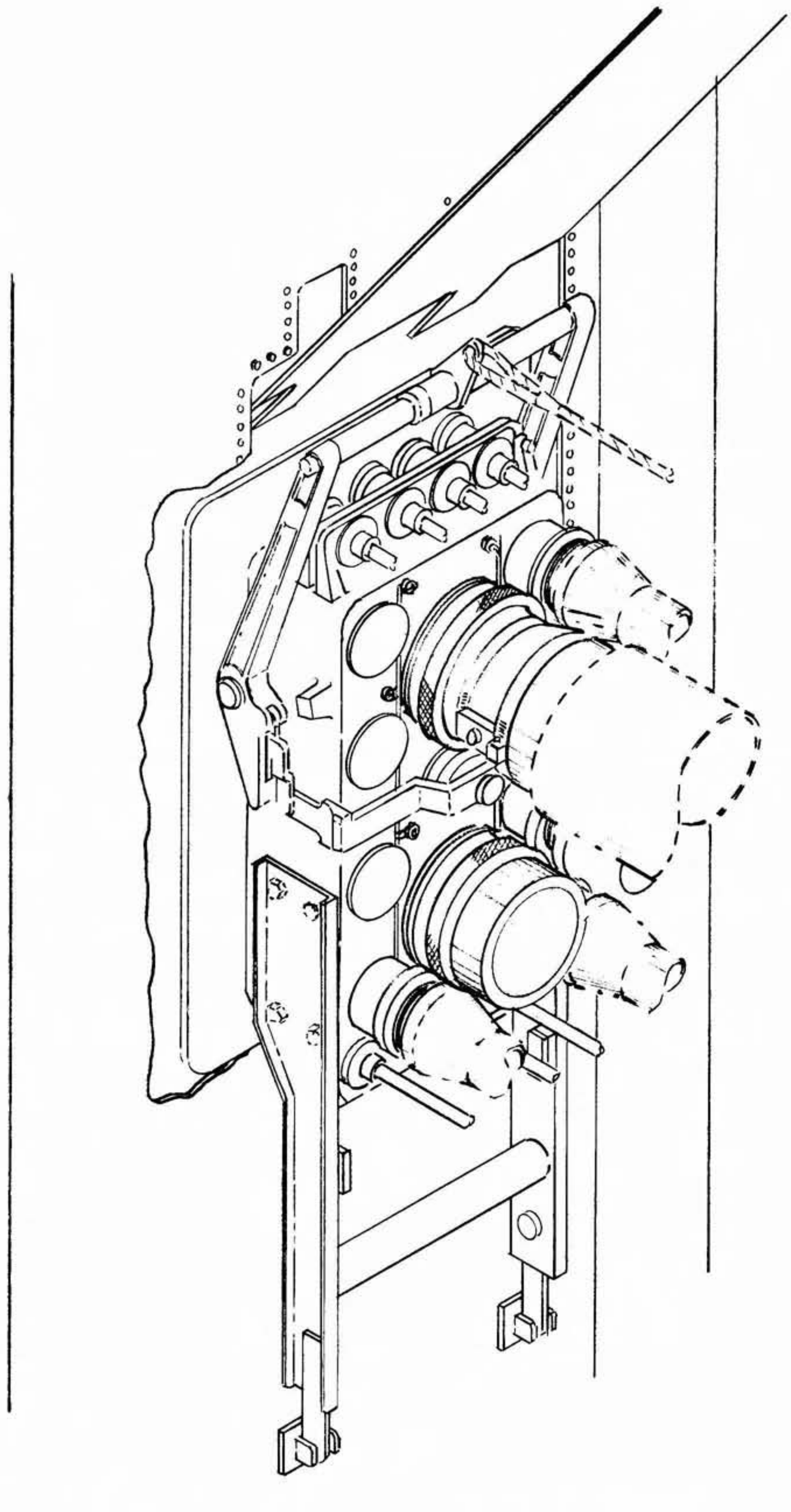

Figure 4-46. S-IC FWD Umbilical Carrier

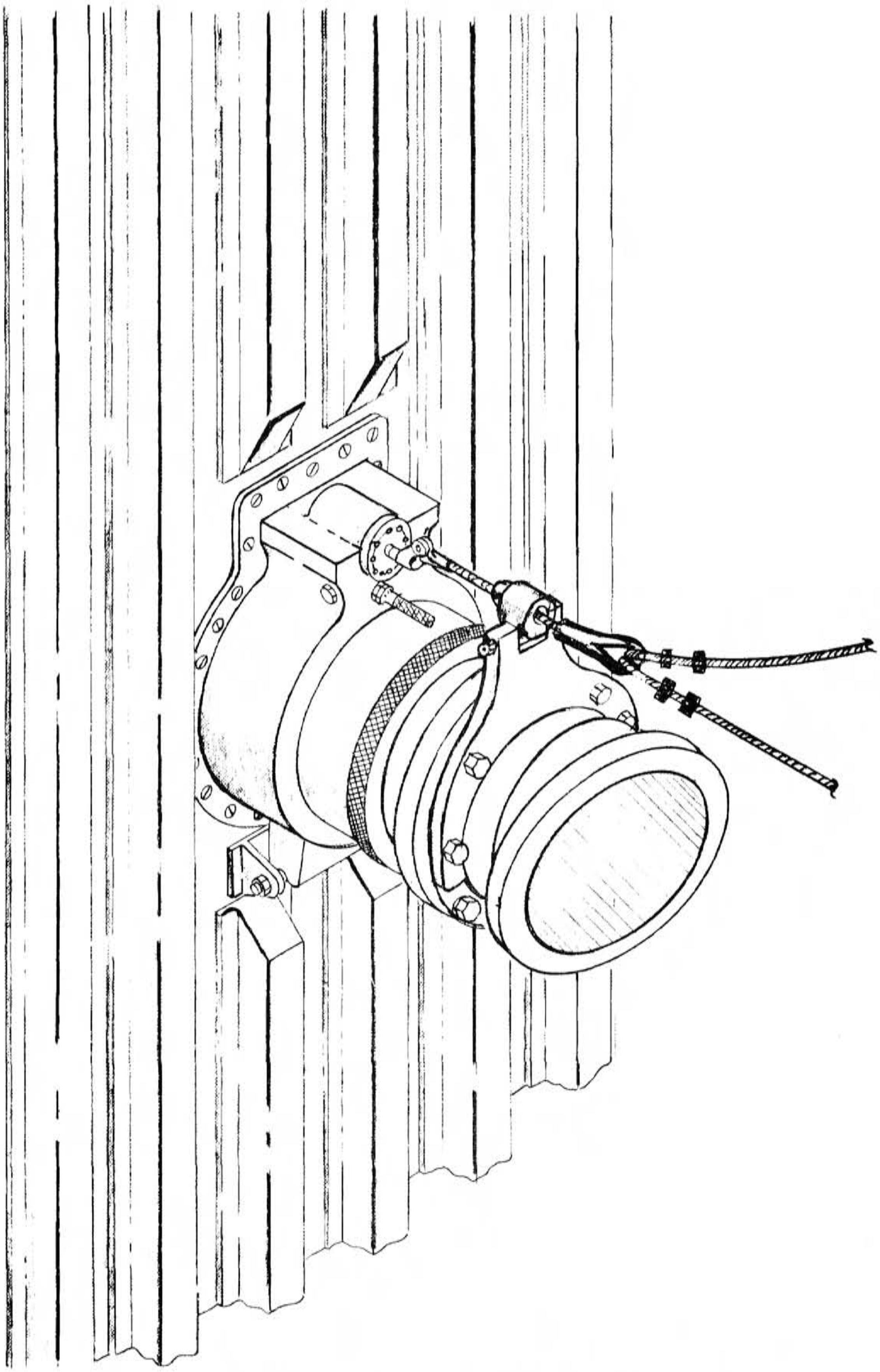

Figure 4-47. S-II INTERMEDIATE Propellant Coupler

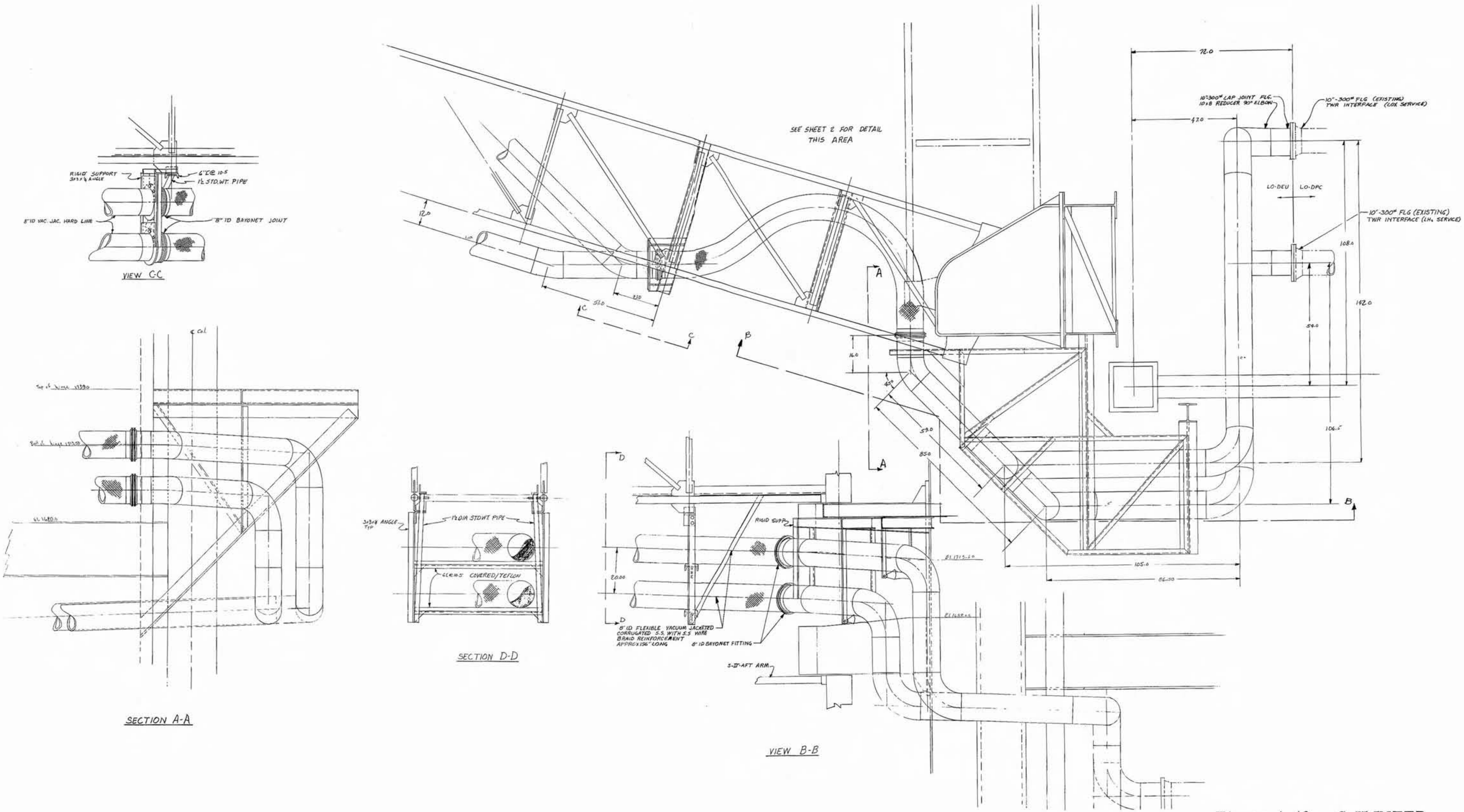

Figure 4-48. S-II INTERMEDIATE Propellant Lines-Tower Interface

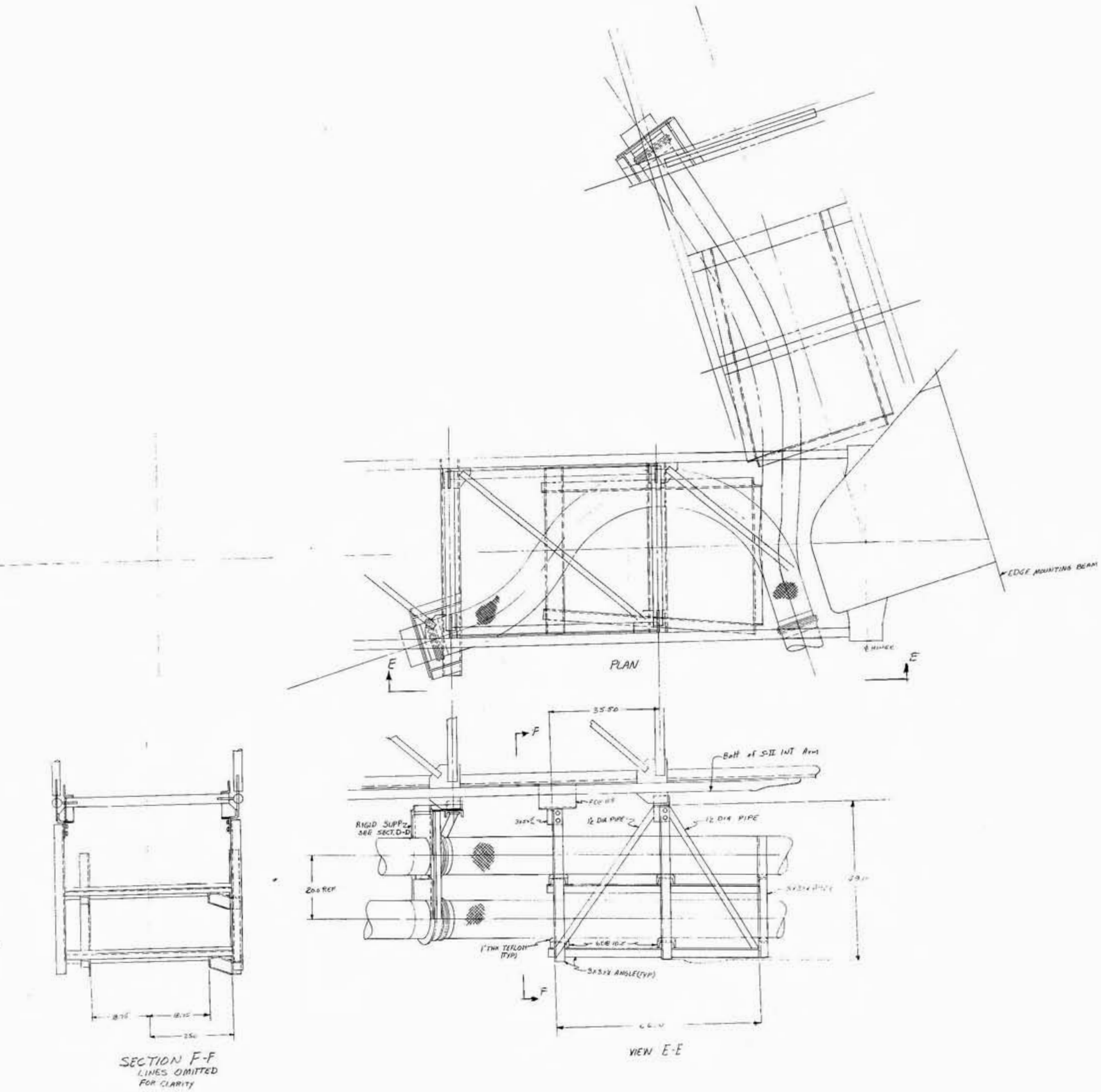

 Figure 4-49. S-II INTERMEDIATE Propellant Lines - Tower Interface

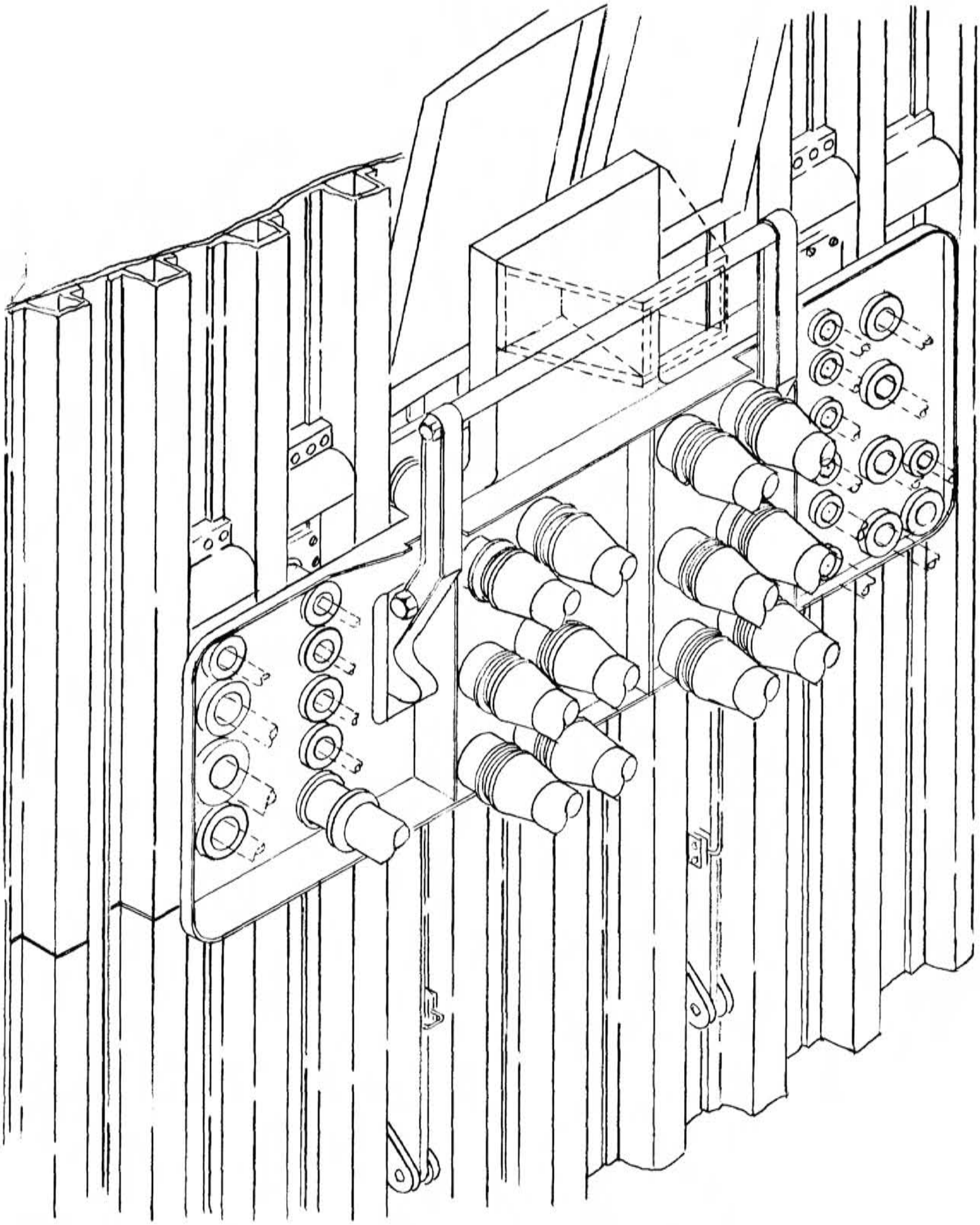

Figure 4-50. S-II INTERMEDIATE Umbilical Carrier

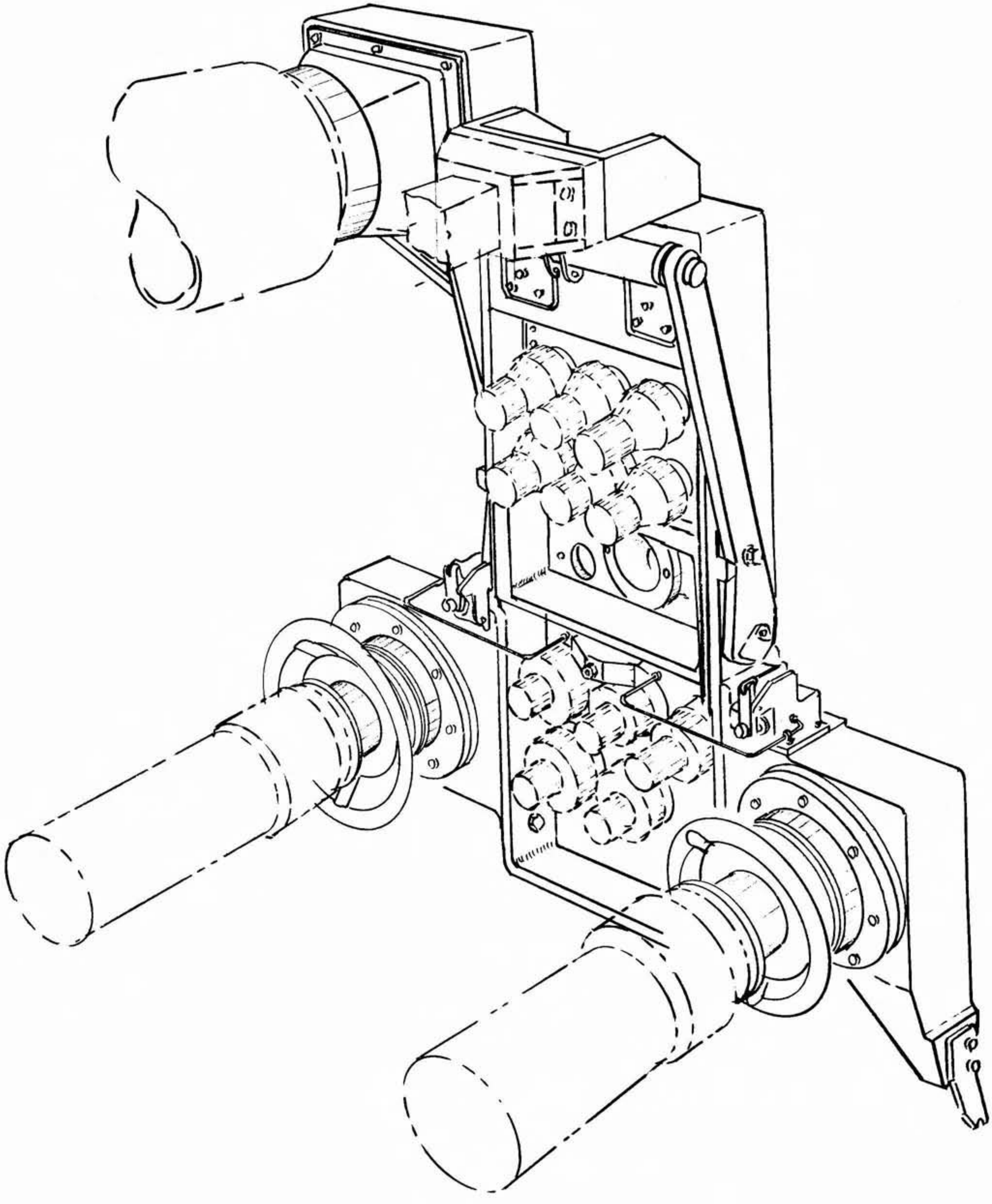

Figure 4-51. S-IVB AFT Umbilical Carrier

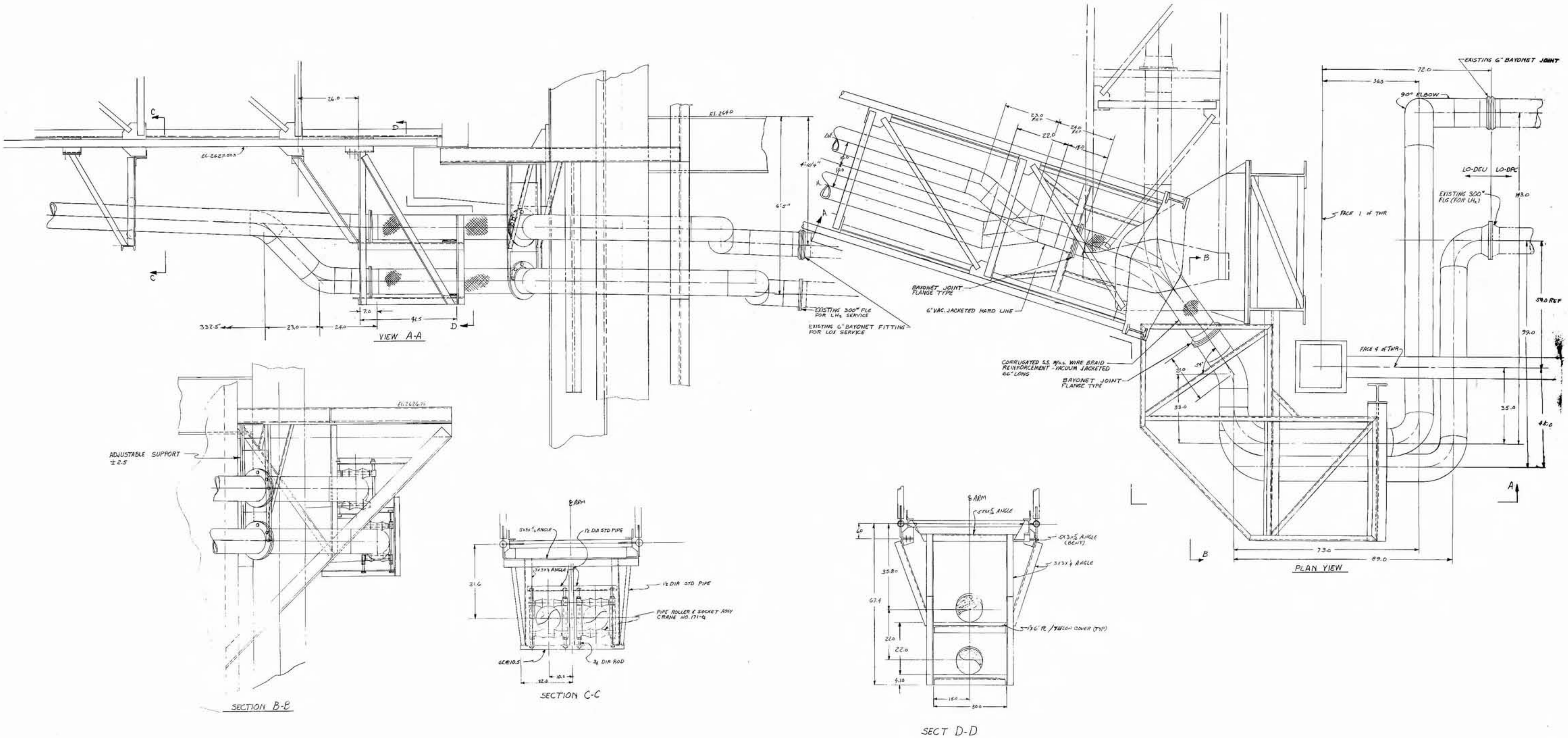

Figure 4-52. S-IVB AFT Propellant Lines - Tower Interface

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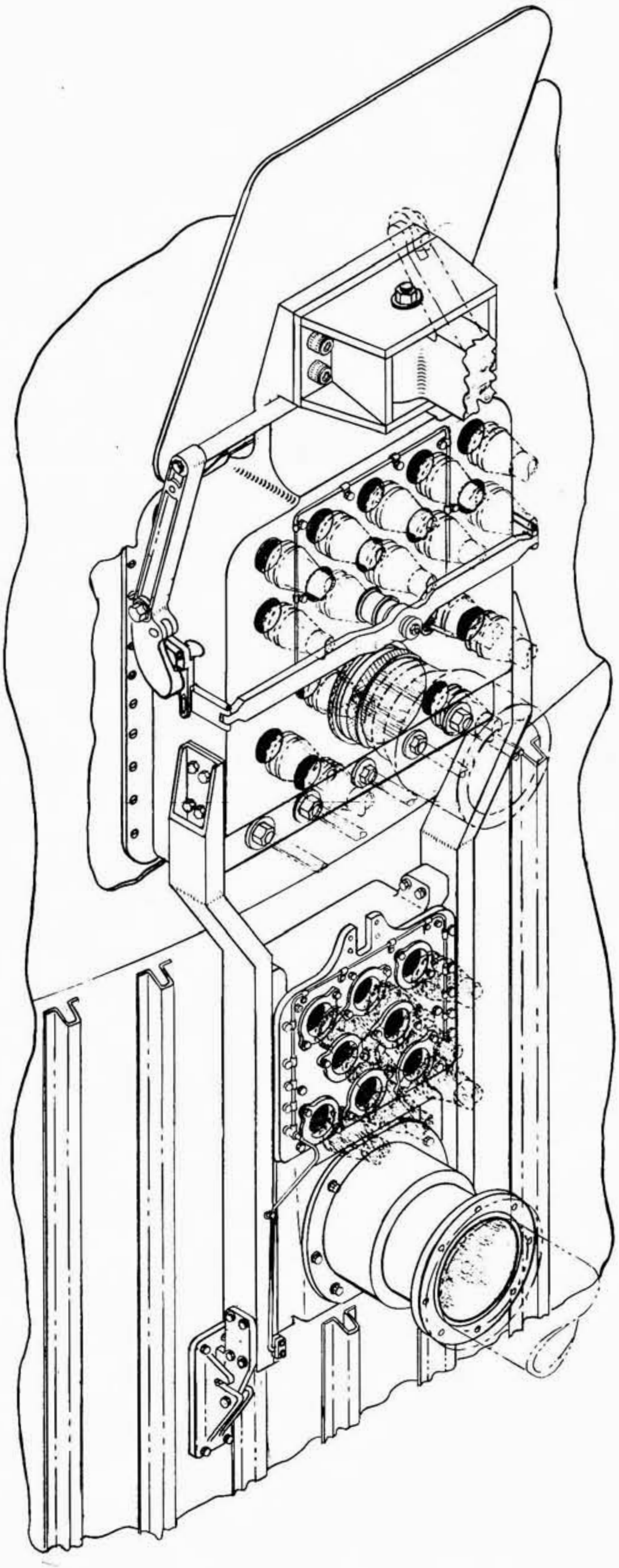


Figure 4-53. Combination S-IVB FWD and IU Umbilical Carrier

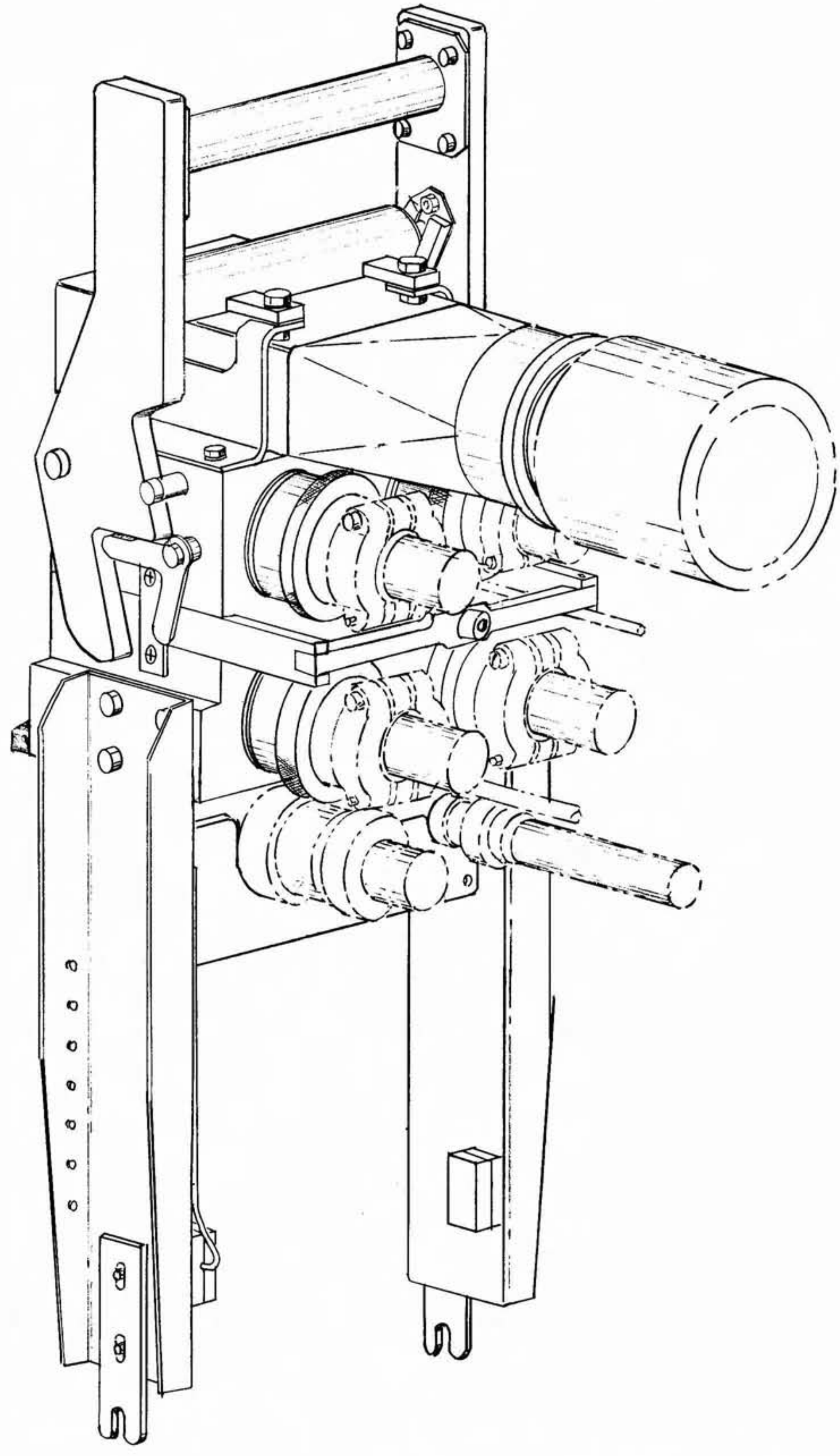


Figure 4-54. Service Module Umbilical Carrier

4-83. SYSTEM OPERATIONAL DESCRIPTION

Semi-automatic and automatic operating sequences for the withdrawal mechanism, in-flight and preflight service arm retraction systems, and extension platform are presented in the following paragraphs. Semi-automatic operations are those which are initiated by the manual positioning of switches, valves, etc., by personnel on the tower levels. Automatic operations are those which are initiated remotely by the lift-off motion of the vehicle or by the output signal from a countdown programmer.

Each component which appears on the applicable schematic is identified by the number mentioned in the chronological sequence of operations. Additional physical descriptions of cylinders, locking devices, switches, and other mechanisms have been excluded from this section since these are contained in other sections of the report.

4-84. CHARGING OPERATION

Each service arm is provided with the following supply lines:

Hydraulic fluid at 3000 psi;
Nitrogen gas at 3000 psi;
Nitrogen gas at 750 psi;
Compressed gas at 125 psi.

These lines are used to initially charge and to replenish the hydraulic accumulators and gas bottles located in the control cabinets. Pressurized gas bottles, hydraulic accumulators, and their combinations are separated from each other either for redundancy or for accomplishing specific functions.

A typical charging cycle is explained for gas bottles A5374, A5375, and A5376 (Figure 4-55). As the LUT panel charging system switch is turned on, solenoid valve A5371 is energized through action of pressure switch A5369. When the pressure in the gas bottles drops to the low setting of pressure switch A5369, the switch completes a circuit and energizes solenoid valve A5371. The valve shifts to its open position, and gas flows through pressure regulator A5372, which controls the outlet pressure and thus the rate of gas flow into the bottles. Pressure in the bottles rises to the high setting of pressure switch A5369 when the bottles are charged. The circuit then opens and as solenoid valve A5371 is de-energized, the spring shifts the valve to its closed position.

A separate standby hydraulic accumulator A5316, charged to 75 psi through its charging components A5302, A5303, and A5320 prevents entry of air into the hydraulic lines.

4-85. WITHDRAWAL MECHANISM

Withdrawal mechanisms may be classified as either lanyard or dual cylinder type. Figure 4-56 shows the schematic for the S-IVB AFT withdrawal mechanism which is a typical dual cylinder type. The schematic for the S-IVB FWD Service Arm (Figure 4-57) is similar to the S-IVB AFT. Valve pressure settings are different, however, and the propellant line cylinder and associated components are not provided.

4-86. Manual Extension. At the start of this operation, the hydraulic and pneumatic cylinders of the withdrawal mechanism are mechanically ratcheted in the retracted position; all the solenoid valves are reset to their pre-launch position; and the hydraulic accumulators and gas bottles are charged. To accomplish manual extension, two operators are required; operator A at control cabinet No. 1, and operator B on the tip of the service arm. Operator A increases pressure on the rod end of the hydraulic cylinder by clockwise adjustment of loader A5406. The resulting pressure change causes an unbalance in the dome of the main pressure regulator A5408 and permits hydraulic fluid to flow into the rod end of the hydraulic cylinder. When pressure gage A5411 indicates approximately 675 psi, operator A stops adjustment of loader A5406. Operator B then removes the pawl from the ratchet mounted at the trunnion of the pneumatic cylinder. Should the pawl be tight, a higher pressure will be required to permit its release. Once the pawl is removed, operator A adjusts loader A5406 counterclockwise to slowly reduce the pressure. As this pressure is reduced, the net moment about the pneumatic cylinder trunnion causes an unbalanced condition which causes extension of the hydraulic cylinder and allows the pneumatic cylinder to rotate toward a horizontal position. Operator B must judge how much rotation is required in one step and signals operator A accordingly. Operator A adjusts loader A5406 to increase the counterbalancing pressure and stop the motion. Operator A then slowly adjusts the setting of pressure regulator A5477. The pressure increases in the blind end of the pneumatic cylinder and causes cylinder extension. Any extension of the pneumatic cylinder will cause further rotation toward the horizontal position; therefore, operator A must gradually increase the pressure in the hydraulic cylinder to counteract the increasing turning moment. Until operator A becomes familiar with the pressure variations required to extend the umbilical carrier smoothly, The incremental method outlined above should be followed. After the umbilical carrier is extended about half way, operator A positions valve A5499 to extend the pneumatic cylinder of the cam mechanism. When this action is completed and the springs in the cam mechanism have gone over center, operator A allows valve A5499 to return to its normal position and thus vents the rod end of the cylinder.

Extension is continued until the umbilical carrier is a few inches from the vehicle. The umbilical carrier is manually positioned to contact the vehicle; the ball locks are engaged; and extension is completed. (Coupling of service line connectors is excluded from this report.) Operator A will then adjust all valves and regulators to the original settings.

Should the manipulation of the hydraulic cylinder as described above prove difficult, an alternate method as outlined below may be used.

Operator A adjusts regulator A5406 to increase the pressure to 1600 psi in the rod end of the hydraulic cylinder. After gage A5411 confirms the pressure increase, operator A closes valves A5407 and A5446 and opens valve A5427. Now the hydraulic cylinder can be advanced, blocked, or retracted by positioning spring-centered manual valve A5428. Setting valve A5428 to either position No. 2 or position No. 1 causes the cylinder to advance or retract respectively. The speed of cylinder movement is controlled by valve A5426. Operation of the pneumatic cylinder is accomplished in the manner previously described. After locking the umbilical carrier to the vehicle, operator A closes valve A5427, checks for centering of valve A5428, opens valves A5407 and A5446, and adjusts valve A5406 to its original pressure setting.

4-87. Manual Retraction. Operation of the withdrawal mechanism cylinders may be checked as follows: The pin is removed from the clevis on the rod end of the pneumatic cylinder, and operator A adjusts regulators A5491 and A5406 clockwise. Increased pressures on the rod ends of the hydraulic and pneumatic cylinders cause their retraction. The rate of retraction depends on the degree of regulator adjustment.

4-88. Vehicle Tracking. The system for vehicle tracking requires an adjustment of pressure settings of regulators A5406, A5441, A5477 and A5491 to induce minimum vehicle skin loading.

4-89. <u>Vehicle Motion Away From the Service Arm.</u> Vehicle motion away from the arm causes movement of the withdrawal mechanism cylinders. For the purpose of this description, let us limit the motion to that directed along the longitudinal axis of the arm.

When the vehicle moves away from the service arm, the withdrawal mechanism pneumatic cylinder extends, and pressure increases on the rod end and decreases on the blind end. As soon as the pressure on the rod end increases 5 psi above the original setting of 150 psi, check valve A5495 closes and regulator A5497 opens to maintain constant rod end pressure. Shuttle valve A5509 remains in the position shown on the schematic. At the same time, the blind end pressure is maintained at 175 psi by pressure regulator A5477. The withdrawal mechanism hydraulic cylinder operates on the same regulating principle. The rod end discharges displaced fluid through a 5 psi differential unloader A5450 into the blind end of the cylinder. The difference in volume between rod and blind ends is provided by accumulator A5449.

The propellant line pneumatic cylinder also extends and displaces gas from its rod end through a 5 psi differential unloader A5445 into the line containing check valve A5442. Thus, the blind end of the propellant line pneumatic cylinder is maintained at a pressure slightly above atmospheric pressure by the discharged gas from unloaders A5445 and A5497. A portion of this gas is relieved through check valve A5442.

4-90. <u>Vehicle Motion Toward the Service Arm.</u> When the vehicle moves toward the service arm, the operation is reversed. The blind end of the withdrawal mechanism pneumatic cylinder now discharges through a 5 psi differential unloader A5460, while the rod end pressure is maintained by action of pressure regulator A5491.

The withdrawal mechanism hydraulic cylinder also retracts as the vehicle moves toward the service arm. The discharge from the blind end of the hydraulic cylinder first charges the accumulator A5449 to 75 psi and then discharges any further fluid through system back pressure valves A5354 and A5355 contained in hydraulic return line 4. Rod end pressure is maintained by fluid supplied through pressure regulator A5408.

As the vehicle moves toward the service arm, the propellant line pneumatic cylinder also retracts. Rod end pressure is maintained by pressure regulator A5441 and blind end pressure is relieved through check valve A5442.

4-91. <u>Disconnect and Withdrawal.</u> When the vehicle rises 3/4 inch, primary lift-off switches No. 1 and No. 2 complete electrical circuits; switch No. 1 energizes solenoid No. 1 and de-energizes solenoid No. 2 of inlet valve A5520 while switch No. 2 energizes the solenoid of inlet valve A5524. Both valves shift and provide paths for the pressurized gas stored in the two separate gas bottles A5522 and A5519. Gas from bottle A5522, which is charged to 900 psi, shuttles valves A5506 and A5525 and blocks the flow from bottle A5519 which is charged to 750 psi maximum. This pressure sequencing gives priority to the higher pressure supply and maintains the redundant second pressure source on standby. Since solenoid valves A5524 and A5520 are actuated from independent buses, the redundant system protects against failure of either of the two lift-off switches or electrical power supplies, valves, or stored energy sources. Shuttle valves A5506 and A5525 will permit operation from whichever pressure source is at the higher level.

NOTE

> The system described above necessitates a continuous electrical signal applied to one of the solenoids of valve A5520. A similar situation exists in other circuits in the control system. This condition is recognized to be undesirable. Therefore, mechanical latching type valves are under development for these applications.

Pressure build-up will occur sooner in the ball-lock and kick-off pneumatic cylinders than in the cam mechanism pneumatic cylinder, due to the difference in flow settings of valves A5526 and A5507. A slight delay will therefore occur between actuation of the ball lock and kick-off cylinders and the redundant cam mechanism pneumatic cylinder.

The umbilical carrier is ejected away from the vehicle by action of either the kick-off or cam mechanism pneumatic cylinders. Release switches No. 1 (A101) and No. 2 (A102) which are mounted in the umbilical carrier then close. These switches operate independently and complete two redundant circuits to initiate action of both the withdrawal mechanism and the arm retraction system.

Operation of the withdrawal mechanism is initiated by the closure of switches No. 1 (A101) and No. 2 (A102). Switch No. 1 energizes solenoid No. 2 and de-energizes solenoid No. 1 of inlet valve A5500. It simultaneously energizes solenoid No. 2 and de-energizes solenoid No. 1 of outlet valve A5462. Switch No. 2 actuates the solenoid of inlet valve A5508 and simultaneously energizes solenoid No. 2 and de-energizes solenoid No. 1 of outlet valve A5463.

Actuation of inlet valves A5508 and A5500 provide flow paths for gas stored in gas bottles A5437 and A5438 (precharged to 650 psi maximum) and A5503 (precharged to 1350 psi minimum). The resulting pressure difference shifts shuttle valve A5509, which blocks the lower pressure source and permits the gas at the higher pressure to flow into the rod end of the withdrawal mechanism pneumatic cylinder. Thus, bottles A5437 and A5438 become the redundant source. Valve A5463 permits flow out of the blind end of the cylinder. Valve A5462 also shifts open but does not permit any flow unless valve A5463 fails to shift.

During the last seven inches of stroke, the withdrawal mechanism pneumatic cylinder and its moving masses are decelerated by the hydraulic shock absorber which is housed inside the cylinder. The shock absorber hydraulic fluid is forced through the orifice of valve A5465 into accumulator A5466 which is gas precharged to 180 psi.

As the withdrawal mechansim pneumatic cylinder retracts, the withdrawal mechanism hydraulic cylinder swings the pneumatic cylinder upwards. The hydraulic cylinder operation is as follows:

Umbilical carrier release switches No. 1 (A101) and No. 2 (A102) actuate inlet valves A5451 and A5413 respectively of the withdrawal mechanism hydraulic circuit from independent electrical buses.

When valve A5451 shifts, it isolates unloader A5450 from the system and permits hydraulic fluid at 1600 psi minimum to flow from accumulator A5404 into the rod end of the withdrawal mechanism hydraulic cylinder. Hydraulic fluid displaced from the blind end of the cylinder flows to the hydraulic return. Valve A5413 shifts and duplicates the function of valve A5451. At the end of the stroke the hydraulic cylinder is retarded by buffering provided in the cylinder blind end.

During retraction of the umbilical carrier, the propellant lines are pulled back by action of the propellant line retract cylinder. The pressure in the rod end of this cylinder is maintained at 100 psi during motion by regulator A5441.

4-92. IN-FLIGHT SERVICE ARMS

Figure 4-55 shows a schematic which is common to all in-flight service arms. The pressure settings indicated on the schematic are preliminary values calculated for the S-IVB AFT Service Arm. The switches referred to in this description are located in Figures C-20 through C-23.

4-93. Semi-Automatic Operation

4-94. Arm Extension. At the start of this operation the service arm is in the fully retracted position and is latched to the tower. The cable from J1 of junction box A5 in control cabinet No. 1 is disconnected from J2 of the control distributor by the operator who plugs the portable arm control box into control cabinet No. 1 and then assumes a convenient position near the edge of the tower deck for direct observation of the service arm. The momentary switch S1 on the control box is placed in the EXTEND position and held. Immediately, a circuit is completed through limit switches A110 and A111 to an indicator light on the box which confirms the unlocked positions of the arm extended locks. Simultaneously, a circuit is completed to energize solenoid valve A5358. This valve shifts to the cross-over position and gas from the 750 psi supply line enters the rod side of the latch-back release cylinder. The cylinder activates the latch-back mechanism so that the arm is free to swing away from the tower. Limit switch A104 closes and completes a circuit to a second indicator light on the control box confirming release of the latch-back mechanism. The closure of switch A104 also completes circuits to energize solenoid No. 2 of valve A5309 and the solenoid of valve A5379. As these valves shift, hydraulic pressure is applied to the blind ends of the hinge mounted cylinders from secondary supply A5338; flow is directed away from the rod ends of these cylinders to the hydraulic return line; and the blind end of the tower mounted cylinder is vented. The application of torque by the hinge mounted cylinders rotates the service arm away from the tower. As the arm extends, the cable is reeled out through the block and tackle system thus retracting the tower mounted cylinder. Hydraulic fluid enters the rod end of this cylinder from accumulator A5316 through check valve A5329. Approximately 5 minutes is required to extend the arm. This time may be varied by adjustment of valve A5308. After approximately 73° of rotation, the arm hinge plates contact adjustable mechanical stops on the tower mounted hinges. Limit switch A109 then closes to energize solenoid No. 2 of valve A5310. This valve shifts to admit pressure to the rod ends of the arm extended lock cylinders from accumulator A5338. These cylinders drive the locking dogs into engagement with floating inserts in the arm hinge plates. Limit switches A110 and A111 in the top and bottom hinges close to complete a circuit through a third indicator light on the control box and thus confirm the engagement of both locks. The operator continues to hold the arm control switch in the EXTEND position until the 75 psi fluid entering the rod end of the tower mounted cylinder forces the piston to a fully retracted position which ensures proper cable tension. If this pressure is not sufficient to overcome the friction in the system, back pressure regulators A5354 and A5355, regulator A5303, and pressure switch A5320 located in control cabinet No. 1 should be adjusted to higher pressure settings. When the cylinder becomes fully retracted, limit switch A105 closes to complete a circuit to a fourth light on the control box. The arm control switch is released, the portable arm control box is unplugged, and the operation is completed.

The arm may be stopped at any intermediate position during the extension operation by releasing the momentary switch on the control box. If this switch is released, all electrical circuits are opened, and the solenoid valves are de-energized. Valve A5309 returns to the blocked position and the service arm is hydraulically locked. After the arm has stopped, the operator may reverse the original direction of rotation by placing the momentary switch in the RETRACT position.

4-95. Arm Retraction. At the start of this operation, the service arm is in the fully extended position and the arm extended locks are engaged. The operator plugs the portable arm control box into control cabinet No. 1 and takes a suitable position for direct observation of the service arm. The momentary switch is placed in the RETRACT position and held. A circuit is completed to energize solenoid No. 1 of valve A5310. This valve shifts and pressure from accumulator A5338 is applied to the blind ends of the arm extended lock cylinders. The locking dogs are disengaged and the limit switches in the hinges close to complete a circuit to an indicator light on the control box. Closure of these switches also causes solenoid No. 1 of valve A5309 and the solenoid of valve A5378 to be energized. As these valves shift, gas pressure from the primary supply bottles A5374, A5375 and A5376 is applied to the blind end of the tower mounted cylinder. This pressure is intensified by differential piston area and applied to the rod ends of the hinge mounted cylinders through valves A5361 and A5362. Fluid from the blind ends of the hinge mounted cylinders is directed through valve A5309 to the hydraulic return line. Since the intensified pressure keeps check valve A5321 closed, fluid from accumulator A5338 does not flow into the active circuit. The application of torque by the hinge mounted cylinders rotates the service arm towards the tower. The cable is reeled in by the motion of the tower mounted cylinder. Retraction continues until the arm comes into the tower and is automatically engaged by the latch-back mechanism. Limit switch A103 closes when the arm has retracted sufficiently for engagement of the latch-back mechanism. This switch completes a circuit to an indicator light on the control box. The momentary switch is released, all circuits are broken, the portable arm control box is unplugged, and the operation is completed. The same 5-minute operation time mentioned in paragraph 4-9 applies for arm retraction. This time is also subject to the adjustment of valve A5308.

As in the case of extension, the arm may be stopped at any intermediate position by release of the momentary switch. Subsequent continuation of retraction or a change to extension operation may be selected by positioning the momentary switch.

4-96. Automatic Retraction

4-97. Unlocking Operation. At T minus 15 seconds, a signal from the countdown programmer energizes solenoid No. 1 of valve A5310. This valve shifts and hydraulic pressure from supply A5338 is applied to the blind ends of the arm extended lock cylinders. When the locking dogs become fully disengaged, a limit switch in each hinge closes to complete a circuit to an indicator light in the LCC confirming the operation. The arm is now hydraulically locked since both sides of the hinge mounted cylinders are blocked by valves A5327, A5348, and A5349.

4-98. Normal Retraction. The operational sequence prior to closure of the umbilical carrier release confirm switches is described in paragraph 4-91.

As the umbilical carrier is ejected from the vehicle, release confirm switch No. 2 closes to energize solenoid No. 2 of valve A5377 and to energize solenoid No. 1 of valve A5349. At the same time, release confirm switch No. 1 closes to energize solenoid No. 2 of valve A5326 which directs hydraulic pilot pressure to valves A5327 and A5348. Valve A5377 shifts to the straight-through position and system primary pressure at 2100 psi from bottles A5374, A5375 and A5376 is applied to the blind end of the tower mounted cylinder. This pressure is intensified to 2700 psi by differential piston area and is applied through valves A5361 and A5362 to the rod ends of the hinge mounted cylinders. Valves A5348 and A5349 shift to their straight-through positions and allow fluid from the blind ends of the hinge mounted cylinders to flow through valves A5350, A5355, and A5354 to the hydraulic return line. The torque applied by the hinge mounted cylinders causes the service arm to retract while the cable is automatically reeled in by the motion of the tower mounted cylinder. Although valve A5327 is shifted to the straight-through position, fluid from accumulator A5338, charged to 2000 psi, is blocked by check valve A5324. As the arm retracts toward the tower, its dynamic characteristics are governed by flow control valve A5350 (see paragraph 4-51 for a detailed description of this valve).

For normal operation, the flow through the cam controlled pressure compensated orifice is independent of pressure fluctuations on the upstream and/or downstream side of the valve and, in effect, flow rate depends only on the cross-sectional area of the orifice. The integral sequence and pressure relief valves remain closed during normal operation. Operation of valve A5350 causes angular velocity of the arm to vary as a function of arm angular displacement closely approximating a half sine wave. These dynamic characteristics are dictated by the contour of a cam attached to the service arm pivot. The peak velocity occuring at the half angle of rotation is equivalent to a flow rate of approximately 120 gpm for the S-IVB AFT service arm. The corresponding retraction time, excluding delays due to response time for valves, switches, etc., is approximately 6 seconds. The service arm contacts the tower mounted shock absorber after rotation through a 70° angle and since the velocity of contact is small, an additional time delay included in the 6 seconds is required to collapse the shock absorbers. The latch-back mechanism engages the arm as it becomes fully retracted. A limit switch closes at the completion of the retraction cycle and energizes a relay in the base of the LUT for further distribution, recording, and indication at the LCC.

Relief valves A5328, A5330, A5352, and A5373 are provided for protection against excessive increase in the stored energy pressures which could result from engine exhaust gases impinging upon the tower levels and consoles.

4-99. Redundant Modes of Retraction. Several different intersystem modes of arm retraction are automatically initiated by possible subsystem or component failure. These specific failures have been divided into groups below. Each set of failures is followed by a description of the subsequent system operation.

a. Complete loss of primary supply pressure.

Possible reasons: Gas bottles A5374, A5375, and A5376 not charged; valve A5379 vented; valve A5377 and/or valve A5362 closed; loss of supply line to blind end of tower mounted cylinder; or malfunction of umbilical carrier release switch No. 2 (A102).

Closure of umbilical carrier release switch No. 1 (A101) insures that valves A5327 and A5348 have shifted to their straight-through positions. Since primary supply pressure is absent, flow immediately proceeds from accumulator A5338 through check valve A5324 into the rod ends of the hinge mounted cylinders. This flow is produced by a secondary supply pressure of 2000 psi from gas bottles A5336, A5337, and A5339.

The remainder of the operational sequence is identical to that described for normal retraction except that the tower mounted cylinder does not extend, and thus the cable is not reeled in at the normal rate.

b. Gradual or intermittent loss of primary supply pressure.

Possible reasons: Leakage in the supply line, leakage or sticking of valves A5379 and A5377.

A decrease in primary supply pressure will be accompanied by a corresponding decrease in the intensified hydraulic pressure supplied by the tower mounted cylinder to the hinge mounted cylinders. If the initial intensified hydraulic pressure is between 2600 and 2000 psi, the retraction operation will be normal until gas expansion causes the hydraulic pressure to drop below 2000 psi. When this pressure falls below 2000 psi, the secondary supply takes over; fluid from accumulator A5338 feeds the hinge mounted cylinders through check valve A5324; and arm retraction is completed without any time delay. If leakage has been severe enough to diminish the initial intensified pressure below 2000 psi, the retraction operation will be identical to that described in subparagraph a above.

c. Complete loss of hydraulic fluid in the rod ends of the hinge mounted cylinders.

Possible reasons: Loss of inlet line (breakage).

Should the hydraulic inlet line break, all hydraulic fluid from secondary pressure supply accumulator A5338 and from the rod end of tower mounted cylinder will be discharged. Since the blind end of tower mounted cylinder is pressurized by gas, it will extend and force the cable to reel in, thus completing arm retraction.

d. Gradual loss of hydraulic fluid in the rod ends of the hinge mounted cylinders.

Possible reasons: Hydraulic fluid leakage from any line normally carrying intensified fluid pressure or internal leakage through valve A5309.

Should the fluid leak be slight, the tower mounted cylinder will move faster and increase cable tension. The intensified hydraulic pressure will gradually decrease, but the retraction will be continued without delay since the input power available for retraction is nearly constant.

The torque caused by increased cable tension will be added to the hinge mounted cylinder torque. Once the intensified pressure decreases below that of the secondary pressure supply A5338, the latter will compensate for the leakage and complete the retraction.

4-100. Redundant Modes of Operation for Flow Control Valve A5350. Since the hydraulic return line plays a vital role in controlling the speed of arm retraction, the special cam operated valve A5350 incorporates several fail-safe features to protect the entire system from possible internal failure of any flow control valve component.

a. Failure of the compensator spring.

Possible reason: Overstressing of the spring.

Should the compensator spring break, the flow will rapidly decrease. As a result, upstream pressure will rise and at 3200 psi will operate the sequence valve to direct high pressure fluid behind the compensator spool and force it to its open position. The resulting flow will no longer be compensated for pressure variations but partial control is still maintained.

b. Restriction of valve main flow channels.

Possible reasons: Clogging of the variable orifice, or sticking of the compensator or sequence valve spools.

Should the variable orifice clog, the upstream pressure will rise rapidly and at 3650 psi, the differential type relief valve will be actuated. The flow will force a normally closed spool into an open position and will unload the flow of 120 gpm at a pressure drop of 160 psi. Pressure drop will be a function of flow rate. Flow and resulting arm motion will be uncontrolled.

4-101. PREFLIGHT SERVICE ARMS

The hydro-pneumatic system to operate the preflight service arms is a simplified version of the system used for in-flight arms. All the redundant features provided for the in-flight arms are not incorporated (Figure 4-58). Therefore, the system is limited to two hinge mounted cylinders (no cable arrangement), and the pressure supply and valving contained in control cabinet No. 1.

4-102. Semi-Automatic Operation

4-103. Arm Extension. At the start of this operation, the service arm is in the fully retracted position and latched to the tower. The operator plugs the portable arm control box into control cabinet No. 1; holds momentary switch S1 in the EXTEND position, and system operation proceeds in exactly the same manner as for in-flight arm extension. Since the tower mounted cylinder, its control valves, and limit switch A105 are not included in the preflight system, the operator releases the momentary switch when the limit switches confirm engagement of the arm extended locks.

4-104. Arm Retraction. At the start of this operation, the service arm is in a fully extended position and the arm extended locks are engaged. The operator plugs the portable arm control box into the appropriate jack of the control cabinet, places momentary switch S1 into the RETRACT position, holds it, and proceeds in exactly the same manner described for in-flight arm extension. Since the tower mounted cylinder, its control valves, and the primary pressure supply are not included, retraction is accomplished by the pressurized fluid supply in accumulator A5338.

Control valve and electrical interlock operation was explained in the description of the in-flight service arm retraction sequence.

4-105. Automatic Retraction.

4-106. Unlocking Operation. At T minus 15 seconds, a signal from the countdown programmer energizes solenoid No. 1 of valve A5310 and sequences the unlocking operation in exactly the same manner as described for the in-flight arm.

4-107. Normal Retraction. At T minus 10 seconds, a signal from the countdown programmer initiates the sequence of ejecting the umbilical carrier and/or couplings and retraction of the arms. The resulting sequential operation of the hydraulic retraction system occurs in the same manner as for the in-flight service arms, except that all redundant units and their controls do not exist. The possibility of a countdown hold in the event of system malfunction provides a replacement for the redundant system complexities in the preflight systems. The countdown hold is accomplished automatically by failure of any preflight arm to retract fully and close the arm retracted switch at the tower.

4-108. EXTENSION PLATFORM

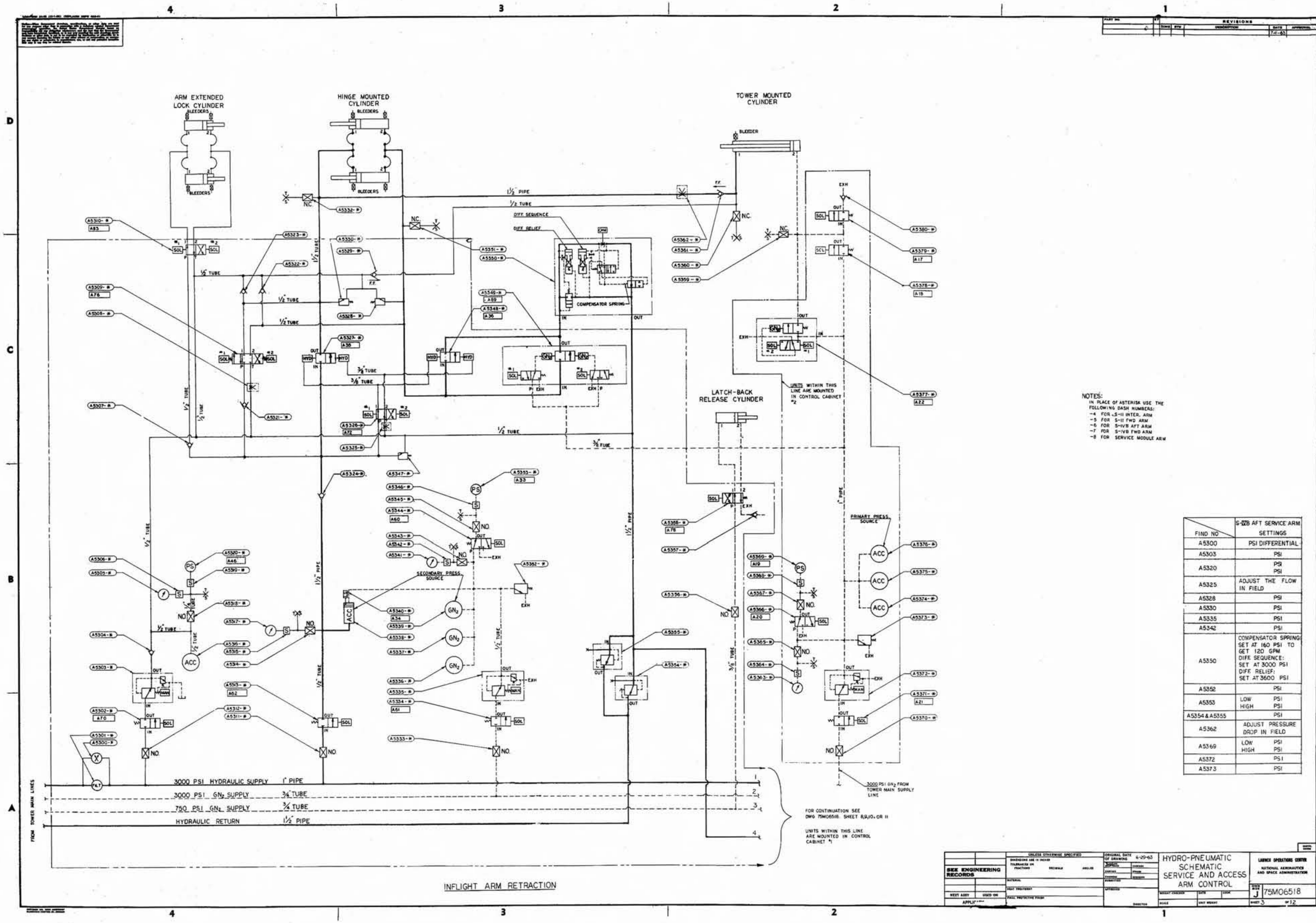
Flow control valves A6000, A6001, A6013, and A6014 (Figure 4-59) are provided for adjustment of motor speed. Pressure regulators A6012 and A6008 are provided to allow motor torque and friction wheel pressure adjustment.

4-109. Manual Extension, Vehicle Tracking, and Retraction. Operation of the extension platform requires two operators. To extend the basic extension platform, operator A moves the handle of valve A6007 to position No. 2, gas at 90 psi flows into the blind ends of both motor positioning cylinders. The rods extend and friction wheels mounted on the arm motor shafts are forced into contact with the arm mounted rails. Now both motors are ready to drive their respective platforms. Operator A manually positions the handle of valve A6010 to the unlock position. Pressure forces the piston of the lock cylinder upwards and disengages the lock. Operator A next places valve A6002 into position No. 2. Nitrogen gas at 40 psi flows into the air motor, the motor starts to rotate, and through its friction wheel extends the platform. After the platform moves approximately one inch, the handle of valve A6010 is released and the rod end of the lock cylinder is vented through check valve A6006. The spring-loaded lock returns into position ready for the next latching. When the basic platform is extended close to the required position, operator A releases the handle of valve A6002. The air motor is thereby pressurized on both sides to slow down and stop the platform. To position the "T" head, the mechanical lock is first released and then valve A6015 is manually turned into position No. 1 or No. 2 by operator A, depending upon whether the platform has to move left or right. When the handle is released, the "T" head stops. Operator B couples the "T" head to the vehicle and operator A places valve A6007 into position No. 1. The friction wheels are pulled away from the rail and the platform is free to track the vehicle.

To retract the platform, the operation is reversed. First operator B disconnects the coupler, then operator A moves the handles of valves A6007 and A6002 into position No. 1. The friction wheels are engaged and basic platform is retracted and automatically locked.

During platform retraction, operator A moves the handle of valve A6015 as required. The "T" head is locked manually in the centered position.

After retraction is complete, operator A shifts valve A6007 into position No. 1.



FIND NO	S-IVB AFT SERVICE ARM SETTINGS
A5300	PSI DIFFERENTIAL
A5303	PSI
A5320	PSI PSI
A5325	ADJUST THE FLOW IN FIELD
A5328	PSI
A5330	PSI
A5335	PSI
A5342	PSI
A5350	COMPENSATOR SPRING: SET AT 160 PSI TO GET 120 GPM DIFF. SEQUENCE: SET AT 3000 PSI DIFF. RELIEF: SET AT 3600 PSI
A5352	PSI
A5353	LOW PSI HIGH PSI
A5354 & A5355	PSI
A5362	ADJUST PRESSURE DROP IN FIELD
A5369	LOW PSI HIGH PSI
A5372	PSI
A5373	PSI

Figure 4-55. In-flight Arm Retraction Schematic

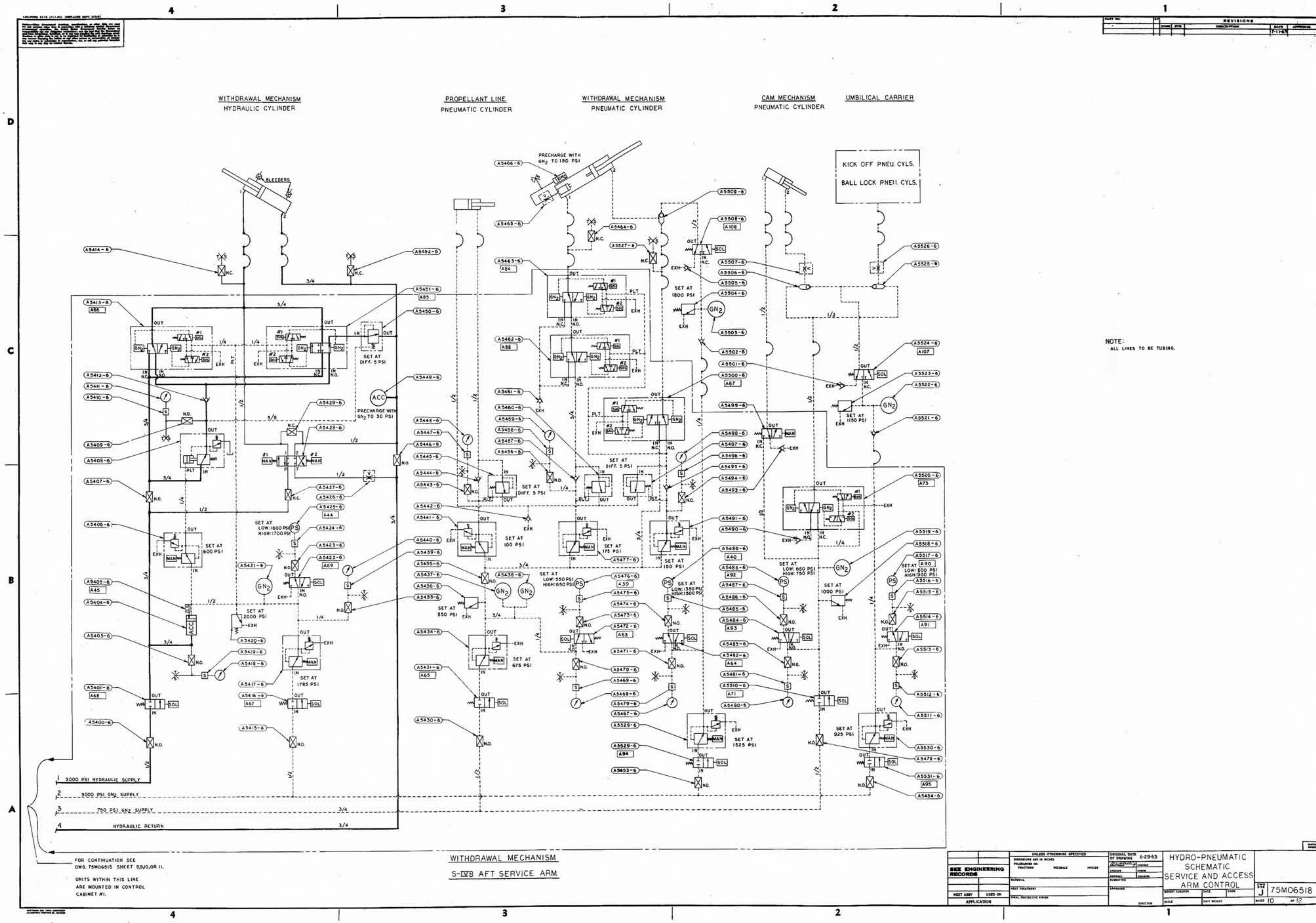


Figure 4-56. S-IVB AFT Withdrawal Mechanism Schematic

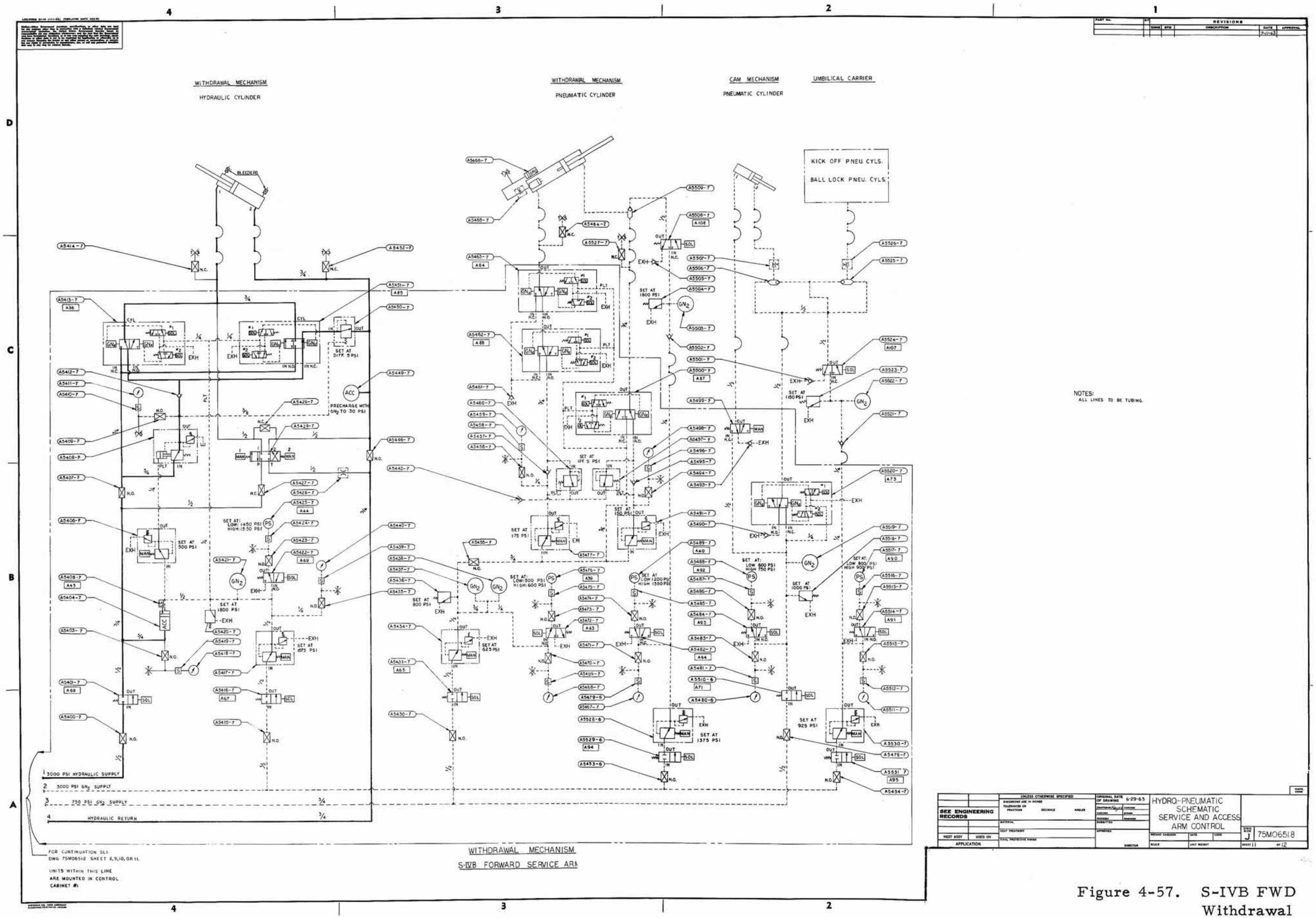


Figure 4-57. S-IVB FWD Withdrawal Mechanism Schematic

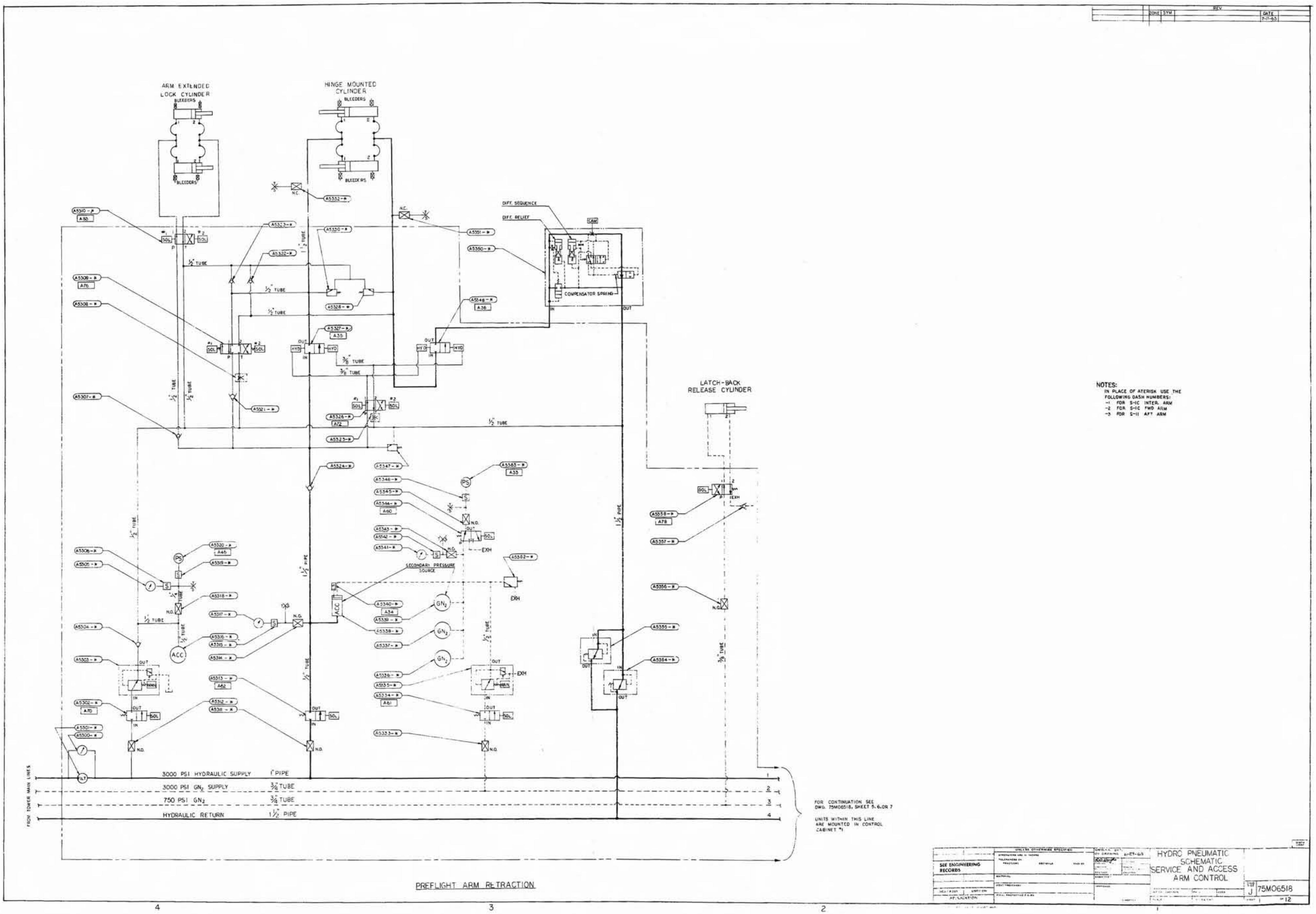
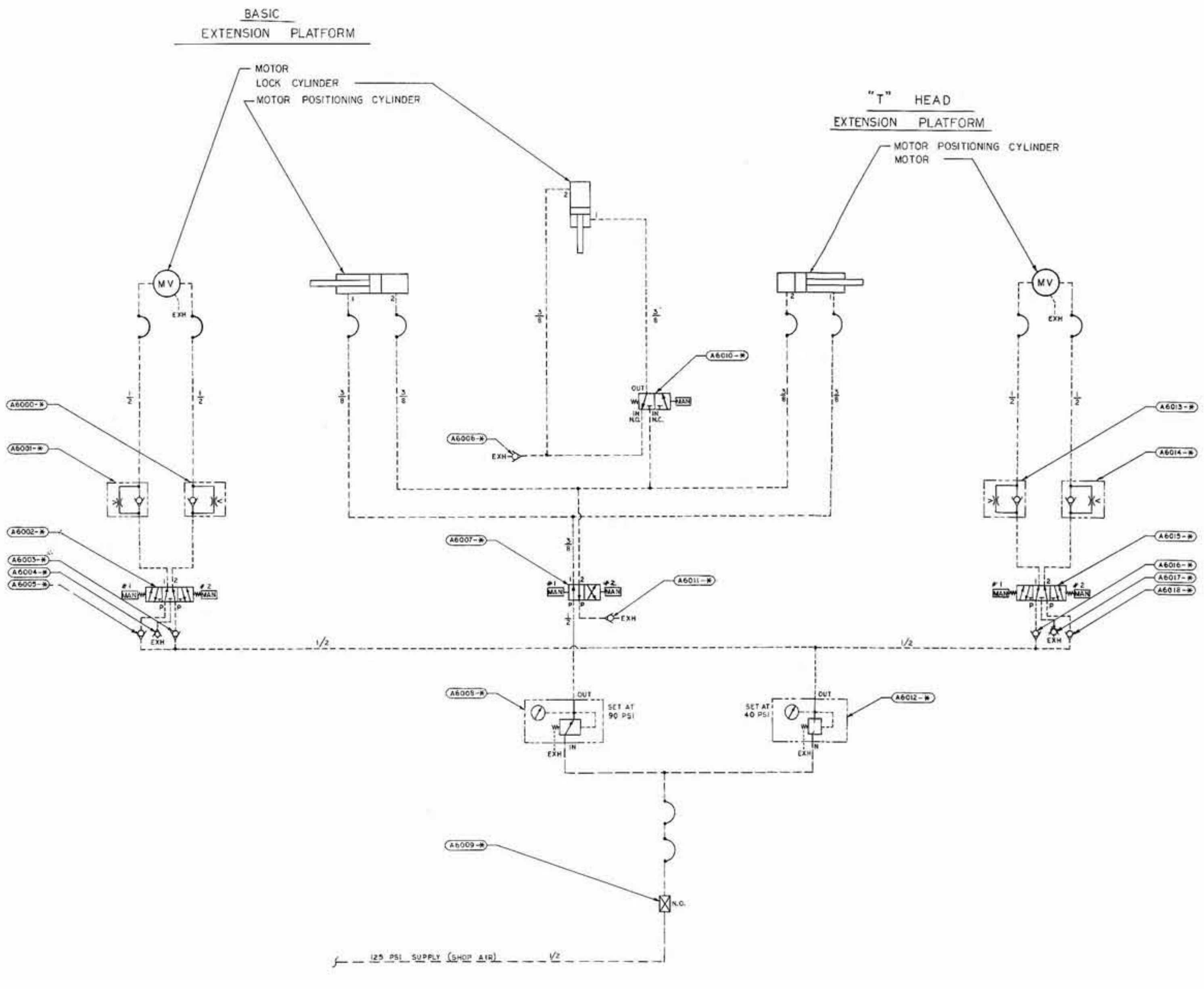


Figure 4-58. Preflight Arm Retraction Schematic



EXTENSION PLATFORMS

NOTES:
1. IN PLACE OF ASTERISK USE THE FOLLOWING DASH NUMBER:
   -5 FOR S II FWD ARM
   -6 FOR S IVB AFT ARM
   -7 FOR S IVB FWD ARM
   -8 FOR SERVICE MODULE ARM
2. ALL LINES TO BE TUBING

Figure 4-59. Extension Platform Schematic

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SECTION V
COMMAND MODULE ACCESS ARM

The Apollo Command Module Access Arm provides an environmentally conditioned means of astronaut ingress and egress to the Apollo spacecraft. The arm, in normal operating position, is extended toward the Saturn V Vehicle forming an angle of 189 degrees with the east face of the LUT. A hydraulically-actuated locking device restrains the extended arm against motion induced by wind, vibration, and other environmental conditions.

5-1. DESIGN CRITERIA AND OPERATIONAL REQUIREMENTS

Design of the Command Module Access Arm will not start until 1964; however, the following design criteria and operational requirements have been established.

At approximately 60 seconds prior to S-IC ignition, the arm extend lock is disengaged, and the arm is freed to rotate to a locked position, parallel to the east face of the LUT. An arm retract lock and support bracing restrain the retracted arm against the tower face. The complete unlock-retract-restrain cycle is accomplished within 30 seconds.

In the event of an abort or hold in the countdown following arm retraction, the arm may be remotely re-extended to contact the spacecraft and relocked in the extended position. The re-extension cycle will also be accomplished within a 30-second time period.

Wind and environment induced displacements, velocities, and acceleration are shown in Table 5-1 for three wind probability conditions. The displacements and oscillations anticipated during transit operations will approximate the same conditions as imposed by a 99.9% probability wind as shown in the table.

The extended access arm will be retracted whenever wind velocities have reached the 95% probability level or more.

The maximum live load imposed on the access arm will be limited to five men. An average weight of 250 pounds for each man and his safety equipment will be used in computing live loads.

Table 5-1 Command Module Access Arm Design Criteria

DESIGN CRITERIA ITEMS	WIND PROBABILITY CONDITIONS					
	95%		99%		99.9%	
	Fueled	Unfueled	Fueled	Unfueled	Fueled	Unfueled
Steady state wind Velocity (knots)	29.4	29.4	38.7	38.7	48.3	48.3
Peak wind velocity (knots)	41.2	41.2	54.2	54.2	67.6	67.6
Displacement of C.M. induced by wind (in.)	5.7	5.4	15.8	15.5	26.0	24.4
Thermal bending envelope (in.)	-	13.3	-	13.3	-	-
Maximum C.M. displacement (in.)	5.7	18.7 *	15.8	28.8 *	26.0	24.4
Amplitude of wind induced oscillations (cps)	3.9	3.8	7.0	6.3	10.2	9.8
Freq. of wind induced oscillations (in./sec)	.33	.80	.33	.80	.33	.80
Velocity of wind induced oscillations (in./sec)	8.1	18.9	14.6	34.2	21.2	49.3
Acceleration of wind induced oscillations	16.9	95.0	30.3	173.0	44.1	247.2
"G" loading wind induced oscillations	0.044	0.246	0.078	0.446	0.114	0.639

*Displacement figures based on thermal and wind induced displacements. Wind induced oscillations occur within the maximum displacement envelope.

5-2. ARM STRUCTURE

The access arm structure (Figure 5-1) is composed of two basic elements; a Pratt truss constructed of T-1 steel, and a composite truss constructed of aluminum alloy. The Pratt truss is 568 inches long and provides an unobstructed walkway to the environmentally conditioned room. The second element is 231 inches long and provides support for the environmentally conditioned room which is also constructed of aluminum alloy.

Two large hinge plates provide the rigidity required to connect the arm to the hinge, and expanded stainless steel screening provides personnel protection. Arm extend locks are installed in the hinge plate and, as on the service arms, a buffer cylinder and arm retract lock is installed on the LUT. Umbilical connections are not provided from this arm; all lines to the environmental chamber are rigidly attached to the arm structural members. Wind provides the maximum loading condition on the arm.

5-3. ARM RETRACTION SYSTEM

The basic hydraulic and pneumatic components required for system operation are shown in Figure 5-2.

5-4. CONTROL CABINET

A stored-energy system utilizing four air receivers and three hydraulic accumulators is provided to permit use of a small capacity hydraulic charging unit in the base of the LUT and to overcome pressureline losses which would be encountered in transporting fluids to various tower levels from a central supply source. Each of the three piston-type accumulators has a 20-gallon fluid capacity and incorporates an electrical level sensor to provide an indication of full capacity. Pressurization of the fluid is accomplished by expansion of gaseous nitrogen stored at 3000 psi in the four 20-gallon air receivers.

5-5. ROTARY ACTUATORS

Arm rotation is accomplished by the application of pressurized hydraulic fluid to the pistons of rotary actuators RA-1 and RA-2. The forces produced by hydraulic pressure acting upon the two opposed pistons rotate a pinion attached to the output shaft. Variable center-depth, involute gear teeth (Figure 5-3) are integrally machined on the sides of each piston. A variable center-depth, tooth configuration provides greater strength than the standard involute tooth profile.

The actuator housing is a ductile nodular iron casting incorporating replaceable bronze sleeves in the piston bores. The sleeves assist in reducing piston friction and provide corrosion resistance during periods of system inactivity. Tapered roller bearings support each end of the shaft and absorb both radial and axial shaft loads. Standard elastomer O-rings are used as shaft and moving piston seals.

Each of the two units required in the complete arm actuation system produces 1.55×10^6 inch-pounds of torque at an applied pressure of 2000 psi, is rated at 3000 psi, and weighs 5100 pounds. The shaft extending from the upper surface of the actuator has been modified to permit mounting of a cam which actuates a flow control valve mounted on a support plate spanning the two cylinders. These valves appear in Figure 5-2 as valves VCO-1 and VCO-2.

5-6. HYDRAULIC SYSTEM

Cam-operated, pressure-compensated, flow control valves provide the desired discharge flow rates from the rotary actuators during arm operation. Compensation for the effects of wind loading and other environmental conditions is accomplished in these valves to maintain approximately the same arm rotational time under all operating conditions. Actuator discharge flow control is provided by cam-valve action during the acceleration and deceleration phases of arm operation. The valve is identical in design to that used in the service arm control system.

The back pressure valve (VBP-1) and hydraulic accumulator (HYD ACC-4) maintain a definite pressure level within the system during standby periods to minimize the possibilities of introducing air into the system.

System control valves (VA-6 and VA-9) are pilot-operated ball valves detented to remain in the last position selected. Pilot pressures are selected by pilot valves (VA-10 and VA-11).

5-7. Automatic Arm Extension. In the event of an abort or hold in the countdown following automatic retraction, the access arm may be re-extended upon command from the Launch Control Center (Figure 5-4).

Actuation of either the access arm extend switch in the Launch Control Center or the access arm extend switch on the remote hydraulic console in the base of the LUT provides an electrical signal to solenoid valve VA-12. Opening this valve permits pressurized nitrogen to act upon the piston of linear actuator CY-1, compressing the spring and releasing the latch-back device.

Upon release of the latching mechanism, an electrical signal will be directed to solenoid 2 of pilot valve VA-11. Hydraulic pilot pressure will then be directed to open control valves VA-7 and VA-9. Fluid under pressure will flow from the hydraulic accumulators through control valve VA-7 to rotary actuators RA-1 and RA-2. Rotary actuator outlet flow will be regulated by cam-operated, pressure-compensated, flow-control valve VCO-2 before flowing through control valve VA-9 and back-pressure regulator valve VBP-1.

Upon reaching the limit stop at the fully extended position, an electrical signal will be initiated to energize solenoid 1 of valve VA-5. This action permits linear actuator CY-2 to position a lock, thereby preventing arm motion caused by wind or other environmental conditions. An electrical signal, to de-energize solenoid 2 and energize solenoid 1 of pilot valve VA-11, is also obtained when the arm contacts the extend limit stop and the lock is in place.

5-8. Automatic Arm Retraction. The bold lines appearing on schematic diagram (Figure 5-5) indicate the portion of the system involved in an automatic arm retraction cycle. At 60 seconds prior to S-IC ignition, an electrical signal is directed to solenoid 2 of valve VA-5. Valve actuation permits pressurized fluid stored in hydraulic accumulators 1, 2, and 3 to actuate cylinder CY-2, thereby retracting the arm extend lock. An electrical signal is provided to indicate either successful accomplishment of the unlocking operation, or to provide an automatic countdown hold in the event of malfunction.

At 45 seconds prior to S-IC ignition, an electrical signal is automatically directed to solenoid 2 of pilot valve VA-10. Valve actuation provides pressure to actuate ball valves VA-6 and VA-8. These valves permit fluid flow from the accumulators to the rotary actuators and from the actuators through cam flow-control valve VCO-1 and the back pressure valve prior to returning to the sump in the base of the LUT.

Upon completion of the 30-second retraction cycle, the arm contacts an arm retract lock. An electrical signal is provided at the completion of arm retraction. Failure to obtain this signal results in an automatic countdown hold.

5-9. Manual Arm Extension. Placing the latch-back release switch on the local control panel in the release position provides an electrical signal to energize solenoid valve VA-12 (Figure 5-2). Nitrogen gas stored in air receivers AR-1, AR-2, AR-3, and AR-4 will then flow to cylinder CY-1 through the circuit indicated on Figure 5-2. Pressure regulator VR-4 maintains pressure in the circuit at 750 psi and needle valve VM-8 permits an adjustment of cylinder actuation time. An indicator light on the local control panel will indicate when the arm is no longer restrained to the tower by the latch-back mechanism.

Following release of the latching mechanism, the LUT-mounted hydraulic charging unit can be connected to the circuit by placing the local control panel hydraulic supply switch in the on position. Solenoid valve VA-2 is operated by the electrical signal provided. An indicator light on the local panel will confirm the open condition of the valve.

Movement of the manual "RETRACT-EXTEND" valve (VM-6) to the "EXTEND" position will direct hydraulic fluid to rotary actuators RA-1 and RA-2 as shown in Figure 5-2. The arm will slowly extend as a result of the applied actuator torque at a rate of speed governed by needle valve VM-5.

During arm rotation, a continuous monitor signal of arm position is provided to panels in the Launch Control Center and in the LUT. When the arm reaches its fully-extended position and has made contact with a limit stop, the panel-mounted, lock pin control switch is placed in the "LOCK" position; an electrical signal is thereby provided to open solenoid 1 of valve VA-5 and direct hydraulic fluid to linear actuator CY-2. The actuator extends and positions the locking device to prevent arm movement. An indicator light will verify the arm-locked condition.

The extension cycle is completed by locking the arm and the "RETRACT-EXTEND" valve (VM-6) and returning the HYDRAULIC SUPPLY and LATCH-BACK release switches to their off positions. Upon removal of the electrical stimulation from the latch-back release switch, linear actuator CY-1 is vented to the atmosphere through valve VA-12 and the internal spring returns the latch-back release pin to the locked position.

5-10. <u>Manual Arm Retraction</u>. The retraction cycle (Figure 5-6) is initiated by placing the lock pin control switch in the "UNLOCK" position. Solenoid 2 of valve VA-5 is energized by the electrical signal produced, and hydraulic pressure is directed to linear actuator CY-2. As the actuator piston retracts, it removes the locking device from the arm. An indicator light will verify removal of the locking device from the arm.

Connection to the LUT-mounted, variable-displacement hydraulic pump is obtained when the hydraulic supply switch is placed in the "ON" position to energize solenoid valve VA-2. An indicator light will signify that hydraulic fluid from the LUT pump is available.

When an indication of availability of hydraulic pressure has been obtained, "RETRACT-EXTEND" valve (VM-6) can be placed in the "RETRACT" position to direct fluid flow to rotary actuators RA-1 and RA-2, as shown. Arm rotational speed is again determined by needle valve VM-5 and the panel-mounted indicators provide continuous monitoring of arm position.

When the arm has reached the fully-retracted position, it will be mechanically restrained by the panel-type, latch-back device. An indicator light will confirm the restrained position of the arm.

Return of "RETRACT-EXTEND" valve (VM-6) and hydraulic supply valve (VA-2) to the "OFF" position after the arm restrained indication has been obtained, completes the retraction cycle.

5-11. ENVIRONMENTAL CHAMBER

An environmental chamber will be mounted to the aluminum alloy second element of the access arm. Due to the length of the arm, the chamber and associated equipment should be as light as possible. Lightweight construction material such as aluminum alloys aids in reducing inertia forces on the arm rotational drive system which already is subjected to extremely high wind loads.

To provide consistency of arm rotational system methods of operation with those used on service arms, the access arm will incorporate an arm extend lock. All vehicle tracking functions will, therefore, be incorporated in the environmental chamber similar to the manner in which tracking functions are included in the service arm withdrawal mechanisms.

The access arm will be extended toward the command module during VAB assembly operations. It will be retracted to a position along the tower side as soon as the vehicle and LUT have moved from the VAB. This retraction will permit only functional test of the retraction system following vehicle assembly in the VAB. The arm will remain locked to the tower side throughout LUT and vehicle transit from the VAB to the firing site. The locked-to-tower position eliminates the requirements for unreasonably large tracking excursions and a large capacity hydraulic charging unit in the base of the LUT during a period when all electrical power must be self-generated within the LUT. The charging unit would be required if the arm had to track maximum vehicle displacements during transit. After arrival at the firing site, the arm will be extended toward the command module, and the environmental chamber tracking unit will be placed in contact with the field splice between the command and service modules. A bellows-type shroud and platform will be extended to provide a passage between the environmental chamber and the command module access hatch.

A conditioned air supply duct will be routed along the arm structure to provide cooled, controlled-humidity, salt-free air to the environmental chamber.

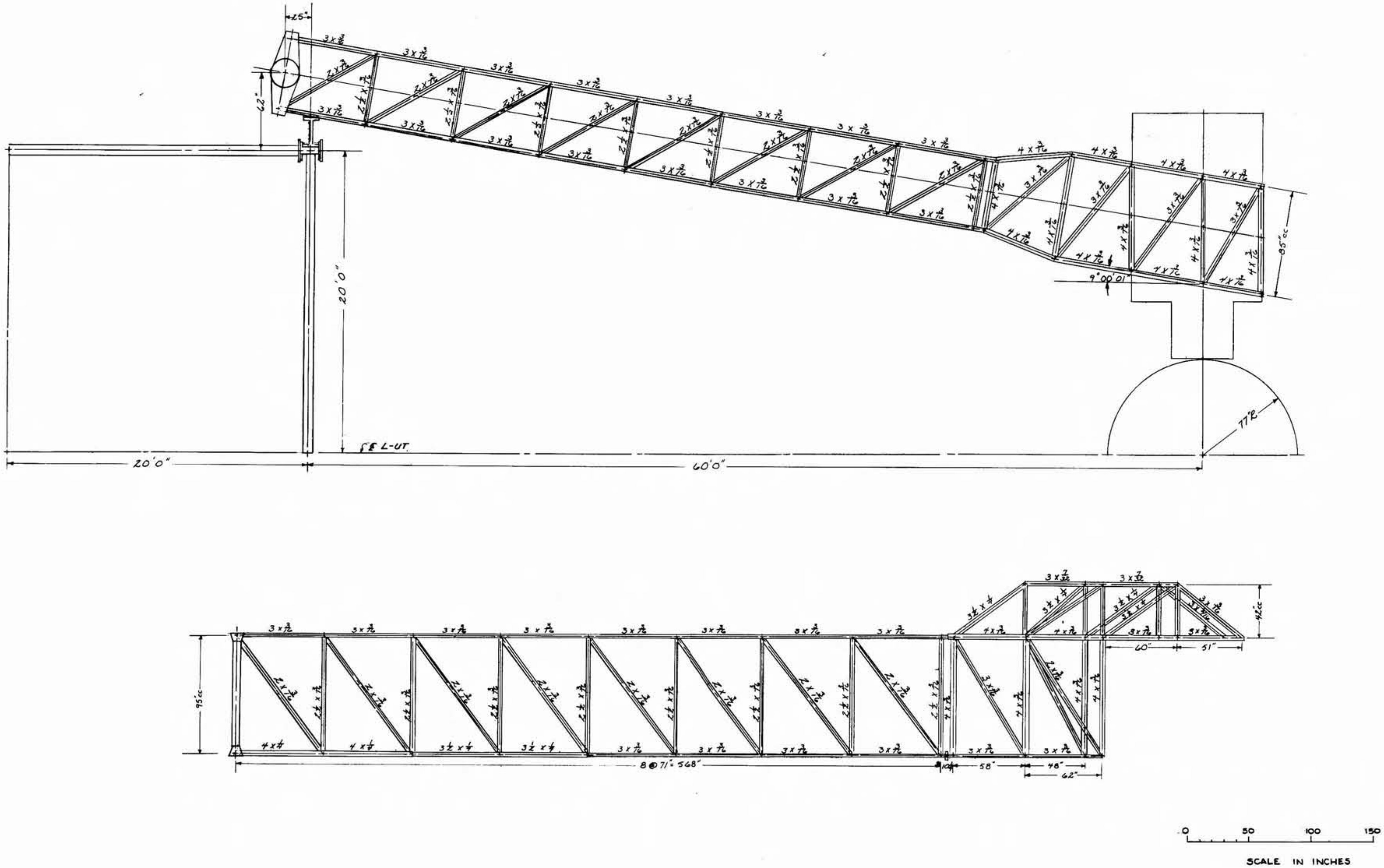

Figure 5-1. Command Module Access Arm Structure

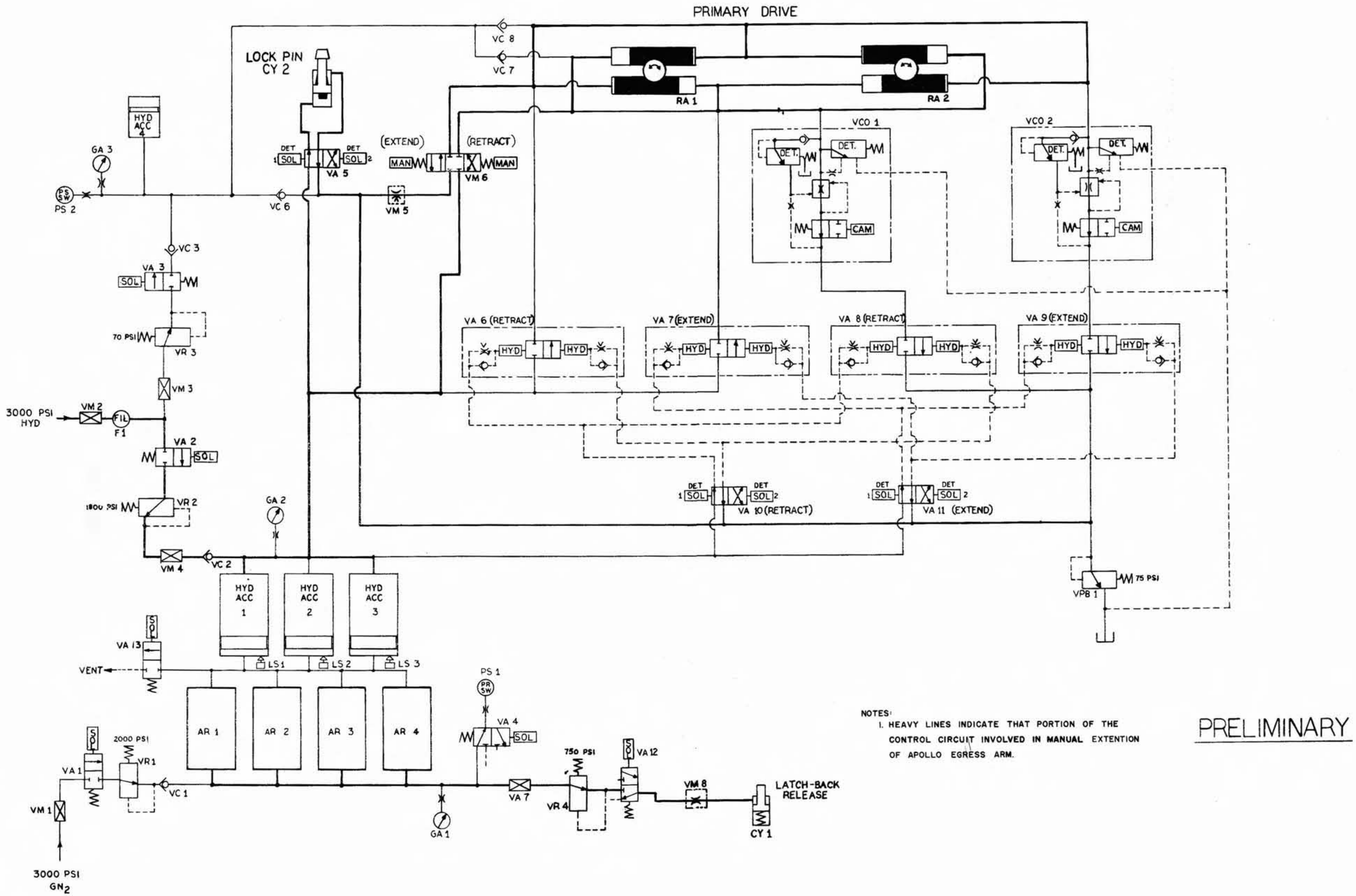

Figure 5-2. Manual Extension Schematic

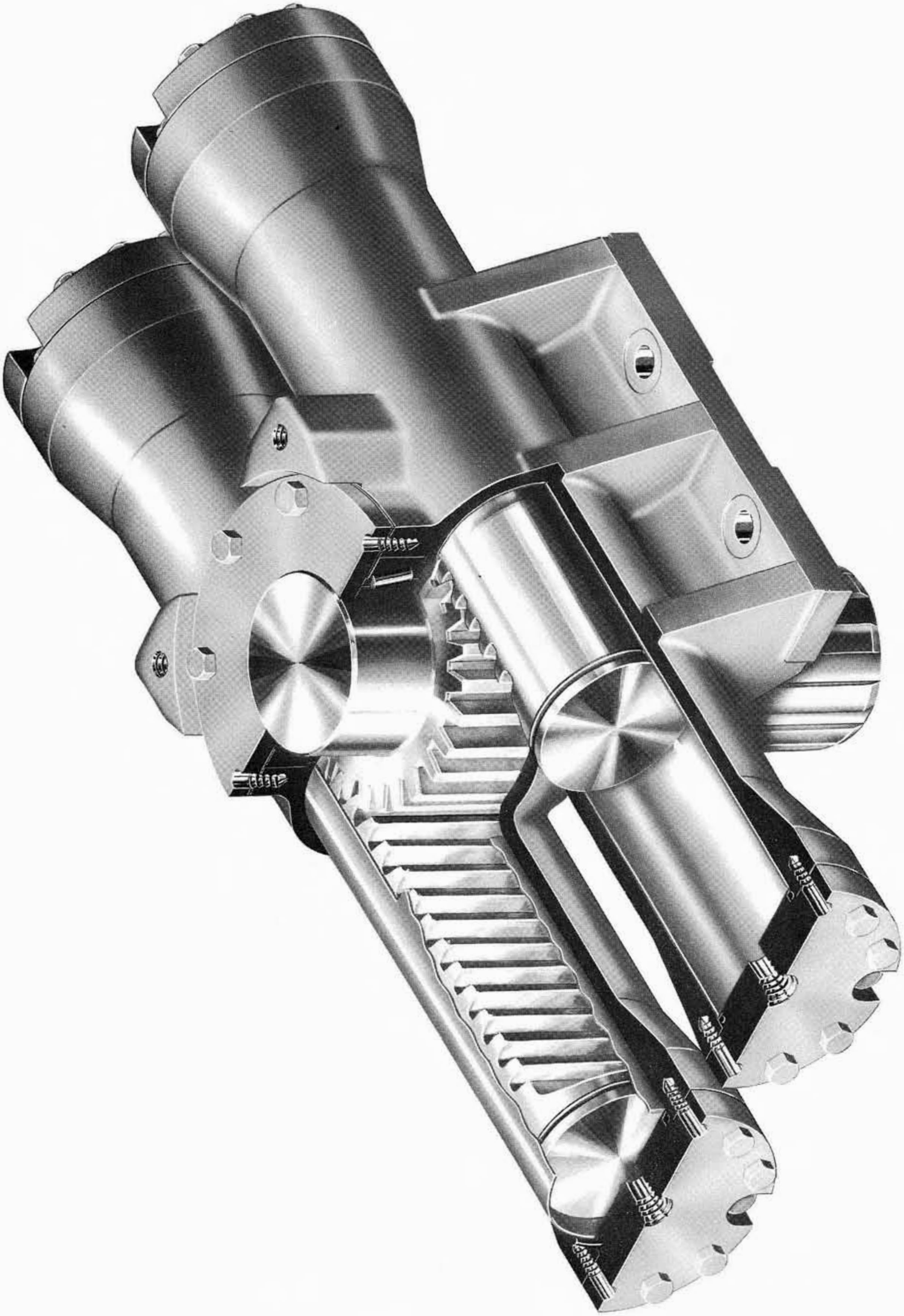

Figure 5-3. Rotary Actuator

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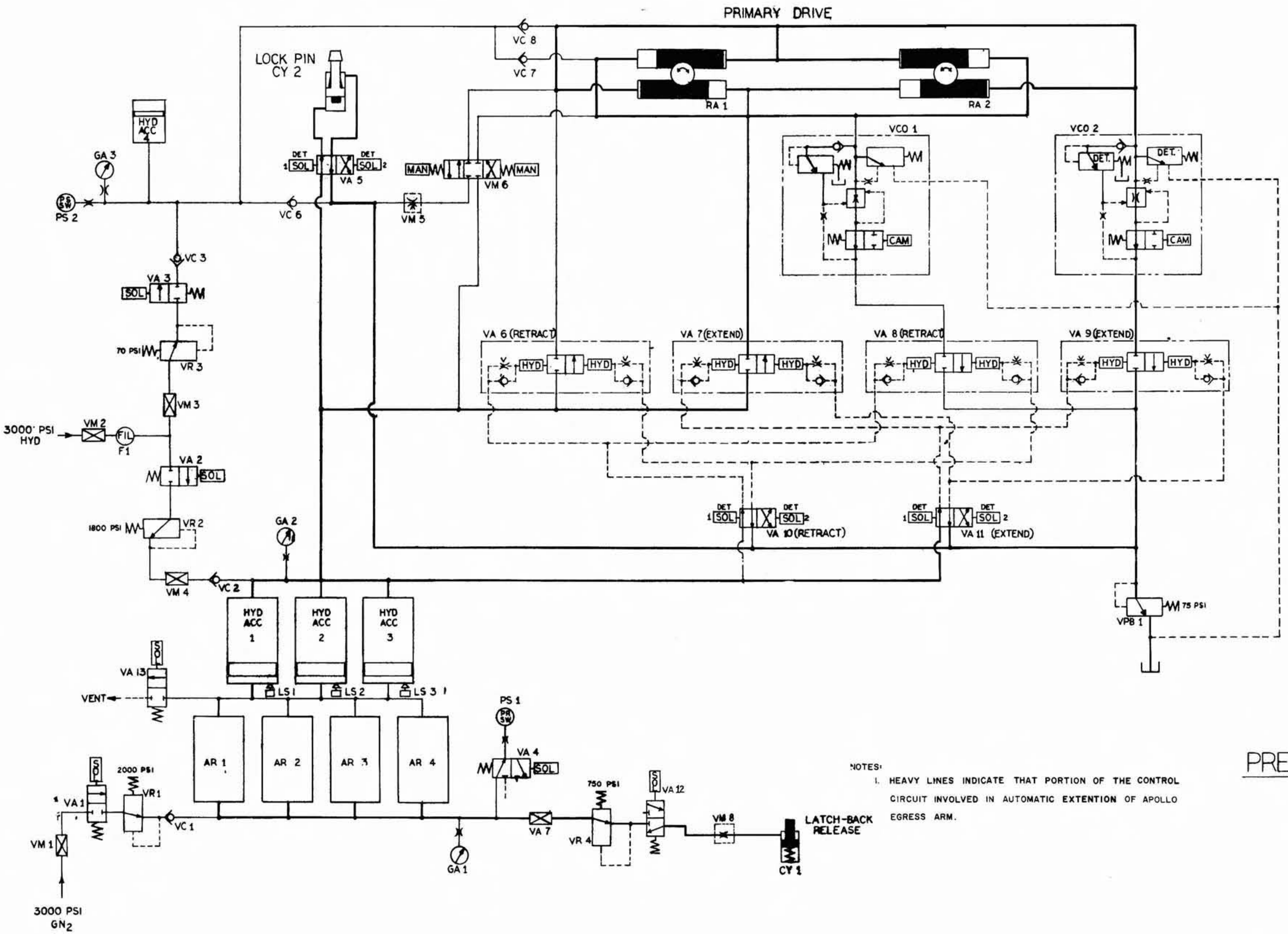
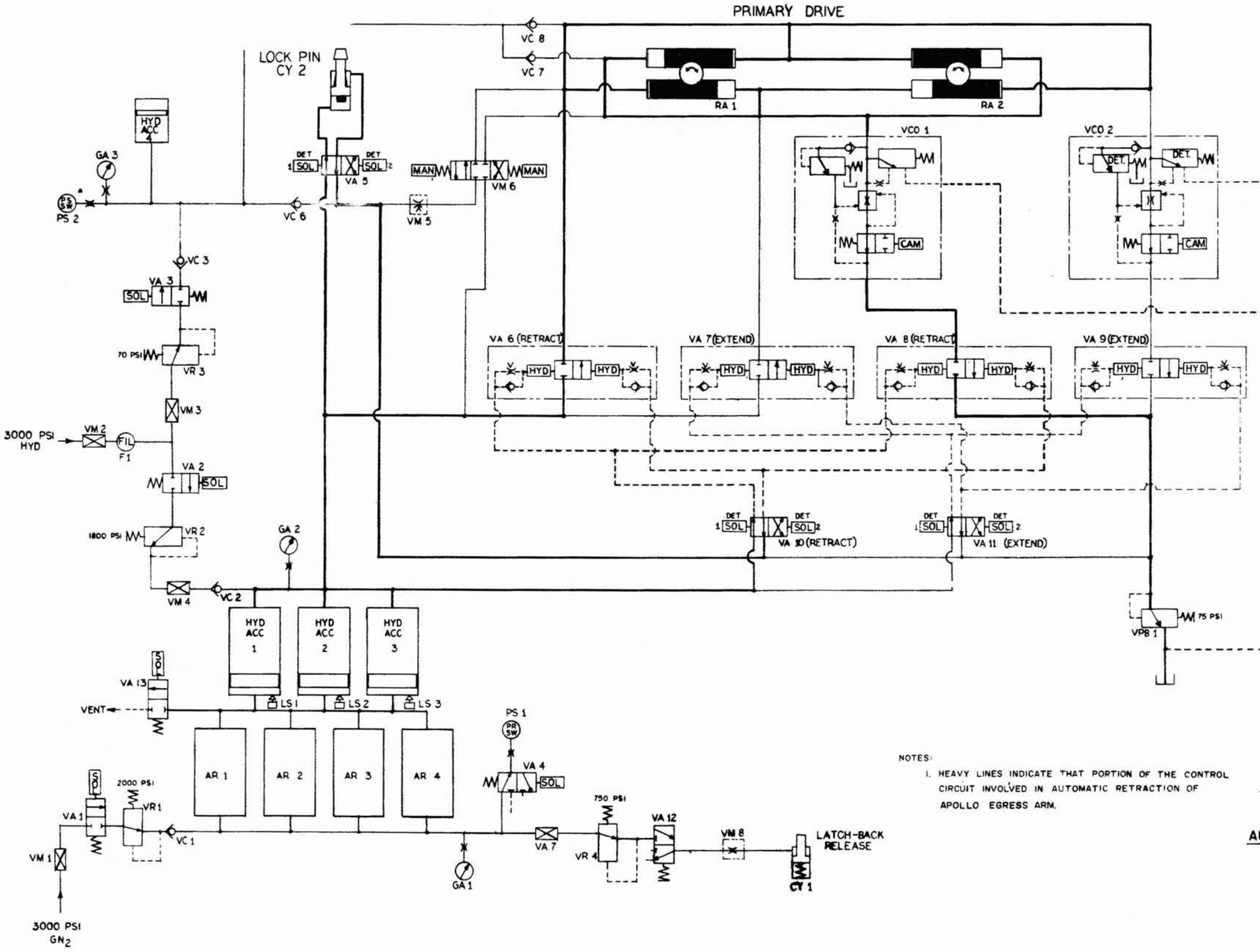


NOTES:

1. HEAVY LINES INDICATE THAT PORTION OF THE CONTROL CIRCUIT INVOLVED IN AUTOMATIC EXTENTION OF APOLLO EGRESS ARM.

PRELIMINARY

Figure 5-4. Automatic Extension Schematic



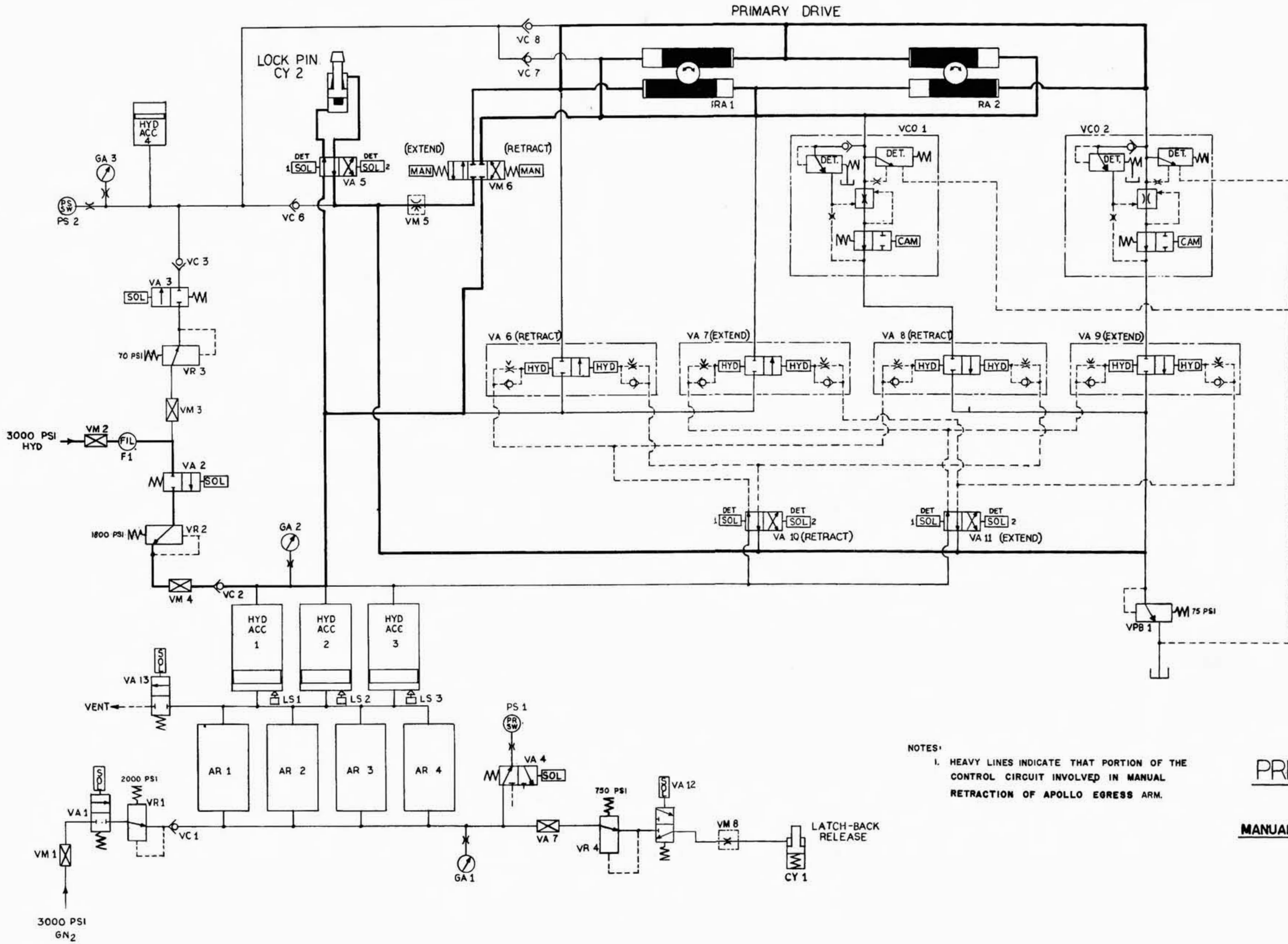
NOTES:

1. HEAVY LINES INDICATE THAT PORTION OF THE CONTROL CIRCUIT INVOLVED IN AUTOMATIC RETRACTION OF APOLLO EGRESS ARM.

PRELIMINARY

AUTOMATIC RETRACTION

Figure 5-5. Automatic Retraction Schematic



NOTES:

1. HEAVY LINES INDICATE THAT PORTION OF THE CONTROL CIRCUIT INVOLVED IN MANUAL RETRACTION OF APOLLO EGRESS ARM.

PRELIMINARY

MANUAL RETRACTION

Figure 5-6. Manual Retraction Schematic

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SECTION VI
AUXILIARY COMPONENTS

Included in this section are the hydraulic charging unit, water quench system, service arm transporter, arm accessways, arm supports, latchback and holddown devices, skids, and tower-mounted secondary retract beams.

The transporter is used in the preassembly and prelaunch phases to transport the service arms from the MSFC Test Area, Huntsville, Alabama, to Complex 39.

The hydraulic charging unit is used to initially charge and to periodically replenish the service arm control system accumulators. The unit is operated under standby conditions during vehicle transport from the VAB to the Firing Site, during checkout operations, and while the vehicle is at the Firing Site. During the final phase of the launch countdown, the unit is inactivated and the launch sequence is completed with energy stored in the system accumulators.

The water quench system is not required to complete a vehicle launch but is used to cool the service arms and permit their reuse with a minimum of repair after exposure to the high temperature engine exhaust gases.

Arm accessways give personnel access onto the arms from the tower for maintenance and checkout.

Arm supports, skids, and tower-mounted secondary retract beams are described in subsequent paragraphs.

6-1. HYDRAULIC CHARGING UNIT

The hydraulic charging unit (Figure 6-1) is used to initially charge and to periodically replenish the hydraulic accumulators which provide sources of stored energy for the service and access arm control systems. This unit also furnishes fluid, under pressure, to permit the umbilical withdrawal mechanisms to track vehicle excursions. The charging unit is mounted in the lower level of the LUT base and is de-energized during the final seconds of launch countdown.

The hydraulic charging unit is comprised of three major subassemblies, a reservoir, and two skid-mounted hydraulic pumping units. The system design, as shown in schematic diagram (Figure 6-2), is such that either pumping unit may be readily removed without operational interference with the other unit.

The reservoir shape was dictated by the 5 x 8 foot opening in the LUT decking through which the unit is lowered for installation. The stainless-steel reservoir serves both as a storage vessel for 500 gallons of MIL-H-5606 hydraulic fluid and as a structural support for the skid-mounted pumping assemblies, a gage panel, and associated valves. The tank is internally baffled to reduce fluid foaming and to provide a settling area for fluid contaminations, and vented overboard through the LUT sidewall.

The reservoir is 73.75 inches long, 49.25 inches wide, and 47 inches high. The reservoir is designed to accommodate a 4-inch return line from the tower supplies, two 0.75-inch supply lines, one for each pumping unit, auxiliary 2-inch and 4-inch return lines, and a 4-inch vent line. Dry weight of the complete assembly is approximately 4500 pounds.

The two pump drives, A6044-1 and A6044-2 (Figure 6-2) are 20 horsepower, 220/440 volt, 3 phase, totally enclosed, fan cooled motors operating at 1800 rpm. The aluminum alloy motor frames conform to NEMA classification 286-U and are double-ended with flanges on each end bell to accommodate drive pads for both superchargers and main stage pumps. The motor windings are specially impregnated to permit use in hazardous atmospheres. All motor control equipment is hydrogen ignition proof where NASA LOC qualified components are available. All electrical components not within protected enclosures are either hydrogen safe or capable of being made hydrogen safe if required later by hermetic sealing, encapsulating, or purging. The motors are fastened to skids fabricated from 1020 steel plate and channel sections.

The supercharger pumps, A6011-1 and A6011-2, are fixed displacement units employing 1-inch wide helical gear pumping elements. Each pump will deliver 11 gpm of hydraulic fluid at an output pressure of 30 psi. Supply fluid for these pumps is drawn from the reservoir through 60 mesh monel strainer assemblies A6010-1 and A6010-2. Pump discharge passes through 10 micron nominal, 25 micron absolute, pleated wire cloth filters, A6012-1 and A6012-2, prior to entering the inlet ports of the main stage pumps.

Relief valves A6024-1 and A6024-2, are also included to unload the supercharger pumps when no demand is placed upon the hydraulic system and when the main stage pumps are operating under standby conditions. The valves have a cracking pressure of 30 psi and return to supercharger pump output flow to the hydraulic reservoir.

The main stage pumps A6026-1 and A6026-2, are pressure compensated variable displacement units capable of delivering 9.3 gpm at 3000 psi discharge pressure. Fluid displacement is a function of demand and requires only sufficient power to meet the functional and delivery requirements of the system.

Discharge of the two main stage pumps is directed to a common header through check valves A6034-1 and A6034-2. Header pressure is limited by relief valve A6036 if there is a failure of the pressure compensator which is an integral part of the main stage pump.

The tower header may be drained by block valve A6035 and individual pump unit cycling, under flow conditions, may be achieved by block valves A6032-1 and A6032-2.

Motor control and necessary instrumentation will exist on the charging unit and at both the LUT and LCC service arm monitors.

One pumping unit will be operated continuously while the LUT is in the VAB. A loss of hydraulic supply, in this environment, is not considered critical. Only one pumping unit will be operated during transit, in order to minimize power demand. (Constant monitoring, therefore, should be considered to permit selection of the second unit operation in the event of a pumping unit malfunction). After the LUT arrives at the launch site both units will be placed in operation and remain in operation until launch.

6-2. HYDRAULIC CHARGING UNIT MOTORS AND CONTROLS.

This section generally covers all electrical power and control components required for connecting and controlling the hydraulic pump motors which are used to charge the swing arm hydraulic system.

Each LUT hydraulic charging unit (Figure 6-3) will have 20 hp motors. These motors will be electrically connected and controlled individually. Therefore, all description herein will refer to only one pump motor and system.

6-3. OPERATIONAL DESCRIPTION

The following is a general description of the operational procedures for the electrical system of the hydraulic pump motor.

There are three control panel locations, one in the Launch Control Center, one in the Launcher-Umbilical Tower Monitor Room and one mounted in the Pump Room on the hydraulic instrument assembly. The control panels are used to control and indicate proper functioning of the electrical and hydraulic systems

The main electrical service will be provided by the facility power source through a sight switch. With the sight switch in the "ON" position, the following indicator lights should be lighted on all control panels; "Phase Sequence OK", "AC on", and "DC on" also the "Control" light will be lighted on the controlling panel which has charge of the system. The "Phase Wrong" light should not be lit but if lit, operation shall cease until the wrong phase condition is corrected.

The pump motor is started by the "Start" switch at the controlling location. This switch energizes an autotransformer starter which starts the motor. If the system functions properly the Hydraulic "Pressure OK" light will come on when the pressure operating level is reached. The pressure switch will be adjustable between the operative limits of 2300 to 3000 psi. Additional control panel indicators will be a motor overtemperature light, hydraulic pressure transducer read-out meter and "Protection Control Bypass" switch with danger light. The pump motor will continue to operate until the "Stop" switch is actuated which stops the motor and resets the control system. The indicating lights and autotransformer holding coils will be of the 28 vdc type. All indicating lights will be dual bulb legend type suitable for mounting in panels.

The control panel having the Start - Stop function will be the one connected to the control receptacle on the distributor assembly. All control panel cabling will be interchangeable to facilitate the plug-swap control/monitor functions. Changing of this control from one location to another will require an exchange of plugs. These changes will be made with the power disconnected from the motor.

All electrical equipment in the Monitor and Motor Rooms shall be capable of being easily converted to "Hydrogen Ignition Safe". All motor windings and transformer coils shall be vacuum impregnated with G. E. RTV-11 encapsulating silicone rubber compound. Each piece of equipment must be mounted in such a manner that it can be removed and replaced by disconnecting cable connectors, purge lines (if required for hydrogen safing) and mounting brackets or attachments.

All components shall be tested and certified as to their capability of performance under the worst vibrating conditions expected during movement of the LUT or during launch.

6-4. ELECTRICAL CONTROL SYSTEM COMPONENTS.

The control systems will generally include but not be limited to the following number and type of items:

a. One 28-vdc power source.

b. Two phase sequence indicators and relays. One of these is connected for correct rotation and one for incorrect.

c. Three 110-vac relay coils connected through resistors to each phase of the 440 V supply with normally open contacts connected in series ahead of main contactor coil to prevent operation in case a phase failed.

All above items will be provided with a minimum of 2 fuses, sufficiently sized, on the line side.

d. One autotransformer starter as shown on drawing.

e. Three overload relays with heater elements installed in each motor lead, and their contacts connected normally closed in control circuit.

f. Three Start-Stop controls.

g. Eighteen indicator lights suitable for 28 vdc operation with dual 40 ma bulbs.

h. One transducer connected to hydraulic system for pressure readout.

i. One overtemperature relay imbedded in motor frame and connected normally closed in control circuit.

j. One 20 hp, 1800 rpm, 440/220 volt, 3 phase, double end shaft, totally enclosed fan cooled (TEFC) with G. E. RTV-11 encapsulated dual winding motor with space heater and drain plugs to alleviate moisture condensation in high humidity environment.

This equipment will be connected generally as shown on Motor Control Circuit Drawings.

All components must have a certified function test of at least 10 cycles of satisfactory consecutive operations before being released from the manufacturer.

The assembled unit will have a checkout procedure including continuity and complete functional performances.

6-5. Power Cables With Connectors. The power cables used for power supply from the sight switch to the starter assembly and from the motor terminals to the starter assembly will be of flexible cable consisting of seven No. 8 tinned-copper stranded conductors with a tinned-copper braided overall shield enclosed with mold-cured neoprene sheath cover. The power cables will conform to NASA specifications of cable drawing No. A75M50222.

6-6. Control Cables With Connectors. The control cables connecting the Distributor to the Relay and control panels shall consist of sixty-one No. 20 conductors with an overall shield which shall conform to NASA cable drawing A75M50223, these cables shall be interchangeable, using similar plugs. Lengths of these cables shall be such as to accommodate the maximum distance between locations of terminals in the LUT hydraulic motor room.

The control cable connecting the starter assembly to the distributor will consist of nineteen No. 20 conductors with overall shield which shall conform to NASA drawing A75M50223.

The cables used to connect the relay assembly with LCC controls shall be as required according to NASA controlling authorities.

A 3 wire No. 18 conductor cable shall connect the control panels to a pressure switch sensing hydraulic pressure, connected through the hydraulic unit electrical distributor A1. The cable shall be constructed to conform to NASA LO-DE standard cable subassemblies.

6-7. Receptacles. The receptacles shall be mounted on the assemblies and gasketed to provide a leak proof seal. The connections to the receptacles shall be hermetically sealed by potting between the connecting terminals and the box interior. The control and distributor receptacles shall be according to standard cable subassembly drawings. All component receptacles on Hydraulic Unit Distributor A1 shall be MS3100 type. The power receptacles shall be rated for 600 volts and 40 amperes on the power and grounding terminals and 10 amperes on the low voltage terminals.

The starter assembly shall have 2 power receptacles and one 19 pin control receptacle. Distributor assembly A1 shall have one 19 pin and three 61 pin control receptacles. Each control panel shall have one 61 pin control receptacle and one DC power 3 pin receptacle.

6-8. Starter Assembly. The starter assembly A3 shall be constructed to house the autotransformer starter, low voltage transformer and 28 vdc rectifier, plus right and wrong phase sequence relays, phase to phase connected 115 volt relay and dropping resistors, line overload relays, fuses, terminal boards and all other necessary equipment needed for mounting and connecting indicated components.

This assembly shall be constructed of rigid sheet metal steel sealed with gaskets and capable of being purged with an inert gas making it hydrogen ignition proof if ever required. The plug-in receptacles shall be installed in the sides or bottom of the assembly. The assembly shall have been protected from rust with galvanized or bonderized paint per NASA standards. All electrical connections shall be made with the applicable connectors. All relay contacts located in the starter section shall be ignition proof or installed in an environmental panel to give explosion proof protection.

The starter and all components shall be of the capacity and size to meet all National Electric Code Safety requirements.

The assembly shall be mounted in a manner to make interchanging of assemblies easy. If any component within the assembly should become faulty the complete assembly could be replaced by unplugging cables and exchanging to a spare starter assembly. The assembly shall be frame mounted as shown on plan.

6-9. Distributor A1. This box will provide the interconnect between the starter, monitor and control panels. The distributor shall have a sufficient number of terminal boards for all present needs plus 20 percent spares.

The terminal boards shall be of the solder type and shall be firmly secured to the distributor.

The distributor shall have three identical sized 61 pin control jacks. One jack shall be labeled "Control" and each of the other jacks shall be labeled "Monitor."

The distributor shall be constructed of rigid sheet steel equipped with a gasket. It shall be of a standard size and shall be protected from rust and moisture accumulations by galvanizing or bonderized paint. It shall be capable of being purged for extra hydrogen safing if ever required.

6-10. Control Panels. All LUT hydraulic unit control panels are to be identical, standard 24-inch rack mount type, shallow depth panels. They may be connected for "Monitor" or "Control" operation by a plug swap into the appropriate control jack at the distributor A1. The local control panel will be located in the area of the pump below the hydraulic gages. The primary purpose will be to start and stop the pump motor and monitor operations. A toggle switch will be used for starting and stopping the motor. Eight indicator lights will be used for monitoring. All components on the local control panel will be per MSFC STD-110 except as specially required for motor control.

All control circuits from the panel will exit through a 61 pin connector.

6-11. LUT Remote Monitor-Control Panel. The LUT remote control panel will be located in the LUT control room. A standard size panel as described above will be used to match existing panels within the area. This panel will be primarily used for monitoring the operations of the pump electrical and hydraulic systems, but when the cable to the distributor box is connected in the "Control" position, the LUT monitor room panel can function as the main control panel. The eight indicator lights on the panel will be 28 vdc Master Specialties, Word Indicator Lite with appropriate legends engraved on each light.

6-12. LCC Control Panel. The LCC control panel will be furnished by other NASA contractors and will probably contain functions similar to LUT panels.

6-13. Motor. The hydraulic electric motor shall be a 30 hp, 1800 RPM 440/220 V, 3 phase, totally enclosed, fan cooled, double end shaft. The shaft shall be hollow with a 1-inch diameter hole and constructed for the installation of the specified pumps on each end.

The motor housing shall have two 1/4 inch drain holes tapped to the stator section of the motor. These drain holes shall be used to remove any condensate or may be connected to a dry nitrogen purge system where hydrogen safing is required. A 200 watt strip heater shall be installed in or adjacent to the inside cooling section to provide above ambient temperature to the internal section of the motor housing and further alleviate condensation.

The motor windings shall be vacuum impregnated and encapsulated with General Electric RTV-11 silicone rubber compound or equal. The motor winding leads shall be according to MIL-W-8777 wire and shall be solder terminated to a Bendix Hus-Key connector anchored and extending through the side of the motor lead terminal box. The leads and soldered end of the connector shall be potted with clear LTV 602 silicone.

The motor shall have a terminal overtemperature switch which will be embedded in the motor winding. The switch shall operate with excessive temperature rise to turn on a warning light when the overtemperature occurs.

The motor shall be made of No. 363 aluminum alloy with not more than 3 percent elongation in 2 inches and a maximum weight of 300 pounds. The motor shall be similar to Reuland's horizontal double end hydraulic pump motor frame No. 286U.

6-14. Hydraulic Pressure Read-Out. Transducers and pressure switches shall be furnished and connected into the indicator system to provide pressure read-out located on all control panels. All equipment will be furnished according to NASA approved components.

6-15. WATER QUENCH SYSTEM

The water quench system will provide for rapid heat dissipation and fire control on the service arms and CM access arm immediately after launch. The limits of design call for tower-mounted headers using 7500 gpm of water and the assumption that wind conditions are nullified by aspiration effects during vehicle ascent.

6-16. OPERATIONAL REQUIREMENTS

The service arm and equipment was considered to be cooled to an average temperature of 212°F in one minute. Even though no appreciable cooling effect could be gained during lift-off, it is desirable to have the water flowing on the arm during firing to insure immediate heat dissipation after blast has cleared the arms. Actuation of the water spray system should take place at lift-off.

Since a uniform water spray must be designed for cooling on a "per unit area" basis, the tubes of the service arm determine the water requirements. In this case a flow rate of one gpm per square foot of projected area was required.

The water quench headers are placed above and below each service arm in positions that will allow clearance of arm hardware and yet provide complete water spray coverage over top and bottom of service arm.

The piping used for the water quench system will be seamless carbon steel, schedule 40. Spray nozzles are the square spray type to provide uniform coverage. Water will be piped as near the center of the tower mounted headers as possible so that spraying will start uniformly. Water pressure at each header will be determined by the number of nozzles per arm and will be regulated by a pressure reducing orifice.

The piping (Figure 6-4) will be supported by brackets attached to the face of the arm-mounting beam, two vertical beams, and to the floor-mounting beam at each individual arm level. Piping will be fabricated to provide easy installation by tower crane. A flanged interface is provided at each floor-mounting beam.

The piping, nozzles, etc., for the water quench system are standard design and commercially available.

6-17. CONTROL SYSTEM

The water quench control system consists of a control valve located at each arm level, one solenoid valve to supply pneumatic pressure to operate the control valves, and a control panel located in the base of the LUT. The control valves will be located near the tower interface at each arm level so the water is as near the arms as possible.

At holddown arm release, the solenoid valve receives an electric signal which opens the valve and allows pneumatic pressure to actuate the control valves. By opening the control valves at this time, water will reach the arms before they are exposed to the exhaust heat.

A timing circuit in the control panel will determine the length of time the control valves will remain open. The time will be adjustable. Between one and two minutes of quenching is expected to be sufficient. At the end of the desired time, the solenoid valve will be de-energized and the control valves will close and stop the water flow.

A second control system consisting of one large control valve located below the first service arm level was considered; however, it was found that the head of water could not rise as quickly as the vehicle.

6-18. SERVICE ARM TRANSPORTER

The Complex 39 umbilical service arms will require transportation from the Marshall Space Flight Center in Huntsville, Alabama to Complex 39, as well as requiring local transportation at both locations The size of the service arms and the protection necessary preclude the use of completely standard transportation methods.

Transportation by trailers is necessary for local movement and has been found to be the best and most efficient means of transportation from Huntsville to Cape Canaveral. Comparison with barge and rail transportation indicates that trailer transportation requires less handling, coordination, and travel time than the other modes of transportation and provides better protection for the service arms. Minor disassembly of some of the service arm components is required for trailer transportation to provide sufficient bridge clearances.

The trailers required to transport the service arms are special drop deck, 22 ton capacity, platform type semitrailers with removable body panels, roof bows, and tarpaulin tops. The trailers are 56 feet long and 10 feet wide and constructed in accordance with NASA drawings and specifications (Figure 6-5). Standard commercial components and practices are used and meet or exceed the requirements of the Interstate Commerce Commission "Motor Carrier Safety Regulations".

6-19. ARM SUPPORTS

Arm supports (Figure 6-6) are provided for the service and access arms against the anticipated vehicle engine exhaust pressure. The supports were designed on the basis of a 10 psi pressure upon the vertical projection of the arms.

The service arm auxiliary supports are always mounted on one of the two vertical beams which are provided specifically for their installation. These double-web beams have mounting holes in their outer flanges in the face nearest the vehicle. The holes are located at the same pitch as the main arm mounting beam (5 inches) and at equal tower elevations. The auxiliary supports will be mounted at least one hole lower than the normal position, due to arm deflection.

The auxiliary arm support (Figures 6-7, 6-8, and 6-9) is made from ASTM A-441 steel, is of all welded construction, and is connected to the tower with two vertical rows of 1-inch diameter bolts. A cutout is provided in the support to allow the passage of a water header for the quenching system. Shims are used to keep the top of the support skid at approximately the correct elevation. The blast load is transferred through the skids to the auxiliary arm support. A complete skid arrangement consists of two skids: an arm mounted skid and a support mounted skid.

6-20. SKIDS

Skids are used to seat the arms in the retracted position where they receive the blast load from the vehicle engine exhaust.

6-21. Arm Mounted Skid. The arm mounted skid (Figure 6-10) is bolted to the lower chords of the second element. The skid is fabricated from plates and has the shape of a wide flange beam with a sloping lower flange that matches the angle of the support mounted skid. The seating of the two sloping surfaces furnishes the automatic vertical adjustment and also a dampening of the linear and rotational vibratory motion as the arm swings to the fully-retracted position.

To provide a latch-back mechanism and holddown system, (Figure 6-6), a series of rungs are fabricated onto the bottom flange of the arm mounted skid. These rungs act with a spring loaded latching device, housed in the support mounted skid, providing a ratchet-type lock with several locking positions.

6-22. Support Mounted Skid. The support mounted skid (Figure 6-11) is a constant depth weldment of plates and also has the cross-sectional configuration of a wide flange beam. The top flange will be covered with a sheet of nonsparking material. The top flange is installed on the auxiliary arm support and positioned with a series of shims which provides 5 inches of vertical adjustment. The outboard end of the skid slopes downward from the tower and parallel to the top of the auxiliary arm support. In addition to supporting the arms, the skid is utilized as a housing for the arm latch-back and holddown mechanisms.

6-23. TOWER MOUNTED SECONDARY RETRACT BEAM

A pair of sheaves, one in the horizontal plane and one in the vertical plane, provide the directional change for the secondary cable. The horizontal sheave is mounted on the inboard face of the tower mounted secondary retract beam (Figure 6-12) at approximately the same elevation as the center of the arm. Because of the eccentricity of the retract cable with respect to the beam, considerable torsion is carried by the beam.

Tower connections for the secondary retract beam are furnished at every floor above the 80 foot level and will have common bolting pattern for interchangeability of the beams. The holes for the mounting of the sheaves will be located and drilled during installation. Since the beams are furnished only to meet the present requirements, any subsequent relocation of the arms requires additional field drilling for the mounting of the sheaves.

6-24. ARM ACCESSWAYS

Service and equipment installation for the verticle requires access of personnel from the tower to the vehicle. To fulfill this requirement, accessways (Figures D-11, D-12, D-13, and D-14) leading from the tower levels to the arm levels are provided. All arm accessways, with the exception of the S-IC INTERTANK arm, consist of two landings and at least one arm peculiar transitional section. This section may be a stair, ladder, platform, combination of stair and platform, or a combination of a ladder and a platform. The arm landing and the tower landing, including their supporting structures, are common to all arms except the S-IC INTERTANK. A mounting beam on the east face of the tower provides support for one side of the arm landing.

For the S-IC INTERTANK arm, access is provided through the interior to tower. This route, however, does not allow the walkway clearance of 42 inches by 78 inches that is normally maintained. All obstacles interfering with headroom clearances will be clearly marked in an approved manner.

For personnel protection in the area of the arm mounting hinge and arm landing, a retractable enclosure (Figure 6-13) is provided. This enclosure allows protection for personnel for all positions of the arm.

The design loading for the accessways is a 5 psi blast loading.

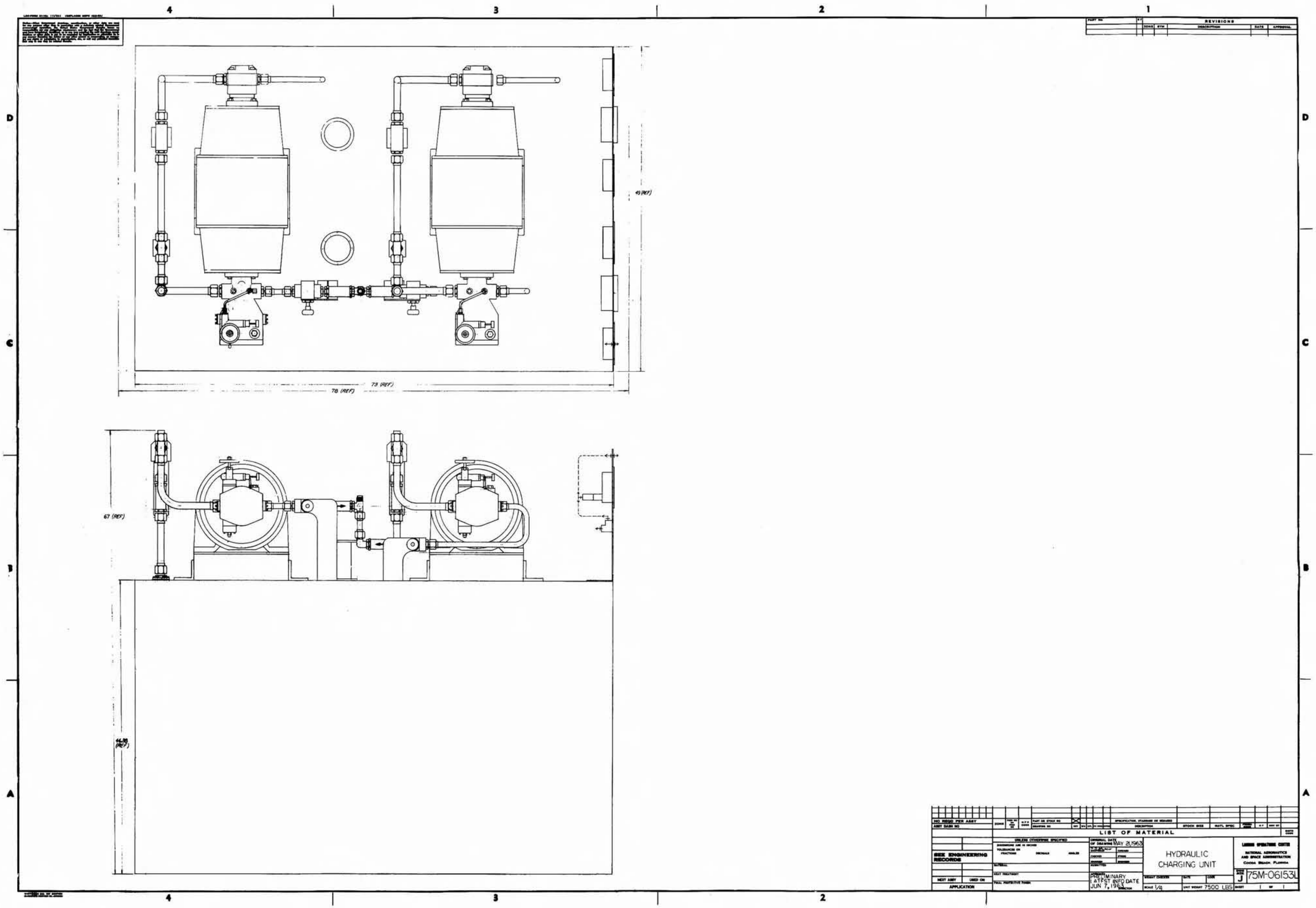

Figure 6-1. Hydraulic Charging Unit

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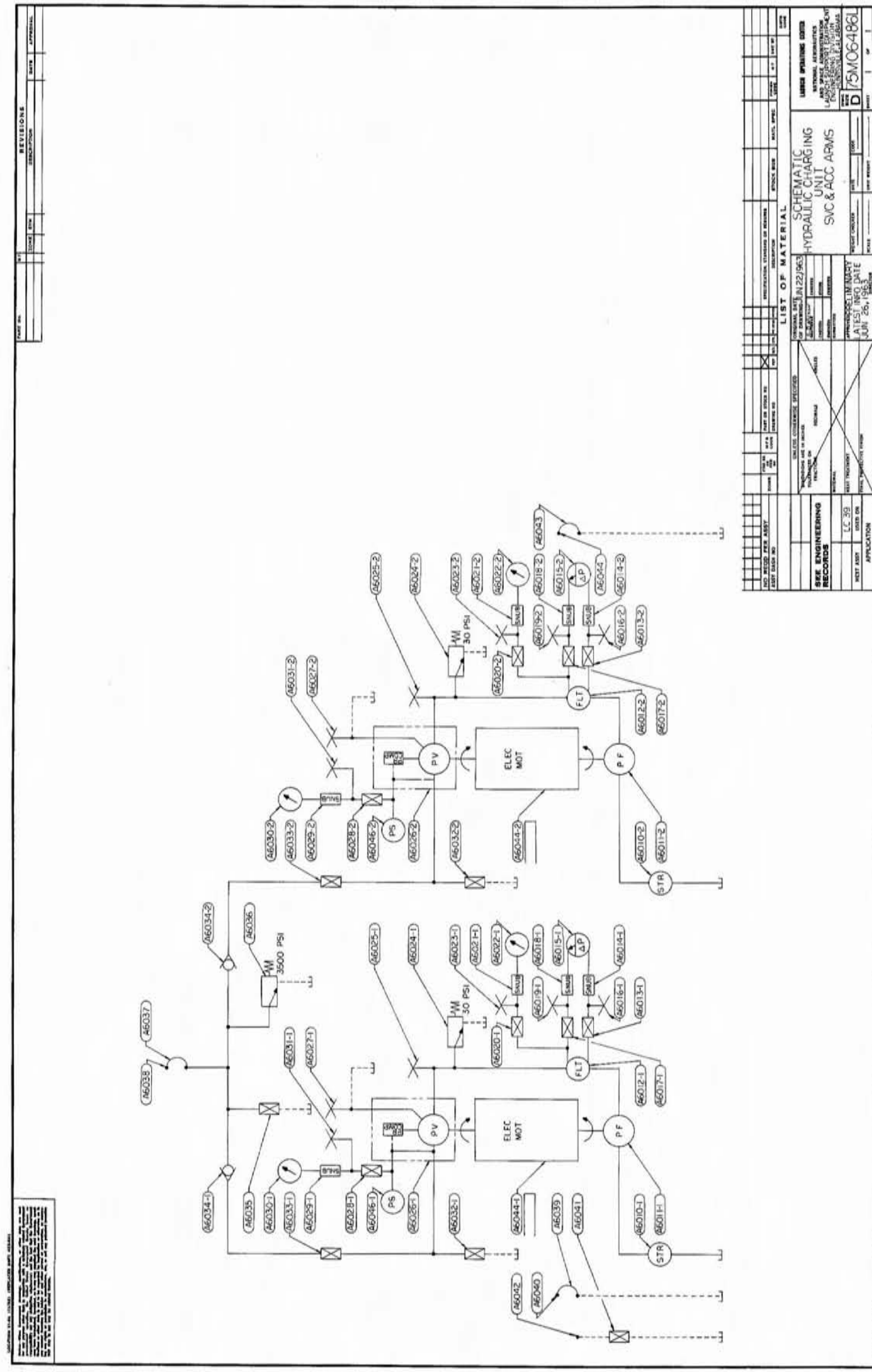

Figure 6-2. Hydraulic Charging Unit Schematic

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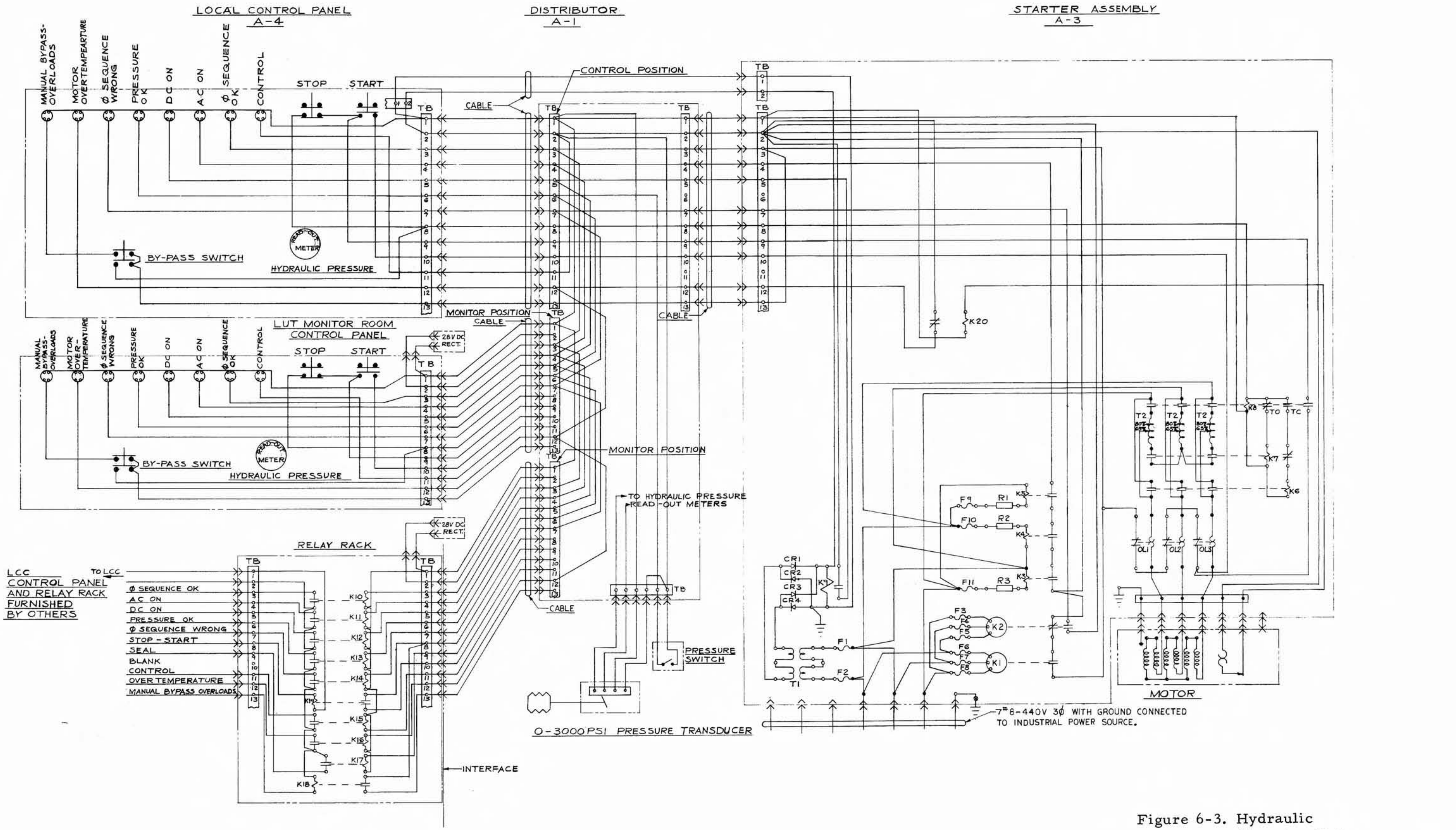

Figure 6-3. Hydraulic Charging Unit Electrical Schematic

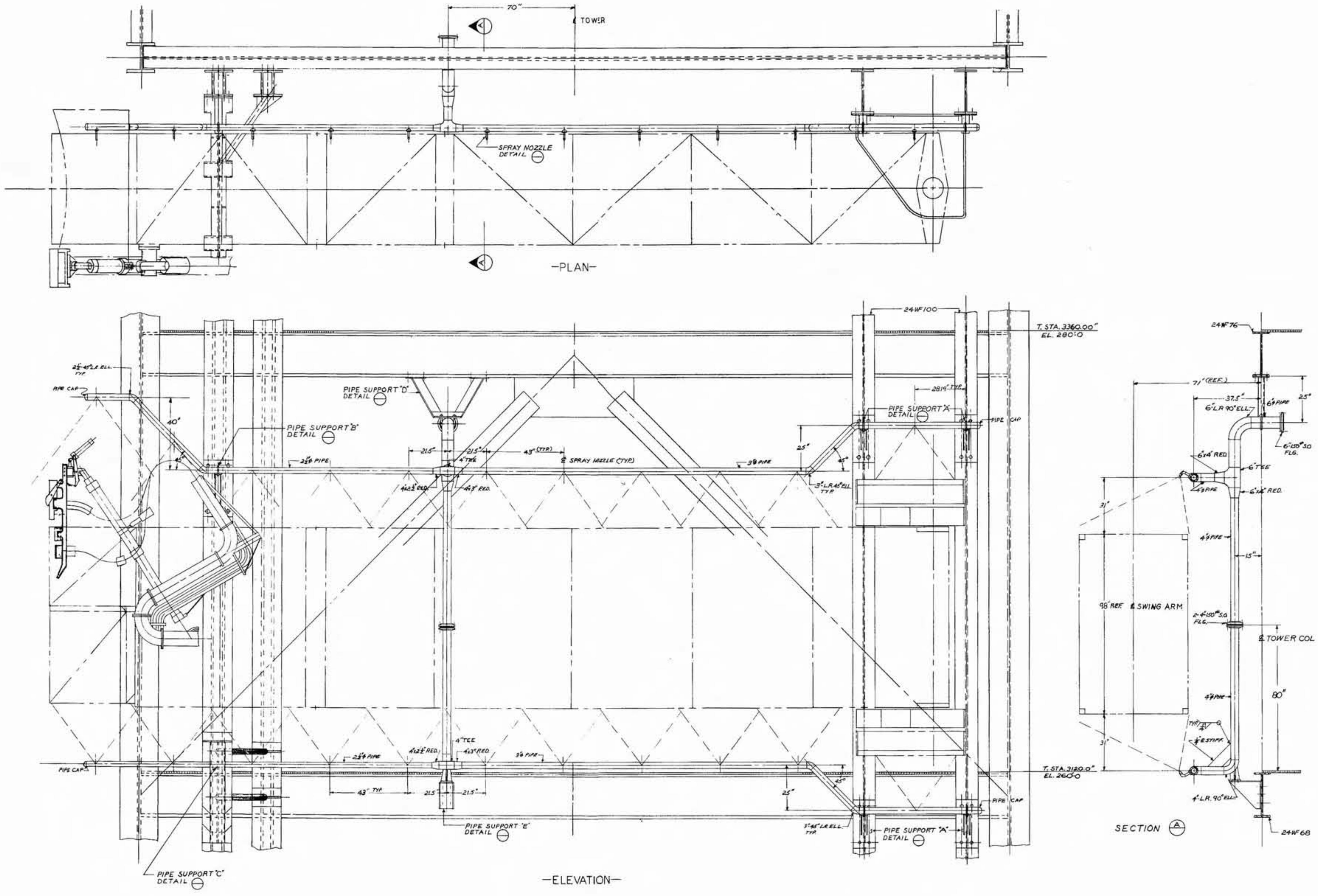

Figure 6-4. Water Quench Piping Layout

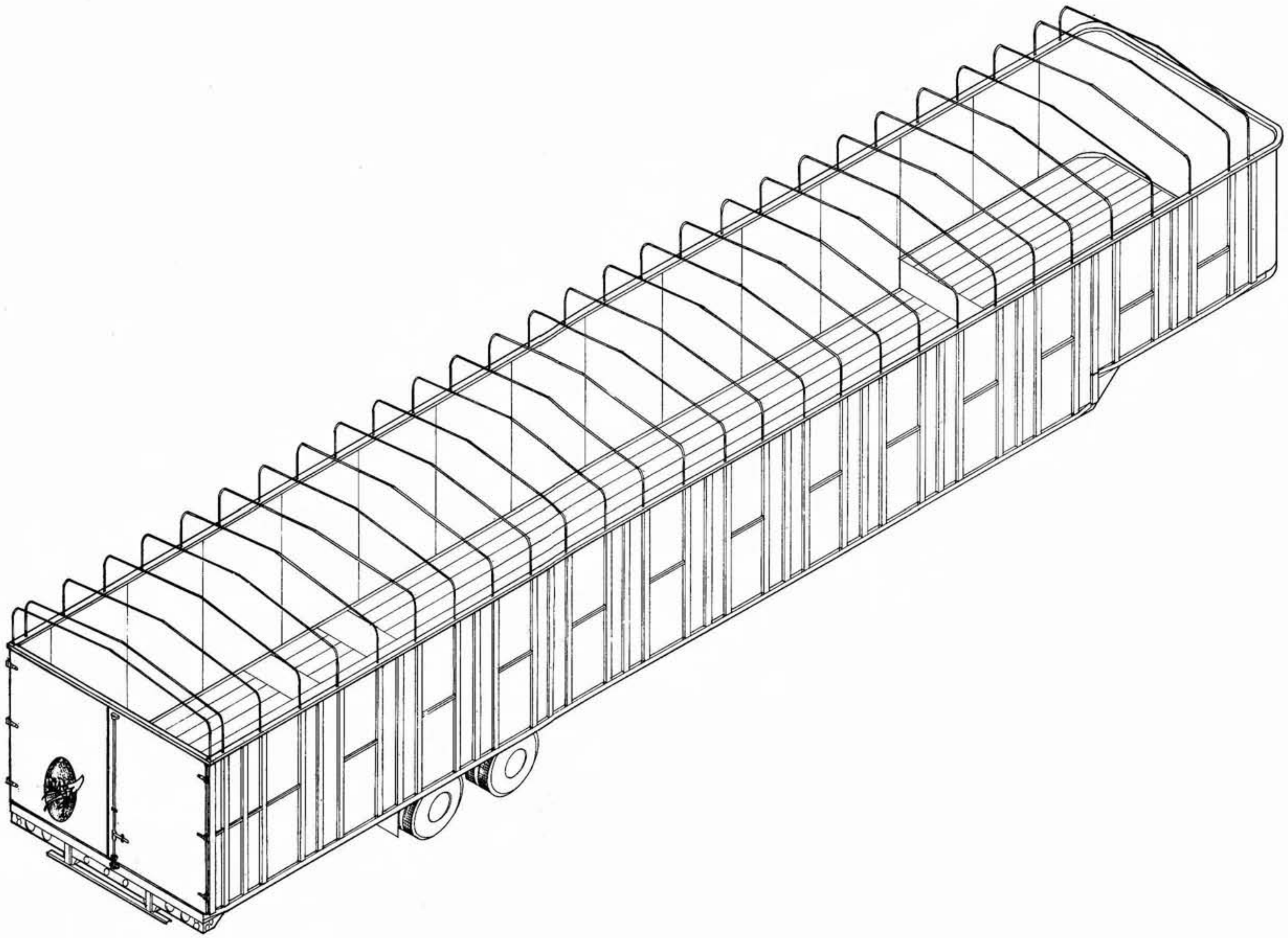

Figure 6-5. Service Arm
Transportation
Trailer

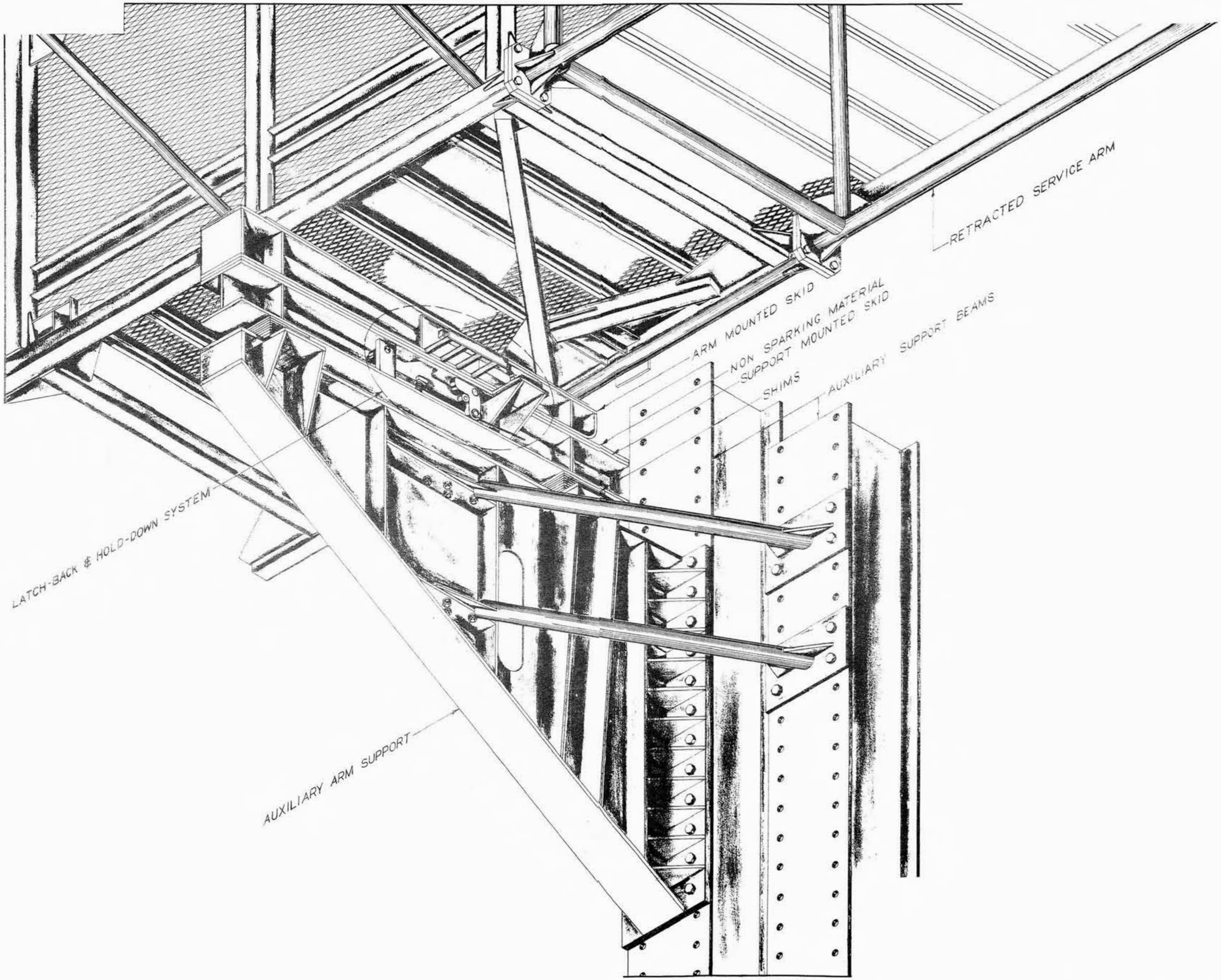

Figure 6-6. Service Arm Support

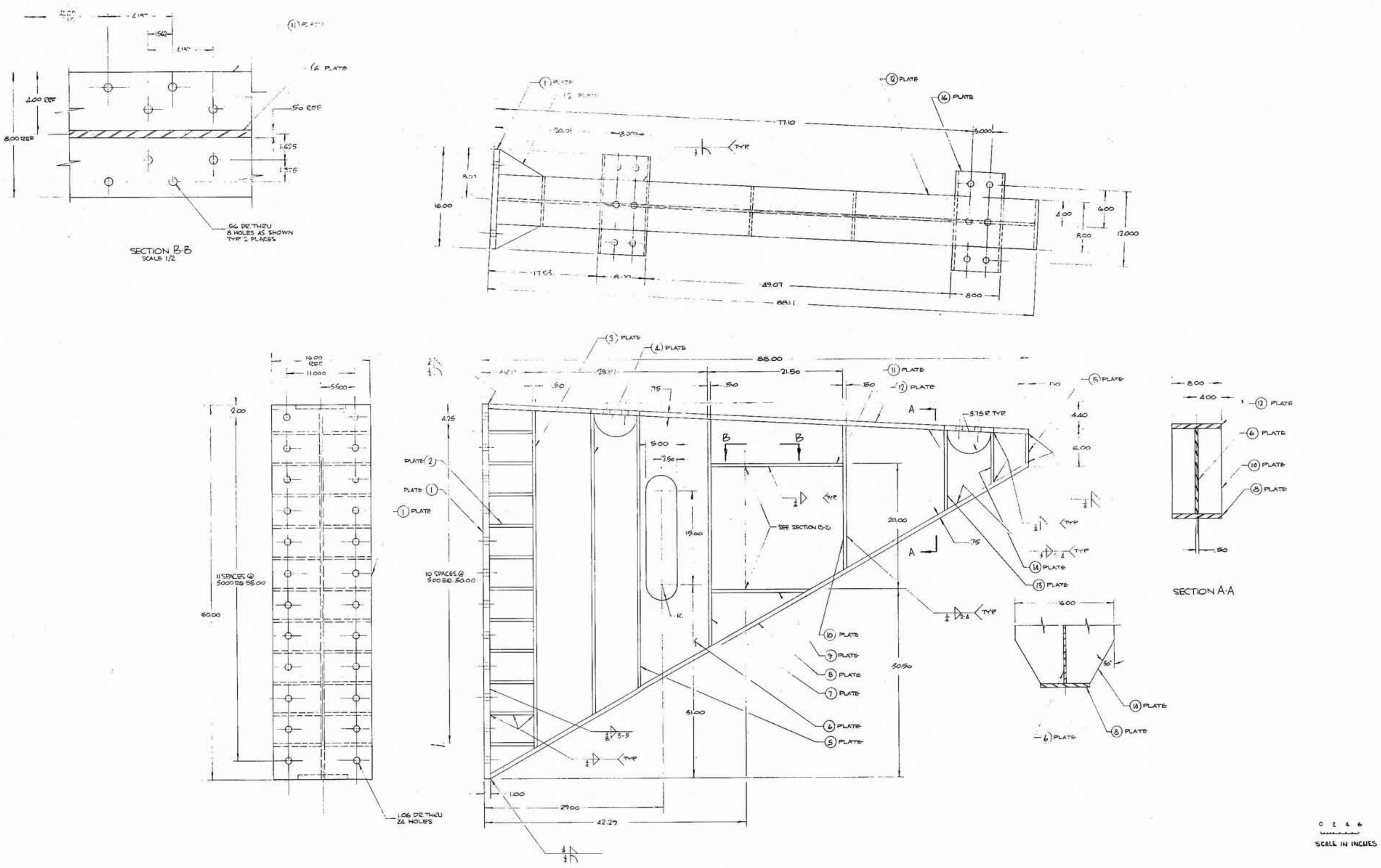

Figure 6-7. Service Arm Support Bracket - Basic

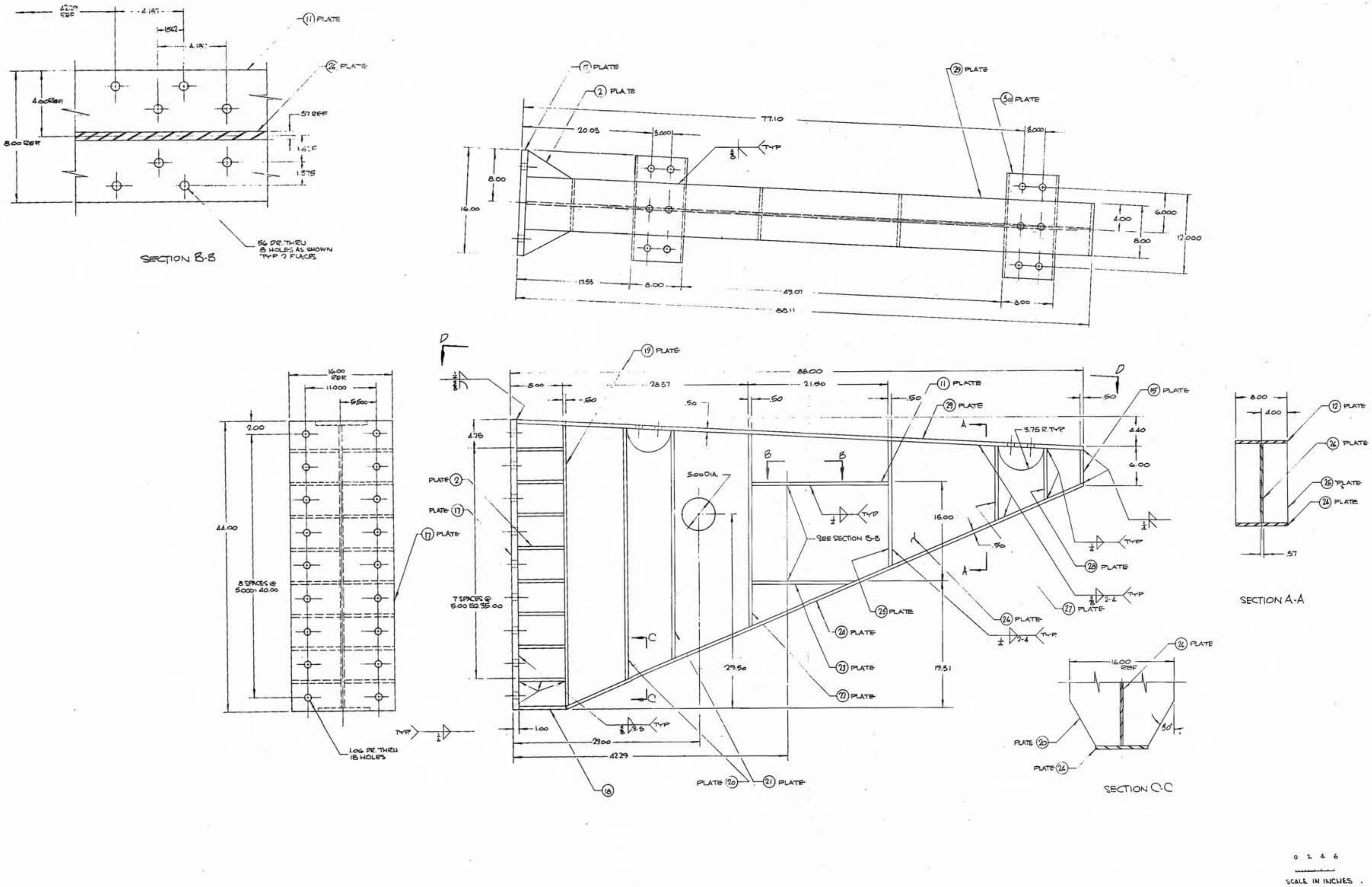

Figure 6-8. Service Arm Support Bracket S-IC INTERTANK

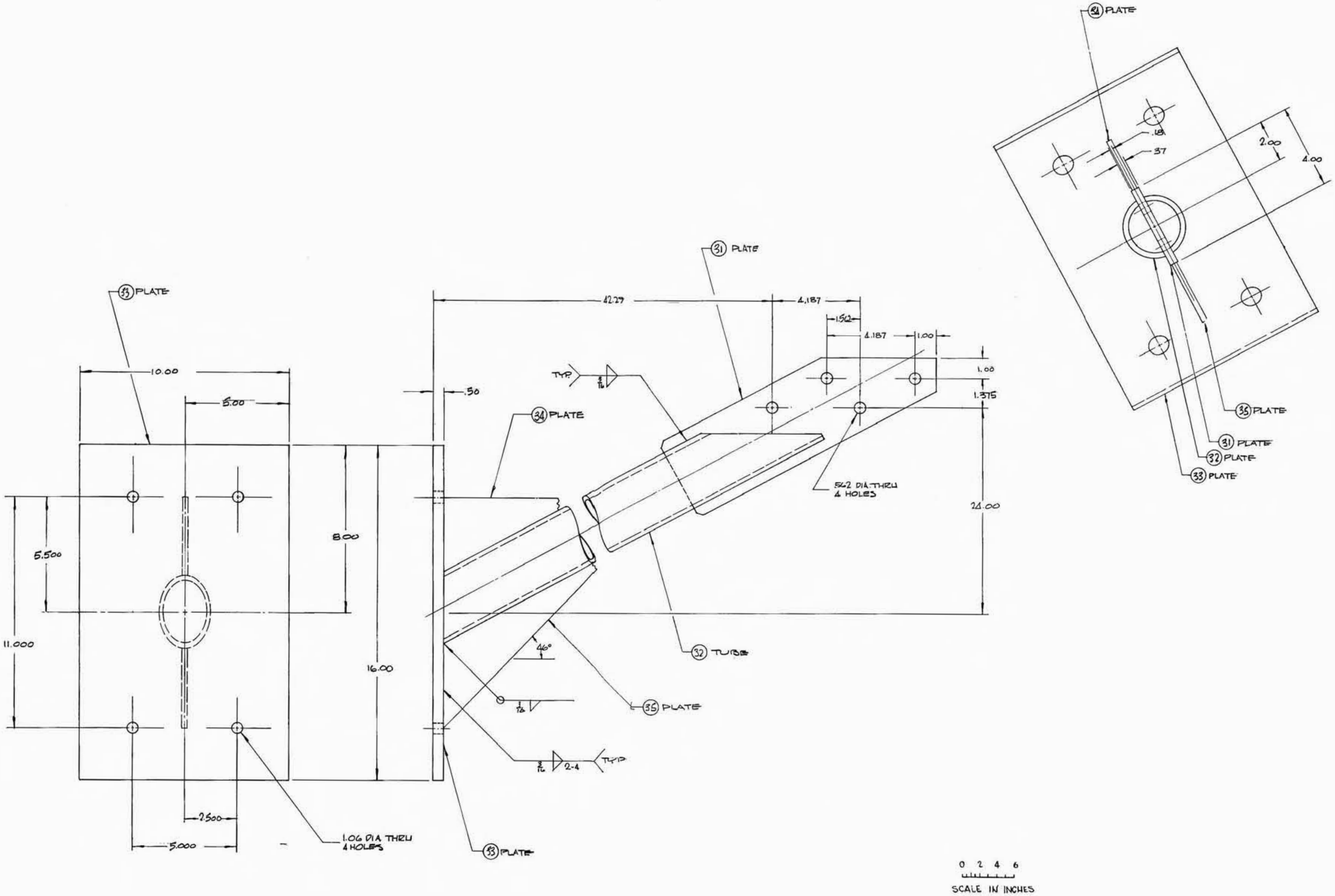

Figure 6-9. Arm Support Brace

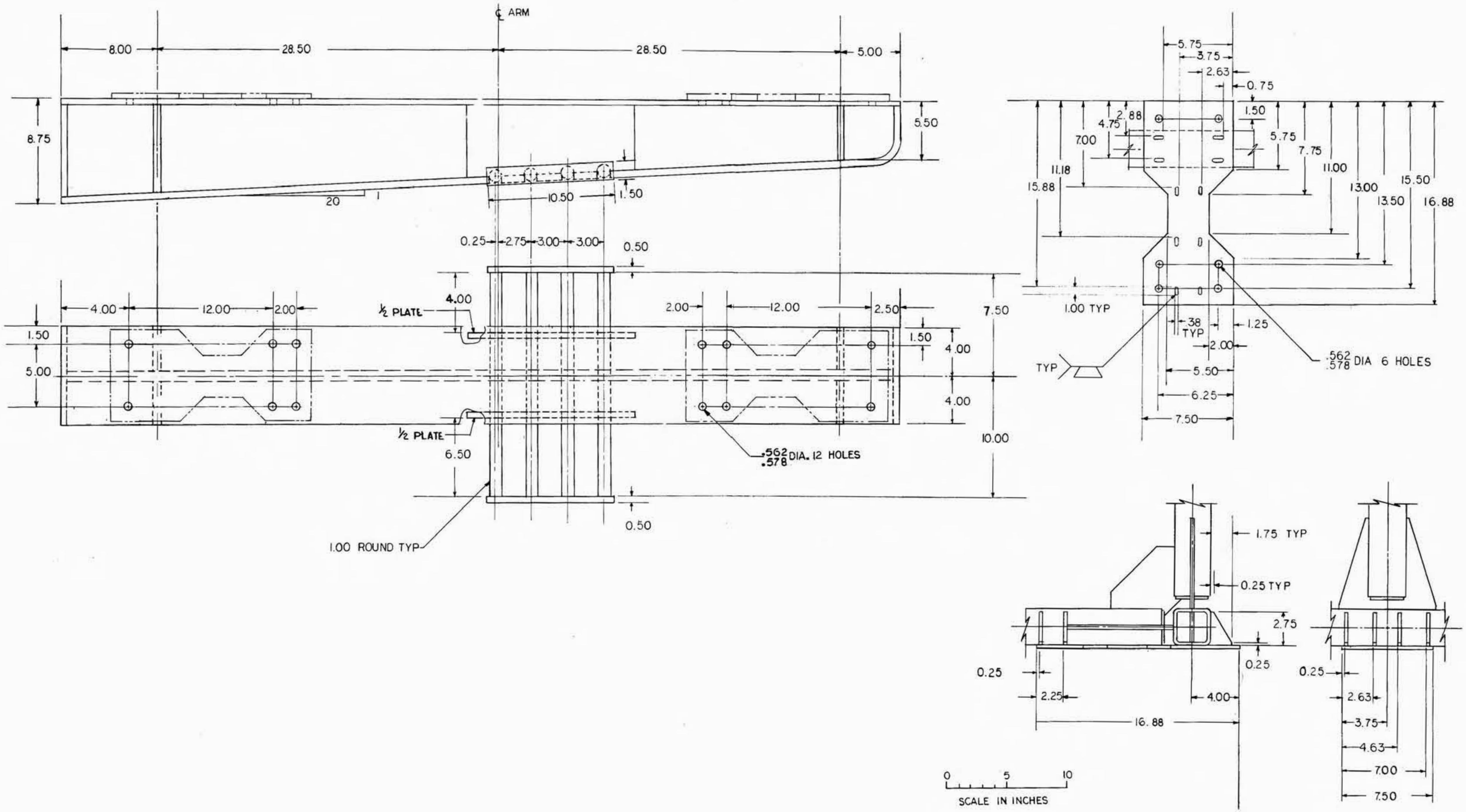

Figure 6-10. Service Arm Skid - Arm Half

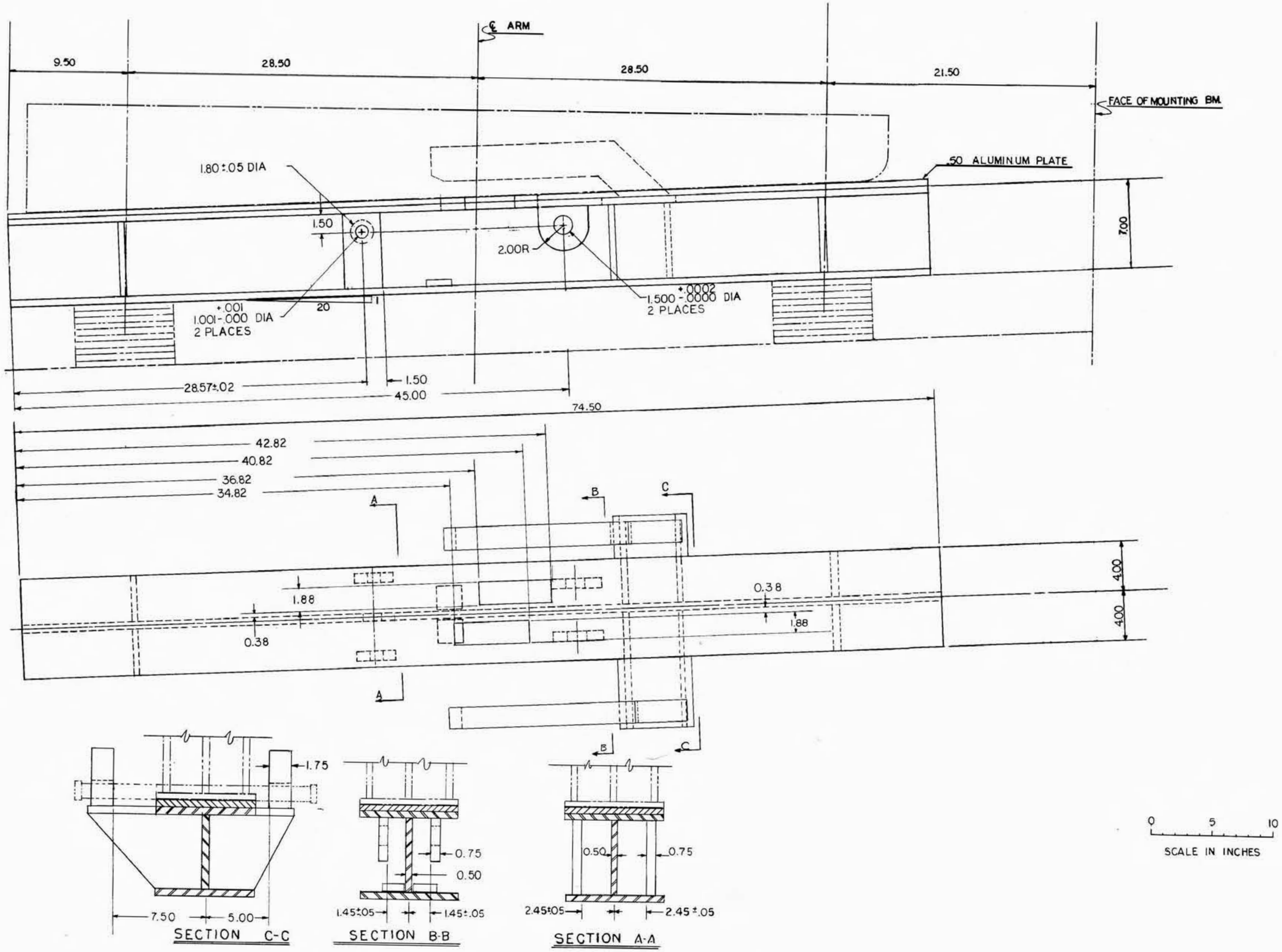

Figure 6-11. Service Arm Skid
- Bracket Half

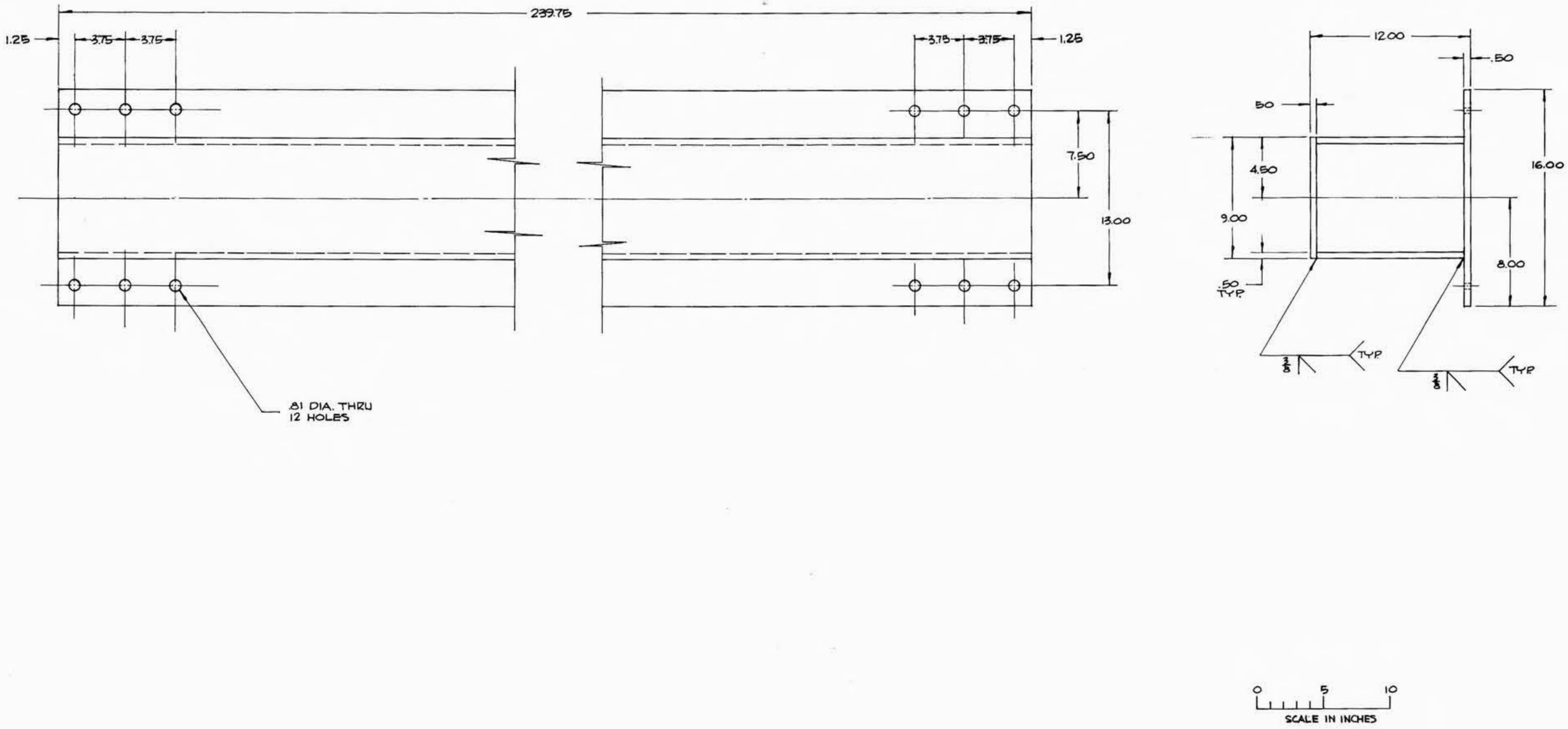

Figure 6-12. Tower-Mounted Secondary Retract Beam

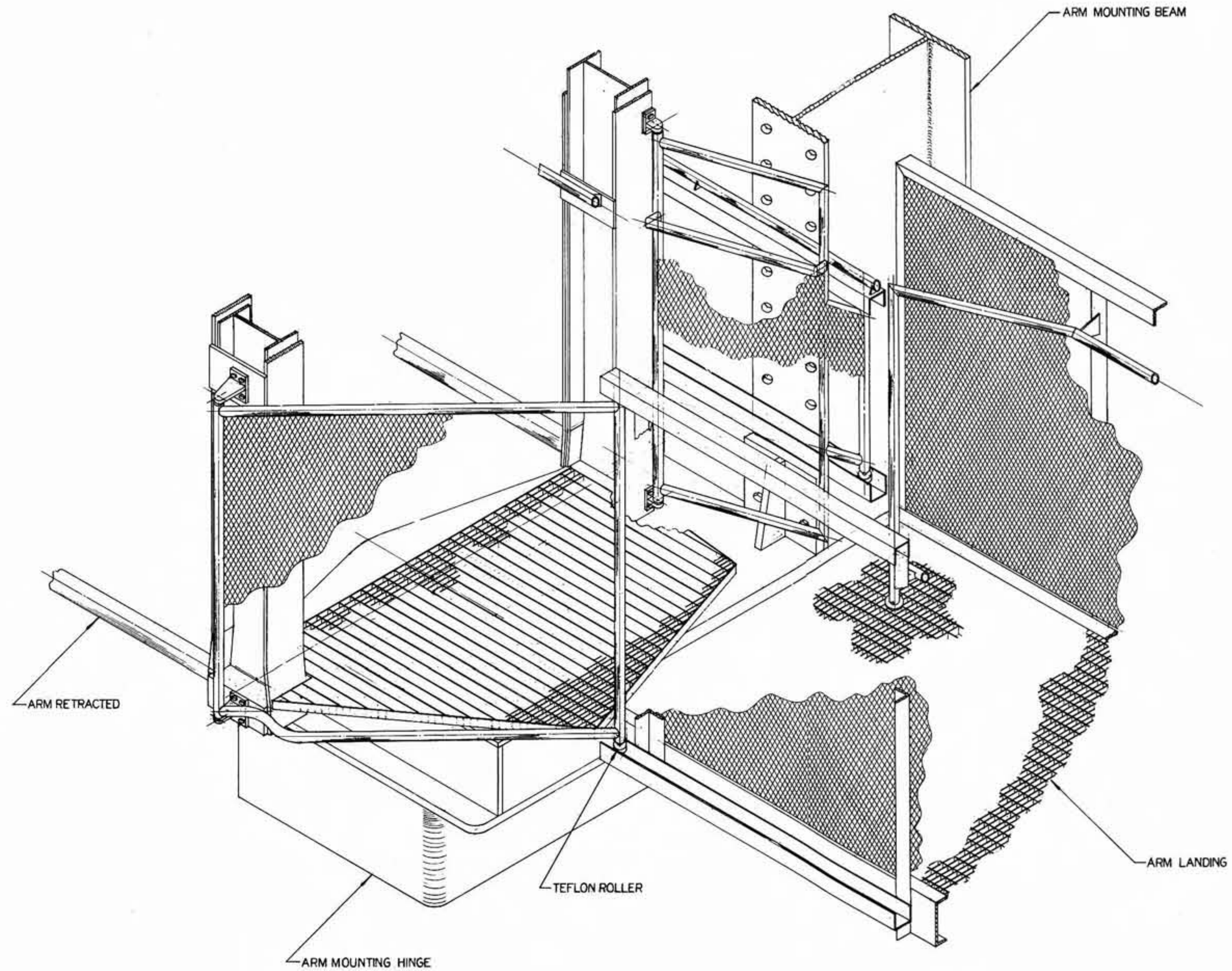

Figure 6-13. Service Arm Accessway

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SECTION VII
INTERFACES

This section presents the location and definition of each interface affecting the service arms, access arm, and associated equipment. The design responsibility of each affected organization is delineated as the established interfaces are defined.

The interfaces are presented in four general paragraphs entitled:

Vehicle Interfaces
Tower Interfaces
Arming Tower Interfaces
Vertical Assembly Building (VAB) Interfaces

Vehicle interfaces will in general define the design responsibilities of LOC and M-P&VE. Tower interfaces will define the responsibilities of various branches and sections with LOC. Arming Tower and VAB interfaces indicate the necessary structural modifications required on the extendable work platforms to provide adequate clearance and environmental control around the service and access arms.

7-1. VEHICLE INTERFACES

All points of contact and connection between the service arms and the vehicle are defined in this section. The areas include extension platform bumpers and couplers, propellant lines, pneumatic lines, air conditioning lines, electrical lines, and the interface between the umbilical carrier and the cylinder type withdrawal mechanism. The vehicle ground half connectors and the umbilical carriers are the responsibility of M-P&VE. The interfaces covered in this section are as follows:

a. Propellant Lines. These interfaces consist of a LOC furnished vacuum jacketed stainless steel flex line mating with a M-P&VE furnished coupling by means of a floating flange, gasket, and bolts supplied by LOC.

b. Pneumatic Lines. Metal or teflon flex hose furnished by LOC will interface with a M-P&VE supplied quick disconnect coupling by means of tube fittings or flanges. Gaskets and bolts will be furnished by LOC.

c. Air Conditioning Lines. A flexible air conditioning line supplied by LOC interfaces with a M-P&VE furnished vehicle ground half coupling. This interface is a flange or slip-on cuff and clamp. Gaskets, bolts and clamps will be furnished by LOC.

d. Electrical Lines. A cable and connector with the pin insert supplied by LOC will mate with a M-P&VE furnished connector located on the vehicle and will mount in the M-P&VE furnished carriers.

e. Umbilical Carrier. The M-P&VE carrier which groups the small lines together in a common housing will have a bolted interface with the LOC withdrawal mechanism. This interface is shown in Figure 7-1. LOC will furnish the bolts.

f. Extension Platform Coupler. Personnel access extension platforms for the S-II FWD, S-IVB AFT, S-IVB FWD, and SM service arms will couple directly to the vehicle. This coupler is detailed in Figure 4-37. Permission for a hard point on the SM for this purpose has not yet been granted by the Manned Spacecraft Center.

g. Extension Platform Bumper. On all personnel access extension platforms, a bumper assembly (Figure 7-2) will be provided by LOC. This resilient bumper provides surface area for contact against the vehicle skin. The bumper is used in conjunction with the coupler discussed in paragraph f on the S-II FWD, S-IVB AFT, S-IVB FWD and SM service arms.

h. Cylinder-Type Withdrawal Mechanism Interface. As shown in Figure 7-1, LOC furnishes the complete assembly including the shock mount joint, small cylinder, springs, and driving linkage connected to the small cylinder. M-P&VE provides the driving linkage for the umbilical carrier cam-off lever. These two driving linkages are keyed to a common spline provided by LOC.

Following is a detailed explanation, by service arm, of the vehicle interfaces.

7-2. S-IC INTERTANK ARM

Two 8-inch stainless steel flex lines interface with M-P&VE vehicle ground half propellant devices (Figure A-1, Appendix A and Figure F-64, Appendix F) with raised face flanges. The extension platform interfaces with a bumper as shown in Figure 7-2.

7-3. S-IC FWD ARM

The extension platform bumper (Figure 7-2) will contact, but not couple with the vehicle. The lanyard withdrawal mechanism (Figures 4-21 and 4-22) will interface with the umbilical carrier on the cam-off lever. All of the service lines (Figures A-3 and A-4) interface at the umbilical carrier (Figure 7-3) as outlined in subparagraphs b through d.

7-4. S-II AFT ARM

The bumper (Figure 7-2) does not couple to the vehicle. The LOC/ M-P&VE interface is at the ground half of the quick disconnect coupling. LOC furnishes flex line up to the coupling as well as the lanyard for the withdrawal mechanism. This lanyard will be connected to an attachment on the coupling.

7-5. S-II INTERMEDIATE ARM

As there is no personnel access into the vehicle from this arm, neither of the extension platforms contact the vehicle. The M-P&VE umbilical carrier, which will have a mounting pad as an interface, is shown in Figure 7-4. The LOC withdrawal mechanism will bolt to this mounting pad. The service lines (Figures A-7, A-8 and A-9) interface as outlined in subparagraphs a through d. The LOC/M-P&VE interface for the LO_2 fill and drain line is detailed in Figure 7-5. The LOC portion of this interface consists of the vacuum jacketed flex hose with the 150-pound raised face floating flange, bolts, and gasket. LOC also provides the retract and cam-off lanyards and the six small pneumatic and purge flex lines which interface at the coupling valve and flex hose. M-P&VE will supply the coupler, the butterfly shut-off valve, and the support bracket which interface with the LOC retract lanyard. The LH_2 fill and drain line, which is handled by a lanyard device (Figure 7-5) has an interface similar to the LO_2 connector. The LOC flex line interfaces with the M-P&VE butterfly valve by means of a 150-pound floating flange.

7-6. S-II FWD ARM

The extension platform will have a "hard" connection as well as a "soft" bumper. The individual umbilical carrier and extension platform interfaces are discussed in paragraph 7-1 b, c, d, f, g, and h.

7-7. S-IVB AFT ARM

The interfaces for the extension platform coupler and bumper are covered in paragraphs 7-1 f and g. All of the service lines are supported by the umbilical carrier which is handled by a cylinder type withdrawal mechanism. These LOC provided lines interface with M-P&VE supplied quick-disconnect couplings as outlined in paragraph 7-1 a, b, c, and d. The M-P&VE carrier (Figure 7-6) interfaces with the LOC withdrawal mechanism as detailed in paragraph 7-1 e and h.

7-8. S-IVB FWD ARM

There will be a "hard" and "soft" connection between the extension platform and the vehicle. Refer to paragraph 7-1 f and g. The S-IVB FWD and IU umbilical carriers are supported in a common frame (Figure 7-7). M-P&VE will provide an interface on this frame for the LOC cylinder type withdrawal mechanism. Details on this interface are given in paragraph 7-1 e and h. The service line data is covered in Figure A-14 and the interfaces in paragraph 7-1 b, c and d.

7-9. SERVICE MODULE ARM

Although there will be no personnel access into the vehicle from this arm, a coupler will be used, if a hard point can be provided. This coupler is detailed in Figure 4-37. The service line data is covered in Figures A16 and A17. The umbilical carrier (Figure 7-8) has an M-P&VE/LOC interface on the cam-off lever where the LOC lanyard withdrawal mechanism attaches (Figure 4-27). The line interface is outlined in 7-1 b, c, and d.

7-10. COMMAND MODULE ACCESS ARM

There are two vehicle interfaces on this arm. The environmental room bumper(s) as presently considered will contact and track, but not couple with, the vehicle at the vehicle station 3716.555 field splice. An interface also exists between the environmental room seal and the edge of the access door.

7-11. <u>TOWER INTERFACES</u>

All interfaces discussed in this paragraph are those between service and access arms, with their associated equipment, and the LUT. All tower interfaces (Appendix D) are the responsibility of the Launch Support Equipment Engineering Division (LO-D) of LOC. The following branches and sections of the division are affected:

LO-DE - Launch Equipment Branch
LO-DE5 - Electrical Section
LO-DE3 - Pneumatic Section
LO-DE4 - Umbilical Arm Section
LO-DL - Launch Transporter Systems Branch
LO-DL3 - Structures Section
LO-DL5 - Electrical Section
LO-DP3 - Mechanical Section
LO-DP2 - Cryogenics Section

The interfaces established delineate realms of responsibility between the branches and sections of LO-D.

7-12. LO-DE4/LO-DL INTERFACES

7-13. Service Arms and Command Module Access Arm. Each service arm will have two hinges (Figure 4-13) which bolt to the Launcher Umbilical Tower Mounting Beam. The tower elevation at the bottom of the lower chord of each service arm is as follows: S-IC INTERTANK - 666.000, S-IC FWD - 1391.000, S-II AFT - 1566.000, S-II INTERMEDIATE - 1741.000, S-II FWD - 2391.000, S-IVB AFT - 2631.000, S-IVB FWD - 3156.000, and SM - 3636.000 (Figure 2-2). Details of service arm hinge mounting is given in Appendix D. The Command Module Access Arm interfaces with the Launcher Umbilical Tower in a manner similar to the service arm interface. However, the mounting beam is located on the east face of the tower.

7-14. Control Consoles. Refer to Appendix D for details on the LUT interface with the consoles on tower levels 60, 120, 140, 160, 200, 220, 260, 300 and 320. Another interface exists in the LUT base where the hydraulic charging unit will be mounted.

7-15. Arm Accessways. There are nine accessways between the Launcher Umbilical Tower and the service amrs. The accessways are furnished by LO-DE4 and are detailed in Figure D-11, Appendix D.

7-16. Arm Support, Beam, and Linear Shock Absorber. The tower-mounted service arm skid, support and beam are furnished by LO-DE4. The linear shock absorber used to stop the arm is also furnished by LO-DE4. Refer to Figures D-1 through D-10 for locations at each level of the arm supports and linear shock absorbers.

7-17. Tower Mounted Cylinder. This mechanism is located on tower levels 140, 200, 220, 260, and 300 as shown in Figures D-4, D-6, D-7, D-8 and D-9. It is used in the service arm retraction system as outlined in paragraphs 4-46 and 4-50.

7-18. Water Quench System. A piping system for spraying each arm with water at the tower will be furnished by LO-DE4. This water quench system interfaces with the tower as detailed on the following figures in Appendix D:

S-IC INTERTANK arm - Figure D-2
S-IC FWD arm - Figure D-3
S-II AFT arm - Figure D-4
S-II INTERMEDIATE arm - Figure D-5
S-II FWD arm - Figure D-6
S-IVB AFT arm - Figure D-7
S-IVB FWD arm - Figure D-8
Service Module arm - Figure D-9
Command Module Access arm - Figure D-10

7-19. LO-DE4/LO-DL5 INTERFACES

7-20. Control. An interface will exist between the cables, distributors, and consoles furnished by LO-DE4 and the facility furnished by LO-DL5.

7-21. Umbilical. These are the LO-DE4 furnished shell size 40 cables which supply all electrical service to the vehicle. They are outlined in the following figures in Appendix A:

S-IC FWD Arm - Figure A-3
S-II INTERMEDIATE arm - Figures A-7 and A-8
S-II FWD arm - Figure A-10
S-IVB AFT arm - Figure A-12
S-IVB FWD arm - Figure A-14
Service Module arm - Figure A-16

The cables interface on the tower levels with an umbilical cross-over distribution panel.

7-22. Lights and Receptacles. The cables which furnish service to the arm mounted lights and 120/208 receptacles interface with a lighting distributor panel on tower levels 60, 120, 140, 160, 200, 220, 260, 300, and 320. Refer to Appendix C, Figures C-32 and C-36 for further details.

7-23. Firing. LO-DE4 has an interface at tower levels 160, 200, 220, 260 and 300 in the lift-off and umbilical release switch circuitry. A cable from the in-flight service arms interfaces with a distribution panel located on the above mentioned tower levels. Another interface exists with the umbilical release circuitry for the preflight arms. These interfaces are located on tower levels 60, 120, 140, and 320 at distributor panels.

7-24. LO-DE4/LO-DP2 INTERFACES

The interfaces discussed here are between the cryogenic lines and the environmental lines on the service arms and access arm and the tower supply lines.

7-25. LO_2. There are three LO_2 fill lines on the service arms; the S-IC INTERTANK arm (two lines), the S-II INTERMEDIATE arm, and the S-IVB AFT arm. Each of these LO-DE4 lines has an interface with LO-DP2 furnished line. The S-IC INTERTANK service arm 8-inch ID lines will interface approximately as shown in Figure D-2, Appendix D. The S-II LO_2 fill line interface is shown in Figure D-3. The S-IVB LO_2 fill line interface is as shown in Figure D-6.

7-26. LH$_2$. There are two LH$_2$ fill line interfaces. These are the 8-inch line at the S-II INTERMEDIATE service arm shown in Figure D-3, and the 6-inch ID line at the S-IVB AFT service arm as shown in Figure D-6.

7-27. GH$_2$ Vent. There are two GH$_2$ vent areas. One line is located at the S-II FWD service arm and interfaces with tower piping as shown in Figure D-6, and the other line is located at the S-IVB FWD service arm and interfaces as shown in Figure D-8 with the tower piping.

7-28. Environmental Control (LO-DPM). The interfaces discussed here are the connections between the service-arm-mounted and tower-mounted air conditioning and GN$_2$ purge lines; and between the access-arm-mounted and the tower-mounted lines. These flanged interfaces are located at the S-IC FWD, S-II INTERMEDIATE, S-II FWD, S-IVB AFT, S-IVB FWD, and Service Module arms as well as the access arm.

7-29. LO-DE4/LO-DE3 INTERFACES

The pneumatic section will furnish pneumatics for the vehicle, the umbilical carrier withdrawal mechanisms, and the hydraulic charging unit.

7-30. Service Arm Pneumatics. LO-DE4 will receive at the various tower levels the necessary pressurized air and GN$_2$ for operation of the pneumatic equipment on the service arms and access arm.

7-31. Hydraulic Charging Unit. There will be several hydraulic interface areas on the tower. One is located in the base of the LUT while the other is located at the consoles on the various levels. LO-DE3 will supply the piping from the LUT up to the control consoles.

7-32. Vehicle Pneumatics. LO-DE4 will interface with LO-DE3 at the tower levels for pneumatic service to the vehicle.

7-33. Vehicle Conditioning Fluids. LO-DE3 will furnish LO-DE4 the water/glycol for the Service Module arm and the water/methanol for the S-IVB FWD service arm from the supply units mounted on tower levels 260 and 300.

7-34. VERTICAL ASSEMBLY BUILDING INTERFACES

As the stages are assembled in the VAB, the respective service arm will be extended. As the service arms are extended, the VAB work platforms will be positioned. There will be provision in the work platforms for openings to accommodate the service arms and associated equipment. These cutouts are defined by the figures in E-2, Appendix E. A recommended universal clearance envelope for the service arm cutout in the VAB wall is detailed in Figure E-4 so that LO-DE4 may provide a standardized diaphragm for environmentally closing the cutout.

7-35. ARMING TOWER INTERFACES

The Command Module Access arm will not be extended until the LUT has been positioned at the Firing Site. Openings or cutouts will be provided in the arming tower platforms in order to accommodate the service and access arms which will be in the extended position. These opening requirements are outlined in Figures E-5 and E-6, Appendix E.

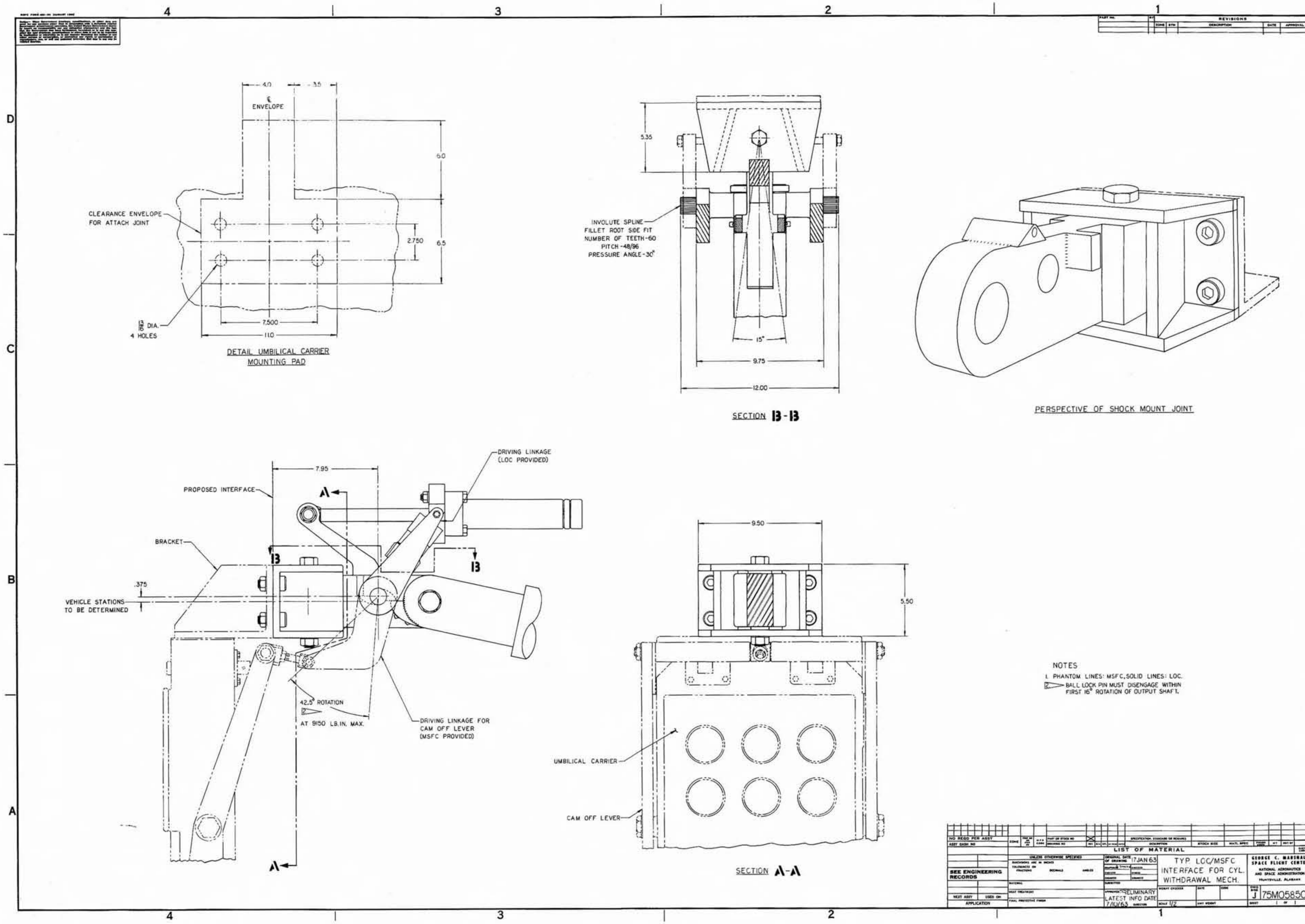
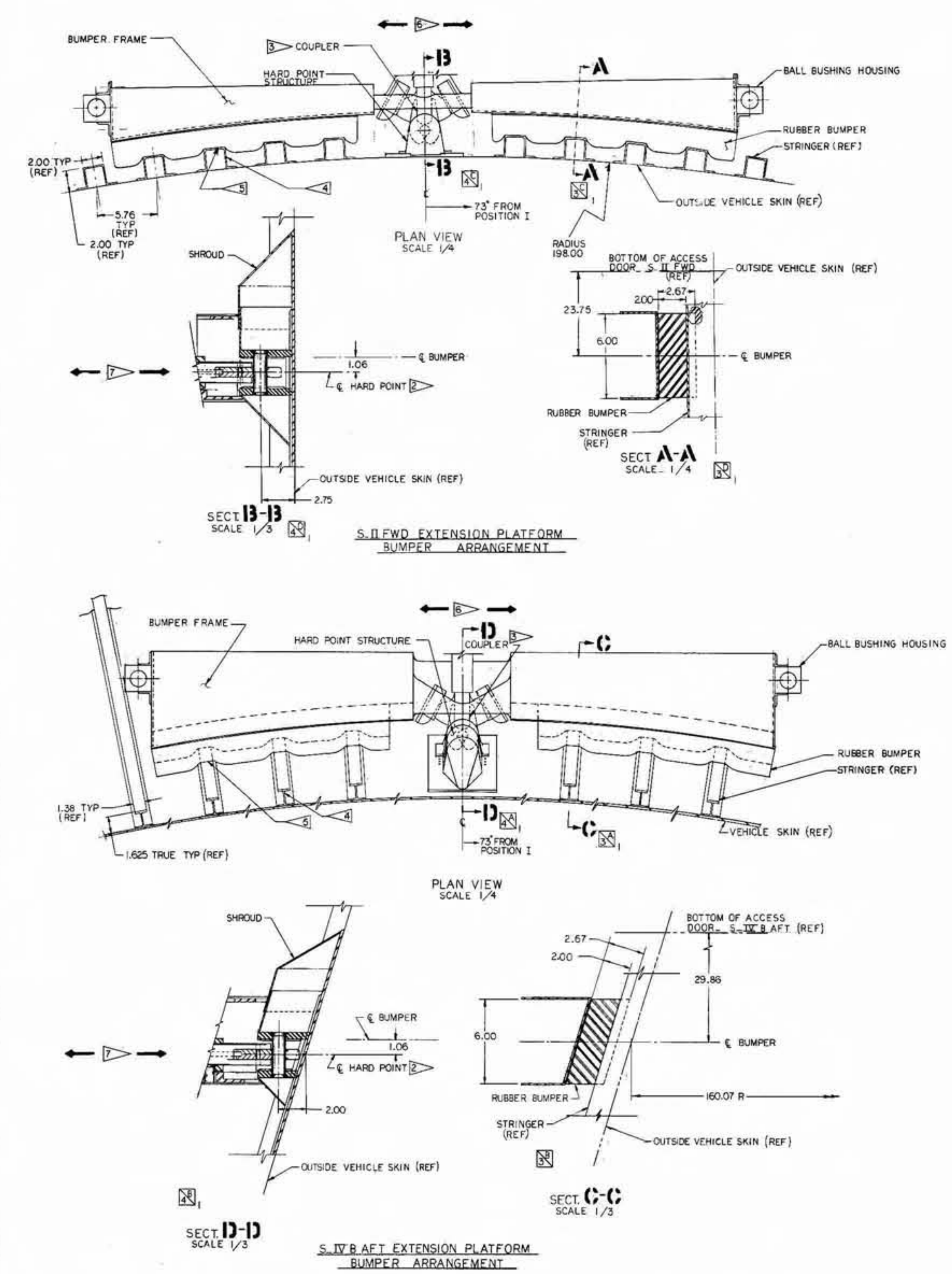
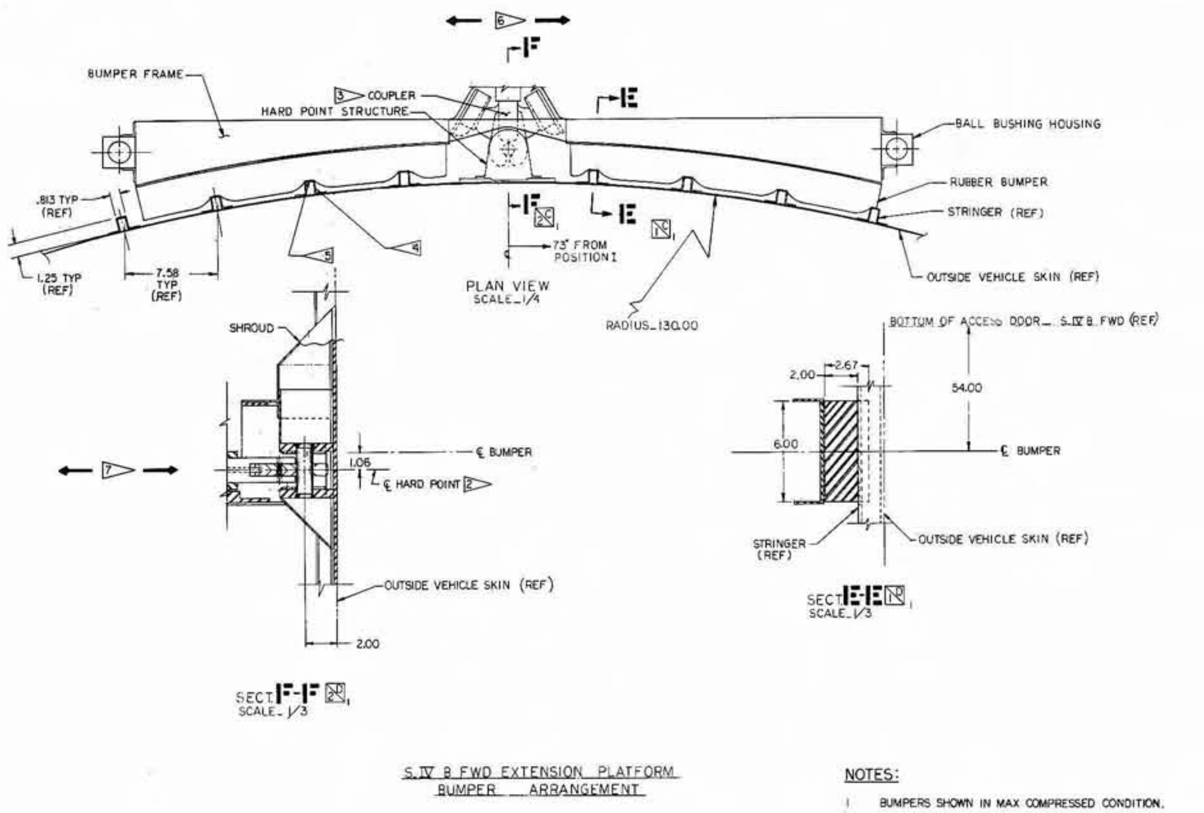


Figure 7-1. Cylinder-Type Withdrawal Mechanism Interface





EXTENSION PLATFORM	[4] NO. OF STRINGERS SUPPORTING BUMPER	[5] MAX. PRESS. ON STRINGERS (NO LOAD FACTOR)	DEFLECTION 95% WIND	[6] TANGENTIAL FORCE MAX. (NO LOAD FACTOR)	[7] RADIAL FORCE MAX. (NO LOAD FACTOR)
S-I C INTERTANK	10	0.32 PSI	0.65 IN		34.28 LBS
S-I C FWD	10	0.62	2.60		58.60
S-II AFT	10	0.72	3.20		62.80
S-II INTER					
S-II FWD	8	2.59	7.00	187.60 LBS	316.43
S-IV B AFT	6	8.80	8.30	249.60	395.43
S-IV B FWD	6	26.90	12.50	278.60	471.43
SM			16.80		
CM			17.80		

GROUND RULES – SATURN V EXTENSION PLATFORM OPERATION

1 MAX. WIND CONDITION WHILE CONNECTED TO THE VEHICLE = 95%
2 MAX WIND CONDITION FOR PERSONNEL ON PLATFORMS = 30 KNOTS.
3 TOWER DEFLECTIONS ARE NOT CONSIDERED FOR PLATFORM DEFLECTIONS.
4 NATURAL FREQUENCY OF VEHICLE = .80 DRY AND .33 FUELED.

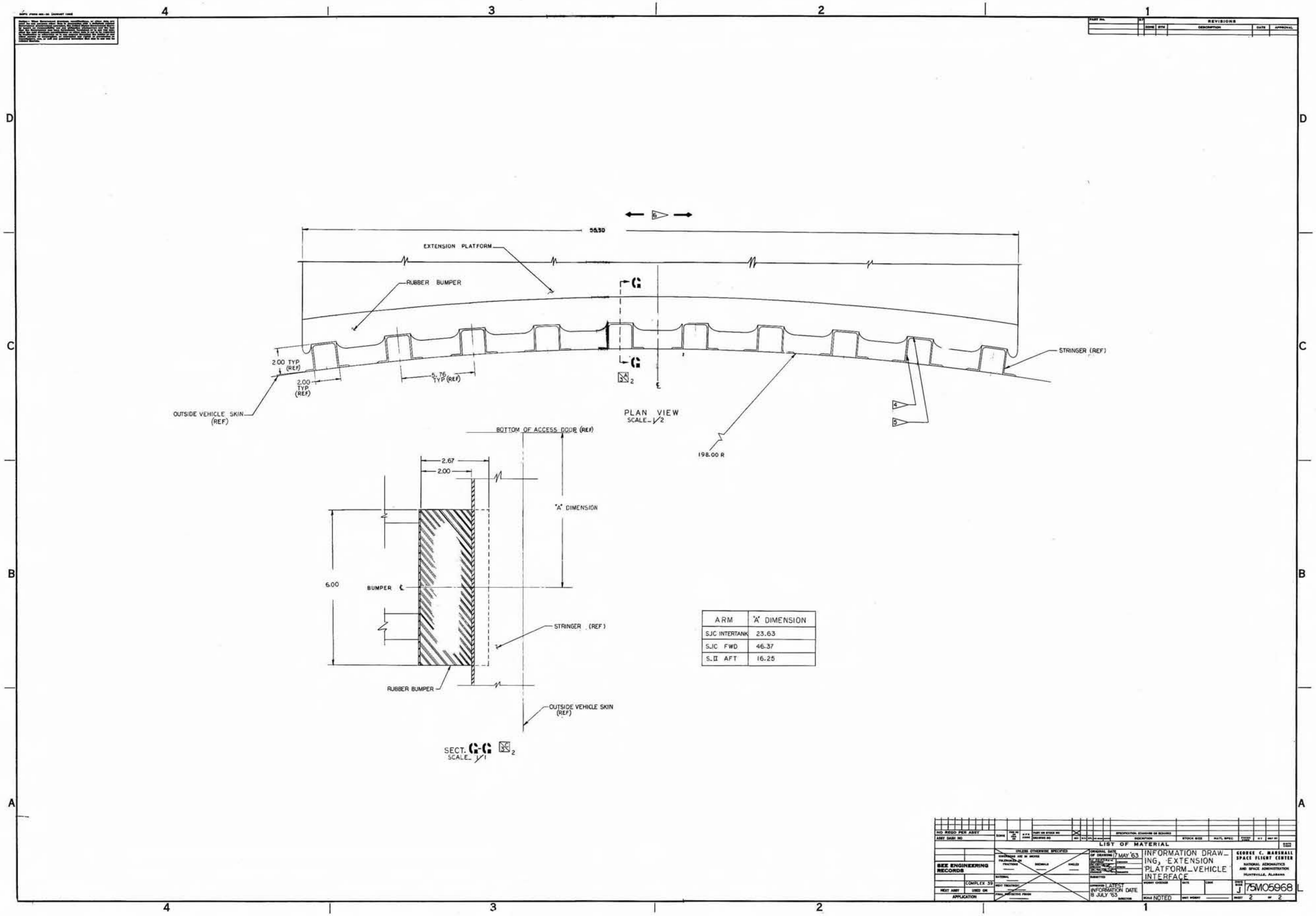
NOTES:

1 BUMPERS SHOWN IN MAX COMPRESSED CONDITION.
[2] HARD POINT TO BE ADJUSTABLE 1.50 FWD AND AFT OF POSITION SHOWN. ATTACHMENT BAR TO BE 1.00 DIA.
[3] OPENING IN COUPLER JAWS TO BE 1.12 DIA.

LIST OF MATERIAL

SEE ENGINEERING RECORDS
COMPLEX 39
ORIGINAL DATE OF DRAWING 17 MAY '63
APPROVED LATEST INFORMATION DATE 8 JULY '63
INFORMATION DRAWING, EXTENSION PLATFORM - VEHICLE INTERFACE
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA
SCALE NOTED
DWG SIZE J 75M05968
SHEET 1 OF 2

Figure 7-2. Extension Platform - Vehicle Interface (Sheet 1 of 2)



ARM	'A' DIMENSION
SJC INTERTANK	23.63
SJC FWD	46.37
S-II AFT	16.25

Figure 7-2. Extension Platform - Vehicle Interface (Sheet 2 of 2)

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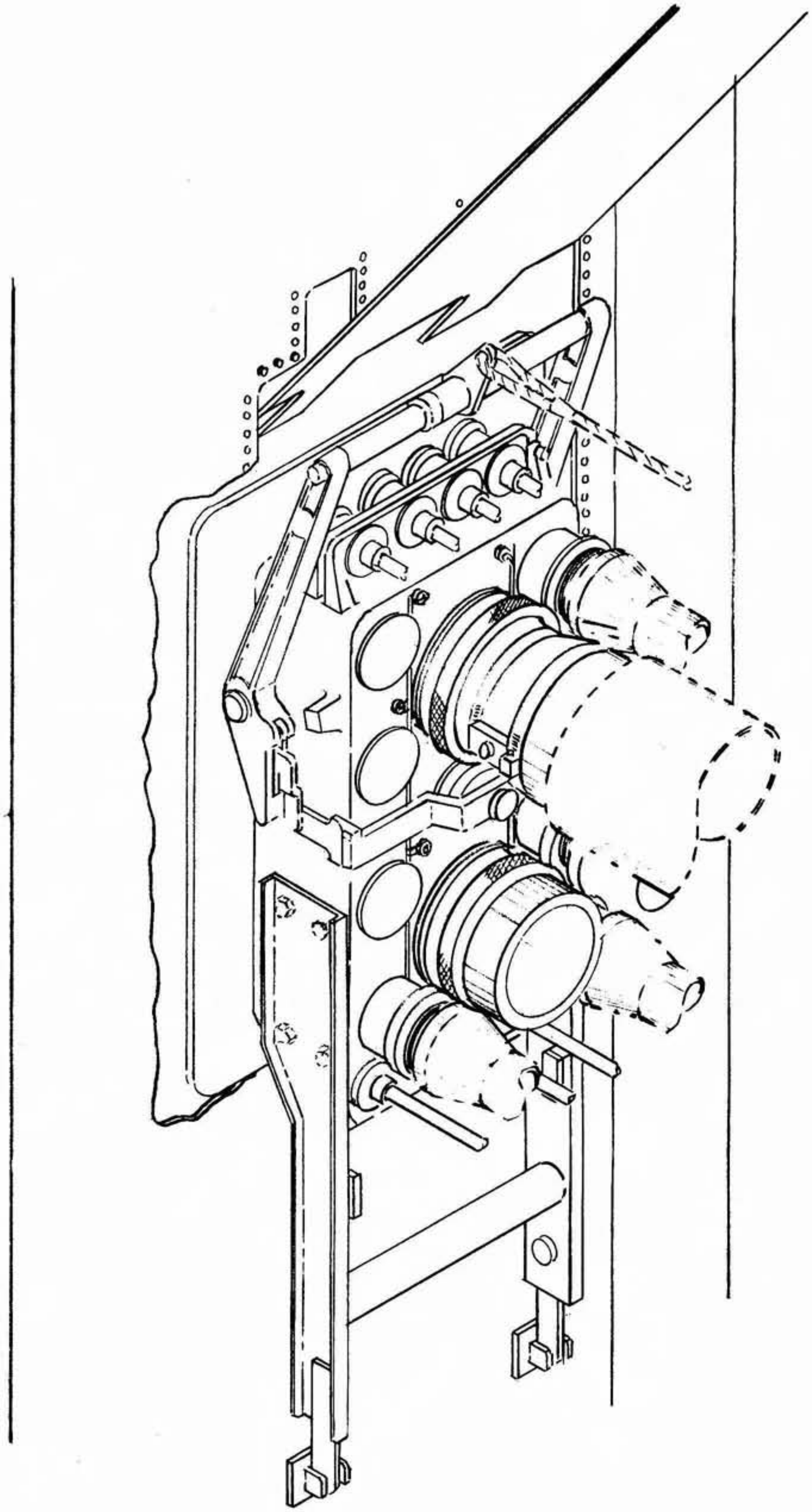


Figure 7-3. S-IC FWD Umbilical Carrier

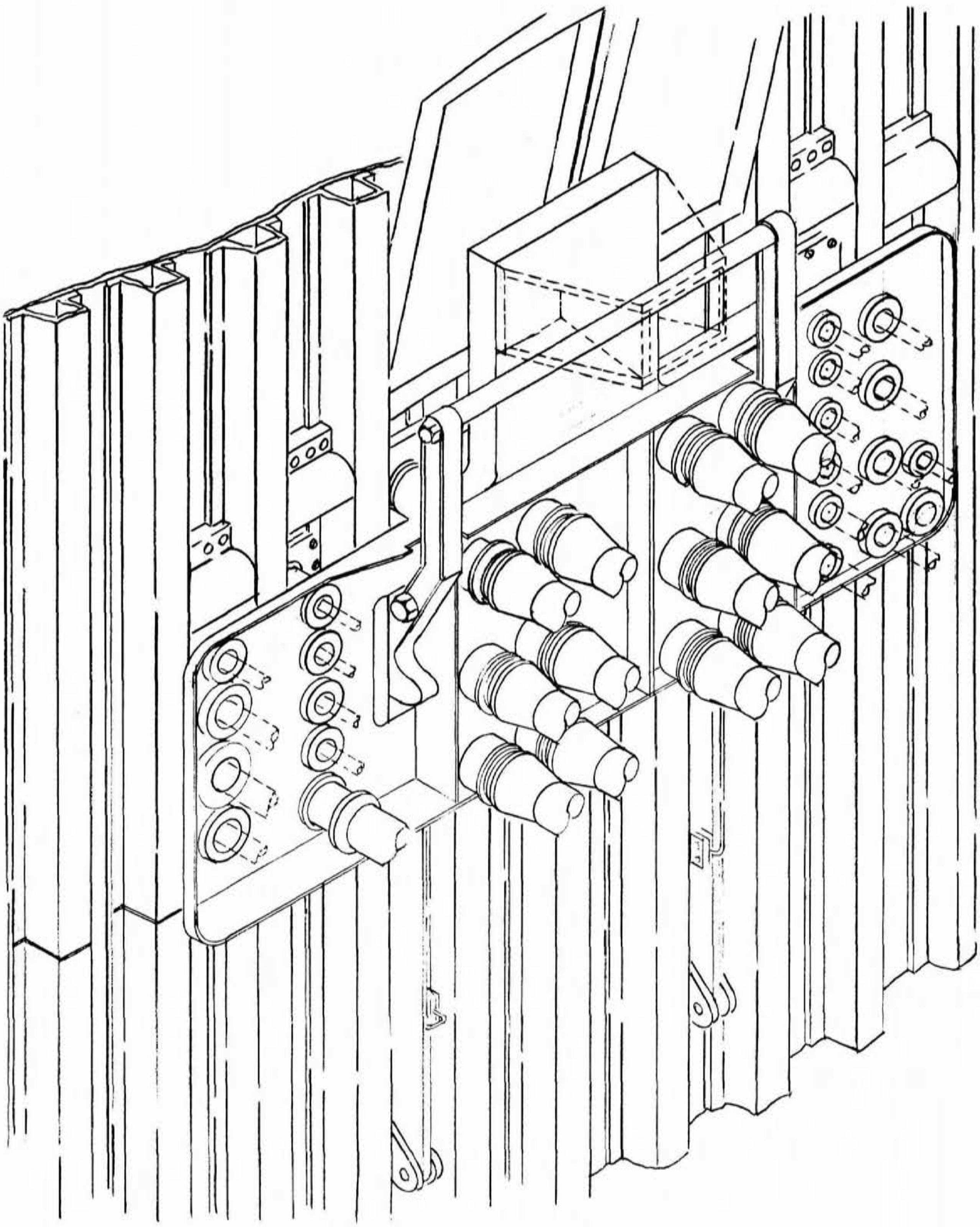


Figure 7-4. S-II INTERMEDIATE Umbilical Carrier

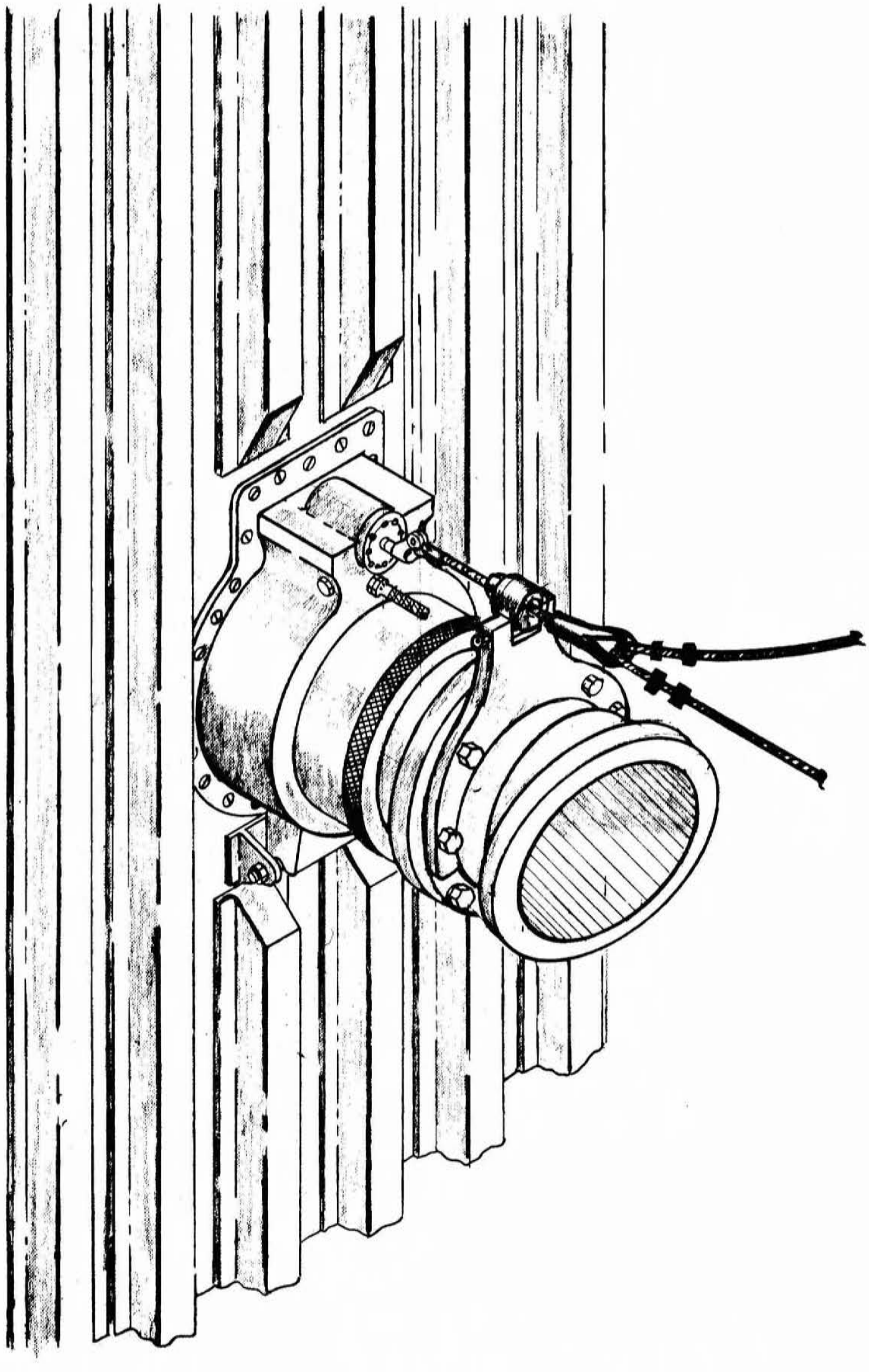


Figure 7-5. S-II INTERMEDIATE Propellant Coupler

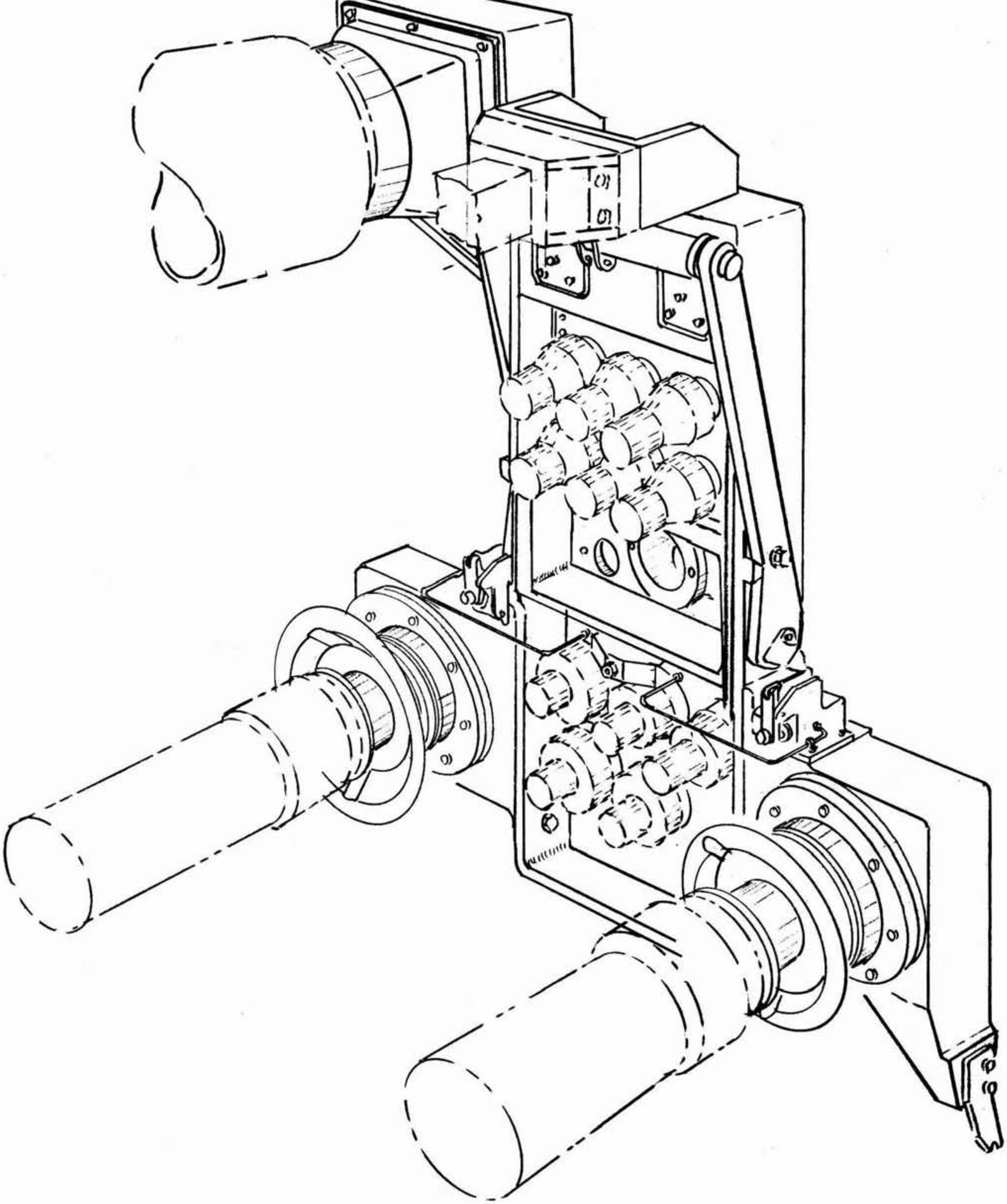


Figure 7-6. S-IVB AFT Umbilical Carrier

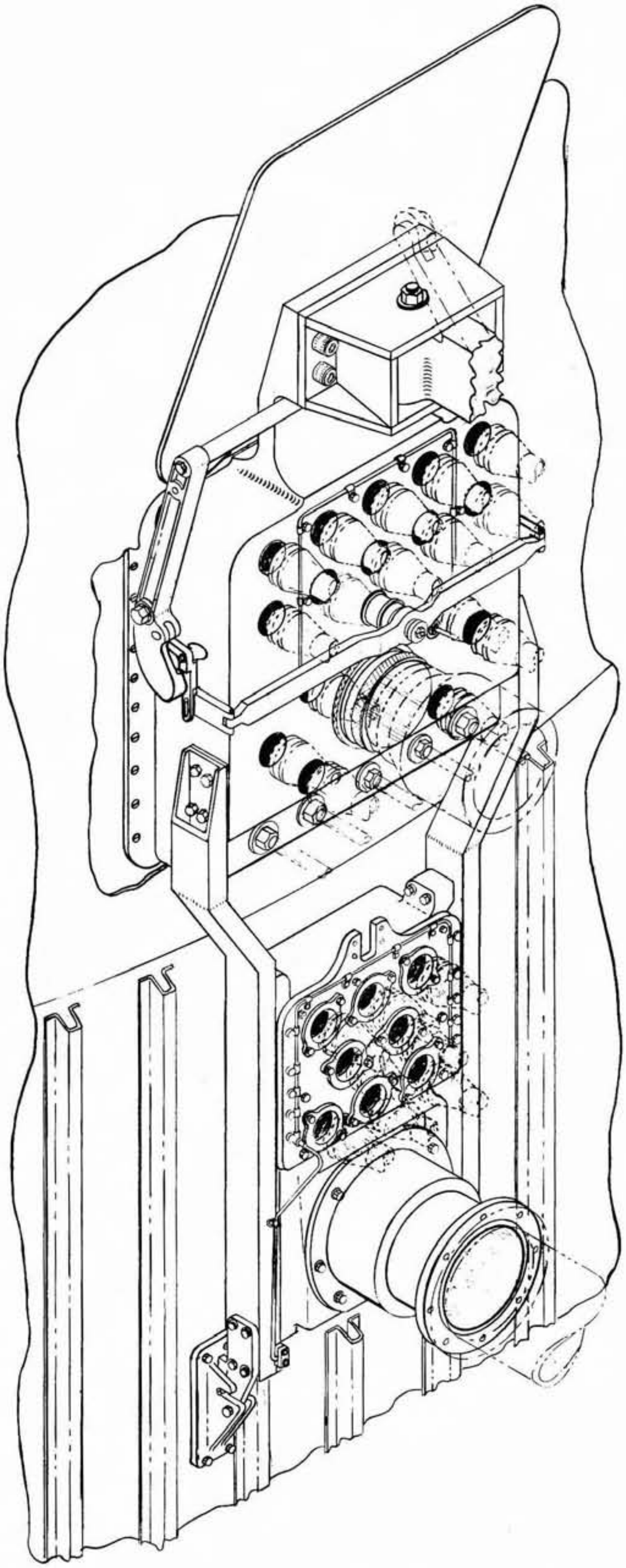


Figure 7-7. Combination S-IVB FWD and IU Umbilical Carrier

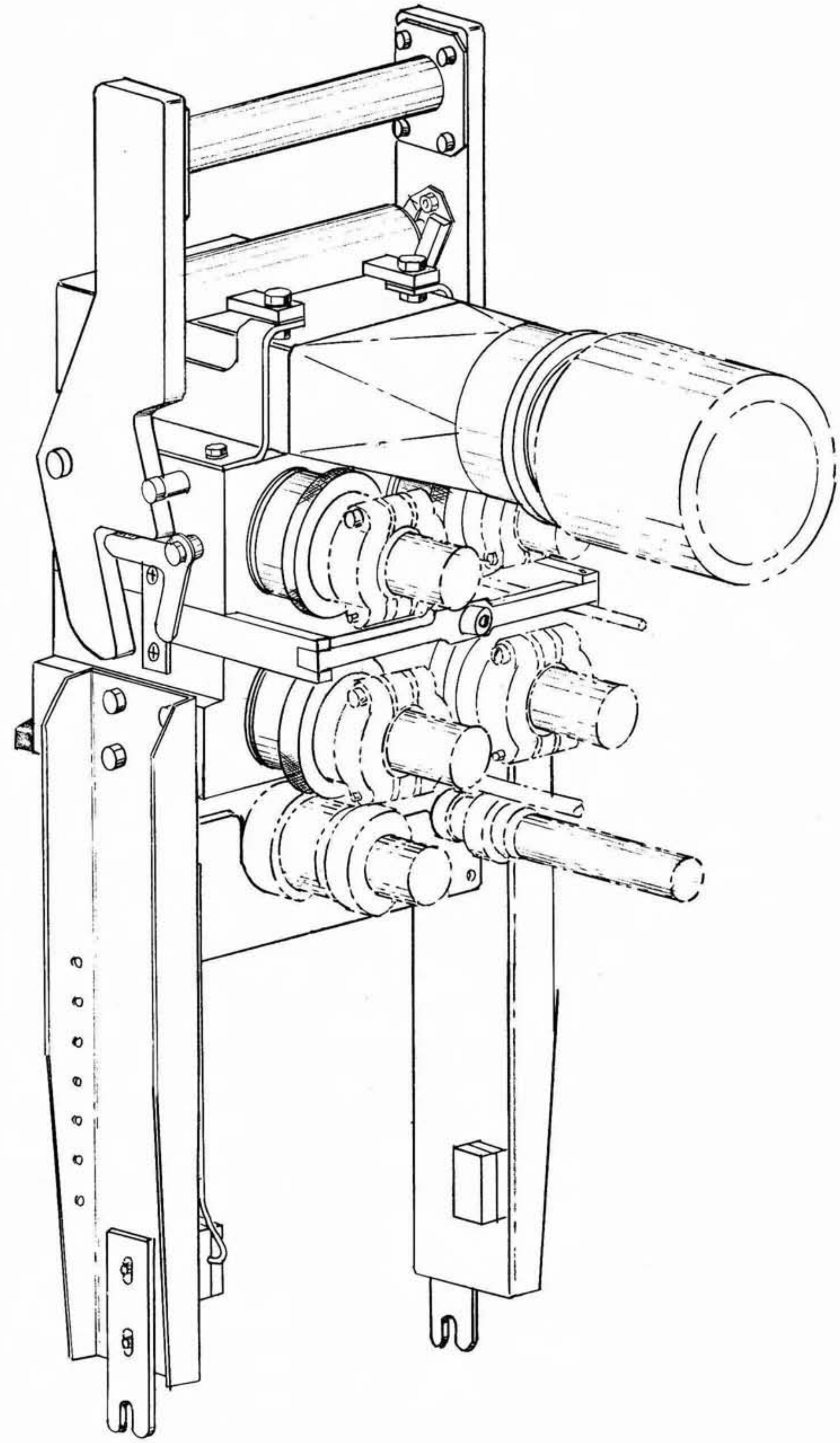


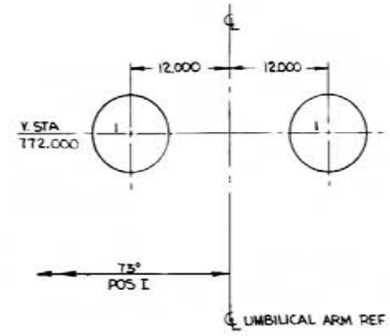
Figure 7-8. Service Module Umbilical Carrier

APPENDIX A

Preface

Appendix A contains tabular data on the umbilical service lines, such as specification, insulation, size, type material, source, and bend radii.

PART NO.	N F	ZONE	SYM	REVISIONS DESCRIPTION	DATE	APPROVAL



NOTES:
1. LOX CLEAN NO.1 TO MSFC SPEC 164.
2. ALL S.ST. FLEX LINES ARE TO BE CLOSE PITCH, ANNULAR CORRUGATED, BUTT WELDED, TYPE 321 STAINLESS STEEL (MIL-S-6721). FITTINGS AND BRAID SHALL BE ATTACHED BY HELI-ARC WELDING PER MIL-W-8611.

								CONNECTOR			TIP FLEX LINE DATA										
NUMBER	FUNCTION	NUMBER OF LINES	MEDIA	PRESS. (PSIG)	TEMP (°F)	FLOW RATE (LBS/MIN)	QUANTITY (LBS)	NOM SIZE (I.D. IN)	WEIGHT (LBS)	DISC FORCE (LBS)	TYPE	SOURCE	NOM I.D. (IN)	NOM O.D. (IN)	PROOF PRESS (PSIG)	WEIGHT LBS/FT	FITTINGS	LENGTH	℄ BEND RADIUS (IN. MIN) STATIC	FLEXING	BENDING MOMENT IN-LB/DEG
1	OXIDIZER TRANSFER	2	LOX	130	-297 TO -165	34,500	3,226, 769	6	TBD	TBD	CORRUGATED S.ST. WITH A S.ST. WIRE BRAID REINFORCEMENT—VACUUM JACKETED	*	8	12	260	20	TBD		27	45/82	TBD
2																					
3																					

SOURCE
* 1 MP & VE-EP "SATURN V FLUID REQUIREMENTS" 3/1/63
* 2 MP & VE-EA
* 3 BOEING DRAWING 5KG5B7431
4
* 5 FLEXONICS
* 6 ANACONDA

SEE ENGINEERING RECORDS	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS ANGLES	ORIGINAL DATE OF DRAWING 3/7/63	SATURN V UMBILICALS S-IC-INT. SERVICE ARM		GEORGE C. MARSHALL SPACE FLIGHT CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE, ALABAMA
		DRAFTSMAN GAMBILL CHECKER STRESS ENGINEER			DISTR CODE
	MATERIAL	SUBMITTED			
	HEAT TREATMENT	APPROVED PRELIMINARY - LATEST INFORMATION DATE 6/21/63 DIRECTOR	WEIGHT CHECKER	DATE CODE	DWG SIZE C 75M05626-L
NEXT ASSY / USED ON APPLICATION	FINAL PROTECTIVE FINISH		SCALE	UNIT WEIGHT	SHEET 1 OF 18

PART No.	M F	REVISIONS				
		ZONE	SYM	DESCRIPTION	DATE	APPROVAL

CONTINUED FROM SHEET 1

HARD LINE DATA										HINGED JOINT OR BELLOWS DATA					FLEX HOSE AT HINGE POINT						
NUMBER	NOM SIZE IN	TYPE	SPECIFICATION	WALL THICKNESS	INSULATION	WEIGHT LBS/FT	LENGTH (IN)	END FITTINGS	SOURCE	TYPE	SPECIFICATION	UNIT WEIGHT LBS	LENGTH (IN)	SOURCE	TYPE	O D	WEIGHT LBS/FT	LENGTH (IN)	SOURCE	BEND RADIUS	BENDING MOMENT IN-LBS
1	8	TBD ←																		→	TBD

DISTR. CODE

		UNLESS OTHERWISE SPECIFIED	ORIGINAL DATE OF DRAWING 5/9/63		SATURN V UMBILICALS, S-IC INT SERVICE ARM			LAUNCH OPERATIONS CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE, ALABAMA
SEE ENGINEERING RECORDS		DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS ANGLES	DRAFTSMAN	CHECKER				
			CHECKER	STRESS				
			ENGINEER	ENGINEER				
		MATERIAL	SUBMITTED					DWG SIZE C 75M05626L
		HEAT TREATMENT	APPROVED PRELIMINARY LATEST INFORMATION DATE 5/9/63 DIRECTOR		WEIGHT CHECKER	DATE	CODE	
NEXT ASSY	USED ON	FINAL PROTECTIVE FINISH			SCALE	UNIT WEIGHT		SHEET 2 OF 18
APPLICATION								

DIETZGEN NO. 137 DRAFTEX BLACKSTONE PRINTING CO. CHICAGO

MSFC FORM 422-2 (AUGUST 1960)

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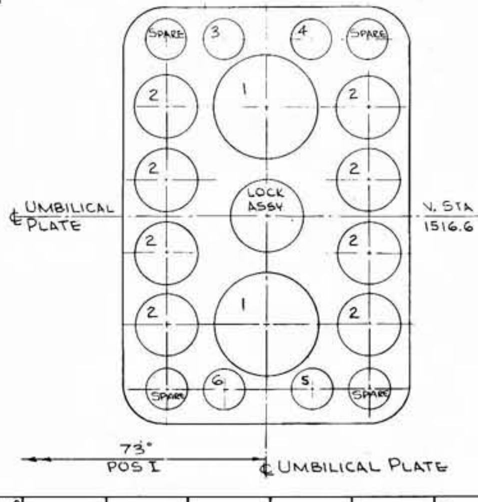
PART No.		REVISIONS				
		ZONE	SYM	DESCRIPTION	DATE	APPROVAL



NOTES:
1. HOUSING IDENTICAL TO S-IB HOUSING.
2. END FITTINGS ON 3-10 TO BE PER MC 223, MSFC SPEC 143.
3. LOX CLEAN 3-8 TO MSFC SPEC LEVEL 164
4. CONNECTOR DISCONNECT FORCE FOR Nº 3-8 IS 40 LBS; FOR Nº 2, 180 LBS
5. SEE NOTE 2, SHEET 1.
6. 3" THICK FLEXIBLE FIBERGLASS INSULATION WITH ATTACHED MOISTURE BARRIER. K FACTOR OF .25 BTU/HR IN/FT²/°F/IN.

NUMBER	FUNCTION	NUMBER OF LINES	MEDIA	PRESS. (PSIG)	TEMP. (°F)	FLOW RATE (LBS/MIN)	QUANTITY (LBS)	CONNECTOR NOM SIZE (I.D.-IN)	CONNECTOR WEIGHT (LBS)	TIP FLEX LINE TYPE	SOURCE	NOM I.D. (IN)	NOM O.D. (IN)	PROOF PRESS. (PSIG)	WEIGHT LBS/FT	FITTINGS	LENGTH	℄ BEND RADIUS MIN (IN) STATIC	FLEXING	BENDING MOMENT (IN-LBS)
1	AIR CONDITIONING & PURGE	2	AIR & GN_2	42 IN H_2O	40-150	30	TBD	4.00	2 EA	REF DRAWING Nº 75M05690-L	8	4	10	2.25	1.67	CLAMP OVER CUFF	130	N/A	6	TBD
2	ELECTRICAL	8	N/A	N/A	N/A	N/A	N/A	SHELL SIZE 40	3 EA	60 WIRE, REF. 75M02943	11	N/A	2	N/A	2.00	SEE SHEET 4	130	12	15	TBD
3	DELETED																			
4	DELETED																			
5	LO_2 VENT VALVE CONTROL PRESSURE	1	GN_2	750	AMB	6	TBD	.25	.2	TEFLON TUBE WITH S.ST. WIRE BRAID REINFORCEMENT	5 6	.25	.35	1500	.09	SEE NOTE 2	130	N/A	2	TBD
6	LOX AUTOMATIC CHECKOUT	1	GN_2	55	AMB	STATIC	TBD	.25	.2	SAME AS Nº 5	5 6	.25	.35	100	.09	SEE NOTE 2	130	N/A	2	TBD
7	DELETED																			
8	DELETED																			
9	UMBILICAL HOUSING PURGE	1	GN_2	TBD	AMB	TBD	TBD	.25	.2	SAME AS Nº 4	5 6	.25	.35		.09	SEE NOTE 2	130	N/A	2	TBD
10	UMBILICAL HOUSING DISCONNECT SUPPLY	1	GN_2	750	AMB	TBD	TBD	.25	.2	SAME AS Nº 4	5 6	.25	.35	1500	.09	SEE NOTE 2	130	N/A	2	TBD

SOURCE (Nºs 1, 2, 3 & 4 APPLY TO LINES 1-8)

1. M-P&VE-EF SATURN V FLUID REQUIREMENTS 3/1/63
2. BOEING SK 6587431-11 2/22/63
3. " -101 2/25/63
4. M-P&VE-EA
5. RESISTOFLEX (CAT R-500-4)
6. AEROQUIP (CAT #SGG-4)
7. FLEXIBLE TUBING CORP
8. ACTIONFLEX (ATCO CO)
9. WIGGENS
10. ON MARK
11. BROWN ENGR. CO.

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MATERIAL	
HEAT TREATMENT	
FINAL PROTECTIVE FINISH	
ORIGINAL DATE OF DRAWING	3/6/63
DRAFTSMAN	BALDWIN
APPROVED	PRELIMINARY LATEST INFORMATION DATE 6/21/63 DIRECTOR
TITLE	SATURN V UMBILICALS S-IC FWD. SERVICE ARM
	GEORGE C. MARSHALL SPACE FLIGHT CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE, ALABAMA
DWG SIZE	C
DWG NO.	75M05626-L
SHEET	3 OF 18

CONTINUED FROM SHEET 3

HARD LINE DATA										HINGED JOINT OR BELLOWS DATA					FLEX HOSE AT HINGE POINT						
NUMBER	NOM SIZE IN	TYPE	SPECIFICATION	WALL THICKNESS	INSULATION	WEIGHT LBS/FT	LENGTH (IN)	END FITTINGS	SOURCE	TYPE	SPECIFICATION	UNIT WEIGHT (LBS)	LENGTH (IN)	SOURCE	TYPE	FITTINGS	WEIGHT LBS/FT	LENGTH IN	SOURCE	BEND RADIUS	BENDING MOMENT IN-LBS
1	4	ALUMINUM DUCT	TBD	.04	SEE NOTE 6	TBD	TBD	CLAMP		N/A	N/A	N/A	N/A	N/A	SILICONE FIBERGLASS W/WIRE HELIX		1.67	TBD	75M05606L	6	
2	2 O.D	SAME AS Nº 2 SHEET 3		N/A	DYNA THERM	2	TBD	10-323640-55P CA-22511-0	BENDIX (TOWER) CANNON (VEHICLE)	N/A	N/A	N/A	N/A	N/A	SAME AS Nº 2 SHEET 3		2	TBD	11	12/15	
3		DELETED																			
4		DELETED																			
5	.25	TYPE 316 S.ST TUBING	DWG A75M05698	.035	NONE	.081	TBD	MC124C4 MC125C4		N/A	N/A	N/A	N/A	N/A	TEFLON W/ S.ST BRAID	SPEC 143	.09	TBD	5/6	2	
6	.25	TYPE 316 S.ST TUBING	DWG A75M05698	.035	NONE	.081	TBD	MC124C4 MC125C4		N/A	N/A	N/A	N/A	N/A	TEFLON W/ S.ST BRAID	SPEC 143	.09	TBD	5/6	2	
7		DELETED																			
8		DELETED																			
9	.25	TYPE 316 S.ST TUBING	DWG A75M05698	.035	NONE	.081	TBD	MC164C4 MC174C4		N/A	N/A	N/A	N/A	N/A	TEFLON W/ S.ST BRAID	SPEC 143	.09	TBD	5/6	2	
10	.25	TYPE 316 S.ST TUBING	DWG A75M05698	.035	NONE	.081	TBD	MC124C4 MC125C4		N/A	N/A	N/A	N/A	N/A	TEFLON W/ S.ST BRAID	MC 223	.09	TBD	5/6	2	

PART No. | REVISIONS: ZONE | SYM | DESCRIPTION | DATE | APPROVAL

SEE ENGINEERING RECORDS

NEXT ASSY | USED ON

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DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACTIONS DECIMALS ANGLES
MATERIAL
HEAT TREATMENT
FINAL PROTECTIVE FINISH

ORIGINAL DATE OF DRAWING 11 MAY 63
DRAFTSMAN | CHECKER
CHECKER | STRESS
ENGINEER | ENGINEER
SUBMITTED
APPROVED PRELIMINARY, LATEST INFORMATION DATE 7/2/63
DIRECTOR

SATURN V
UMBILICALS, S-IC FWD
SERVICE ARM

WEIGHT CHECKER | DATE | CODE
SCALE | UNIT WEIGHT

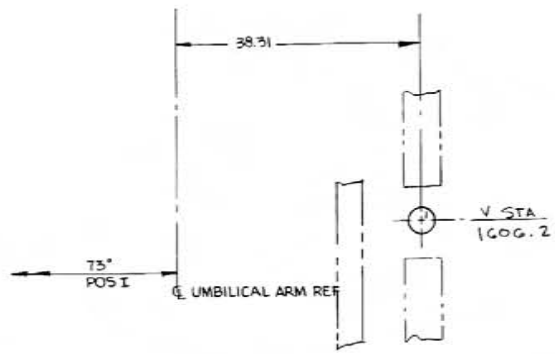
LAUNCH OPERATIONS CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

DWG SIZE C 75M05626L
SHEET 4 OF 18

DISTR. CODE

MSFC FORM 423-5 (AUGUST 1960)

PART NO.		REVISIONS			
	ZONE	SYM	DESCRIPTION	DATE	APPROVAL



NOTES

1. LOX CLEAN NO. 1 TO MSFC SPEC 164
2. SEE NOTE 2, SHEET 1.
3. FITTINGS TO BE PER MC223, MSFC SPEC-143
4. BLK FITTINGS MC164C16, NUTS MC174C16 & MC124C16, SLEEVE MC125C16.

NUMBER	FUNCTION	NUMBER OF LINES	MEDIA	PRESS. (PSIG)	TEMP (°F)	FLOW RATE (LBS/MIN)	QUANTITY (LBS)	CONNECTOR NOM SIZE (I.D. IN.)	CONNECTOR WEIGHT (LBS)	CONNECTOR DISC FORCE (LBS)	TIP FLEX LINE DATA TYPE	SOURCE	NOM I.D. (IN.)	NOM O.D. (IN.)	PROOF PRESS. (PSIG)	WEIGHT LBS/FT.	FITTINGS	LENGTH	℄ BEND RADIUS (IN. MIN) STATIC	℄ BEND RADIUS (IN. MIN) FLEXING	BENDING MOMENT IN-LB/DEG
1	LOX PUMP SEAL BLEED	1	LO2 GO2	5	-297	TBD	TBD	1.00	1.34	40	CORRUGATED S.ST. WITH S.ST. WIRE BRAID REINFORCEMENT REF RF8IL	5 6	1.00	1.54	25	1.04	SEE NOTE 3	TBD	2.75	9	TBD
2																					
3																					
4																					
5																					

SOURCE
1. M-P & VE-EF SATURN V FLUID REQUIREMENTS 3/1/63 (1-2)
2. M-P & VE-EA (1-2)
3. NAA DRAWING V7-949027 (4/26/63)
4.
5. FLEXONICS
6. ANACONDA
7. WIGGENS
8. ON MARK

SEE ENGINEERING RECORDS	
NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACTIONS DECIMALS ANGLES
MATERIAL
HEAT TREATMENT
FINAL PROTECTIVE FINISH

ORIGINAL DATE OF DRAWING 3/7/63
DRAFTSMAN CAMBELL
CHECKER
ENGINEER
STRESS
SUBMITTED
APPROVED PRELIMINARY LATEST INFORMATION DATE 6/21/63 DIRECTOR

SATURN V
UMBILICALS S II AFT
SERVICE ARM

WEIGHT CHECKER | DATE | CODE
SCALE | UNIT WEIGHT

DISTR CODE

GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

DWG SIZE C 75M05626L
SHEET 5 OF 18

LOC-FORM 21-5 (11/1/62) (REPLACES MRFC 422-8)

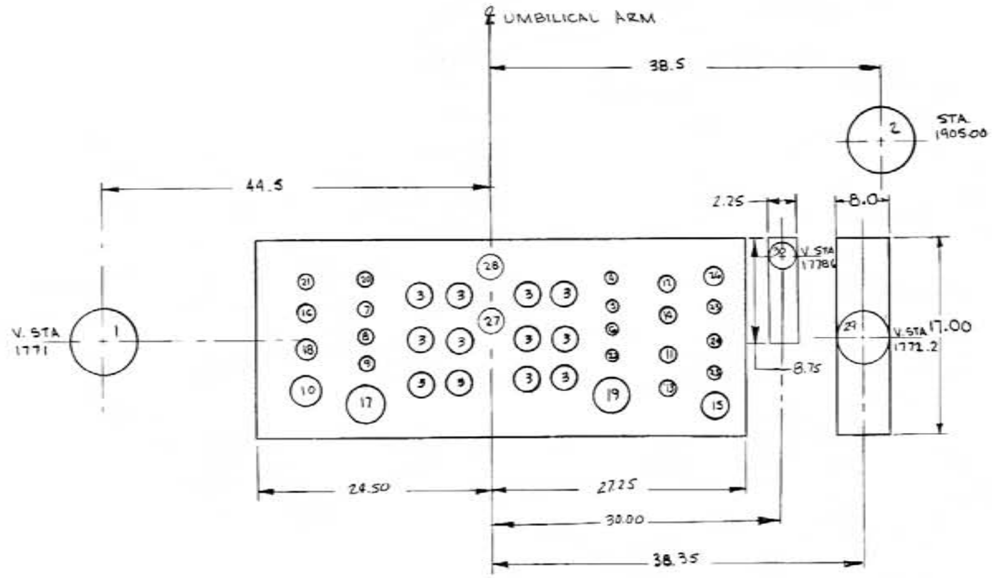
PART No.	NT	REVISIONS				
		ZONE	SYM	DESCRIPTION	DATE	APPROVAL

CONTINUED FROM SHEET 5

HARD LINE DATA										HINGED JOINT OR BELLOWS DATA					FLEX HOSE AT HINGE JOINT						
NUMBER	NOM SIZE IN	TYPE	SPECIFICATION	WALL THICKNESS	INSULATION	WEIGHT LBS/FT	LENGTH (IN)	END FITTINGS	SOURCE	TYPE	SPECIFICATION	UNIT WEIGHT LBS	LENGTH (IN)	SOURCE	TYPE	FITTINGS	WEIGHT LBS/FT	LENGTH (IN)	SOURCE	BEND RADIUS	BENDING MOMENT IN/LBS
1	1.00	TYPE 316 S.S.T. TUBING	DWG A75M05698	.049	NONE	.50	TBD	SEE NOTE 4	TBD	EXPANSION JOINT	TBD	1	5	5 6	SAME AS #1 SHEET 5	SEE NOTE 9	1.04	TBD	5 6	2.75/9	TBD

		UNLESS OTHERWISE SPECIFIED	ORIGINAL DATE OF DRAWING 10 MAY 63	SATURN V UMBILICALS, S II AFT SERVICE ARM			LAUNCH OPERATIONS CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE ALABAMA	DISTR. CODE
SEE ENGINEERING RECORDS		DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS ANGLES	DRAFTSMAN CHECKER					
			CHECKER STRESS					
		MATERIAL	ENGINEER ENGINEER					
			SUBMITTED					
		HEAT TREATMENT	APPROVED PRELIMINARY, LATEST INFORMATION DATE 5/21/63 DIRECTOR	WEIGHT CHECKER	DATE	CODE	DWG SIZE C 75M05626L	
NEXT ASSY	USED ON	FINAL PROTECTIVE FINISH		SCALE	UNIT WEIGHT		SHEET 6 OF 18	
APPLICATION								

DIETZGEN NO. 187 DRAFTING BLACKSTONE PRINTING CO. CHICAGO



NOTES:

1. LOX CLEAN Nº 1 & 2 TO MSFC SPEC 164.
2. SEE NOTE 2 SHEET 1.
3. BLK FITTINGS MIG4C8, NUTS MC174C8 & 124C8, SLEEVE MC125C8.
4. BLK FITTINGS MIG4C6, NUTS MC174C6 & 124C6, SLEEVE MC125C6
5. BLK FITTINGS. MIG4C32 NUTS: MC174C32 & 124C32 SLEEVE MC125C32
6. BLK FITTINGS, MIG4C12, NUTS, MC174C12 & 124C12, SLEEVE MC125C12.
7. BLK FITTINGS, MIG4C16, NUTS, MC174C16 & 124C16, SLEEVE MC125C16
8. BLK FITTINGS, MIG4C24, NUTS. MC174C24 & 124C24, SLEEVE MC125C24.
9. FITTINGS TO BE MC 223 PER MSFC SPEC 143.
10. ARMSTRONG "ARMAFLEX 22" OR EQUAL.
11. 2.0" THICK FLEXIBLE FIBERGLASS INSULATION WITH ATTACHED MOISTURE BARRIER. K FACTOR OF .25 BTU/HR IN/FT² 1°F/IN.

12. A 1/2" TEFLON ACTUATING LINE AND A 3/8" TEFLON SENSING LINE WILL RUN TO THE 1" CONNECTOR IN THE HOUSING
13. A 1/2" TEFLON ACTUATING LINE WILL RUN TO THE 1" CONNECTOR IN THE HOUSING
14. TWO VALVE CONTROL LINES (1/2"), TWO PURGE LINES (1/2") ONE ACTUATION LINE (1/2") AND ONE CONNECTOR BOOT PURGE LINE (1/2") ARE REQUIRED OUT TO THE GROUND HALF OF THE PROPELLENT CONNECTOR AND TO THE END OF THE FLEX HOSE.

SOURCE:

1. M-P&VE-EF "SATURN V FLUID REQUIREMENTS" 3/1/63 (1-21)
2. M-P&VE-EA SK 10-1351 11/27/62 (1-21)
3. VAA 5 & 10 V7-000003 1/15/63 (1-21)
4. NAA 5 & 10 V7-949027 4/26/63, DWG SK33-0038 (6/4/63)
5. ACTIONFLEX (ATCO CO)
6. FLEKONICS
7. RESISTOFLEX
8. AEROQUIP
9. WIGGENS
10. BROWN ENG CO
11. FLEXIBLE METAL HOSE MFG CO
12. ANACONDA
13. CONNECTICUT HARD RUBBER Co.

SEE ENGINEERING RECORDS	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS ANGLES	ORIGINAL DATE OF DRAWING 13 MAY 63	SATURN V UMBILICALS, S-II INT SERVICE ARM
NEXT ASSY / USED ON	MATERIAL / HEAT TREATMENT / FINAL PROTECTIVE FINISH	APPROVED PRELIMINARY LATEST INFORMATION DATE 6/21/63 DIRECTOR	LAUNCH OPERATIONS CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE, ALABAMA
APPLICATION			DWG SIZE C 75M05626 SHEET 7 OF 18

PART No.	EF	ZONE	SYM	REVISIONS DESCRIPTION	DATE	APPROVAL

CONTINUED FROM SHEET 7

NUMBER	FUNCTION	NUMBER OF LINES	MEDIA	MAX WORKING PRESSURE (PSIG)	TEMP (°F)	FLOW RATE (LB/MIN)	QUANTITY MAX (LBS)	CONNECTION: SIZE NOM IN I.D.	CONNECTION: WEIGHT (LBS)	CONNECTION: DISCON. NET FORCE	TIP FLEX LINE DATA: TYPE	SOURCE	NOM I.D. (IN)	NOM O.D. (IN)	PROOF PRESS	WEIGHT LBS/FT	FITTINGS	LENGTH (FT)	℄ BEND RADIUS MIN (IN): STATIC	℄ BEND RADIUS MIN (IN): FLEXING	BENDING MOMENT (IN/LBS)
1	OXIDIZER TRANSFER 14	1	LO_2	132	-290	47,320	775,000	8.00	60 MAX		VACUUM JACKETED CORRUGATED S.ST. WITH S.ST WIRE BRAID REINFORCEMENT	6/12	8	11.33	264	20	BAYONET	92/35	27	45/82	20
2	FUEL TRANSFER 14	1	LH_2	132	-423	5,922	155,000	8.00	60 MAX				8	11.33	264	20	BAYONET	180	27	45/82	20
3	ELECTRICAL	12	N/A	N/A	N/A	N/A	N/A	SHELL SIZE 40	3	180	60 WIRE, REF 75M02943	11	N/A	2	N/A	2	SEE SHEET 9	* TBD	12	15	TBD
4	LO_2 TANK FILL & VENT VALVE ACTUATION	1	He	750	AMB	TBD	TBD	.50	.42	40	TEFLON TUBE WITH S ST WIREBRAID REINFORCEMENT	7/8	.50	.59	1500	.15	SEE NOTE 9		N/A	4.75	
5	LO_2 TANK VALVE & PRESSURE SWITCH	1	He	37	AMB			.375	.38	40	SAME AS NUMBER 4	7/8	.375	.47	73	.12			N/A	4.00	
6	LH_2 TANK FILL VALVE ACTUATION	1	He	750	AMB			.75	.88	40	SAME AS NUMBER 4	7/8	.75	1.12	1500	.25			N/A	6.5	
7	TURBO PURGE	1	He	100	AMB			.75	.88	40	SAME AS NUMBER 4	7/8	.75	1.12	200	.25			N/A	6.5	
8	GH_2 START TANK VENT CONTROL	1	He	500	AMB			.50	.42	40	SAME AS NUMBER 4	7/8	.50	.59	1000	.15			N/A	4.75	
9	ENGINE HELIUM BOTTLE FILL	3 (12)	He	3200	-250±50			1.00	1.34	40	CORRUGATED S ST WITH S ST WIRE BRAID REINFORCEMENT 12	6/12	1.00	TBD	G400	1.5			TBD	15	
10	LO_2 TANK He PREPRESS & RECEIVER PRESS	1	He	3250	AMB TO -250			1.50	3.00	40	SAME AS NUMBER 9		1.50	TBD	G500	4.81			5.5	11/20	
11	GH_2 START TANK FILL	1	GH_2	1300	AMB TO -250±50			1.00	1.34	40	SAME AS NUMBER 9 REF RF45CP		1.00	2.12	2600	2.39			4.75	8.5/16	
12	LH_2 PUMP SEAL DRAIN	1	LH_2-GH_2	130	-430			1.00	1.34	40	SAME AS NUMBER 9 REF RF45CP		1.00	1.42	260	.86			3.0	10	
13	GH_2 START TANK VENT & RELIEF	1	GH_2	1300	-250±50			1.00	1.34	40	SAME AS NUMBER 9 REF RF45CP		1.00	1.52	2600	1.35			3.5	12	
14	THRUST CHAMBER JACKET PURGE	1	He	750	AMB To -250			1.00	1.34	40	SAME AS NUMBER 9 REF RF45CP	6/12	1.00	1.42	1500	.86			3.0	10	
15	LO_2 RECIRCULATION He BUBBLING	1	He	TBD	TBD			1.00	1.34	40	TBD		1.00	TBD	TBD	TBD			N/A	TBD	
16	LO_2 FILL & DRAIN OVERBOARD DUMP	1	LO_2-He	132				1.00	1.34	40	SAME AS NUMBER 9 REF RW8IL	6/12	1.00	2.32	264	1.80			3.75	12	
17	GAS GENERATOR COOL DOWN BLEED	1	LO_2-GO_2	35				2.00	7.25	40	SAME AS NUMBER 9 REF RF45CP	6/12	2.00	1.42	70	.86			3.0	10	
18	RECIRCULATION PNEUMATIC CONTROL SYSTEM	1 (13)	He	3250	TBD	TBD	TBD	1.00	1.34	40	TBD 13		1.00	TBD	G500	TBD			N/A	TBD	
19	DELETED																				
20	GH_2 PRESSURIZATION SYSTEMS PURGE	1	He	750	TBD	TBD	TBD	.50	.42	40	TBD		.50	TBD	1500	TBD			N/A	TBD	
21	DELETED																				
22	DELETED																				
23	DELETED																				
24	PRESSURE SYSTEM PRESSURE REGULATOR CHECKOUT	1	GN_2	1000	TBD	TBD	TBD	.25	.20	40	TBD		.25	TBD	2000	TBD			N/A		
25	RECIRCULATION PRESSURE REGULATOR CHECKOUT	1	GN_2	1000	TBD		TBD	.50	.42	40	TBD		.50	TBD	2000	TBD			N/A		
26	RECIRCULATION LH_2 RET. LINE PURGE BLEED	1	GN_2	50	TBD		TBD	1.00	1.34	40	TBD		1.00	TBD	100	TBD			N/A		
27	ELECTRICAL DISCONNECT PURGE	1	GN_2	2	AMB	TBD	N/A	.50	.42	40	SAME AS NUMBER 4	7/8	.50	.59	4	.15			N/A	4.75	
28	UMBILICAL HOUSING DISCONNECT SUPPLY	1	GN_2	750	AMB	STATIC	N/A	.50	.42	40	SAME AS NUMBER 4	7/8	.50	.59	1500	.15	SEE NOTE 9		N/A	4.75	
29	A/C ENGINE COMPARTMENT PURGE	1	AIR GN_2	2.5	80-250	500	N/A	8x17 TO 14Φ	TBD	TBD	REF DRAWING 75M05693L	5/13	14.00	18	20	TBD	TBD		N/A	21	
30	A/C INSTRUMENT COOLING & PURGE	1	AIR GN_2	10	70-150	25	N/A	2¼x8¾ TO 4Φ	TBD	TBD	REF DRAWING 75M05690L	5/13	4.00	8	20	1.67	TBD	TBD	N/A	6	TBD

* APPROXIMATE LENGTH - 12 FT.

DISTR. CODE

SEE ENGINEERING RECORDS

NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACTIONS DECIMALS ANGLES
MATERIAL
HEAT TREATMENT
FINAL PROTECTIVE FINISH

ORIGINAL DATE OF DRAWING 10 MAY 63
DRAFTSMAN CHECKER
CHECKER STRESS
ENGINEER ENGINEER
SUBMITTED
APPROVED PRELIMINARY INFORMATION LATEST 6/21/63
DATE DIRECTOR

SATURN V
UMBILICALS, S-II INT
SERVICE ARM

WEIGHT CHECKER | DATE | CODE
SCALE | UNIT WEIGHT

LAUNCH OPERATIONS CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE ALABAMA

DWG SIZE C 75M05626L
SHEET 8 OF 18

LOC-FORM 21-5 (11/1/62) (REPLACES MRFC 422-8)

Notice—When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

PART No.	MF	REVISIONS				
		ZONE	SYM	DESCRIPTION	DATE	APPROVAL

CONTINUED FROM SHEET 7

HARD LINE DATA

NUMBER	Nom Size IN	TYPE	SPECIFICATION	WALL THICKNESS	INSULATION	WEIGHT LBS/FT	LENGTH (IN)	END FITTINGS	SOURCE
1	8	TBD [14]	TBD	TBD	V.J.	TBD	TBD	BAYONET	
2	8	TBD [14]	TBD	TBD	V.J.	TBD		BAYONET	
3	2 OD	SAME AS № 3 SHEET 8	N/A	N/A	DYNA THERM	2		10-923640-539 CA-22511-0	BENDIX-TOWER CANNON-VEHICLE
4	.5	TYPE 316 S.ST. TUBING	DWG A75M05698	.035	NONE	.18		SEE NOTE № 3	
5	.375			.035		.13			
6	.75			.049		.50			
7	.75			.049		.50			
8	.5	TYPE 316 S.ST. TUBING	DWG A75M05698	.036	NONE	.18		SEE NOTE № 3	
9	1.00	TYPE 316 SCH 40S S.ST. PIPE [12]		1.33	SEE NOTE 10	1.68			
10	1.5	TYPE 316, SCH 80S S.ST. PIPE		.20	SEE NOTE 10	3.63			
11	1.0	TYPE 316 S.ST. TUBING	DWG A75M05698	.049	SEE NOTE 10	.50		SEE NOTE № 7	
12	1.0				NONE				
13	1.0				NONE				
14	1.0			.049	SEE NOTE 10	.50		SEE NOTE № 7	
15	1.00			TBD	NONE			SEE NOTE № 7	
16	1.0			.049		.50		SEE NOTE № 7	
17	2.0	TYPE 316 S.ST. TUBING	DWG A75M05698	.083		1.7		SEE NOTE № 5	
18	1.00	TYPE 316, SCH 40S S.ST. PIPE [13]		.133		1.68			
19		DELETED							
20	.5	TYPE 316 S.ST. TUBING	DWG A75M05698	.035		.18		SEE NOTE № 3	
21		DELETED							
22		DELETED							
23		DELETED							
24	.25	TYPE 316 S.ST TUBING	DWG A75M05698	.035		.18		SEE NOTE 3	
25	.5			.035		.18		SEE NOTE № 3	
26	1.00			.049		.50		SEE NOTE № 7	
27	.5			.035		.18		SEE NOTE № 3	
28	.5	TYPE 316 S.ST TUBING	DWG A75M05698	.035	NONE	.18		SEE NOTE № 3	
29	14	ALUM. SHEET DUCT		.04	SEE NOTE 11	2.5		CLAMP	
30	4	ALUM SHEET DUCT		.04	4"(2x NOTE 11)	.5	TBD	CLAMP	

HINGED JOINT OR BELLOWS DATA

NUMBER	TYPE	SPECIFICATION	UNIT WEIGHT (LBS)	LENGTH (IN)	SOURCE
1	EXPANSION JOINT	TBD	TBD	TBD	TBD
2	EXPANSION JOINT	TBD	TBD	TBD	TBD
3	N/A	N/A	N/A	N/A	N/A
4					
5					
6					
7					
8	N/A	N/A	N/A	N/A	N/A
9	EXPANSION JOINT	TBD	TBD	TBD	TBD
10	EXPANSION JOINT				
11	EXPANSION JOINT				
12	EXPANSION JOINT				
13	EXPANSION JOINT				
14	EXPANSION JOINT	TBD	TBD	TBD	TBD
15	N/A				N/A
16	EXPANSION JOINT	TBD	TBD	TBD	TBD
17	EXPANSION JOINT	TBD	TBD	TBD	TBD
18	N/A	N/A	N/A	N/A	N/A
19					
20					
21					
22					
23					
24					
25					
26					
27					
28					
29					
30	N/A	N/A	N/A	N/A	N/A

FLEX HOSE AT HINGE POINT

NUMBER	TYPE	FITTINGS	WEIGHT LBS/FT	LENGTH (IN)	SOURCE	BEND RADIUS	BENDING MOMENT IN-LBS
1	V.J. S.ST. FLEX HOSE	BAYONET	20	156	6 11 12	45 / 82	600
2	V.J. S.ST. FLEX HOSE	BAYONET	20	156		45 / 82	600
3	SAME ASSY 3, SHEET 8	SAME AS HAROL	2	TBD	10	15	TBD
4	TEFLON W/ S.ST. BRAID	SEE NOTE 9	.15		7 8	4.75	
5			.12			4	
6			.25			6.5	
7			.25			6.5	
8	TEFLON W/ S.ST. BRAID		.15		7 8	4.75	
9	S.ST		1.5		6 11 12	15	
10			4.81			11 / 20	
11			2.39			8.5 / 16	
12			.86			10	
13			1.35			12	
14	S.ST.		.86		6 11 12	10	
15	TBD		TBD			TBD	
16	S.ST.		1.80		6 11 12	12	
17	S.ST.		.86		6 11 12	10	
18	TBD		TBD			TBD	
19							
20	TBD		TBD			TBD	
21							
22							
23							
24	TBD		TBD			TBD	
25	TBD		TBD			TBD	
26	TBD		TBD			TBD	
27	TEFLON W/ S.ST. BRAID		.15		7 8	4.75	
28	TEFLON W/ S.ST. BRAID	SEE NOTE 9	.15		7 8	4.75	
29	SILICONE/ FIBERGLASS	SEE NOTE	6.00		5 13	21	
30	SILICONE/ FIBERGLASS	SEE NOTE	1.67	TBD	5 13	6	TBD

DISTR. CODE

SEE ENGINEERING RECORDS

NEXT ASSY | USED ON

APPLICATION

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACTIONS DECIMALS ANGLES
MATERIAL
HEAT TREATMENT
FINAL PROTECTIVE FINISH

ORIGINAL DATE OF DRAWING 11 MAY '63
DRAFTSMAN / CHECKER / CHECKER / STRESS / ENGINEER / ENGINEER / SUBMITTED
APPROVED PRELIMINARY, LATEST INFORMATION, 6/21/63
DATE DIRECTOR

SATURN V
UMBILICALS, S-II INT
SERVICE ARM

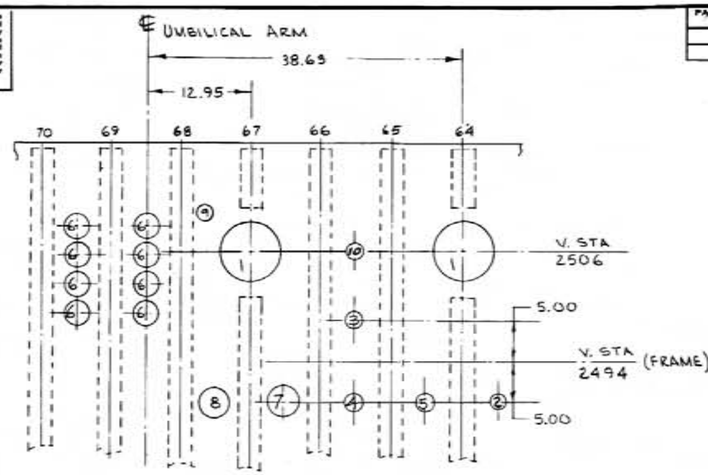
WEIGHT CHECKER | DATE | CODE
SCALE | UNIT WEIGHT

LAUNCH OPERATIONS CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

DWG SIZE C 75M05626-L
SHEET 9 OF 18

DIETZGEN NO. 157 DRAFTEX

PART NO.		ZONE	SYM	REVISIONS DESCRIPTION	DATE	APPROVAL



NOTES:

1. LOX CLEAN 1-5 & 5-9 TO MSFC SPEC 164
2. ALL S.ST. FLEX. LINES ARE TO BE CLOSE PITCH, ANNULAR CORRUGATED, BUTT WELDED, TYPE 321 STAINLESS STEEL (MIL-S-6721). FITTINGS & BRAID SHALL BE ATTACHED BY HELI-ARC WELDING PER MIL-W-8611
3. FITTINGS FOR N°S 2,3,4,5 & 8,9,10 TO BE PER MC 223, MSFC SPEC 143.
4. BLK FITTING MIG4C8, NUTS MC174C8 & 124C8, SLEEVE MC125C8

[5] A 1/2" TEFLON ACTUATING LINE AND A 3/8" TEFLON SENSING LINE WILL RUN TO THE 1" CONNECTOR IN THE HOUSING

NUMBER	FUNCTION	NUMBER OF LINES	MEDIA	PRESS. (PSIG)	TEMP (°F)	FLOW RATE (LBS/MIN)	QUANTITY (LBS)	CONNECTOR NOM SIZE (I.D. IN.)	CONNECTOR WEIGHT (LBS)	CONNECTOR DISC FORCE (LBS)
1	FUEL TANK VENT	2	GH_2	22	-423	300	N/A	7	~15	
2	FUEL TANK PRESSURIZATION & PURGE	3 / [5]	GN_2 / GHe / He	153 / 153 / 3300	AMB / AMB / -250°	184.8 / 20	5980 / 3900 / 210	1.00	1.34	40
3	LH_2 TANK PRESSURE SWITCH & VENT VALVE	1	H_E	14.3 TO 22.3	AMB	STATIC	N/A	.375	.38	40
4	LH_2 TANK VENT AND VALVE ACTUATION	1	H_E	750	AMB	STATIC	N/A	.50	.42	40
5	PRESSURE SYS PRESS REG CHECKOUT	1	GN_2	1000	TBD	TBD	TBD	.50	.42	40
6	ELECTRICAL	8	N/A	N/A	N/A	N/A	N/A	SH 40	3# EA	180
7	ELECTRICAL EQUIPMENT PURGE A/C	1	AIR GN_2	10	70-150	25	N/A	3		
8	DELETED									
9	HOUSING PURGE	1	GN_2	2	AMB	TBD	N/A	.50	.42	40
10	UMBILICAL HOUSING DISCONNECT SUPPLY	1	GN_2	750	AMB	STATIC	N/A	.50	.42	40

NUMBER	TIP FLEX LINE DATA: TYPE	SOURCE	NOM I.D. (IN.)	NOM O.D. (IN.)	PROOF PRESS. (PSIG)	WEIGHT LBS/FT	FITTINGS	LENGTH	℄ BEND RADIUS (IN. MIN) STATIC	℄ BEND RADIUS (IN. MIN) FLEXING	BENDING MOMENT IN-LB/DEG
1	CORRUGATED S.ST. WITH S.ST. WIRE BRAID REINFORCEMENT. REF. RF45CP	4 5 6	8	10	50	8.6	FLANGE	* TBD	19	29/48	TBD
2	CORRUGATED S.ST. WITH S.ST. WIRE BRAID REINFORCEMENT [5]	4 5 6	1.000	1.85	6600	3.0	TBD	↓	4	15	↓
3	TEFLON TUBE WITH S.ST. WIRE BRAID REINFORCEMENT	7 8	.375	.47	50	.12	SEE NOTE 3		N/A	4.00	
4	SAME AS NO. 3	7 8	.50	.59	1500	.15	SEE NOTE 3		N/A	4.75	
5	SAME AS NO 3	7 8	.50	.59	2000	.15	SEE NOTE 3		N/A	4.75	
6	60 WIRE, REF. 75M02943	10	N/A	2	N/A	2	N/A		12	15	
7	REF DWG 75M05690-L	11	4	12	20	1.67	CLAMP		N/A	6	
8											
9	SAME AS NO 3	7 8	.50	.59	4	.15	SEE NOTE 3	↓	N/A	4.75	↓
10	SAME AS No 3	7 8	.50	.59	1500	.15	SEE NOTE 3	TBD	N/A	4.75	TBD

* APPROXIMATE LENGTH - 10 FT

SOURCE

1. MP & VE-EF "SATURN V FLUID REQUIREMENTS" 3/1/63 (1-8)
2. MP & VE-EA (1-8)
3. N.A.A. V7-949027 (4/26/63), SK-33-0039 (6/14/63)
4. FLEXIBLE METAL HOSE MFG CO.
5. FLEXONICS
6. ANACONDA
7. AEROQUIP
8. RESISTOFLEX
9. WIGGENS
10. BROWN ENGR. Co
11. ACTO Co

SEE ENGINEERING RECORDS	
NEXT ASSY	USED ON
APPLICATION	

UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES. TOLERANCES ON: FRACTIONS, DECIMALS, ANGLES. MATERIAL. HEAT TREATMENT. FINAL PROTECTIVE FINISH.

ORIGINAL DATE OF DRAWING 3/7/63. DRAFTSMAN GAMBILL. CHECKER. ENGINEER. STRESS. SUBMITTED. APPROVED: PRELIMINARY, LATEST INFORMATION DATE 6/21/63, DIRECTOR.

SATURN V
UMBILICALS S-II FWD
SERVICE ARM

WEIGHT CHECKER. DATE. CODE. SCALE. UNIT WEIGHT.

GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

DISTR CODE

DWG SIZE C 75M05626-L

SHEET 10 OF 18

LOC-FORM 21-5 (11/1/62) (REPLACES MSFC 422-3)

PART No.	NF	ZONE	SYM	REVISIONS DESCRIPTION	DATE	APPROVAL

CONTINUED FROM SHEET 10

HARD LINE DATA										BELLOWS OR FLEX HINGED JOINT DATA					HINGE POINT FLEX HOSE DATA						
NUMBER	NOM SIZE (IN)	TYPE	SPECIFICATION	WALL THICKNESS	INSULATION	WEIGHT LBS/FT	LENGTH (IN)	END FITTINGS	SOURCE	TYPE	SPECIFICATION	UNIT WEIGHT LBS	LENGTH (IN)	SOURCE	TYPE	FITTINGS	WEIGHT (LBS)	LENGTH (IN)	SOURCE	BEND RADIUS	BENDING MOMENT IN-LBS
1	8.0	SCH 5 S.S. TYPE 316 S.ST. PIPE		.109	NONE	13.4	TBD	FLANGE		EXPANSION JOINT	TBD	TBD	TBD	5, 6	S. ST	TBD	8.6	* TBD	4, 5, 6	29 / 48	TBD
2	1.0	SCH 40 S. TYPE 316 S.ST PIPE		.133	SEE NOTE 5	1.68	↓	FLANGE		EXPANSION JOINT	TBD	TBD	TBD	5, 6	S. ST	TBD	30	↓	4, 5, 6	15	↓
3	.375	TYPE 316 S.ST. TUBING	DWG A75M05698	.035	NONE	.13		SEE NOTE 4		N/A	N/A	N/A	N/A	N/A	TEFLON W/ S.ST BRAID	SEE NOTE 5	.12		7, 8	4.00	
4	.5	↑	↑	.035	↑	.18		SEE NOTE 4		↑	↑	↑	↑	↑	↑	↑	.15		7, 8	4.75	
5	.5	TYPE 316 S.ST. TUBING	DWG A75M05698	.035		.18		SEE NOTE 4							TEFLON W/ S.ST BRAID	SEE NOTE 3	.15		7, 8	4.75	
6	2 O.D.	SAME AS NUMBER 6 SHEET 10						10-323640-53P CA-22511-0	BENDEX - TOWER CANNON - VEHICLE						SAME AS #6 SHEET 10	N/A	2		10	15	
7	4	ALUM SHEET DUCT		.04	4" OF FIBERGLASS, K=.25			CLAMP							SILICONE & FIBERGLASS	CLAMP	1.67		11	6	
8																					
9	.5	TYPE 316 S.ST TUBING	DWG A75M05698	.035	↓	.18	↓	SEE NOTE 4		↓	↓	↓	↓	↓	TEFLON W/ S.ST.BRAID	SEE NOTE 3	.15	↓	7, 8	4.75	↓
10	.5	TYPE 316 S.ST. TUBING	DWG A75M05698	.035	NONE	.18	TBD	SEE NOTE 4		N/A	N/A	N/A	N/A	N/A	TEFLON W/ S.ST.BRAID	SEE NOTE 3	.15	TBD	7, 8	4.75	TBD

* APPROXIMATE LENGTH - 8 FT.

DISTR. CODE

SEE ENGINEERING RECORDS

NEXT ASSY | USED ON

APPLICATION

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACTIONS DECIMALS ANGLES
MATERIAL
HEAT TREATMENT
FINAL PROTECTIVE FINISH

ORIGINAL DATE OF DRAWING 10 MAY 63
DRAFTSMAN | CHECKER
CHECKER | STRESS
ENGINEER | ENGINEER
SUBMITTED
APPROVED PRELIMINARY, LATEST INFORMATION DATE 6/13/63 DIRECTOR

SATURN V
UMBILICALS S-II FWD
• SERVICE ARM

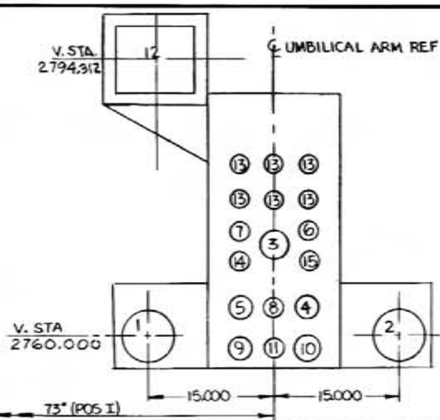
WEIGHT CHECKER | DATE | CODE
SCALE | UNIT WEIGHT

LAUNCH OPERATIONS CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

DWG SIZE C 75M05626L

SHEET 11 OF 18

DIETZGEN NO. 187 GRAPHIC BLACKSTONE PRINTING CO., CHICAGO



NOTES:
1. LOX CLEAN NO 1-12 & 13-17 TO MSFC SPEC 164.
2. SEE NOTE 2 SHEET 1.
3. 6 & 7 SHALL HAVE POLYETHYLENE TUBES.
4. FITTINGS FOR NOS 3-11 AND 14-16 TO BE PER MC 223, MSFC SPEC 143.
5. BLK FITTINGS MC164C4, NUTS MC174C4 & MC124C4, SLEEVE MC125C4
6. BLK FITTINGS MC164C6, NUTS MC174C6 & MC124C6, SLEEVE MC125C6.
7. BLK FITTINGS MC164C8, NUTS MC174C8 & MC124C8, SLEEVE MC125C8.
8. BLK FITTINGS MC164C12, NUTS MC174C12 & MC124C12, SLEEVE MC125C12.
9. ARMSTRONG "ARMAFLEX 22" OR EQUAL.
10. 2.0" THICK FLEXIBLE FIBERGLASS INSULATION WITH ATTACHED MOISTURE BARRIER. K FACTOR OF .25 BTU/HR IN/FT² /°F/IN.

NUMBER	FUNCTION	NUMBER OF LINES	MEDIA	PRESS. (PSIG)	TEMP (°F)	FLOW RATE (LBS/MIN)	QUANTITY (LBS)	CONNECTOR: NOM SIZE (I.D. IN)	CONNECTOR: WEIGHT (LBS)	CONNECTOR: DISC FORCE (LBS)	TIP FLEX LINE DATA: TYPE	SOURCE	NOM I.D. (IN)	NOM O.D. (IN)	PROOF PRESS. (PSIG)	WEIGHT (LBS)	FITTINGS	LENGTH	℄ BEND RADIUS (IN. MIN) STATIC	℄ BEND RADIUS (IN. MIN) FLEXING	BENDING MOMENT IN-LB/DEG
1	MAINSTAGE FUEL TRANSFER	1	LH_2	20	-423	1708	43,059	4	~10	~50	CORRUGATED S.S.T. WITH A S.S.T. WIRE BRAID REINFORCEMENT - VACUUM JACKETED -	4 5	6	9	150	15	BAYONET	119 ~	27	30/66	TBD
2	MAINSTAGE OXIDIZER TRANSFER	1	LOX	18	-292	9500	193,513	4	~10	~50	SAME AS No 1 (REF 5-108091-A)	4 5	6	9	150	15	BAYONET	119 ~	27	30/66	TBD
3	FUEL TANK PRE PRESSURIZATION	1	H_E	500	-360	20	15	.75	.88	40	CORRUGATED S.S.T. WITH A S.S.T. WIRE BRAID REINFORCEMENT REF RW-8IL	4 5 11	.750	1.32	1000	.86	SEE NOTE 4	230	2.13	8	
4	LOX TANK PRE PRESS., PRESS & PURGE	1	H_E	3000	-360	20	225	.50	.42	40	SAME AS NO. 3 REF RW-8I	4 5 11	.500	1.00	6000	.70			1.50	7	
5	TURBINE START BOTTLE GH_2 SUPPLY PRESS. & CHILLDOWN	1	GH_2	800 / 35	-250± / 50	2 / 2	2.6 / 30	.50	.42	40	SAME AS NO. 3 REF RW-8IL	4 5 11	.500	.92	1600	.45			1.50	6	
6	AUX. PROP. SYSTEM H_E BOTTLE PRESS.	1	H_E	3000	AMB	5	10	.25	.20	40	TEFLON OR HI-DENSITY POLYETHYLENE WITH A S.S.T. WIRE BRAID REINFORCEMENT	6 7	.250	.50	6000	.19			N/A	3.25	
7	GH_E SUPPLY BOTTLES	1	H_E	3000	AMB	5	50	.25	.20	40	SAME AS NO. 6	6 7	.250	.50	6000	.19			N/A	3.25	
8	ENGINE H_E BOTTLE PRESSURIZATION	1	H_E	3000	-250±50	5	5	.25	.20	40	SAME AS NO. 3 REF RW 8IL	4 5 11	.250	.58	6000	.22			1.00	5	
9	TURBINE START GH_2 BOTTLE VENT & RELIEF	1	GH_2 / H_E	800	AMB TO -250	180	TBD	.50	.42	40	SAME AS NO. 3 REF RW-8IL	4 5 11	.50	.92	1600	.45			1.50	6	
10	THRUST CHAMBER PURGE & CHILLDOWN	1	H_E	50	AMB TO -250	10.5	157.5	.375	.42	40	SAME AS NO. 3 REF RW 8IL	4 5 11	.375	.76	100	.30			1.13	5.5	
11	FUEL PUMP CAVITY DRAIN	1	H_E / GH_2	TBD	70 TO -423	TBD	TBD	.25	.20	40	SAME AS NO. 3 REF RW 8IL	4 5 11	.250	.58	TBD	.22	SEE NOTE 4	230	1.00	5	
12	AIR CONDITIONING & PURGE	1	AIR & GN_2	25 IN H_2O	85 TO 125	300	TBD	8 13/16 x 9 3/8 TO 10	TBD	TBD	REF DRAWING Nº 75M05693-L	8 12	10	14	4	4.17	CLAMP	100 83	N/A	15	
13	ELECTRICAL	6	N/A	N/A	N/A	N/A	N/A	SHELL SIZE 40	3 EA	180	60 WIRE, REF. 75M02943	10	N/A	2	N/A	2.00	N/A	N/A	12	15	
14	LOW PRESSURE CHECKOUT SUPPLY	1	H_E	50	AMB	TBD	N/A	.25	.20	40	SAME AS NO. 6	6 7	.250	.35	100	.09	SEE NOTE 4	230		2	
15	HIGH PRESSURE CHECKOUT SUPPLY	1	H_E	3000	AMB	TBD	N/A	.25	.20	40	SAME AS NO. 6	6 7	.250	.50	6000	.19	SEE NOTE 4	230		2	
16	DELETED																				
17	UMB. HOUSING ELEC. PURGE	1	GN_2	2	AMB	TBD	N/A	.25	.20	40	SAME AS NO 6	6/7	.250	.35	5	.09	SEE NOTE 4	230	N/A	2	
18	UMBILICAL HOUSING DISCONNECT PURGE	1	GN_2	750	AMB	STATIC	N/A	.25	.20	40	SAME AS Nº 6	6/7	.250	.35	1500	.09	SEE NOTE 4	230	N/A	2	TBD
19																					

SOURCE
1. MP & VE-EF "SATURN V FLUID REQUIREMENTS" 3/1/62 (1-15)
2. MP & VE-EA 1-15
3. DOUGLAS DRAWING Nº 1A69183 (5/2/63)
4. ANACONDA
5. FLEXONICS
6. RESISTO FLEX
7. AEROQUIP
8. ACTIONFLEX (ATCO CO)
9. WIGGENS 3-12-13 & 14
10. BROWN ENGR. CO.
11. FLEXIBLE METAL HOSE MFG CO.
12. CONNECTICUT HARD RUBBER CO.

SEE ENGINEERING RECORDS

NEXT ASSY | USED ON
APPLICATION

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACTIONS DECIMALS ANGLES
MATERIAL
HEAT TREATMENT
FINAL PROTECTIVE FINISH

ORIGINAL DATE OF DRAWING 3/7/63
CAMBILL
CHECKER / STRESS / ENGINEER / ENGINEER / SUBMITTED
APPROVED
PRELIMINARY
LATEST INFORMATION
DATE 6/21/63

SATURN V
UMBILICALS S-IV B AFT
SERVICE ARM

WEIGHT CHECKER | DATE | CODE
SCALE | UNIT WEIGHT

GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

DWG SIZE C 75M05626L
SHEET 12 OF 18

DISTR CODE

LOC FORM 21-5 (11/1/62) (REPLACES MSFC 422-2)

PART No.	M F	ZONE	SYM	REVISIONS DESCRIPTION	DATE	APPROVAL

CONTINUED FROM SHEET 12

HARD LINE DATA

NUMBER	NOM SIZE (IN)	TYPE	SPECIFICATION	WALL THICKNESS	INSULATION	WEIGHT LBS/FT	LENGTH (IN)	END FITTINGS	SOURCE
1	6	SCH 55 316 INNER .025 WALL OUTER		TBD	V. J.	18	TBD	BAYONET	4, 5
2	6	SCH 55 316 INNER .025 WALL OUTER		TBD	V. J.	18	TBD	BAYONET	4, 5
3	.75	TYPE 316 S. ST. TUBING	DWG A75M05698	.065	SEE NOTE 9	.48		SEE NOTE 8	
4	.50			.049	SEE NOTE 9	.24		SEE NOTE 7	
5	.50			.035	SEE NOTE 9	.18		SEE NOTE 7	
6	.25				NONE	.08		SEE NOTE 5	
7	.25				NONE	.08			
8	.25				SEE NOTE 9	.08		SEE NOTE 5	
9	.50				NONE	.18		SEE NOTE 7	
10	.375		DWG A75M05698		SEE NOTE 9	.13		SEE NOTE 6	
11	.25	TYPE 316 S.ST. TUBING		.035	NONE	.08		SEE NOTE 5	
12	.10	ALUM SHEET DUCT		.04	SEE NOTE 10				
13	2 OD	SAME AS Nº 13 SHEET 12			N/A			10-323640-53P CA-22511-0	BENDIX-TOWER CANNON-VEHICLE
14	.25	TYPE 316 S.ST. TUBING							
15	.25	TYPE 316 S.ST. TUBING	DWG A75M05698	.035	NONE	.08		SEE NOTE 5	
16	.25	DELETED	DWG A75M05698	.035	NONE	.08		SEE NOTE 5	
17	.25	TYPE 316 S.ST. TUBING	DWG A75M05698	.035	NONE	.08		SEE NOTE 5	
18	.25	TYPE 316 S. ST. TUBING	DWG A75M05698	.035	NONE	.08	TBD	SEE NOTE 5	

HINGED JOINT OR BELLOWS DATA / FLEX HOSE AT HINGE POINT

NUMBER	HINGED JOINT TYPE	SPECIFICATION	UNIT WEIGHT LBS	LENGTH (IN)	SOURCE	FLEX HOSE TYPE	FITTINGS	WEIGHT LBS/FT	LENGTH (IN)	SOURCE	BEND RADIUS	BENDING MOMENT LBS
1	HINGED JOINT EXPANSION JOINT	TBD	TBD	17.25	4 5-108092-A	V. J. S. ST.	BAYONET	15	66	4, 5, 11	30/66	TBD
2	HINGED JOINT EXPANSION JOINT			17.25	4 5-108092-A	V. J. S. ST.	BAYONET	15	66	4, 5, 11	30/66	
3	EXPANSION JOINT			TBD		S.ST.	SEE NOTE 4	.86	* TBD	4, 5, 11	8	
4	EXPANSION JOINT							.70		4, 5, 11	7	
5	EXPANSION JOINT					S. ST.		.45		4, 5, 11	6	
6	N/A					TEFLON W/ S.ST. BRAID		.19		6, 7	3.25	
7	N/A					TEFLON W/ S.ST. BRAID		.19		6, 7	3.25	
8	EXPANSION JOINT					S.ST.		.22		4, 5, 11	5	
9	EXPANSION JOINT							.45		4, 5, 11	6	
10	EXPANSION JOINT							.30		4, 5, 11	5.5	
11	EXPANSION JOINT	TBD	TBD	TBD		S. ST.	SEE NOTE 4	.22		4, 5, 11	5	
12	N/A	N/A	N/A	N/A		SILICONE & FIBERGLASS	CLAMP	4.17		8, 12	15	
13						SAME AS Nº 12 SHEET 12	N/A	2.00		10	15	
14						TEFLON W/ SST. BRAID	SEE NOTE 4	.09		6, 7	2	
15						TEFLON W/ S.ST. BRAID	SEE NOTE 4	.09		6, 7	2	
16												
17						TEFLON W/ S.ST. BRAID	SEE NOTE 4	.09		6, 7	2	
18	N/A	N/A	N/A	N/A		TEFLON W/ S.ST. BRAID	SEE NOTE 4	.09	TBD	6, 7	2	TBD

* APPROXIMATE LENGTH - 6 FT

SEE ENGINEERING RECORDS

NEXT ASSY | USED ON

APPLICATION

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACTIONS DECIMALS ANGLES
MATERIAL
HEAT TREATMENT
FINAL PROTECTIVE FINISH

ORIGINAL DATE OF DRAWING 11 MAY 63
DRAFTSMAN | CHECKER
CHECKER | STRESS
ENGINEER | ENGINEER
SUBMITTED
APPROVED PRELIMINARY, LATEST INFORMATION DATE 6/21/63 DIRECTOR

SATURN V
UMBILICALS, S-IVB AFT
SERVICE ARM

WEIGHT CHECKER | DATE | CODE
SCALE | UNIT WEIGHT

LAUNCH OPERATIONS CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

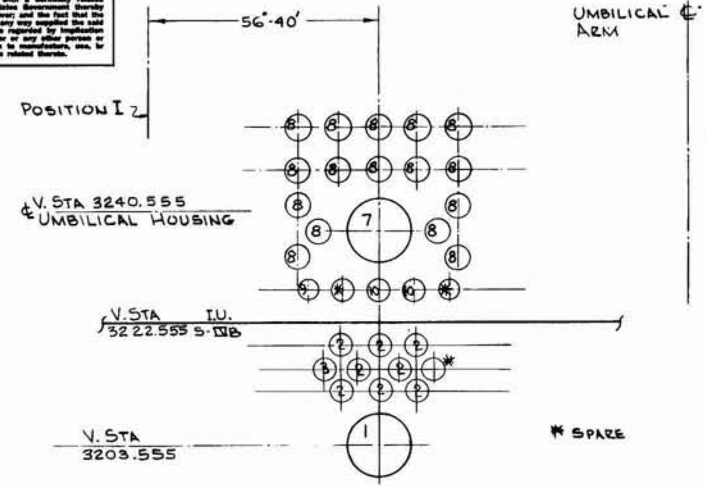
DWG SIZE C 75M05626L

SHEET 13 OF 18

DISTR CODE

DIETZGEN NO. 137 DRAFTED

PART No.	N	ZONE	SYM	REVISIONS DESCRIPTION	DATE	APPROVAL



NOTES:
1. SEE DRAWINGS, MSFC SK10-1421 & DOUGLAS 1A66747 FOR HOUSING CONFIGURATION.
2. END FITTINGS ON 3,9 & 10 TO BE PER MC 223, MSFC SPEC 143.
3. LOX CLEAN 1, 3, 8, 9, & 10 TO MSFC SPEC 164.
4. DISCONNECT FORCE FOR CONNECTOR Nº 3, 4, 9, 10, & 11 IS 40 LBS; FOR 2 & 8, 180 LBS
5. SEE NOTE 2, SHEET 1
6. #9 TO HAVE A POLYETHYLENE INNER TUBE PER ____.
7. ARMSTRONG "ARMAFLEX 22" OR EQUAL.
8. 2.0" THICK FLEXIBLE FIBERGLASS INSULATION WITH ATTACHED MOISTURE BARRIER. K FACTOR OF .25 BTU/HR IN/FT² /°F/IN.
9. BLK FITTINGS MC164C24, NUTS MC174C24 & MC124C24, SLEEVE MC125C24.
10. BLK FITTINGS MC164C6, NUTS MC174C6 & MC124C6, SLEEVE MC125C6
11. BLK FITTINGS MC164C4, NUTS MC174C4 & MC124C4, SLEEVE MC125C4.

NUMBER	FUNCTION	NUMBER OF LINES	MEDIA	PRESS. (PSIG)	TEMP. (°F)	FLOW RATE (LBS/MIN)	QUANTITY (LBS)	CONNECTOR NOM SIZE I.D.-IN	CONNECTOR WEIGHT (LBS)	FLEX LINE TYPE	SOURCE	NOM I.D. (IN)	NOM O.D. (IN)	PROOF PRESS. (PSIG)	WEIGHT LBS/FT	FITTINGS	LENGTH (IN)	℄ BEND RADIUS MIN (IN) STATIC	FLEXING	BENDING MOMENT (IN-LBS)
1	FUEL TANK VENTING	1	GH_2	13	-420	210	N/A	6	4.5	CORRUGATED S.ST. WITH A S.ST. WIRE BRAID REINF. REF RF45	8 9 10 / 9	6	7.1	50	7.2	FLANGE	121 / 24	12.5	19.5 / 33	TBD
2	ELECTRICAL	8	N/A	N/A	N/A	N/A	N/A	SHELL SIZE 40	3 EA	60 WIRE REF 75M02943	11	N/A	2	N/A	2.00	N/A	N/A	12	15	TBD
3	ELECTRICAL HOUSING PURGE	1	GN_2	TBD	TBD	TBD	TBD	.25	.20	TEFLON WITH A S.ST. WIRE BRAID REINFORCEMENT.	6 / 7	.25	.35	TBD	.09	SEE NOTE 2	290	N/A	2	TBD
	INSTRUMENT UNIT																			
7	AIR CONDITIONING & PURGE	1	AIR & GN_2	42 IN H_2O	120	150	N/A	6.000	3.00	REF DRAWING Nº 75M05691-L	10 / 12	6	10	40	2.5	CLAMP	106 / 24	N/A	9	TBD
8	ELECTRICAL	16	N/A	N/A	N/A	N/A	N/A	SHELL SIZE 40	3 EA	60 WIRE, REF. 75M02943	11	N/A	2	N/A	2 EA	N/A	N/A	12	15	TBD
9	AIR BEARING SPHERE PRESSURIZATION	1	GN_2	3000	AMB	TBD	TBD	.375	.38	HI-DENSITY POLYETHYLENE W/S.ST. WIRE BRAID	6 / 7	.375	.80	6000	.36	SEE NOTE 2	290	N/A	5.75	TBD
10	PREFLIGHT CONDITIONING (INTERNAL CLOSED LOOP)	2	60% CH_3OH 40% H_2O	200	20° ± 10°	40 ± 5 GPM	TBD	1.00	3.00	TEFLON WITH A S.ST. WIRE BRAID REINFORCEMENT	6 / 7	1.50	1.68	400	.77	SEE NOTE 2	290	N/A	14	TBD
11	ELECTRICAL HOUSING PURGE	1	GN_2	TBD	TBD	TBD	TBD	.25	.20	TEFLON WITH A SST WIRE BRAID REINFORCEMENT	6 / 7	.25	.35	TBD	.09	SEE NOTE 2	290	N/A	2	TBD

SOURCE
1. MP & VE-FF "SATURN V FLUID REQUIREMENTS" 3/1/63 (Nº 1-10)
2. MP & VE-EA-SK 10-1421 (Nº 7-11)
3. MP & VE-EG (Nº 1-11)
4. DOUGLAS DRAWING Nº 1A 66747 (Nº 1-3)
5. FLEXIBLE METAL HOSE CO.
6. RESISTOFLEX
7. AEROQUIP
8. FLEXONICS
9. ANACONDA
10. ACTIONFLEX (ACTO CO)
11. BROWN ENGR. CO.
12. CONNECTICUT HARD RUBBER CO.
13. FLEXIBLE METAL HOSE MFG CO.

SEE ENGINEERING RECORDS	
NEXT ASSY	USED ON
APPLICATION	
UNLESS OTHERWISE SPECIFIED	DIMENSIONS ARE IN INCHES; TOLERANCES ON FRACTIONS / DECIMALS / ANGLES
MATERIAL	
HEAT TREATMENT	
FINAL PROTECTIVE FINISH	
ORIGINAL DATE OF DRAWING	3/12/63
DRAFTSMAN	BALDWIN
APPROVED	PRELIMINARY LATEST INFORMATION DATE 6/21/63 DIRECTOR
TITLE	SATURN V UMBILICALS S-IV B FWD SERVICE ARM
	GEORGE C. MARSHALL SPACE FLIGHT CENTER, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, HUNTSVILLE, ALABAMA
DWG SIZE	C
DWG NO.	75M05626-L
SHEET	14 OF 18

LOC-FORM 21-5 (11/1/62) (REPLACES MRFC 422-2)

Notice—When Government drawings, specifications, or other data are used for any purpose other than in connection with a definitely related Government procurement operation, the United States Government thereby incurs no responsibility nor any obligation whatsoever; and the fact that the Government may have formulated, furnished, or in any way supplied the said drawings, specifications or other data is not to be regarded by implication or otherwise as in any manner licensing the holder or any other person or corporation, or conveying any rights or permission to manufacture, use, or sell any patented invention that may in any way be related thereto.

PART No.	NF	ZONE	SYM	REVISIONS DESCRIPTION	DATE	APPROVAL

CONTINUED FROM SHEET 14

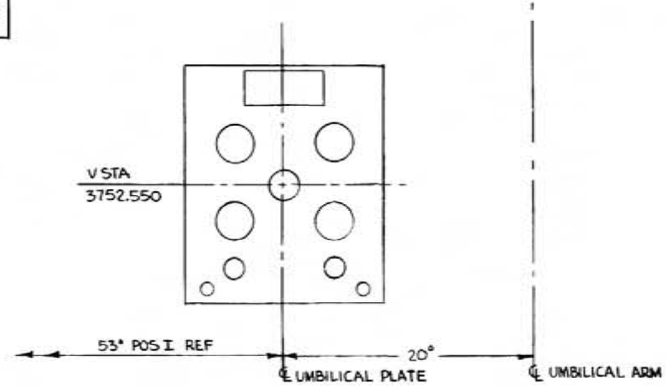
HARD LINE DATA										HINGED JOINT OR BELLOWS DATA					FLEX HOSE AT HINGE POINT						
Number	Nom Size (in)	TYPE	SPECIFICATION	WALL THICKNESS	INSULATION	WEIGHT LBS/FT	LENGTH (IN)	END FITTINGS	SOURCE	TYPE	SPECIFICATION	UNIT WEIGHT (LBS)	LENGTH (IN)	SOURCE	TYPE	FITTINGS	WEIGHT LBS/FT	LENGTH (IN)	SOURCE	BEND RADIUS	BENDING MOMENT IN-LBS
1	6	TYPE 316 S.ST. SCH 55 PIPE		.109	NONE	7.585	TBD	FLANGE		EXPANSION JOINT	TBD	TBD	TBD		S.ST.	FLANGE	7.2	* TBD	8 9 13	19.5 / 33	TBD
2	2 O.D	SAME AS № 2 SHEET 14		N/A	NONE	2.0		10-323640-33P CA-22511 O	BENDIX-TOWER CANNON-VEHICLE	N/A	N/A	N/A	N/A		SAME AS #2 SHEET 14	N/A	2.0		11	15	
3	.25	TYPE 316 S.ST TUBING	DWG A75M05698	.035	NONE	.081		SEE NOTE 1							TEFLON W/ S.ST BRAID	SEE NOTE 11	.09		7 6	2	
4																					
5																					
6																					
7	10	ALUM. SHEET DUCT		.040	SEE NOTE 8			CLAMP							SILICONE & FIBERGLASS	CLAMP	2.5		10 12	9	
8	2 O.D	SAME AS № 8 SHEET 14			NONE	2.0		SEE № 2 ABOVE							SAME AS #8 SHEET 14	N/A	2.0		11	15	
9	.375	TYPE 316 S.ST. TUBING	DWG A75M05698	.035	NONE	.128		SEE NOTE 10							TEFLON W/ S.ST. BRAID	SEE NOTE 10	.36		6 7	5.75	
10	1.50	TYPE 316 S.ST. TUBING	DWG A75M05698	.083	SEE NOTE 7	1.256	TBD	SEE NOTE 9							TEFLON W/ S.ST. BRAID	SEE NOTE 9	.77	TBD	6 7	14	TBD
11	.25	TYPE 316 S.ST TUBING	DWG A75M05698	.035	NONE	.081	TBD	SEE NOTE 1		N/A	N/A	N/A	N/A		TEFLON W/ S.ST. BRAID	SEE NOTE 11	.09	TBD	7 6	2	

* APPROXIMATE LENGTH - 6 FT.

SEE ENGINEERING RECORDS		UNLESS OTHERWISE SPECIFIED	ORIGINAL DATE OF DRAWING 11 MAY '63	SATURN V UMBILICALS, S-IV FWD SERVICE ARM	LAUNCH OPERATIONS CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE, ALABAMA
		DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS ANGLES	DRAFTSMAN CHECKER CHECKER STRESS ENGINEER ENGINEER SUBMITTED		DWG SIZE C 75M05626L
NEXT ASSY	USED ON	MATERIAL HEAT TREATMENT FINAL PROTECTIVE FINISH	APPROVED PRELIMINARY, LATEST INFORMATION DATE 6/11/63 DIRECTOR	WEIGHT CHECKER DATE CODE	SHEET 15 OF 18
APPLICATION				SCALE UNIT WEIGHT	DISTR. CODE

DIETZGEN NO. 197 DRAFTEX BLUEPRINT PRINTING CO.-CHICAGO

MSFC FORM 422-2 (AUGUST 1960)



NOTES:
1. LOX CLEAN NO. 1 TO MSFC SPEC 164.

NUMBER	FUNCTION	NUMBER OF LINES	MEDIA	PRESS. (PSIG)	TEMP (°F)	FLOW RATE (LBS/MIN)	QUANTITY (LBS)	CONNECTOR SIZE (I.D. IN.)	CONNECTOR WEIGHT (LBS)	CONNECTOR DISC FORCE (LBS)	TIP FLEX LINE DATA TYPE	SOURCE	NOM I.D. (IN.)	NOM O.D. (IN.)	PROOF PRESS. (PSIG)	WEIGHT (LBS/FT) DRY	WEIGHT (LBS/FT) WET	℄ BEND RADIUS (IN. MIN) STATIC	℄ BEND RADIUS (IN. MIN) FLEXING	BENDING MOMENT IN-LB/DEG
1	HYDROGEN OVERBOARD PRESSURE RELIEF	1	LH_2	TBD	-260 -408	TBD	TBD	.25	.20	40	TBD →							→	TBD	TBD
2	NITROGEN OVERBOARD PRESSURE RELIEF	1	LN_2	TBD	-90 -320	TBD	↓	.25	.20	40	TBD →							→	TBD	↓
3	ELECTRICAL GROUND CHECKOUT	2	N/A	N/A	N/A	N/A		SHELL 40	3	180	GO WIRE, REF. 75M02943	10	N/A	2	N/A	2	N/A	12	15	
4	ELECTRICAL GROUND POWER & FUEL CELL HEATER	1	N/A	N/A	N/A	N/A		SHELL 40	3	180	GO WIRE, REF. 75M02943	10	N/A	2	N/A	2	N/A	12	15	
5	OXYGEN OVERBOARD PRESSURE RELIEF	1	LOX	TBD	-60 -281	TBD		.25	.20	40	TBD →							→	TBD	
6	FUEL OVERBOARD PRESSURE RELIEF	1	UDMH HYDRAZ	TBD	TBD	TBD		1.25	1.39	40	TBD →							→	TBD	
7	SPS OXIDIZER OVERBOARD PRESSURE RELIEF	1	NTO	TBD	TBD	TBD		1.25	1.39	40	TBD →							→	TBD	
8	WATER GLYCOL GROUND COOLANT RETURN	1	H_2O GLYCOL	50	TBD	4.17		2	3.16	40	TBD →							→	TBD	
9	WATER GLYCOL GROUND COOLANT SUPPLY	1	H_2O GLYCOL	50	TBD	4.17	↓	.25	.20	40	TBD →							→	TBD	↓
10	AIR CONDITIONING & PURGE	2	AIR	3 IN H_2O	65 TO 85	64	TBD	6	3.00	TBD	REF. DWG. Nº 75M05691L	7	6	9	40	2.5	N/A	N/A	9	TBD
11																				
12																				

SOURCE:
1. N.A.A.
2.
3.
4.
5. AEROQUIP
6. RESISTOFLEX
7. ACTIONFLEX (ATCO CO)
8. FLEXONICS
9. ANACONDA
10. BROWN ENGR. CO.

SEE ENGINEERING RECORDS

NEXT ASSY | USED ON
APPLICATION

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACTIONS DECIMALS ANGLES
MATERIAL
HEAT TREATMENT
FINAL PROTECTIVE FINISH

ORIGINAL DATE OF DRAWING 3 MAR 63
CAMPBELL
APPROVED PRELIMINARY LATEST INFORMATION DATE 5-13-63

SATURN V
UMBILICALS SM
SERVICE ARM

GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

DWG SIZE C 75M05626L
SCALE NONE
SHEET 16 OF 18

PART No.	NF	ZONE	SYM	REVISIONS DESCRIPTION	DATE	APPROVAL

CONTINUED FROM SHEET 16

		HARD LINE DATA								HINGED JOINT OR BELLOWS DATA					FLEX HOSE AT HINGE POINT						
NUMBER	NOM SIZE (IN)	TYPE	SPECIFICATION	WALL THICKNESS	INSULATION	WEIGHT LBS/FT	LENGTH (IN)	END FITTINGS	SOURCE	TYPE	SPECIFICATION	UNIT WEIGHT (LBS)	LENGTH (IN)	SOURCE	TYPE	FITTINGS	WEIGHT LBS/FT	LENGTH (IN)	SOURCE	BEND RADIUS	BENDING MOMENT IN-LBS
1	.25	TYPE 316 SST. TUBING	DWG A75M05698	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
2	.25	TYPE 316 S.ST TUBING	DWG A75M05698																		
3	2 OD.	SAME AS Nº 3 SHEET 17																			
4	2 O.D.	SAME AS Nº 4 SHEET 17																			
5	.25	TYPE 316 S.ST. TUBING	DWG A75M05698																		
6	1.25																				
7	1.25																				
8	2																				
9	.25	TYPE 316 S.ST. TUBING	DWG A75M05698	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD		TBD	TBD	TBD
10	6	ALUM. SHEET DUCT		.04	LS FIBER-GLASS K=.25	N/A	N/A	CLAMP	N/A	N/A	N/A	N/A	N/A	N/A	REF DWG 75M05691L	CLAMP	2.5	TBD	7	9	9
11																					
12																					

SEE ENGINEERING RECORDS	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS ANGLES	ORIGINAL DATE OF DRAWING 11 MAY '63
NEXT ASSY / USED ON	MATERIAL	DRAFTSMAN / CHECKER / CHECKER / STRESS / ENGINEER / ENGINEER / SUBMITTED
APPLICATION	HEAT TREATMENT	APPROVED PRELIMINARY, LATEST INFORMATION DATE 5/21/63 DIRECTOR
	FINAL PROTECTIVE FINISH	

SATURN V
UMBILICALS S M
SERVICE ARM

WEIGHT CHECKER | DATE | CODE
SCALE | UNIT WEIGHT

LAUNCH OPERATIONS CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

DWG SIZE C 75M05626L
SHEET 17 OF 18

DISTR. CODE

MSFC FORM 425-2 (AUGUST 1960)

PART NO.	M F	ZONE	SYM	REVISIONS: DESCRIPTION	DATE	APPROVAL

NOTES:
*1. THIS LINE DOES NOT INTERFACE WITH THE VEHICLE
2. 1.5 THICK FLEXIBLE FIBERGLASS INSULATION WITH ATTACHED MOISTURE BARRIER. K FACTOR OF .25 BTU/HR IN/FT² °F/IN.

NUMBER	FUNCTION	NUMBER OF LINES	MEDIA	PRESS. (PSIG)	TEMP (°F)	FLOW RATE (LBS/MIN)	QUANTITY (LBS)	CONNECTOR SIZE (I.D. IN)	CONNECTOR WEIGHT (LBS)	CONNECTOR DISC FORCE (LBS)	TIP TYPE	FLEX LINE DATA SOURCE	NOM I.D. (IN)	NOM O.D. (IN)	PROOF PRESS. (PSIG)	WEIGHT (LBS/FT) DRY	WEIGHT (LBS/FT) WET	℄ BEND RADIUS (IN MIN) STATIC	℄ BEND RADIUS (IN MIN) FLEXING	BENDING MOMENT IN-LBS
1	AIR CONDITIONING *	1	AIR	TBD	TBD	64	TBD	6	TBD	TBD	REF 75M05691L	4 3	6	8		2.5	N/A	N/A	9	TBD

NUMBER	HARD LINE DATA: NOM SIZE (IN)	TYPE	SPECIFICATION	WALL THICKNESS	INSULATION	WEIGHT LBS/FT	LENGTH IN.	END FITTINGS	SOURCE	HINGED JOINT OR BELLOWS DATA: TYPE	SPECIFICATION	UNIT WEIGHT LBS	LENGTH IN.	SOURCE	FLEX HOSE AT HINGE POINT: TYPE	FITTINGS	WEIGHT LBS/FT	LENGTH IN	SOURCE	BEND RADIUS	BENDING MOMENT IN-LBS
1	6	ALUM SHEET DUCT	TBD	.04	SEE NOTE 2	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	REF 75M05691L	CLAMP	2.5	TBD	3 4	9	TBD

SORCE:
1 LO DPM
2.
3 ACTION FLEX (ATCO CO)
4 CONNECTICUT HARD RUBBER CO.

SEE ENGINEERING RECORDS

NEXT ASSY | USED ON
APPLICATION

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACTIONS DECIMALS ANGLES
MATERIAL
HEAT TREATMENT
FINAL PROTECTIVE FINISH

ORIGINAL DATE OF DRAWING 18 MAR 63
DRAFTSMAN CAMPBELL
CHECKER
STRESS
ENGINEER
SUBMITTED
APPROVED PRELIMINARY
LATEST INFORMATION DATE 3/21/63
DIRECTOR

SATURN V
UMBILICALS INGRESS & EGRESS SERVICE ARM

WEIGHT CHECKER | DATE | CODE
SCALE NONE | UNIT WEIGHT

DISTR CODE
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

DWG SIZE C 75M05626L
SHEET 18 OF 18

APPENDIX B

Preface

Appendix B contains information on the weight and center of gravity of all arms except the Service Module Service Arm and Command Module Access Arm. The following errors on these drawings are being corrected.

(1) Sheet 1, vehicle stations are in error.

(2) Sheet 2, S-IC AFT arm LOX loaders have the wrong configuration.

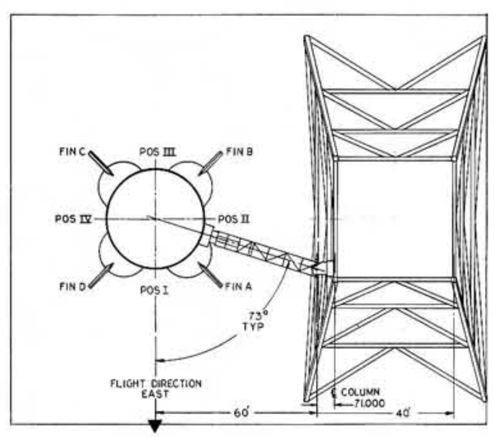
(3) Sheet 4, S-II AFT does not show the S-II INTERMEDIATE service platform, arm length incorrect also.

(4) Sheet 5, shows incorrect LH_2 withdrawal mechanism and incorrect extension platform.

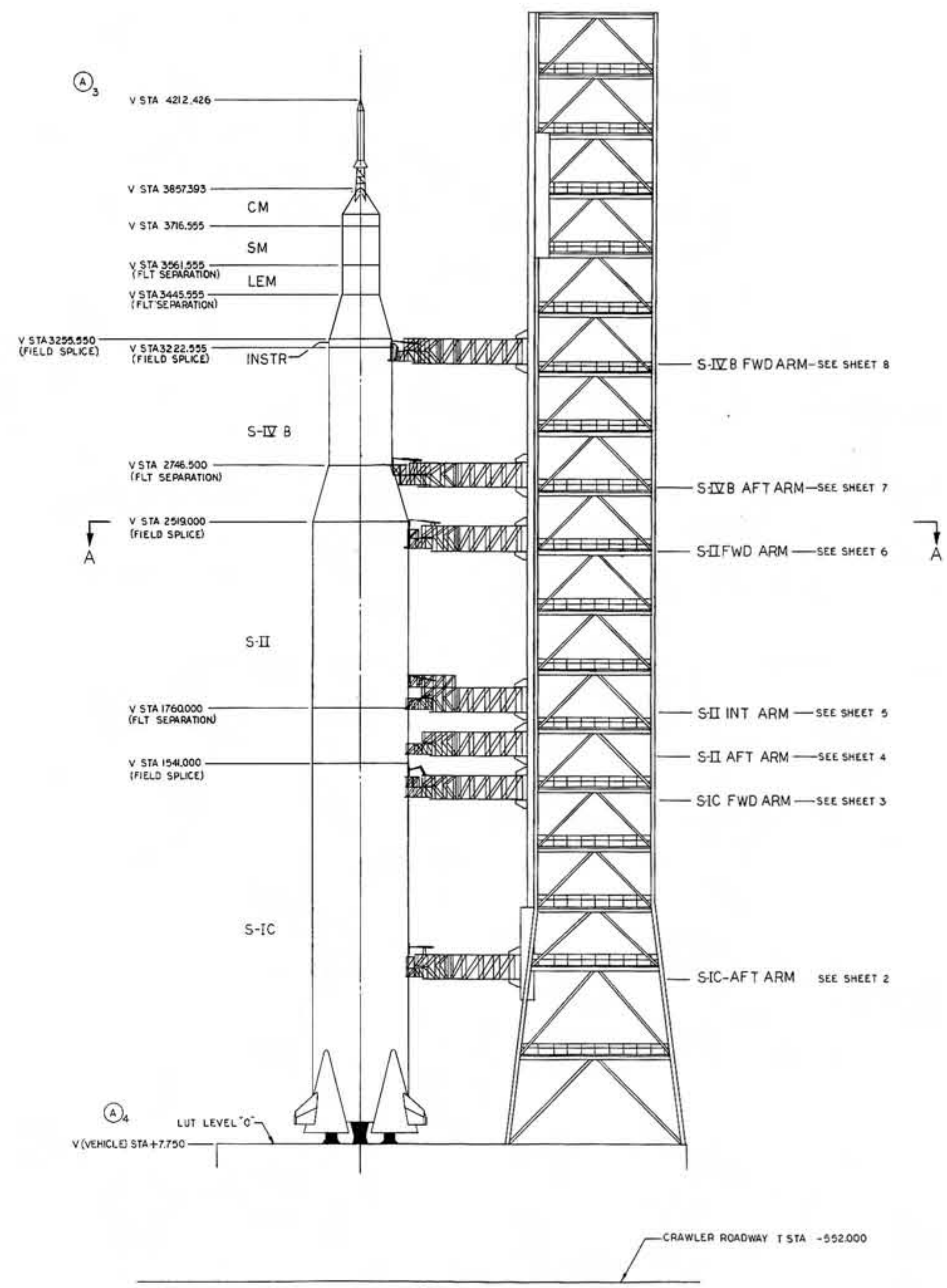
(5) Sheet 7, configuration and centers of gravity changed.

(6) Sheet 8, centers of gravity changed.

ZONE	SYM	DESCRIPTION	DATE	APPROVAL
	A	(1) REVISED & REDRAWN WITH THE FOLLOWING CHANGES	4-8-63	
3B		(2) SECT A-A REVISED TOWER		
3D		BASE (3) REVISED V STATIONS 4209.426 WAS 4231.214 3854.39 WAS 3876.800 DELETED 3767.550 ADDED 3713.555 3558.555 WAS 3592.550 3442.555 WAS 3411.550		
3A		(4) LUT LEVEL "0" WAS LAUNCHER DECK V STA +7.750 WAS +4		
1A		(5) REVISED TITLE "SERVICE" WAS "UMBILICAL"		
C3		(6) REVISED V STA ON SIVB FWD UPWARD (ADDED 3.00)	5-28-63	



SECTION A-A



NOTES:

1. WEIGHT & C.G. OF ASSEMBLY EXCLUDES TOWER HINGE PLATES
2. C.G. OF EXTENSION PLATFORM (DOTTED LINES) & WITHDRAWAL MECHANISM SHOWN FOR RETRACTED POSITION
3. PHANTOM LINES INDICATE EXTENSION PLATFORMS & WITHDRAWAL MECHANISMS IN EXTENDED POSITIONS
4. DIMENSIONS OF ARM STRUCTURE ARE SHOWN AT OUTSIDE OF TUBULAR MEMBERS

SEE ENGINEERING RECORDS

NEXT ASSY | USED ON

APPLICATION

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACTIONS DECIMALS ANGLES

MATERIAL
HEAT TREATMENT
FINAL PROTECTIVE FINISH

ORIGINAL DATE OF DRAWING 22 JAN 63

APPROVED PRELIMINARY
LATEST INFO DATE 5-28-63

SERVICE ARM PRELIMINARY WEIGHT & C.G. STUDY COMPLEX 39

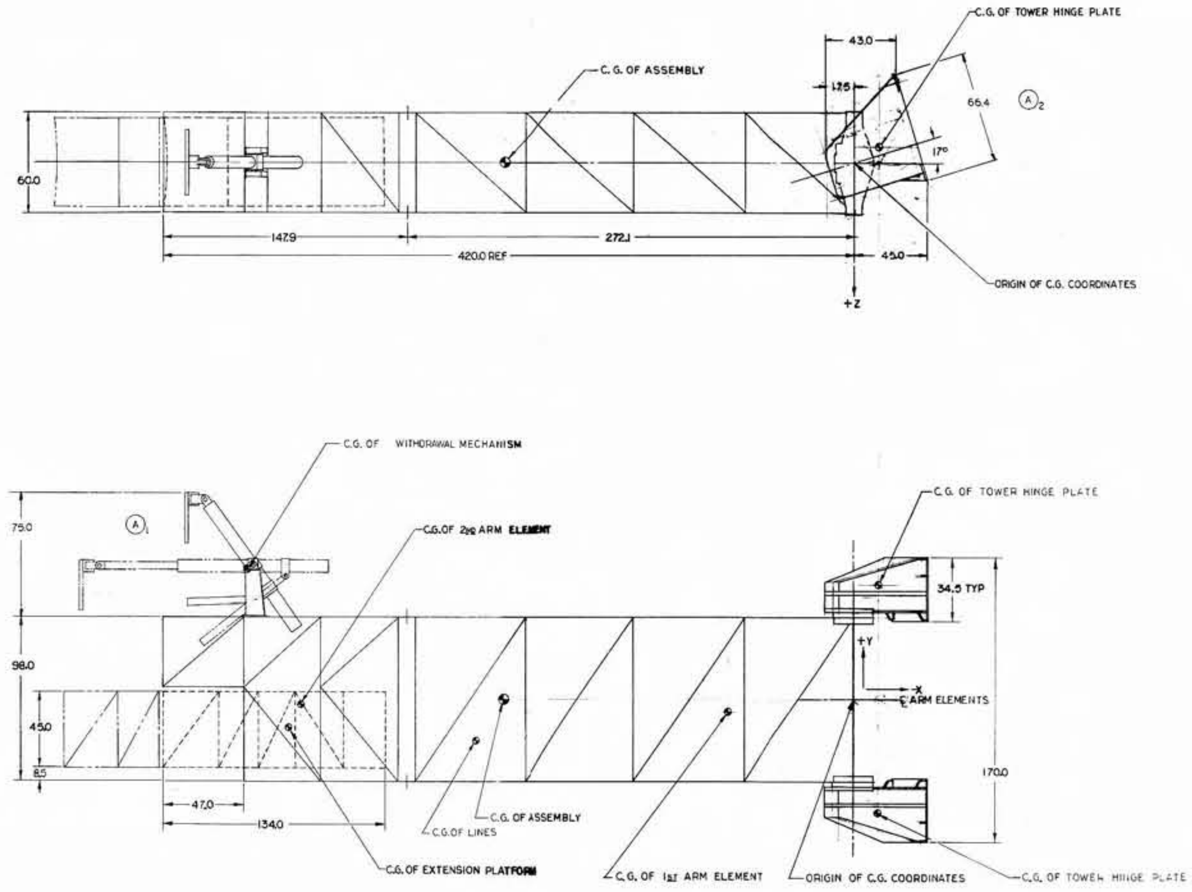
SCALE 1/200

GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

DWG SIZE J 75M-05238L

SHEET 1 OF 8

ZONE	SYM	DESCRIPTION	DATE	APPROVAL
REVISIONS				
2B	A	1 ADDED DISCONNECT MECH.	4-9-63	
2C		2 REVISED TOWER HINGE PLATE 66.4 WAS 60.0, 17.5 WAS 13.0, 43.0 WAS 40.0		
1C		3 REVISED TABULATION BLOCK AS FOLLOWS 5320 WAS 5370 +77 WAS +92 -7 WAS -5 2420 WAS 1790 +336 WAS +33[illegible] -3 WAS -2, 2460 WAS 3560 +68 -68 WAS +61 -61 -10 WAS +1 ADDED C.G. OF DISCONNECT MECHANISM & LINES. 12630 WAS 8950, +218 WAS +191		



S-IC AFT ARM

		LOCATION OF C.G.		
ITEM	WT	X	Y	Z
1ST ARM ELEMENT	[illegible]	[illegible]	[illegible]	0
2ND ARM ELEMENT	[illegible]	+33[illegible]	-[illegible]	0
TOWER HINGE PLATES	[illegible]# EA	-15	+6[illegible] -61	-[illegible]
EXTENSION PLATFORM	1600#	+344	-17	0
[illegible] MECHANISM	[illegible]	[illegible]	[illegible]	[illegible]
LINES	[illegible]	+127	[illegible]	[illegible]
ASSEMBLY	12630#	+218	0	[illegible]

LIST OF MATERIAL

SEE ENGINEERING RECORDS

ORIGINAL DATE OF DRAWING 22 JAN 63

APPROVED PRELIMINARY LATEST INFO DATE 3-28-63

SERVICE ARM
PRELIMINARY
WEIGHT & C.G. STUDY
COMPLEX 39

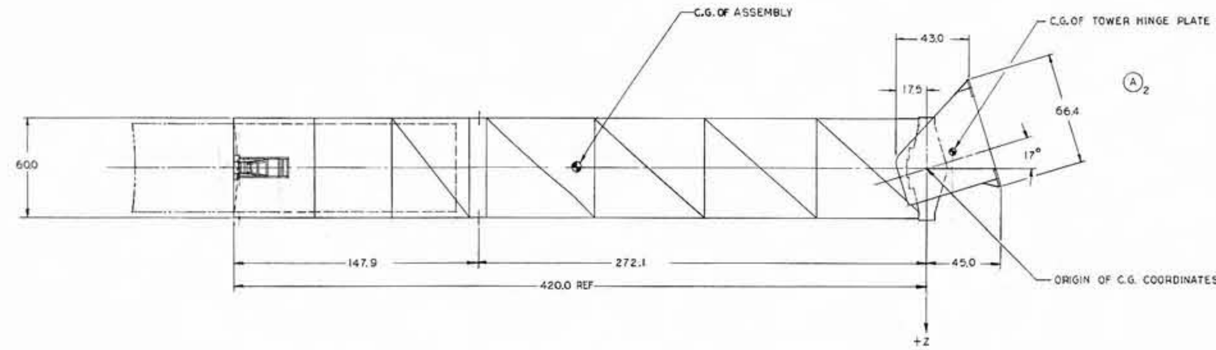
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

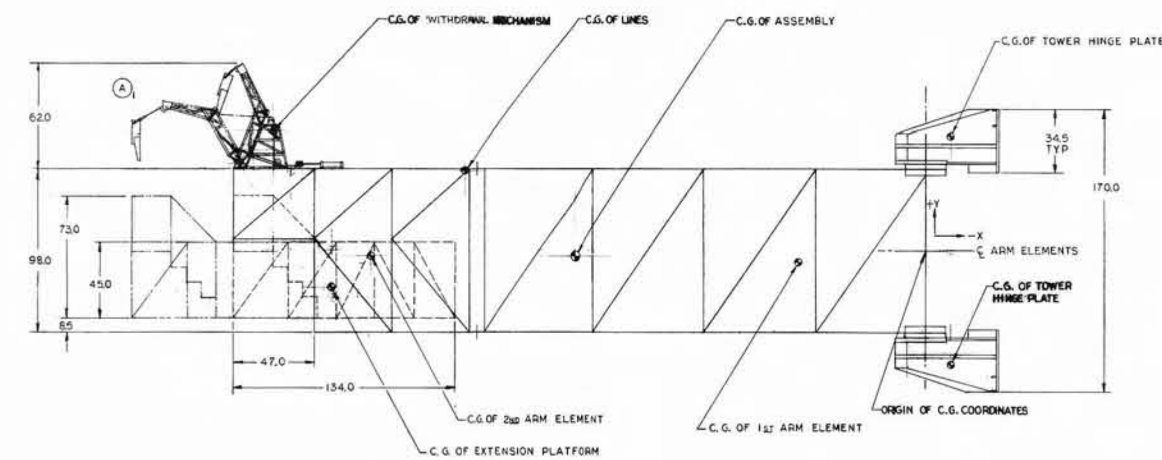
SIZE J 75M-05238L

SCALE 1/30

SHEET 2 OF 8

REVISIONS				
ZONE	SYM	DESCRIPTION	DATE	APPROVAL
3B	A	1) REVISED DISCONNECT MECHANISM. 620 WAS 450	4-8-63	
2C		2) REVISED TOWER HINGE PLATE, 66.4 WAS 60.0, 17.5 WAS 13.0, 43.0 WAS 40.0		
1C		3) REVISED TABULATION BLOCK AS FOLLOWS 5320 WAS 5370, +77 WAS +92, -7 WAS -5, 2420 WAS 1790, +336 WAS +334, -3 WAS -2, 2460 WAS 3580, +68 -68 WAS +61 -61, -10 WAS +1, 240 WAS 1180, +395 WAS +385, +72 WAS +52, 935 WAS 1070, +279 WAS 260, +48 WAS +52, 11025 WAS 11520, +212 WAS +224, -3 WAS +3		





		LOCATION OF C.G.		
ITEM	WT	X	Y	Z
1ST ARM ELEMENT	5320#	+77	-7	0
2ND ARM ELEMENT	2420#	+336	-3	0
TOWER HINGE PLATES	2460# EA	-15	+68 -68	-10
EXTENSION PLATFORM	2100#	+360	-23	0
WITHDRAWAL MECHANISM	240#	+395	+72	0
LINES	935#	+279	+48	0
ASSEMBLY	11025#	+212	+3	0

S-IC FWD ARM

LIST OF MATERIAL

SEE ENGINEERING RECORDS

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

ORIGINAL DATE OF DRAWING 22JAN 63

SUBMITTED PRELIMINARY

APPROVED PRELIMINARY

LATEST INFO DATE 5-28-63

SERVICE ARM PRELIMINARY WEIGHT & C.G. STUDY COMPLEX 39

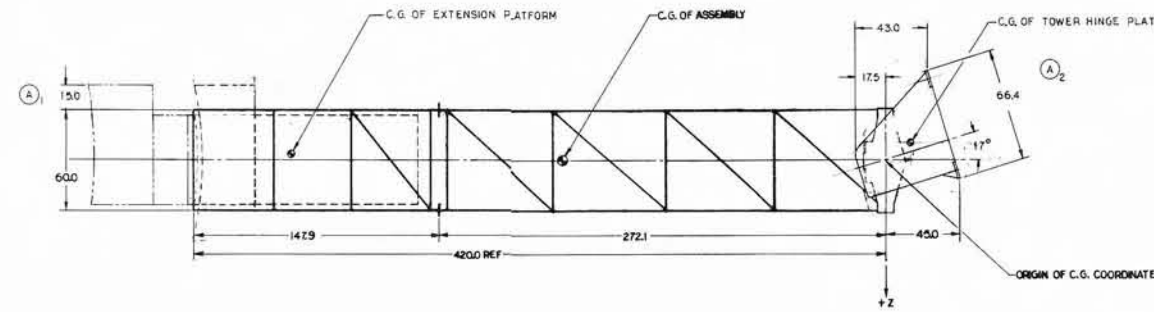
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

DWG SIZE J 75M-05238L

SCALE 1/30

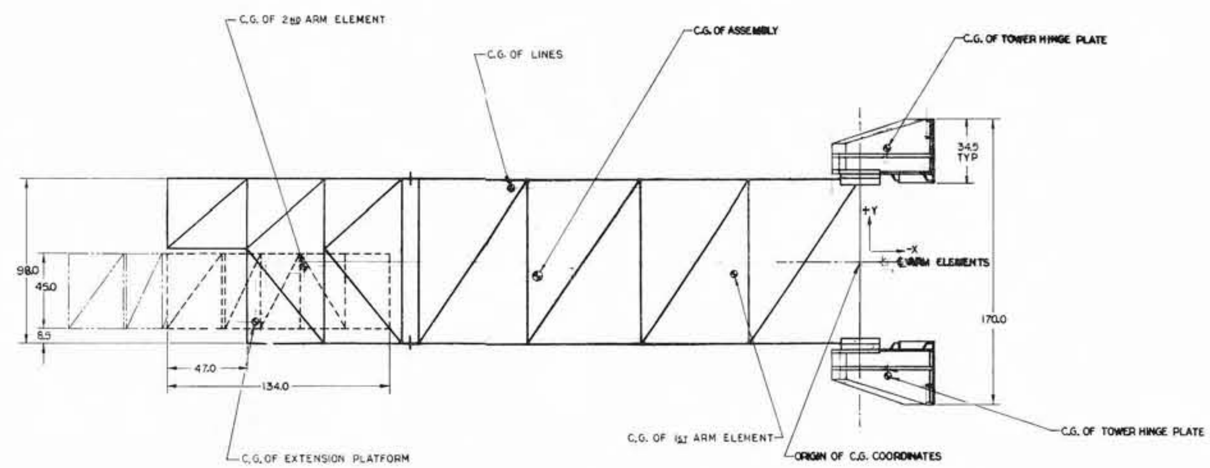
SHEET 3 OF 8

ZONE	SYM	DESCRIPTION	DATE	APPROVAL
3D	A	1) 15.0 WAS 19.0	4.8.63	
2D		2) REVISED TOWER HINGE		
		PLATE 66.4 WAS 60.0 17.5 WAS		
		13.0, 43.0 WAS 40.0		
1C		3) REVISED TABULATION		
		BLOCK AS FOLLOWS 5320 WAS		
		5370 +77 WAS +92 -7 WAS -5		
		2420 WAS 1790 +336 WAS +334		
		-3 WAS -2 2460 WAS 3-140		
		+68 -68 WAS +61 -61 -10 WAS +1		
		9830 WAS 9250 +200 WAS +198		
		-11 WAS -10		



A3

ITEM	WT	LOCATION OF C.G. X	Y	Z
1ST ARM ELEMENT	5320#	+77	-7	0
2ND ARM ELEMENT	2420#	+336	-3	0
TOWER HINGE PLATES	2460# EA	-16	+68 -68	-10
EXTENSION PLATFORM	1940#	+366	-37	-3
LINES	150#	+210	+44	0
1 ASSEMBLY	9830#	+200	-11	0



S-II AFT ARM

LIST OF MATERIAL

SEE ENGINEERING RECORDS

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

ORIGINAL DATE OF DRAWING 22 JAN 63

APPROVED PRELIMINARY LATEST INFO DATE 5-28-63

SCALE 1/30

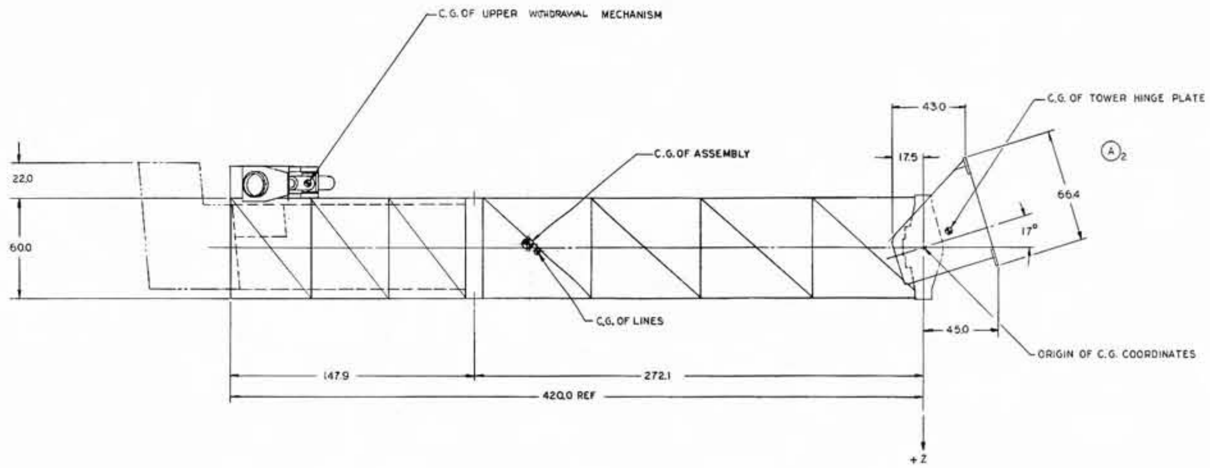
SERVICE ARM PRELIMINARY WEIGHT & C.G. STUDY COMPLEX 39

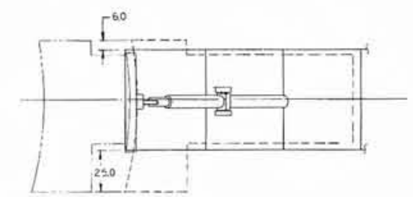
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

DWG SIZE J 75M-05238L

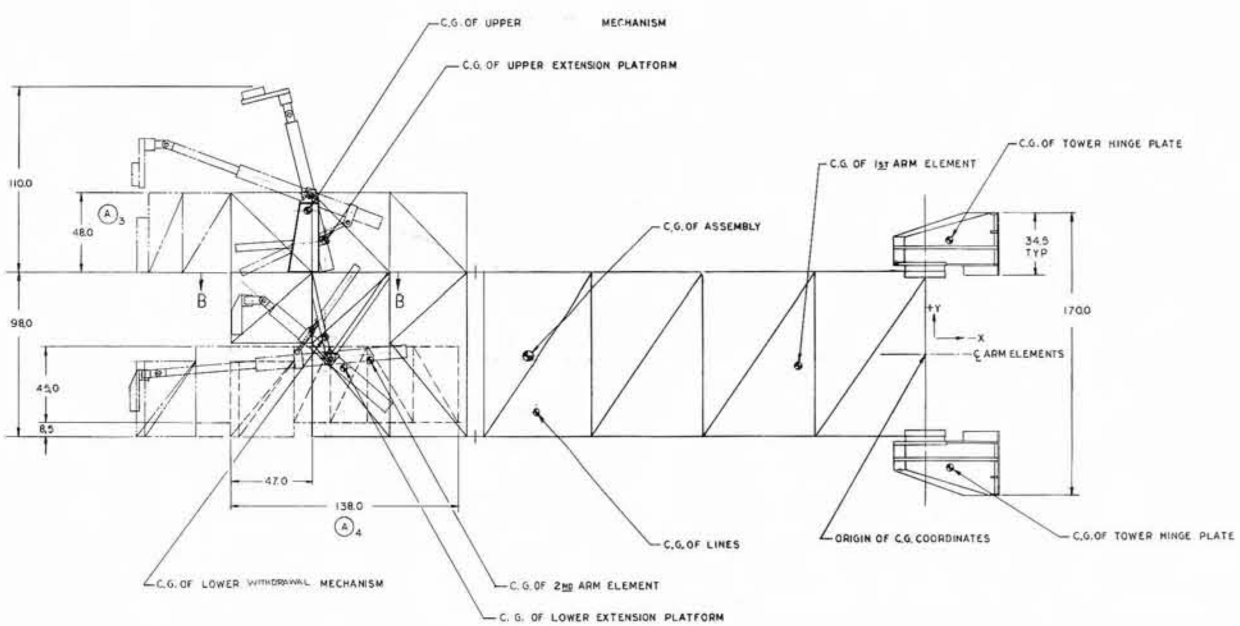
SHEET 4 OF 8

ZONE	SYM	DESCRIPTION	DATE	APPROVAL
	A	1) REVISED & REDRAWN WITH THE FOLLOWING CHANGES	4-9-63	
2 D		2) REVISED TOWER HINGE PLATE 66.4 WAS 60.0, 17.5 WAS 13.0, 43.0 WAS 40.0		
3 B		3) REVISED UPPER EXT. PLATFORM 48.0 WAS 46.0, ADDED DIM 22.0		
3 B		4) DIMS 138.0 WAS 134.0, 110.0 WAS 92.0		
1 B		5) REVISED TABULATION BLOCK AS FOLLOWS 5320 WAS 5370, +77 WAS +92, -7 WAS -5, 2420 WAS 1790, +336 WAS +334, -3 WAS -2, 2460 WAS 3580, +68,-68 WAS +61,-61, -10 WAS +1, 1020 WAS 1430, +363 WAS +358, +68 WAS +60, 0 WAS +19, 1320 WAS 1400, +363 WAS +366, +10 WAS +11, -38 WAS 0, +86 WAS +67, 0 WAS -15, DELETED LADDER & ASSOCIATED DIMS, 4310 WAS 4360, +235 WAS +205, -35 WAS -23, +2 WAS 0, 17290 WAS 17750, +240 WAS +238, -1 WAS +3, -2 WAS +10		





VIEW B-B



(A)5

ITEM	WT	LOCATION OF C.G. X	Y	Z
1ST ARM ELEMENT	5320#	+77	-7	0
2ND ARM ELEMENT	2420#	+336	-3	0
TOWER HINGE PLATES	2460#	-15	+68, -68	-10
EXTENSION PLATFORM (LOWER)	1680#	+352	-8	0
EXTENSION PLATFORM (UPPER)	1020#	+363	+68	0
WITHDRAWAL MECHANISM (LOWER)	1320#	+363	+10	-38
WITHDRAWAL MECHANISM (UPPER)	1220#	+374	+86	0
LINES	4310#	+235	-35	+2
ASSEMBLY (1)	17290#	+240	-1	-2

S-II INTER ARM

SEE ENGINEERING RECORDS

NEXT ASSY | USED ON

APPLICATION

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACTIONS DECIMALS ANGLES
MATERIAL
HEAT TREATMENT
FINAL PROTECTIVE FINISH

ORIGINAL DATE OF DRAWING 22 JAN 63
SUBMITTED
APPROVED PRELIMINARY
LATEST INFO DATE 5-29-63 DIRECTOR

SERVICE ARM
PRELIMINARY
WEIGHT & C.G. STUDY
COMPLEX 39

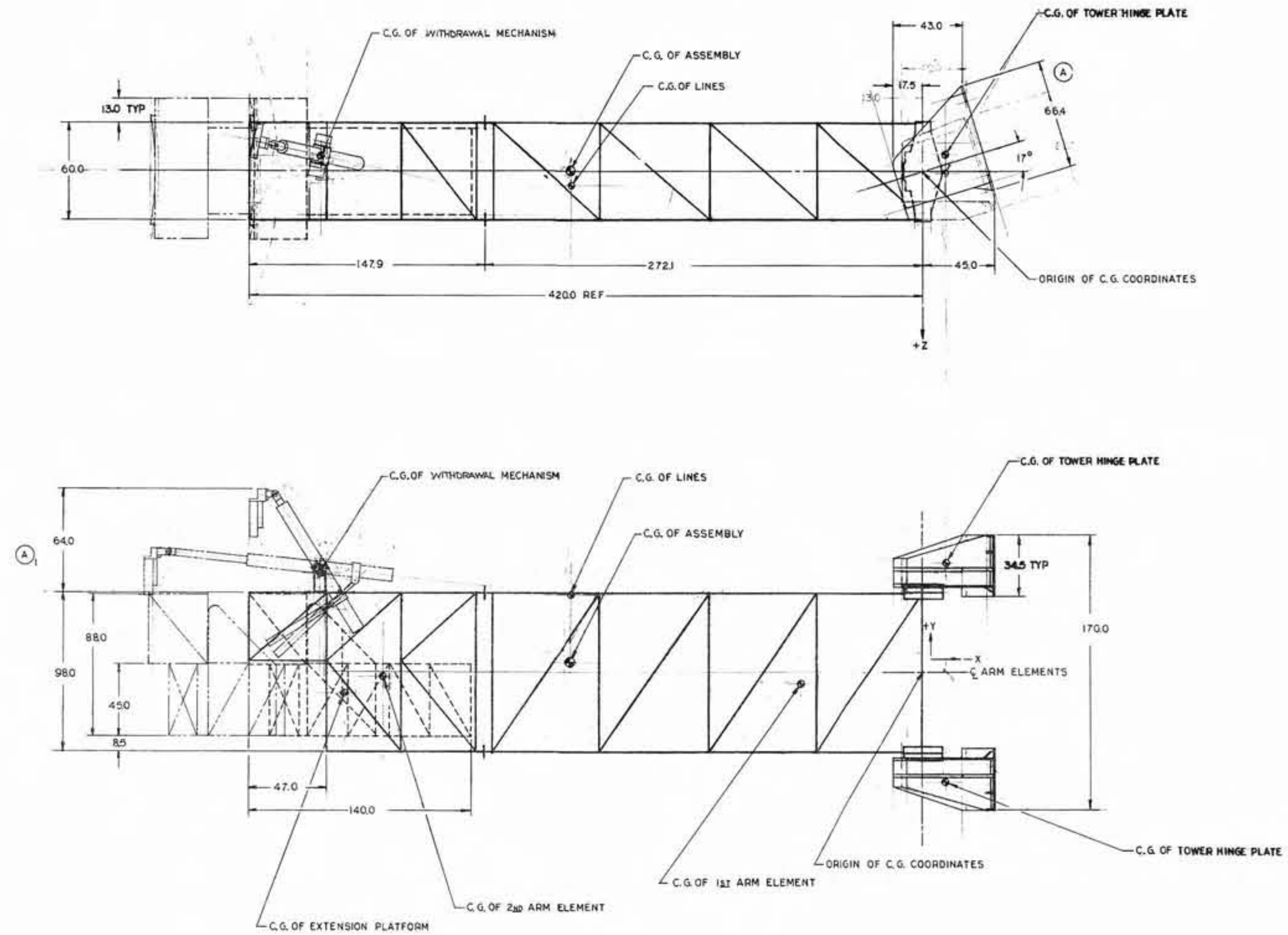
WEIGHT CHECKER | DATE | CODE
SCALE 1/30 | UNIT WEIGHT

GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

DWG SIZE J 75M-05238L

SHEET 5 OF 8

ZONE	SYM	DESCRIPTION	DATE	APPROVAL
		REVISIONS		
4B	A	1) 640 WAS 710	4-8-63	
2D		2) REVISED TOWER HINGE PLATE		
		66.4 WAS 60.0 17.5 WAS 13.0,		
1C		430 WAS 400 [illegible] REVISED		
		TABULATION BLOCK AS FOLLOWS		
		[illegible] WAS [illegible] +77 WAS +[illegible]		
		[illegible]		
		[illegible]		
		2460 WAS 3500 [illegible] WAS		
		[illegible] -10 WAS +[illegible] WAS		
		[illegible] WAS [illegible] WAS 0		
		1870 WAS 2100 +219 WAS +220		
		+50 WAS +[illegible] WAS 0, [illegible]		
		WAS [illegible] +220 WAS +22[illegible]		
		+7 WAS +12, +1 WAS 0		



S-II FWD ARM

ITEM	WT	LOCATION OF C.G. X	Y	Z
1ST ARM ELEMENT	5320#	+77	-7	0
2ND ARM ELEMENT	2420#	+336	-3	0
TOWER HINGE PLATES	2460# EA	-15	+68, -68	-10
EXTENSION PLATFORM	2190#	+360	-13	0
WITHDRAWAL MECHANISM	1090#	+375	+61	-9
LINES	1878#	+219	+50	+14
ASSEMBLY	12890#	+220	+7	+1

LIST OF MATERIAL

SEE ENGINEERING RECORDS

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

ORIGINAL DATE OF DRAWING 22 JAN 63

APPROVED PRELIMINARY LATEST INFO DATE 5-28-63

SERVICE ARM PRELIMINARY WEIGHT & C.G. STUDY COMPLEX 39

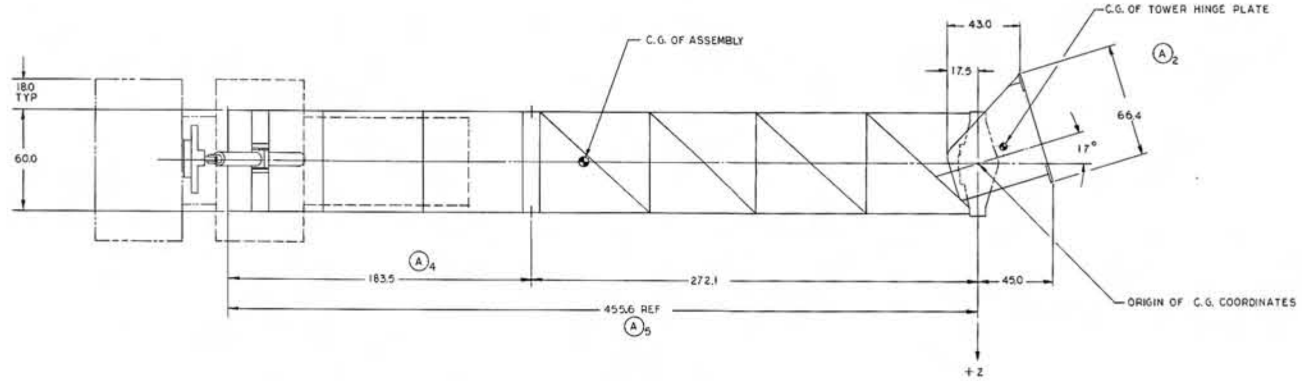
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

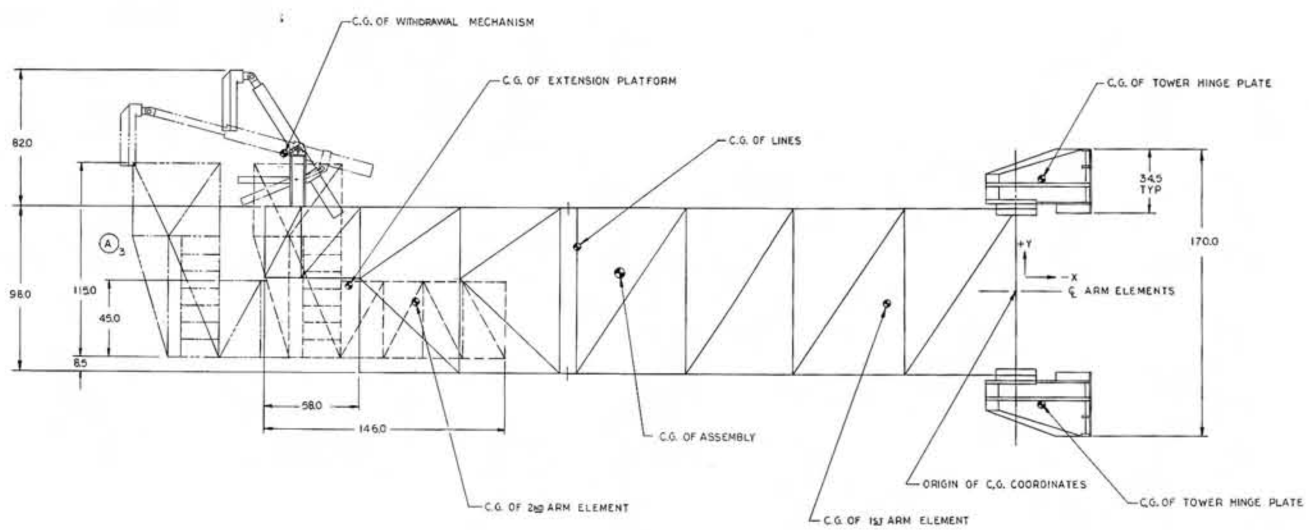
SIZE J 75M-05238L

SCALE 1/30 SHEET 6 OF 6

REVISIONS

ZONE	SYM	DESCRIPTION	DATE	APPROVAL
	A	(1) REVISED & REDRAWN WITH THE FOLLOWING CHANGES	4-9-63	
2D		(2) REVISED TOWER HINGE PLATE, 66.4 WAS 60.0, 17.5 WAS 13.0, 43.0 WAS 40.0		
4B		(3) REVISED EXT. PLATFORM, 115.0 WAS 86.0, 45.0 WAS 47.0		
3A		(4) REVISED 2ND ARM ELEMENT, 183.5 WAS 147.9, 58.0 WAS 47.0		
3C		(5) 455.6 WAS 461.0, 82.0 WAS 71.0		
1C		(6) REVISED TABULATION BLOCK AS FOLLOWS, 5320 WAS 5370, +77 WAS +92, -7 WAS -5, DELETED ARM EXT. PANEL, 2550 WAS 1790, +364 WAS +375, -7 WAS -2, 2460 WAS 3580, +68,-68 WAS +61,-61, -10 WAS +1, 1100 WAS 2200, +435 WAS +408, +11 WAS -14, 1290 WAS 1820, +445 WAS +456, +81 WAS +71, 2920 WAS 1890, +266 WAS +240, +25 WAS +27, 13180 WAS 13990, +240 WAS +260, +10 WAS +8		





A6

		LOCATION OF C.G.		
ITEM	WT	X	Y	Z
1ST ARM ELEMENT	5320#	+77	-7	0
2ND ARM ELEMENT	2550#	+364	-7	0
TOWER HINGE PLATES	2460# EA	-15	+68, -68	-10
EXTENSION PLATFORM	2520#	+404	+2	0
WITHDRAWAL MECHANISM	1290#	+445	+81	0
LINES	2920#	+266	+25	0
ASSEMBLY	14600#	+254	+9	0

S-IVB AFT ARM

SEE ENGINEERING RECORDS

NEXT ASSY | USED ON
APPLICATION

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACTIONS DECIMALS ANGLES
MATERIAL
HEAT TREATMENT
FINAL PROTECTIVE FINISH

ORIGINAL DATE OF DRAWING 22 JAN 63
APPROVED PRELIMINARY
LATEST INFO DATE 5-28-63

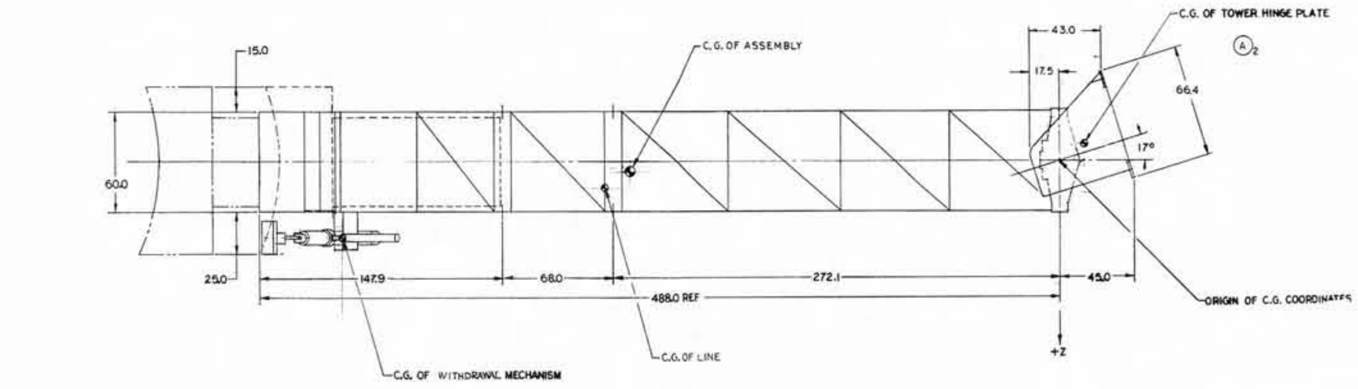
SERVICE ARM
PRELIMINARY
WEIGHT & C.G. STUDY
COMPLEX 39

SCALE 1/30

GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

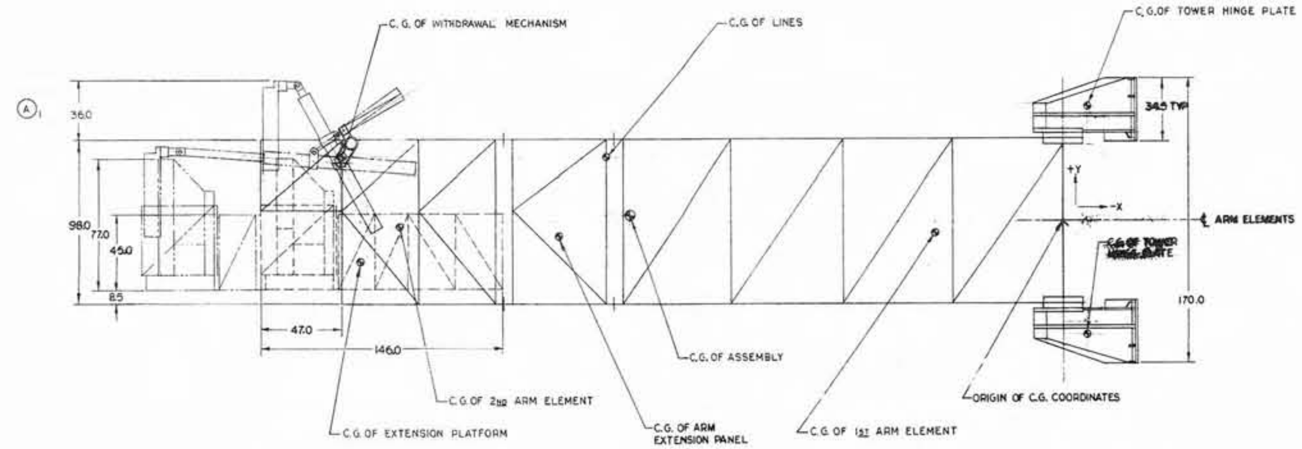
DWG SIZE J 75M-05238L
SHEET 7 OF 8

ZONE	SYM	REVISIONS — DESCRIPTION	DATE	APPROVAL
4 B	A	(1) 36.0 WAS 32.0	4-8-63	
2 D		(2) REVISED TOWER HINGE PLATE 66.4 WAS 60.0, 17.5 WAS		
1 C		13.0, 43.0 WAS 40.0 (3) REVISED TABULATION BLOCK AS FOLLOWS: 5320 WAS 5370, +77 WAS +92, -7 WAS -4, 1050 WAS 1090, 2420 WAS 1790, +404 WAS +402, -3 WAS -2, 2460 WAS 3580, +68 -68 WAS +61 -61, -10 WAS +1, 900 WAS 1410, +438 WAS +461, +39 WAS +41, 3160 WAS 3200, +276 WAS +258, +38 WAS +32, +16 WAS 0, 15200 WAS 15210, +262 WAS +264, +3 WAS +4, +6 WAS +4		



A3

ITEM	WT	LOCATION OF C.G. X	Y	Z
1ST ARM ELEMENT	5320#	+77	-7	0
ARM EXTENSION PANEL	1050#	+306	-9	0
2ND ARM ELEMENT	2420#	+404	-3	0
TOWER HINGE PLATES	2460# EA	-15	+68, -68	-10
EXTENSION PLATFORM	2350#	+427	-28	0
WITHDRAWAL MECHANISM	900#	+438	+39	+45
LINES	3160#	+276	+38	+16
(1) ASSEMBLY	15200#	+262	+3	+6



S-IVB FWD ARM

LIST OF MATERIAL

SEE ENGINEERING RECORDS

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES

ORIGINAL DATE OF DRAWING 22 JAN 63

APPROVED PRELIMINARY LATEST INFO DATE 5-28-63

SERVICE ARM PRELIMINARY WEIGHT & C.G. STUDY COMPLEX 39

GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

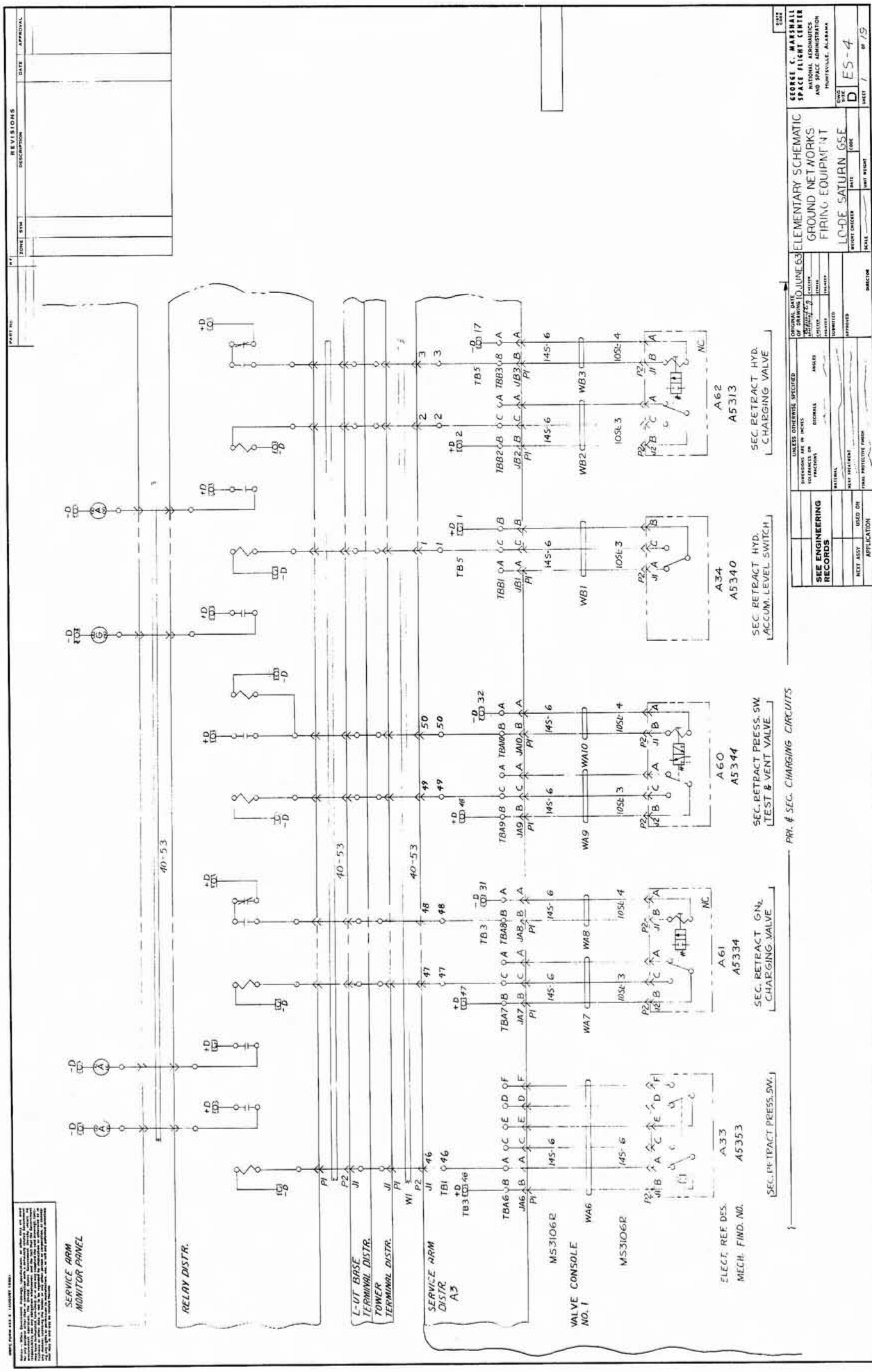
DWG SIZE J 75M05238L

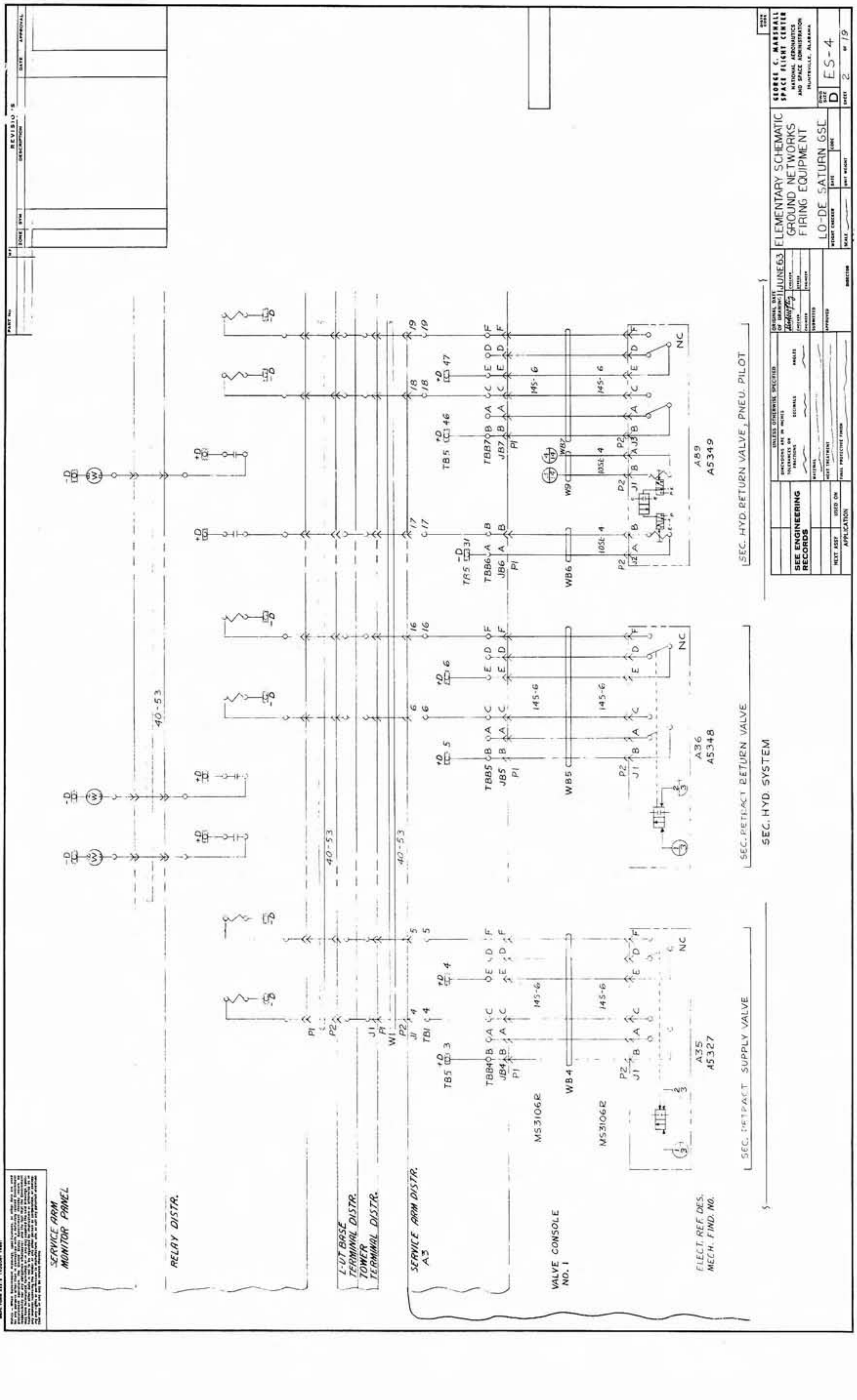
SCALE 1/30 SHEET 8 OF 8

APPENDIX C

Preface

Appendix C contains electrical schematics for ground network firing equipment, service arm monitor cabinet configuration, and a family tree of electrical drawings for service arms. A general equipment layout and arm lighting layout is also included.


SERVICE ARM MONITOR PANEL
RELAY DISTR.
L-UT BASE TERMINAL DISTR.
TOWER TERMINAL DISTR.
SERVICE ARM DISTR. A3
VALVE CONSOLE NO. 1
MS3106R
ELECT. REF. DES.
MECH. FIND. NO.
40-53
A33
A5353
SEC. RETRACT PRESS. SW.
A61
A5334
SEC. RETRACT GN2 CHARGING VALVE
A60
A5344
SEC. RETRACT PRESS. SW. TEST & VENT VALVE
PRI. & SEC. CHARGING CIRCUITS
A34
A5340
SEC. RETRACT HYD. ACCUM. LEVEL SWITCH
A62
A5313
SEC. RETRACT HYD. CHARGING VALVE
REVISIONS
SEE ENGINEERING RECORDS
10 JUNE 63
ELEMENTARY SCHEMATIC
GROUND NETWORKS
FIRING EQUIPMENT
LO-DF SATURN GSE
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA
D
ES-4
1 OF 15



SERVICE ARM MONITOR PANEL
RELAY DISTR.
L-UT BASE TERMINAL DISTR.
TOWER TERMINAL DISTR.
SERVICE ARM DISTR. A3
VALVE CONSOLE NO. 1
ELECT. REF. DES.
MECH. FIND. NO.
MS3106R
A35
A5327
A36
A5348
A89
A5349
SEC. RETRACT SUPPLY VALVE
SEC. RETRACT RETURN VALVE
SEC. HYD. RETURN VALVE, PNEU. PILOT
SEC. HYD. SYSTEM
NC
40-53
145-6
SEE ENGINEERING RECORDS
ELEMENTARY SCHEMATIC
GROUND NETWORKS
FIRING EQUIPMENT
LO-DE SATURN GSE
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA
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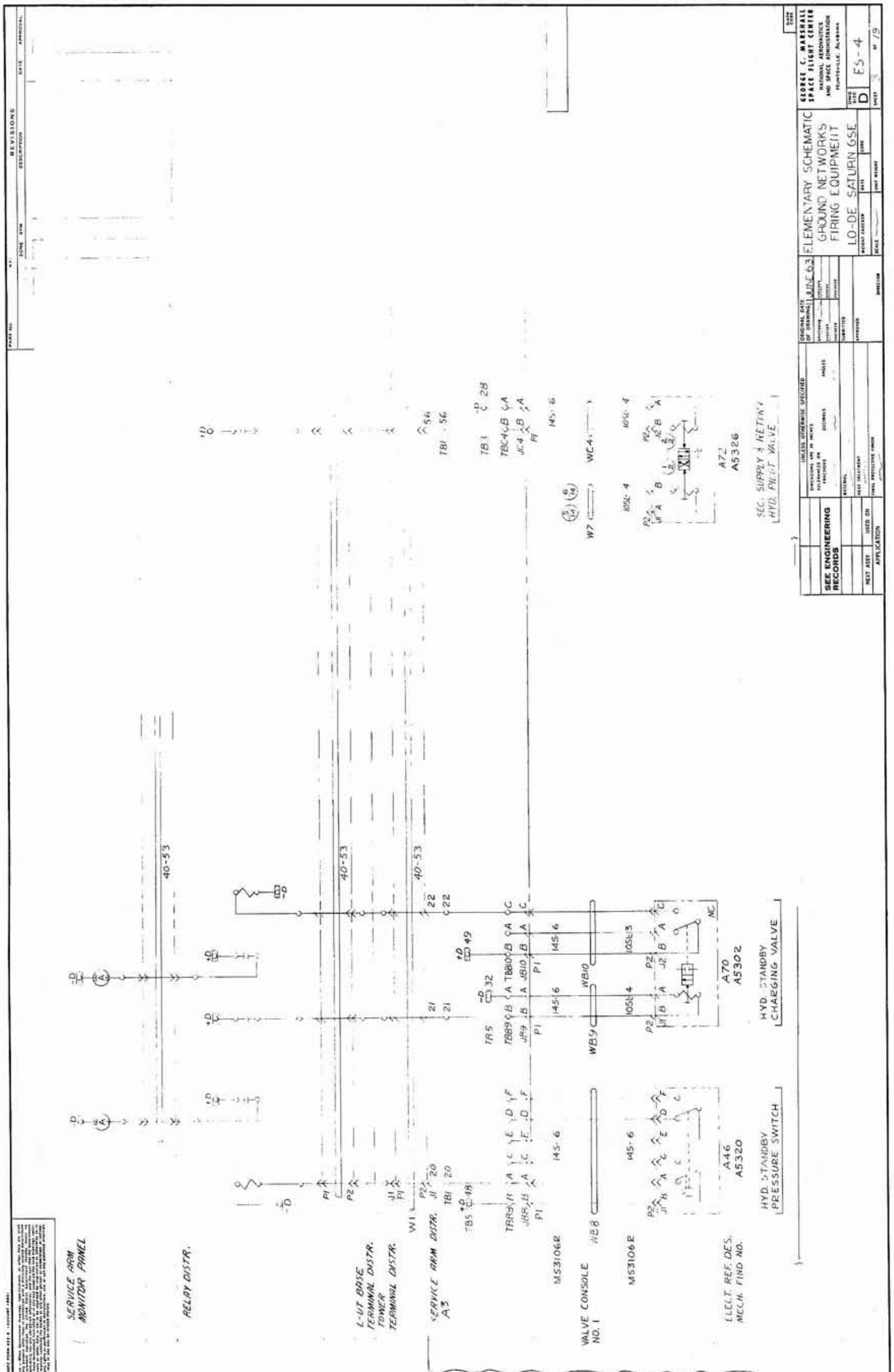
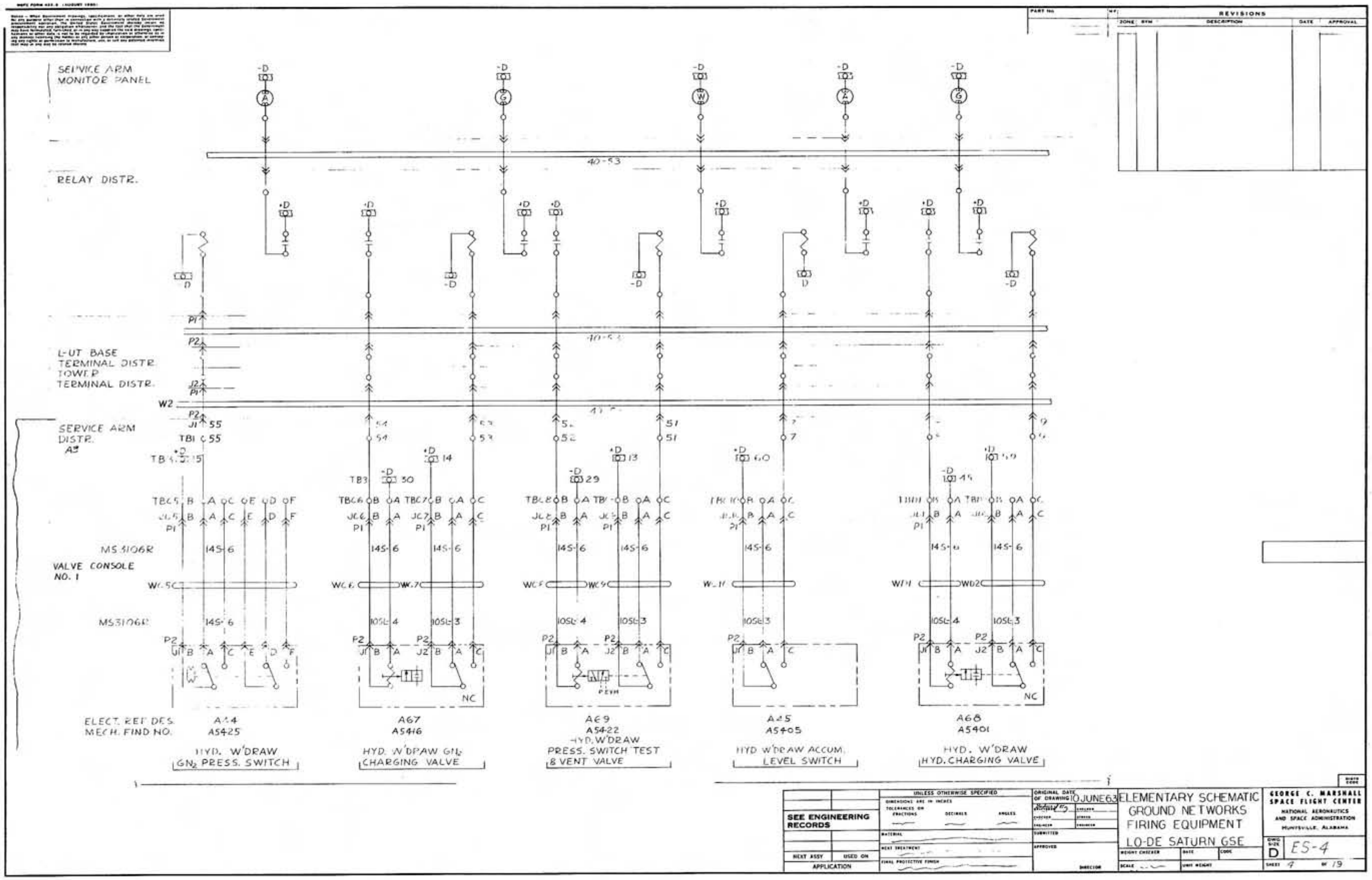
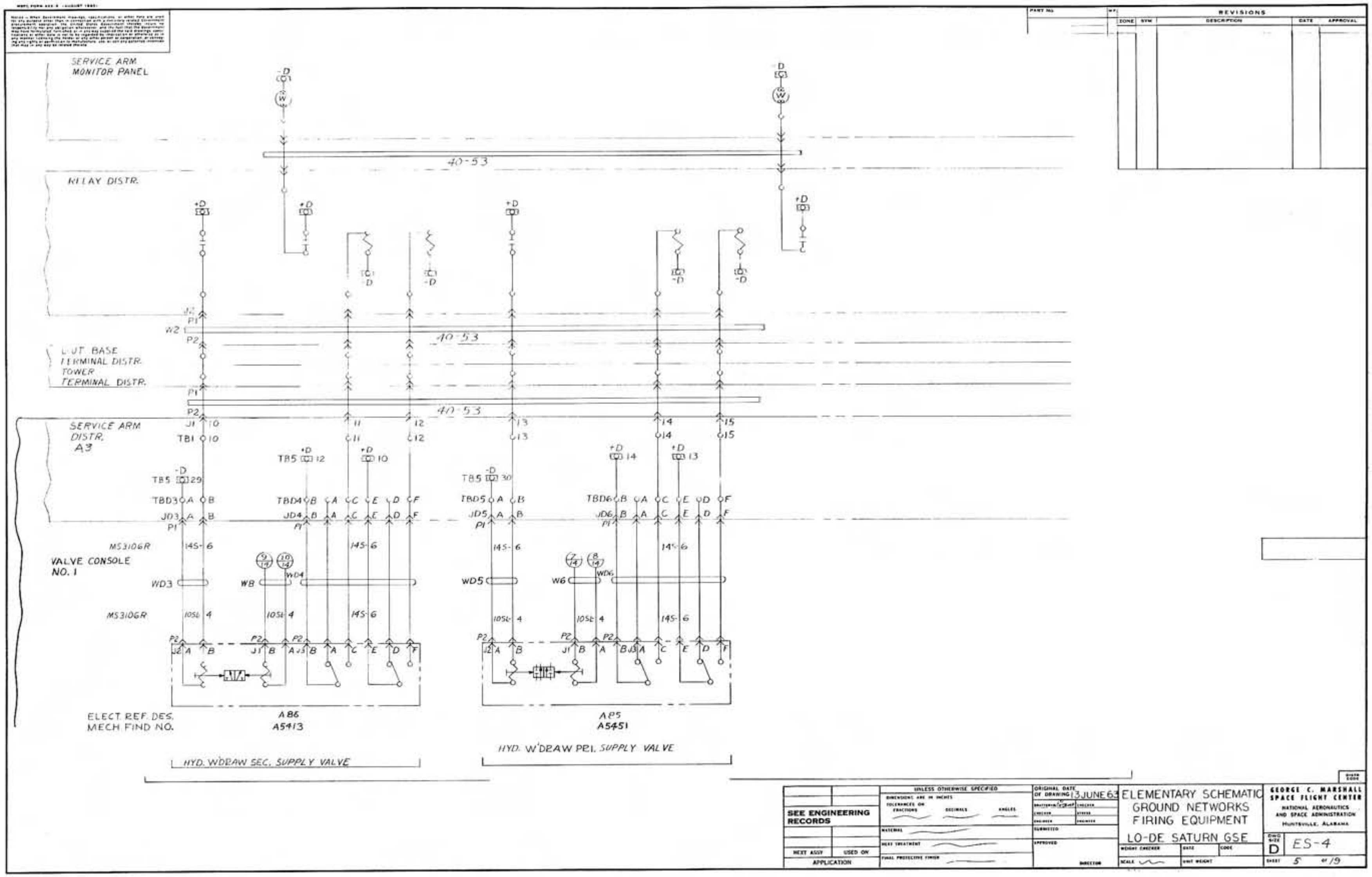
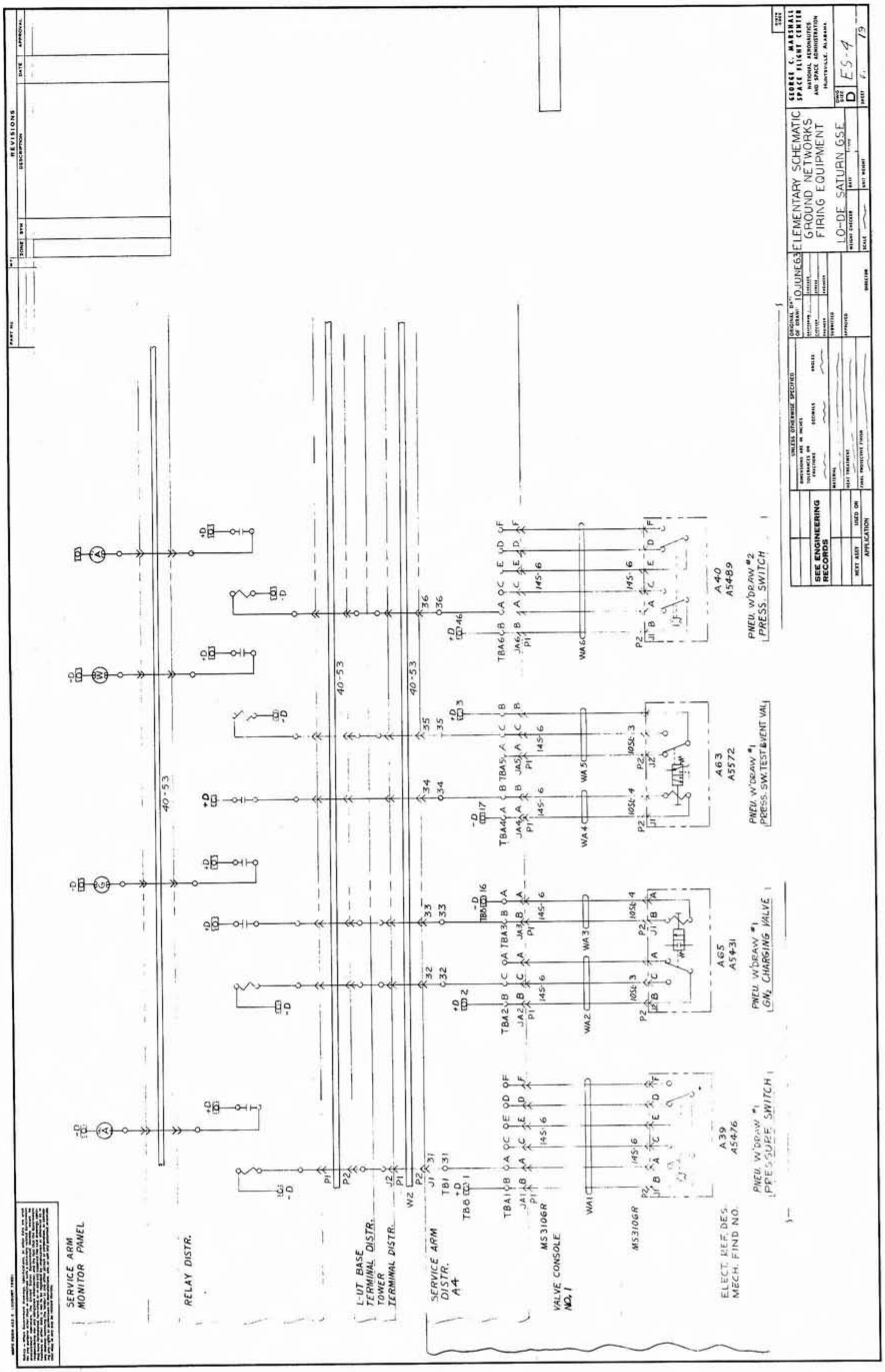
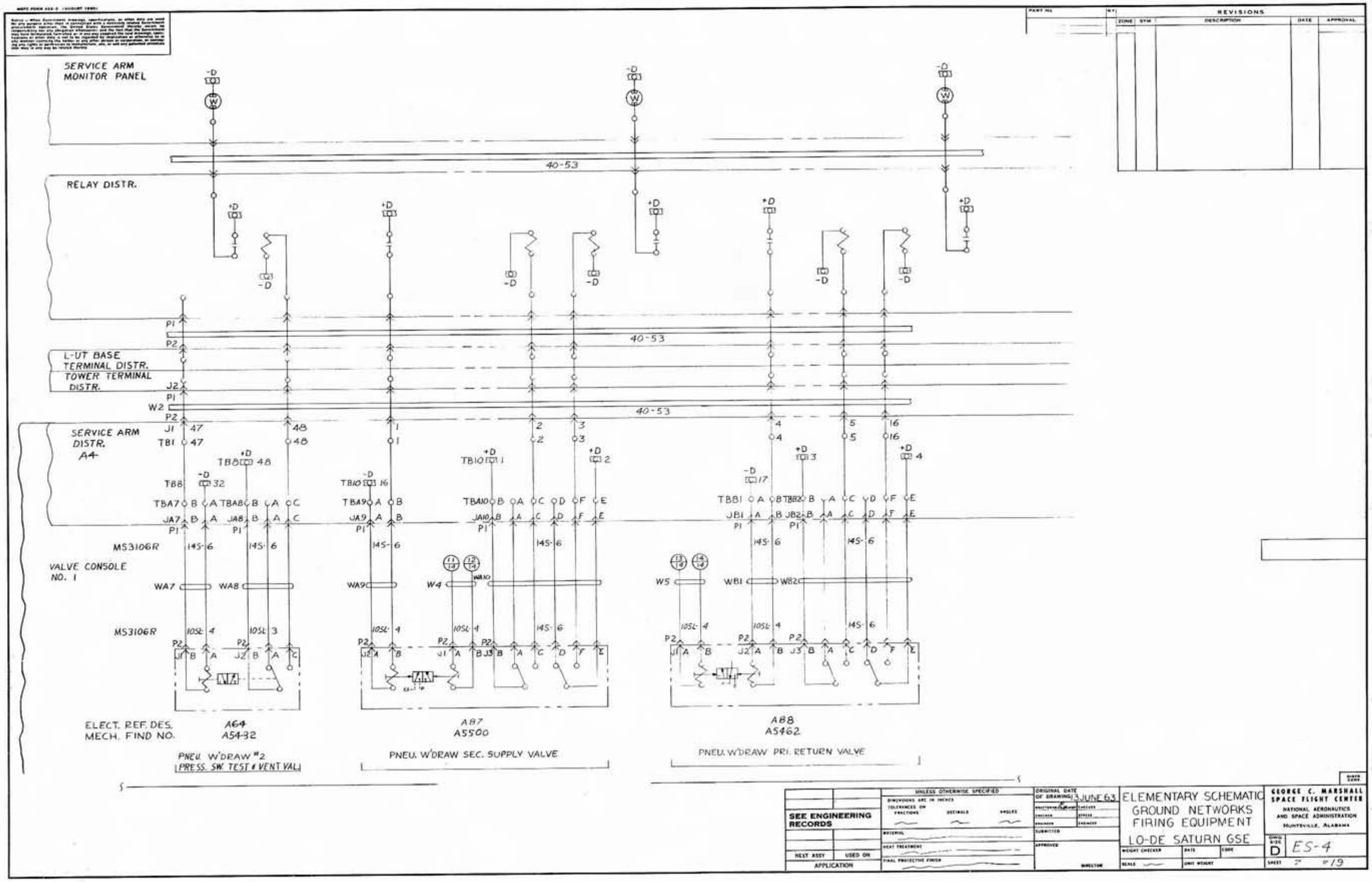
D
REVISIONS


SERVICE ARM MONITOR PANEL
RELAY DISTR.
L-UT BASE TERMINAL DISTR.
TOWER TERMINAL DISTR.
SERVICE ARM DISTR. A3
VALVE CONSOLE NO. 1
MS3106R
MS3106R
ELECT. REF. DES.
MECH. FIND NO.
HYD. STANDBY PRESSURE SWITCH
A46
A5320
HYD STANDBY CHARGING VALVE
A70
A5302
SEC. SUPPLY & RETURN HYD. PILOT VALVE
A72
A5326
40-53
40-53
40-53
145-6
WB9
WB10
W7
WC4
REVISIONS
SEE ENGINEERING RECORDS
ORIGINAL DATE OF DRAWING 1 JUNE 63
ELEMENTARY SCHEMATIC
GROUND NETWORKS
FIRING EQUIPMENT
LO-DE SATURN 65E
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA
D
ES-4
3 of 19


SERVICE ARM MONITOR PANEL
RELAY DISTR.
L-UT BASE TERMINAL DISTR.
TOWER TERMINAL DISTR.
SERVICE ARM DISTR.
VALVE CONSOLE NO. 1
MS3106R
ELECT. REF DES.
MECH. FIND NO.
A14 A5425 HYD. W'DRAW GN2 PRESS. SWITCH
A67 A5416 HYD. W'DRAW GN2 CHARGING VALVE
A69 A5422 HYD. W'DRAW PRESS. SWITCH TEST & VENT VALVE
A25 A5405 HYD W'DRAW ACCUM. LEVEL SWITCH
A68 A5401 HYD. W'DRAW HYD. CHARGING VALVE
REVISIONS
SEE ENGINEERING RECORDS
10 JUNE 63
ELEMENTARY SCHEMATIC
GROUND NETWORKS
FIRING EQUIPMENT
LO-DE SATURN GSE
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA
D ES-4


SERVICE ARM MONITOR PANEL
RELAY DISTR.
LUT BASE TERMINAL DISTR.
TOWER TERMINAL DISTR.
SERVICE ARM DISTR. A3
VALVE CONSOLE NO. 1
MS3106R
MS3106R
ELECT. REF. DES.
MECH FIND NO.
40-53
A86
A5413
A85
A5451
HYD. W'DRAW SEC. SUPPLY VALVE
HYD. W'DRAW PRI. SUPPLY VALVE
TB1
TB5
TBD3
TBD4
TBD5
TBD6
JD3
JD4
JD5
JD6
WD3
W8
WD5
W6
145-6
105L-4
SEE ENGINEERING RECORDS
UNLESS OTHERWISE SPECIFIED
NEXT ASSY
USED ON
APPLICATION
ORIGINAL DATE OF DRAWING 3 JUNE 63
ELEMENTARY SCHEMATIC
GROUND NETWORKS
FIRING EQUIPMENT
LO-DE SATURN GSE
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA
D
ES-4
SHEET 5 OF 19
REVISIONS
ZONE
SYM
DESCRIPTION
DATE
APPROVAL
PART No.


ELEMENTARY SCHEMATIC
GROUND NETWORKS
FIRING EQUIPMENT
LO-DE SATURN GSE
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA
10 JUNE 63
ES-4
SEE ENGINEERING RECORDS
REVISIONS
SERVICE ARM MONITOR PANEL
RELAY DISTR.
L-UT BASE TERMINAL DISTR.
TOWER TERMINAL DISTR.
SERVICE ARM DISTR. A4
VALVE CONSOLE NO. 1
MS3106R
ELECT. REF. DES.
MECH. FIND NO.
A39
A5476
PNEU. W'DRAW #1
PRESSURE SWITCH
A65
A5431
PNEU. W'DRAW #1
GN_2 CHARGING VALVE
A63
A5572
PNEU. W'DRAW #1
PRESS. SW. TEST & VENT VAL.
A40
A5489
PNEU. W'DRAW #2
PRESS. SWITCH
40-53


SERVICE ARM MONITOR PANEL
RELAY DISTR.
L-UT BASE TERMINAL DISTR.
TOWER TERMINAL DISTR.
SERVICE ARM DISTR. A4
MS3106R
VALVE CONSOLE NO. 1
40-53
ELECT. REF. DES.
MECH. FIND NO.
A64
A5432
PNEU. W'DRAW #2 (PRESS. SW. TEST & VENT VAL)
A87
A5500
PNEU. W'DRAW SEC. SUPPLY VALVE
A88
A5462
PNEU. W'DRAW PRI. RETURN VALVE
REVISIONS
SEE ENGINEERING RECORDS
UNLESS OTHERWISE SPECIFIED
3 JUNE 63
ELEMENTARY SCHEMATIC
GROUND NETWORKS
FIRING EQUIPMENT
LO-DE SATURN GSE
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA
D
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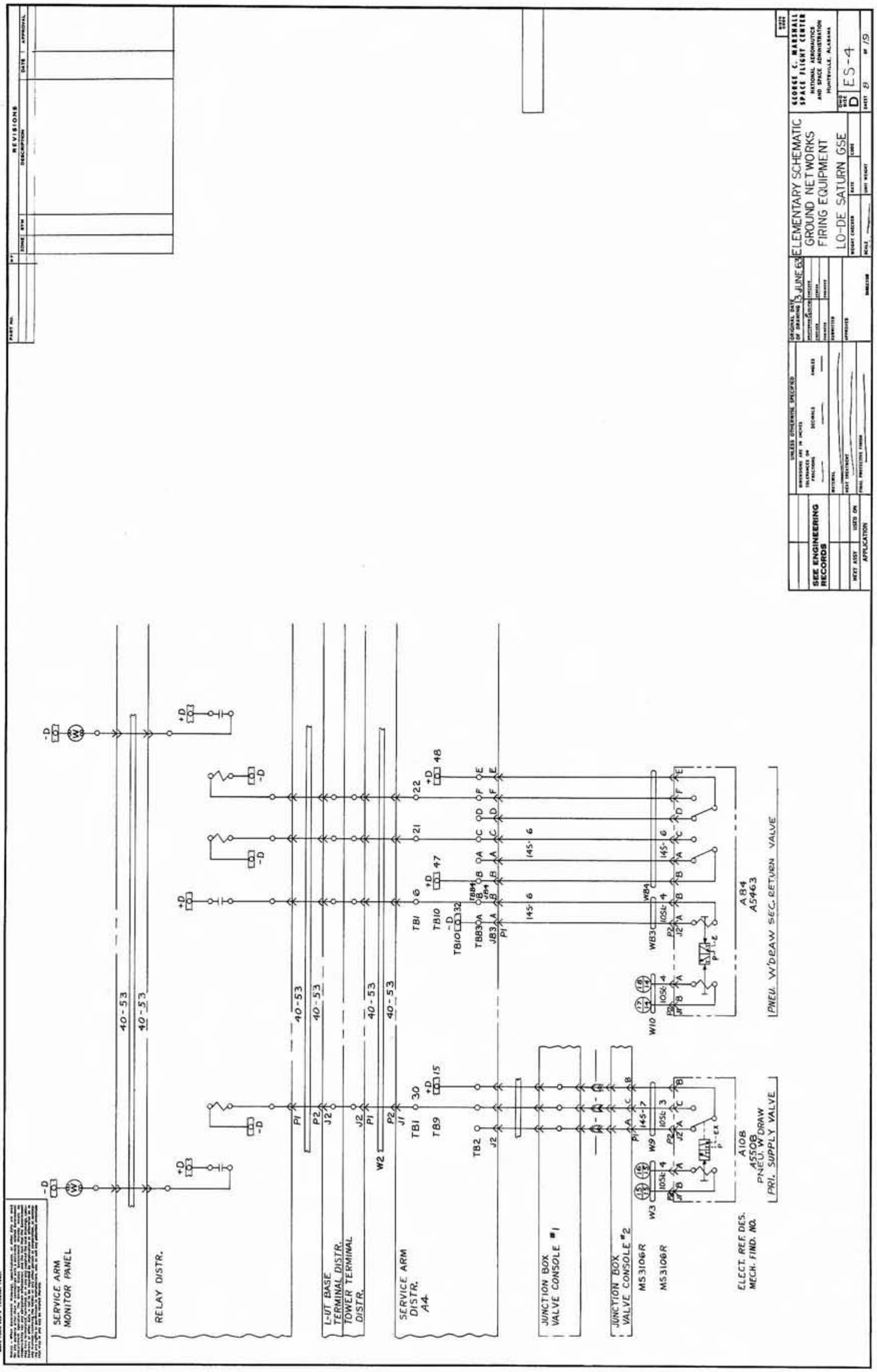
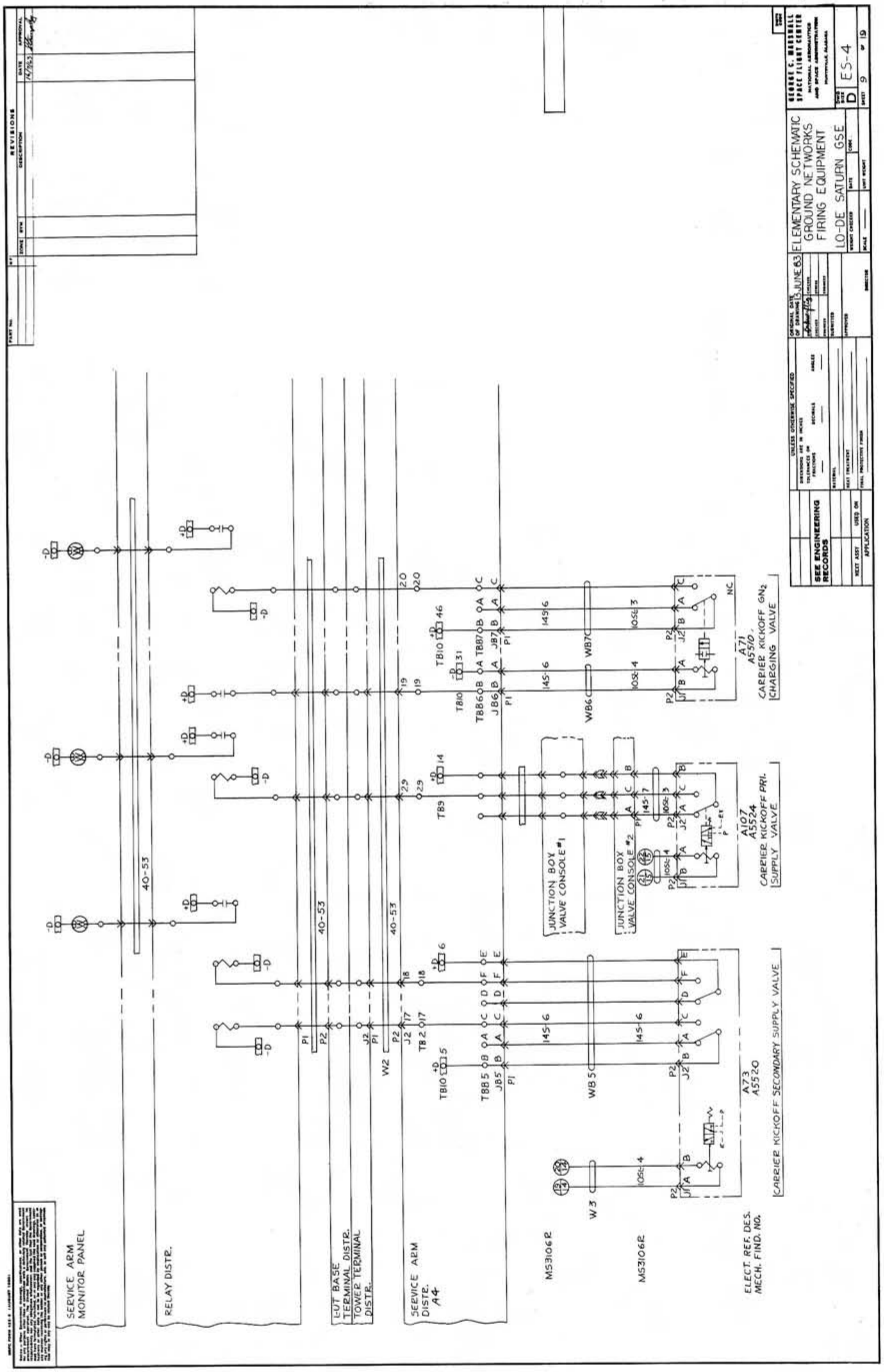
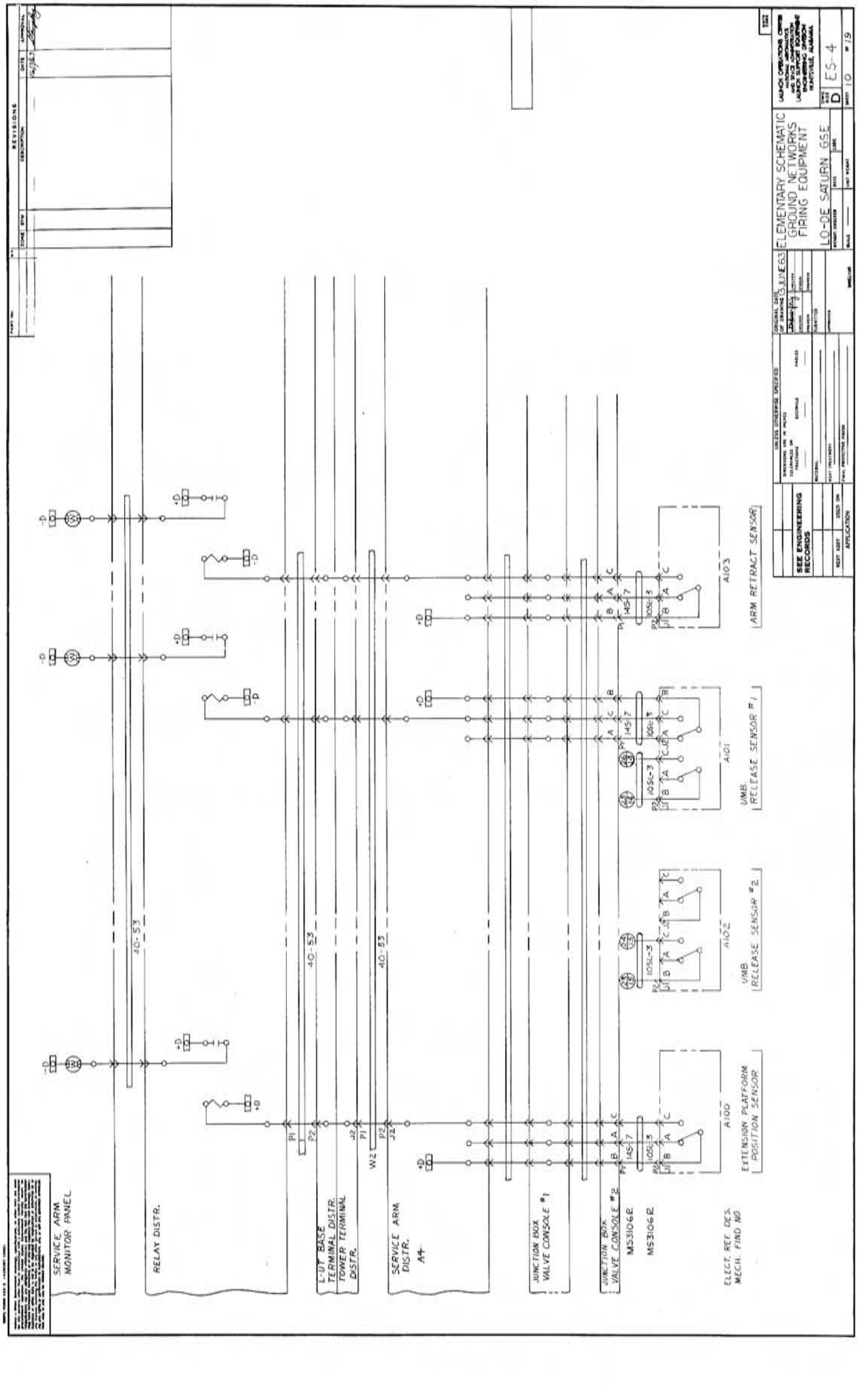
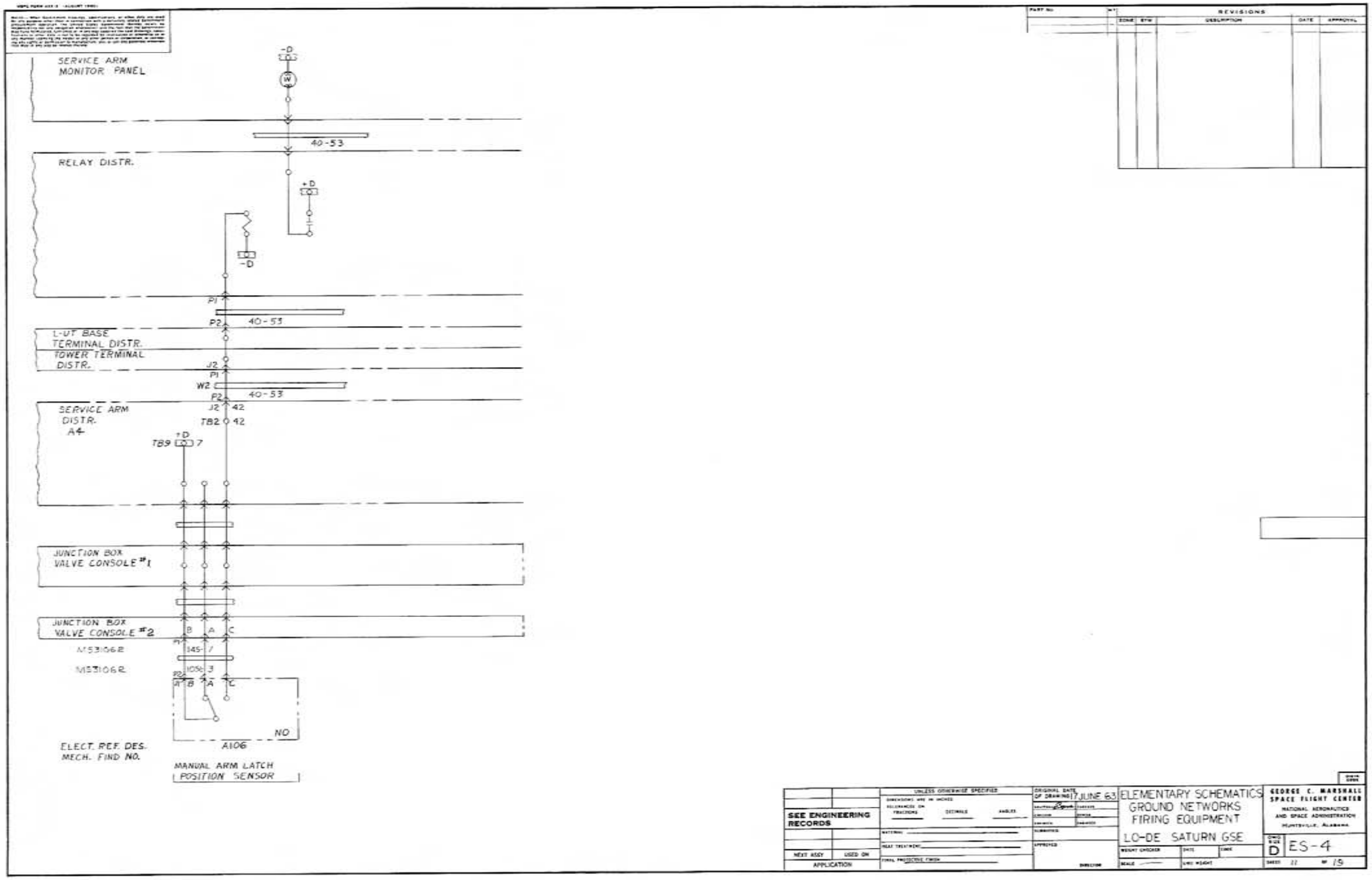


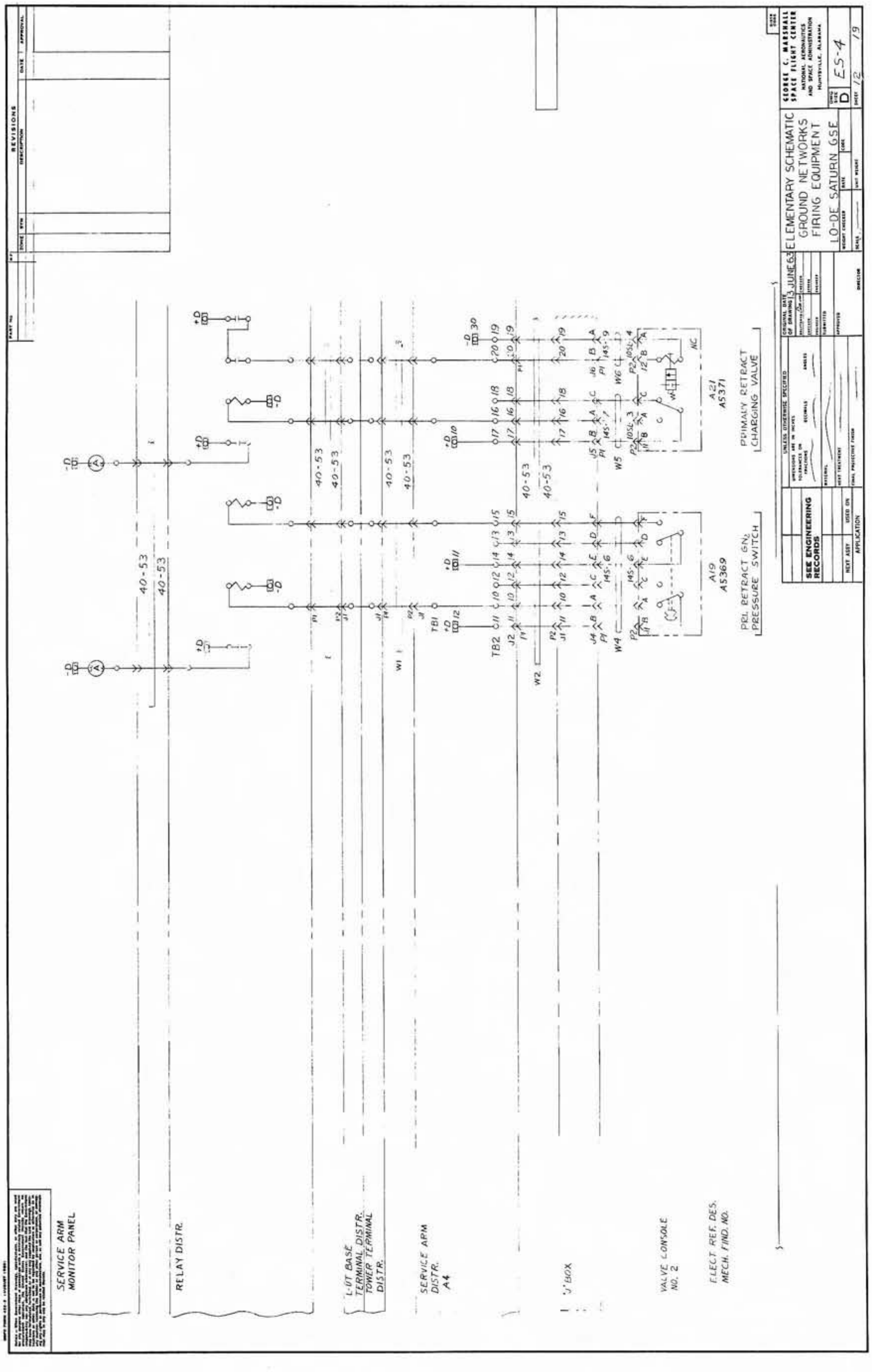
SERVICE ARM MONITOR PANEL
RELAY DISTR.
L-UT BASE TERMINAL DISTR.
TOWER TERMINAL DISTR.
SERVICE ARM DISTR. A4
JUNCTION BOX VALVE CONSOLE #1
JUNCTION BOX VALVE CONSOLE #2
MS3106R
MS3106R
ELECT. REF. DES.
MECH. FIND. NO.
A108
A5508
PNEU. W'DRAW
PRI. SUPPLY VALVE
A84
A5463
PNEU. W'DRAW SEC. RETURN VALVE
40-53
REVISIONS
SEE ENGINEERING RECORDS
3 JUNE 63
ELEMENTARY SCHEMATIC
GROUND NETWORKS
FIRING EQUIPMENT
LO-DE SATURN GSE
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA
D
ES-4

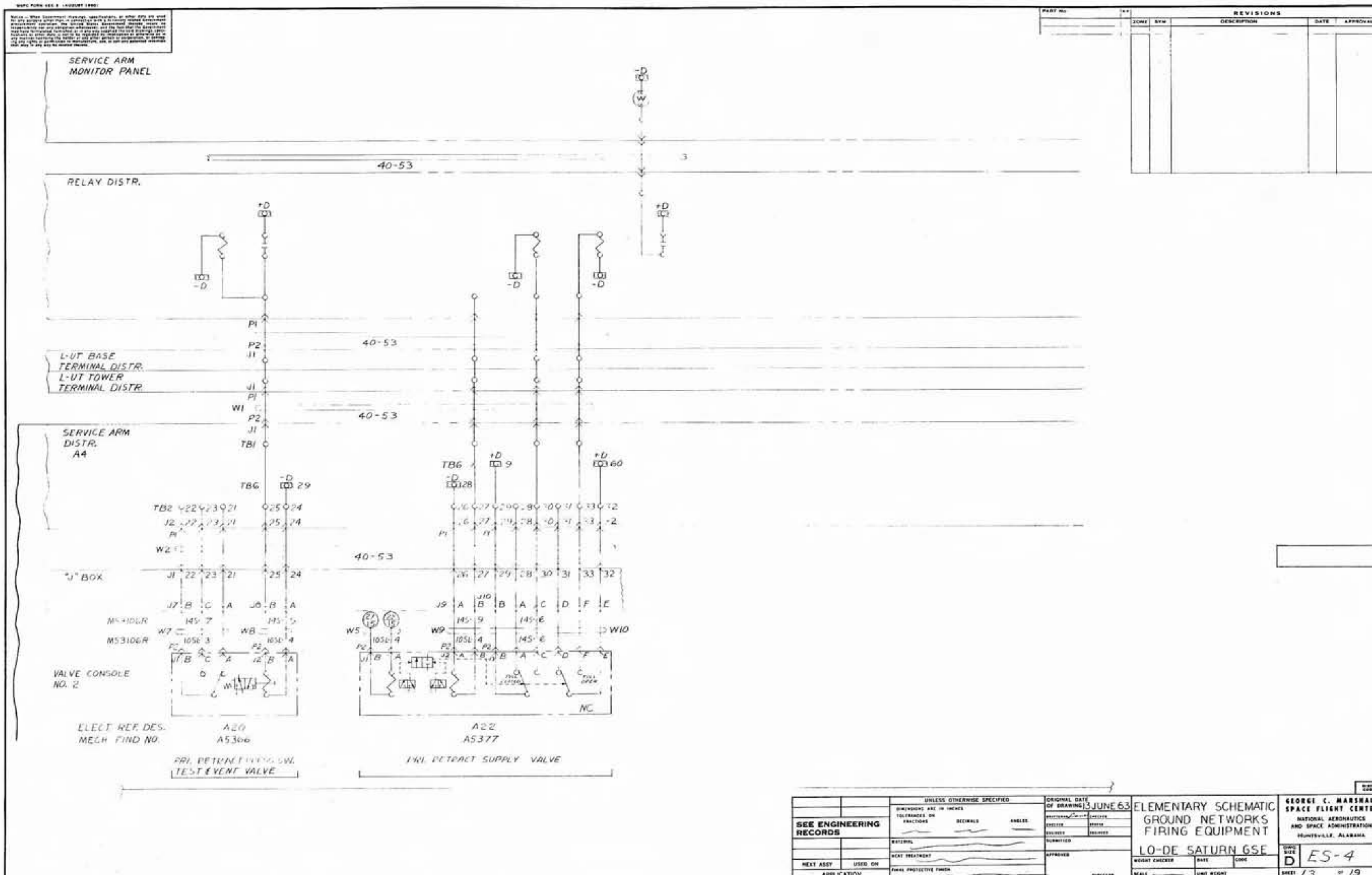


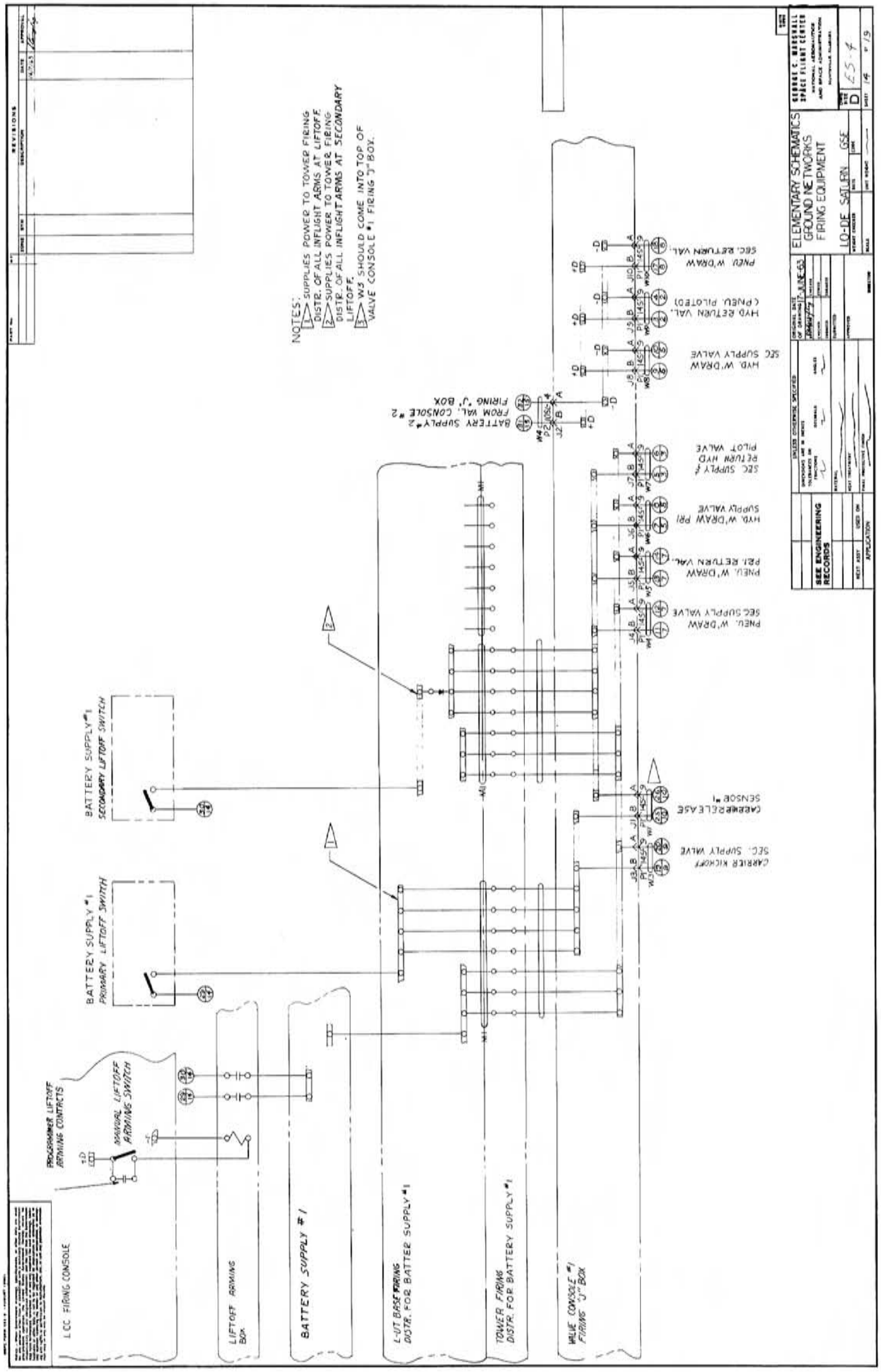
ELEMENTARY SCHEMATIC
GROUND NETWORKS
FIRING EQUIPMENT
LO-DE SATURN GSE
ES-4
SHEET 9 OF 19
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA
ORIGINAL DATE OF DRAWING 13 JUNE 63
SEE ENGINEERING RECORDS
REVISIONS
SERVICE ARM MONITOR PANEL
RELAY DISTR.
LUT BASE TERMINAL DISTR.
TOWER TERMINAL DISTR.
SERVICE ARM DISTR. A4
MS3106R
MS3106R
ELECT. REF. DES.
MECH. FIND. NO.
40-53
CARRIER KICKOFF SECONDARY SUPPLY VALVE
A73
A5520
JUNCTION BOX VALVE CONSOLE #1
JUNCTION BOX VALVE CONSOLE #2
A107
A5524
CARRIER KICKOFF PRI. SUPPLY VALVE
A71
A5510
CARRIER KICKOFF GN2 CHARGING VALVE
W2
W3
WB5
WB6
WB7

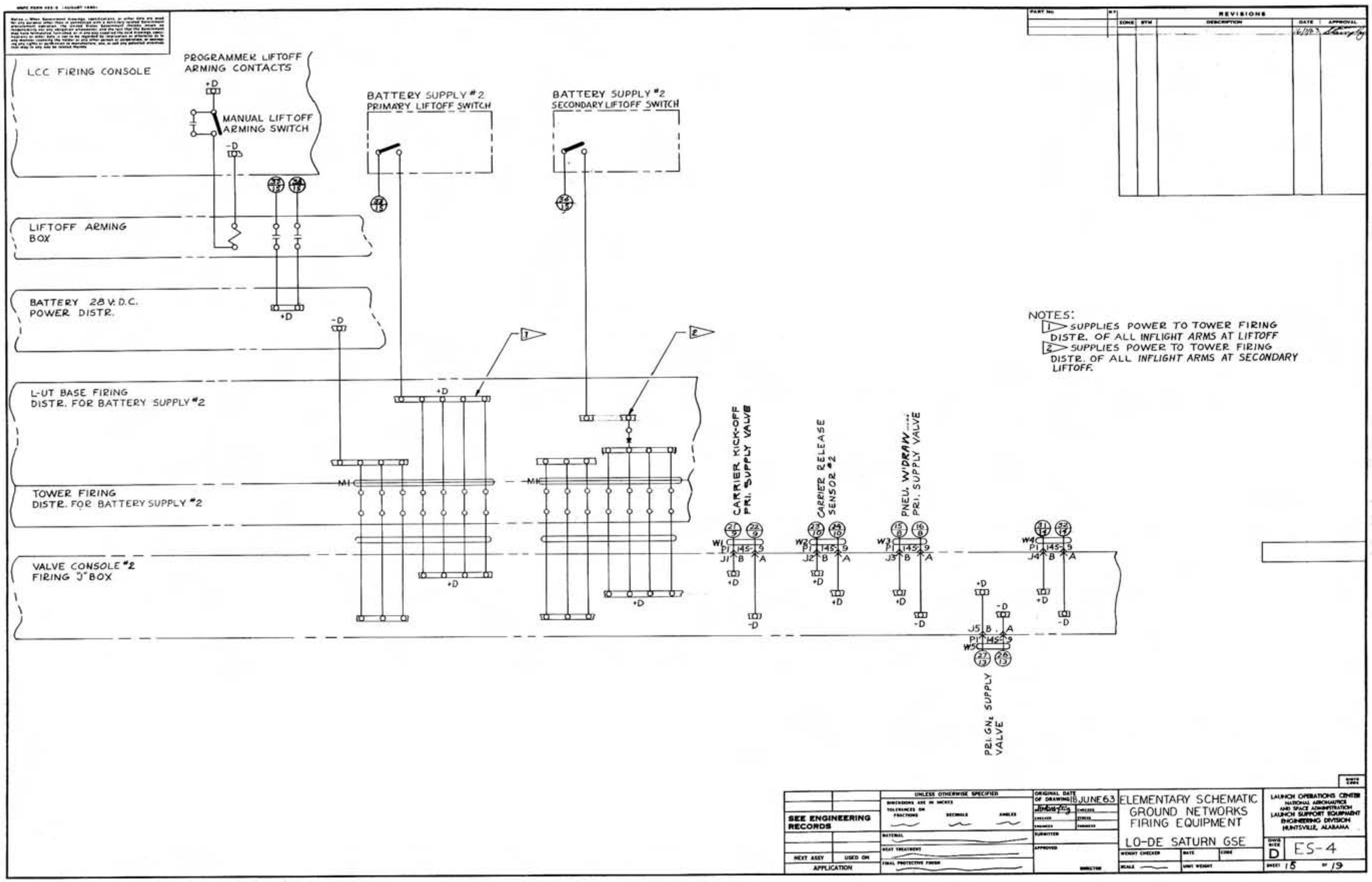

SERVICE ARM MONITOR PANEL
RELAY DISTR.
L-UT BASE TERMINAL DISTR.
TOWER TERMINAL DISTR.
SERVICE ARM DISTR.
A4
JUNCTION BOX VALVE CONSOLE #1
JUNCTION BOX VALVE CONSOLE #2
MS3106R
MS3106R
ELECT. REF. DES.
MECH. FIND NO
40-53
40-53
40-53
A100
EXTENSION PLATFORM POSITION SENSOR
A102
UMB. RELEASE SENSOR #2
A101
UMB. RELEASE SENSOR #1
A103
ARM RETRACT SENSOR
SEE ENGINEERING RECORDS
ELEMENTARY SCHEMATIC
GROUND NETWORKS
FIRING EQUIPMENT
LO-DE SATURN GSE
ES-4

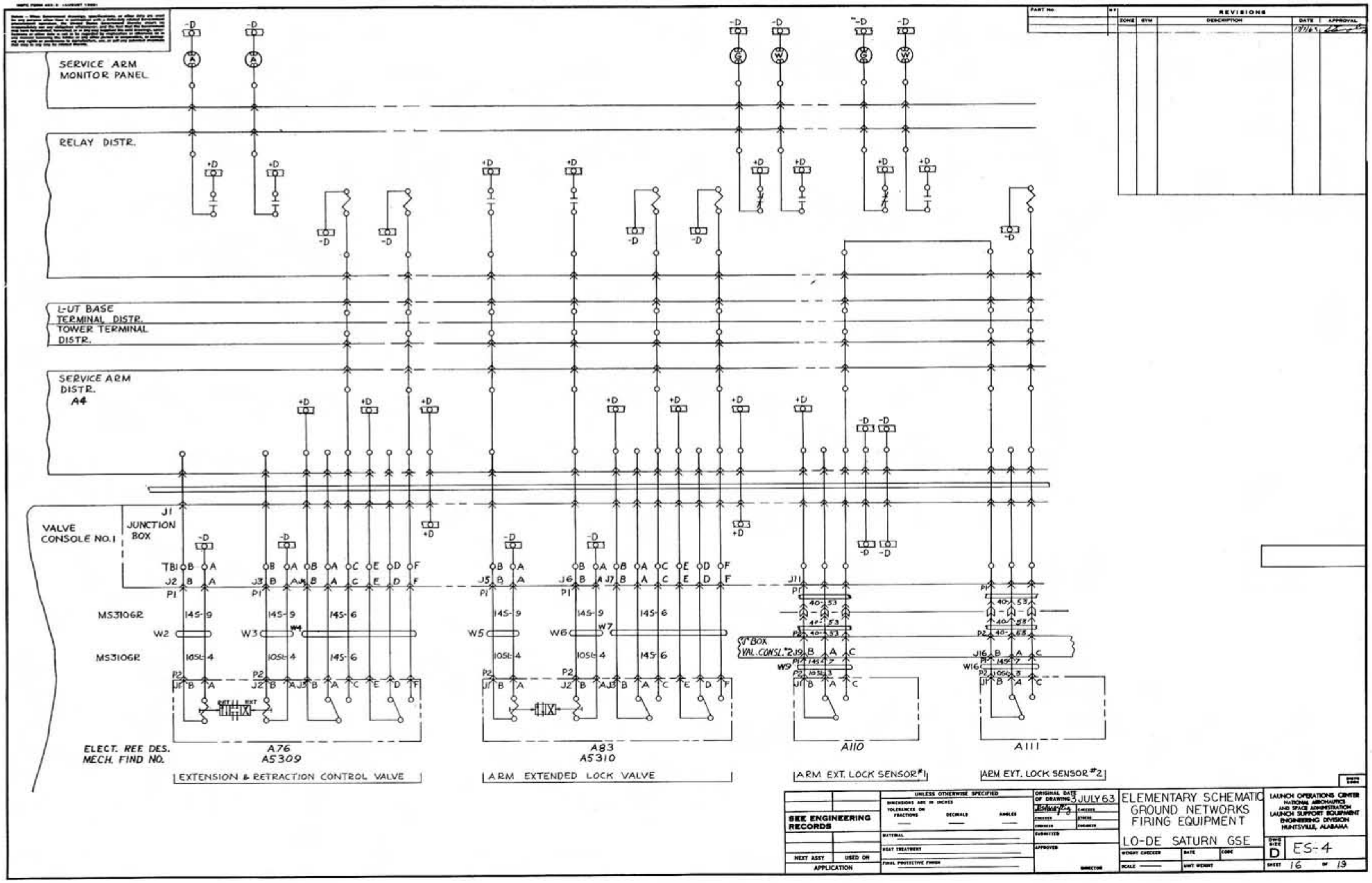

SERVICE ARM MONITOR PANEL
RELAY DISTR.
L-UT BASE TERMINAL DISTR.
TOWER TERMINAL DISTR.
SERVICE ARM DISTR. A4
JUNCTION BOX VALVE CONSOLE #1
JUNCTION BOX VALVE CONSOLE #2
MS3106R
MS3106R
ELECT. REF. DES.
MECH. FIND NO.
40-53
40-53
40-53
-D
+D
-D
+D
W
P1
P2
J2
P1
W2
P2
J2
42
TB2
42
TB9
7
B
A
C
NO
A106
MANUAL ARM LATCH POSITION SENSOR
REVISIONS
SEE ENGINEERING RECORDS
17 JUNE 63
ELEMENTARY SCHEMATICS
GROUND NETWORKS
FIRING EQUIPMENT
LO-DE SATURN GSE
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA
D
ES-4
19

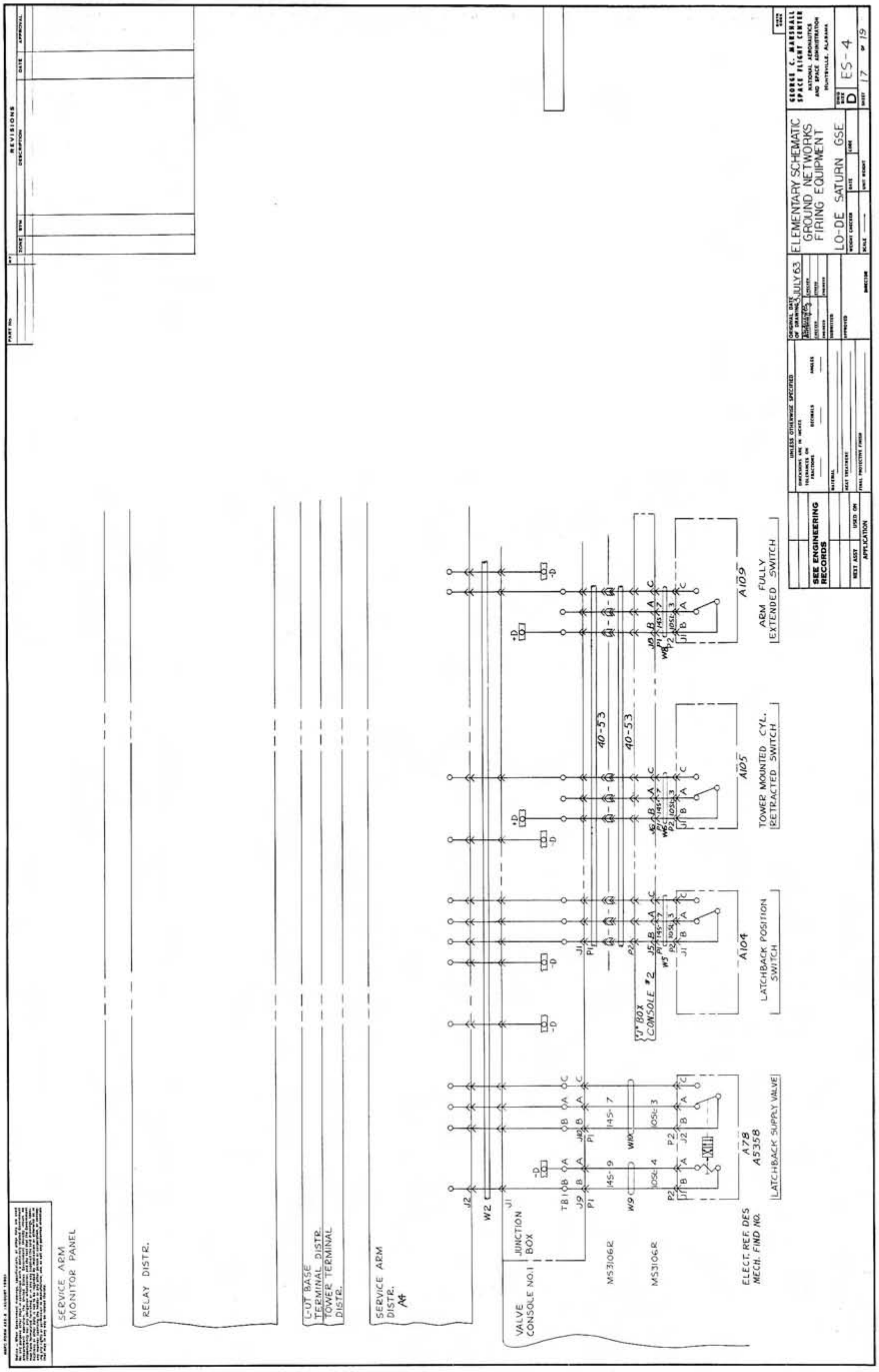

SERVICE ARM MONITOR PANEL
RELAY DISTR.
L-UT BASE TERMINAL DISTR.
TOWER TERMINAL DISTR.
SERVICE ARM DISTR. A4
'J' BOX
VALVE CONSOLE NO. 2
ELECT. REF. DES.
MECH. FIND. NO.
A19
A5369
PRI. RETRACT GN2 PRESSURE SWITCH
A21
A5371
PRIMARY RETRACT CHARGING VALVE
SEE ENGINEERING RECORDS
3 JUNE 63
ELEMENTARY SCHEMATIC
GROUND NETWORKS
FIRING EQUIPMENT
LO-DE SATURN 6SE
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA
ES-4
12
19
REVISIONS


SERVICE ARM MONITOR PANEL
RELAY DISTR.
L-UT BASE TERMINAL DISTR.
L-UT TOWER TERMINAL DISTR.
SERVICE ARM DISTR. A4
"J" BOX
VALVE CONSOLE NO. 2
ELECT. REF. DES.
MECH. FIND NO.
40-53
A20
A5306
A22
A5377
PRI. RETRACT SUPPLY VALVE
TEST & VENT VALVE
REVISIONS
SEE ENGINEERING RECORDS
UNLESS OTHERWISE SPECIFIED
3 JUNE 63
ELEMENTARY SCHEMATIC
GROUND NETWORKS
FIRING EQUIPMENT
LO-DE SATURN GSE
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA
D
ES-4
SHEET 13 OF 19

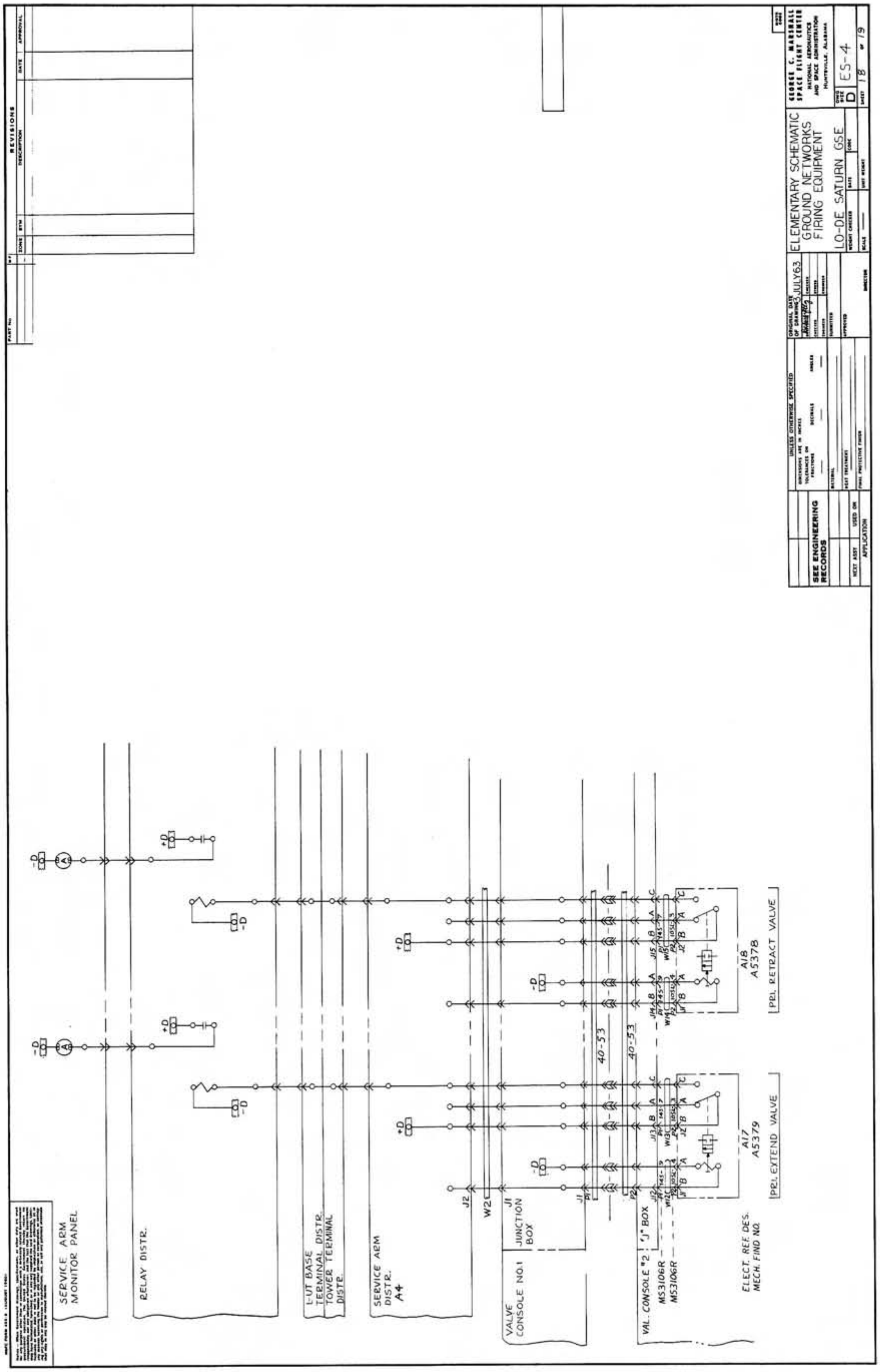

ELEMENTARY SCHEMATICS
GROUND NETWORKS
FIRING EQUIPMENT
LO-DE SATURN GSE
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
SEE ENGINEERING RECORDS
ES-4
NOTES:
1 SUPPLIES POWER TO TOWER FIRING DISTR. OF ALL INFLIGHT ARMS AT LIFTOFF.
2 SUPPLIES POWER TO TOWER FIRING DISTR. OF ALL INFLIGHT ARMS AT SECONDARY LIFTOFF.
3 W5 SHOULD COME INTO TOP OF VALVE CONSOLE #1 FIRING "J" BOX.
LCC FIRING CONSOLE
PROGRAMMER LIFTOFF ARMING CONTACTS
MANUAL LIFTOFF ARMING SWITCH
LIFTOFF ARMING BOX
BATTERY SUPPLY #1
BATTERY SUPPLY #1 PRIMARY LIFTOFF SWITCH
BATTERY SUPPLY #1 SECONDARY LIFTOFF SWITCH
L-UT BASE FIRING DISTR. FOR BATTER SUPPLY #1
TOWER FIRING DISTR. FOR BATTERY SUPPLY #1
VALVE CONSOLE #1 FIRING "J" BOX
CARRIER KICKOFF SEC. SUPPLY VALVE
CARRIER RELEASE SENSOR #1
PNEU. W'DRAW SEC SUPPLY VALVE
PNEU. W'DRAW PRI. RETURN VAL.
HYD. W'DRAW PRI SUPPLY VALVE
SEC. SUPPLY & RETURN HYD PILOT VALVE
BATTERY SUPPLY #2 FROM VAL. CONSOLE #2 FIRING "J" BOX
HYD. W'DRAW SEC SUPPLY VALVE
HYD. RETURN VAL. (PNEU. PILOTED)
PNEU. W'DRAW SEC. RETURN VAL.

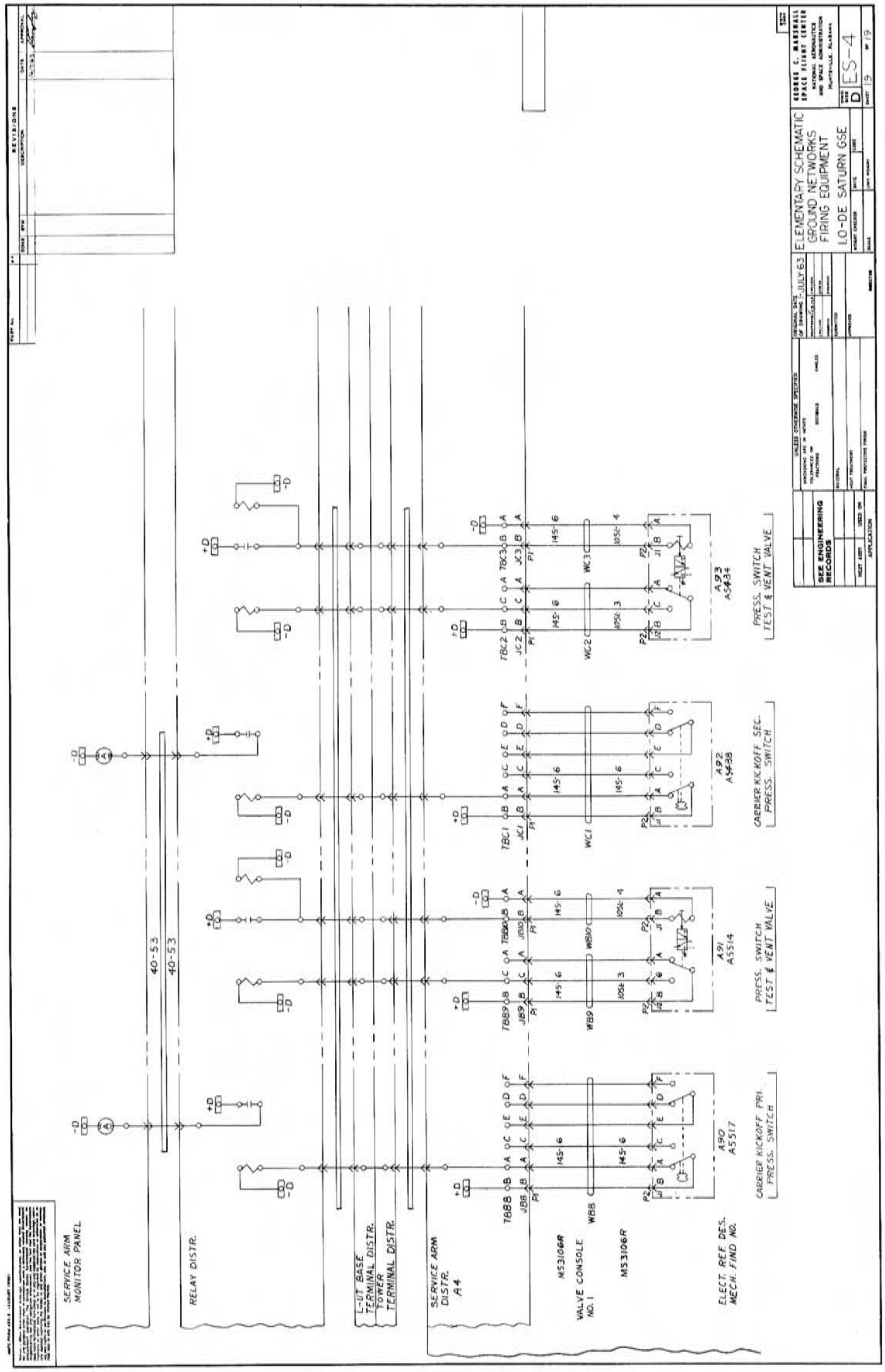

LCC FIRING CONSOLE
PROGRAMMER LIFTOFF ARMING CONTACTS
MANUAL LIFTOFF ARMING SWITCH
BATTERY SUPPLY #2 PRIMARY LIFTOFF SWITCH
BATTERY SUPPLY #2 SECONDARY LIFTOFF SWITCH
LIFTOFF ARMING BOX
BATTERY 28 V. D.C. POWER DISTR.
L-UT BASE FIRING DISTR. FOR BATTERY SUPPLY #2
TOWER FIRING DISTR. FOR BATTERY SUPPLY #2
VALVE CONSOLE #2 FIRING "J" BOX
CARRIER KICK-OFF PRI. SUPPLY VALVE
CARRIER RELEASE SENSOR #2
PNEU. W/DRAW PRI. SUPPLY VALVE
PRI. GN2 SUPPLY VALVE
NOTES:
1 SUPPLIES POWER TO TOWER FIRING DISTR. OF ALL INFLIGHT ARMS AT LIFTOFF
2 SUPPLIES POWER TO TOWER FIRING DISTR. OF ALL INFLIGHT ARMS AT SECONDARY LIFTOFF.
REVISIONS
SEE ENGINEERING RECORDS
18 JUNE 63
ELEMENTARY SCHEMATIC
GROUND NETWORKS
FIRING EQUIPMENT
LO-DE SATURN GSE
LAUNCH OPERATIONS CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LAUNCH SUPPORT EQUIPMENT ENGINEERING DIVISION
HUNTSVILLE, ALABAMA
D
ES-4
SHEET 15 OF 19

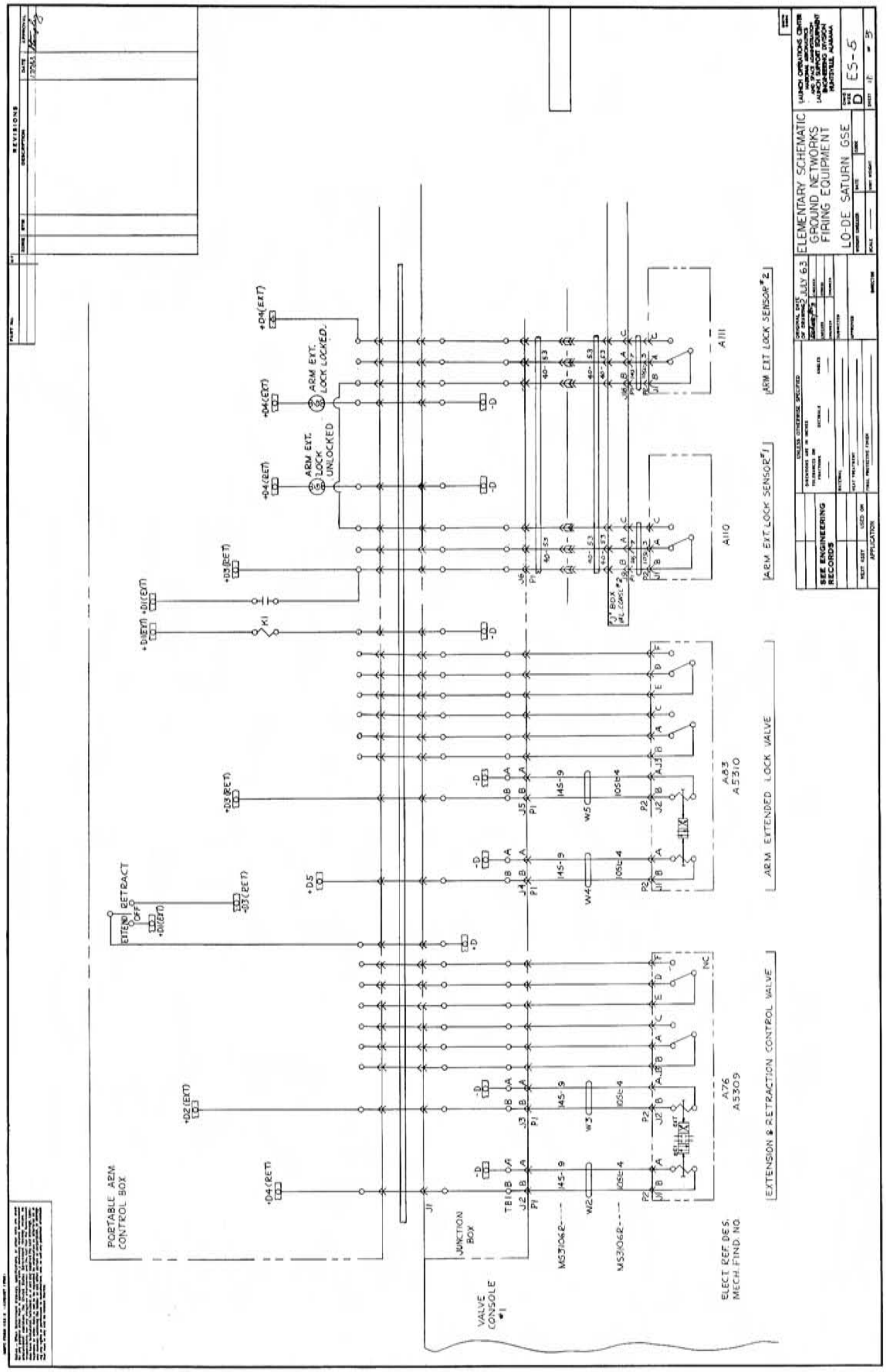

SERVICE ARM
MONITOR PANEL
RELAY DISTR.
L-UT BASE
TERMINAL DISTR.
TOWER TERMINAL
DISTR.
SERVICE ARM
DISTR.
A4
VALVE
CONSOLE NO.1
J1
JUNCTION
BOX
MS3106R
MS3106R
ELECT. REF DES.
MECH. FIND NO.
A76
A5309
EXTENSION & RETRACTION CONTROL VALVE
A83
A5310
ARM EXTENDED LOCK VALVE
A110
ARM EXT. LOCK SENSOR #1
A111
ARM EXT. LOCK SENSOR #2
ST BOX
VAL. CONSL. #2
REVISIONS
SEE ENGINEERING
RECORDS
UNLESS OTHERWISE SPECIFIED
JULY 63
ELEMENTARY SCHEMATIC
GROUND NETWORKS
FIRING EQUIPMENT
LO-DE SATURN GSE
LAUNCH OPERATIONS CENTER
NATIONAL AERONAUTICS
AND SPACE ADMINISTRATION
LAUNCH SUPPORT EQUIPMENT
ENGINEERING DIVISION
HUNTSVILLE, ALABAMA
D
ES-4
16 OF 19

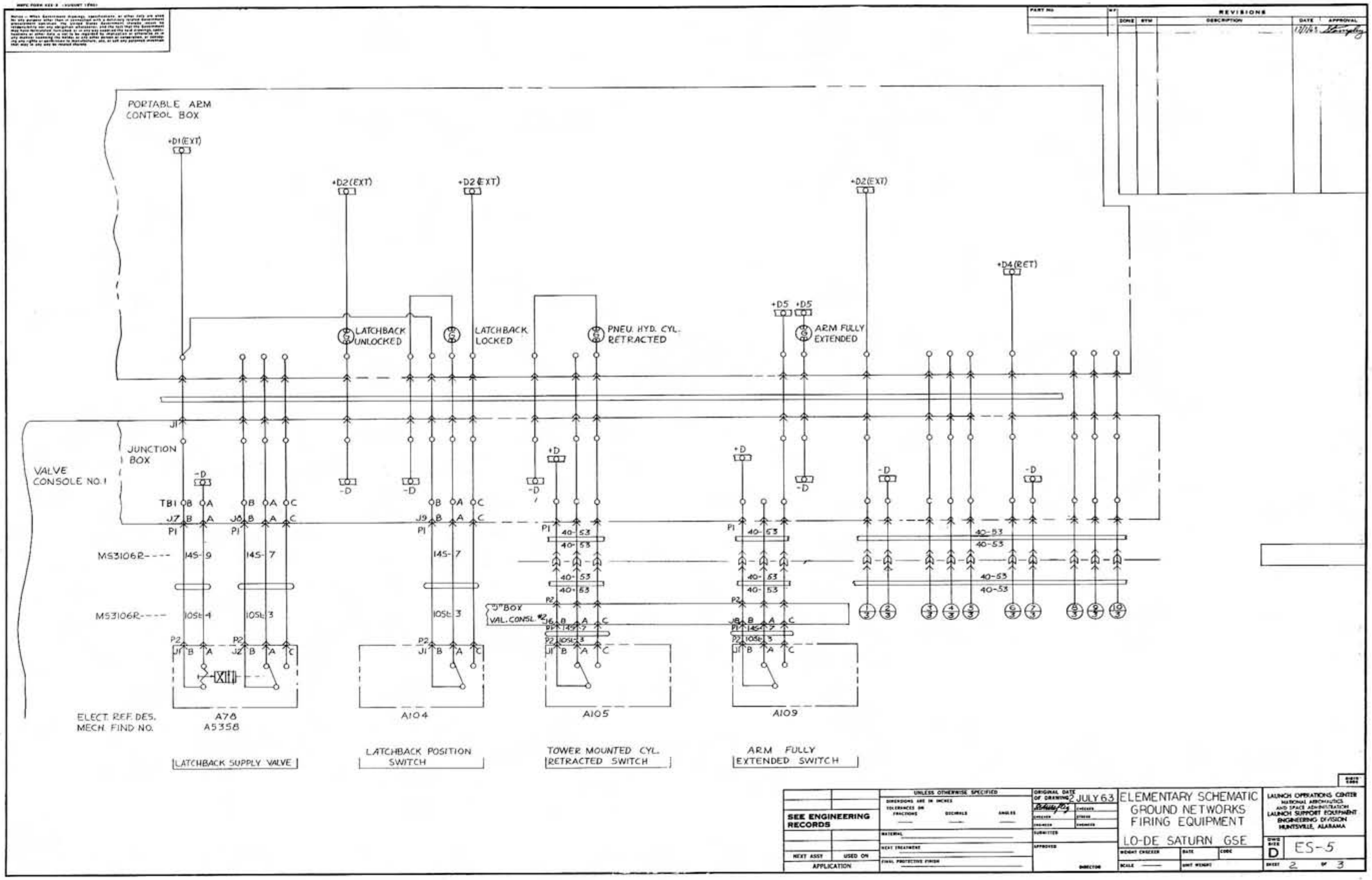


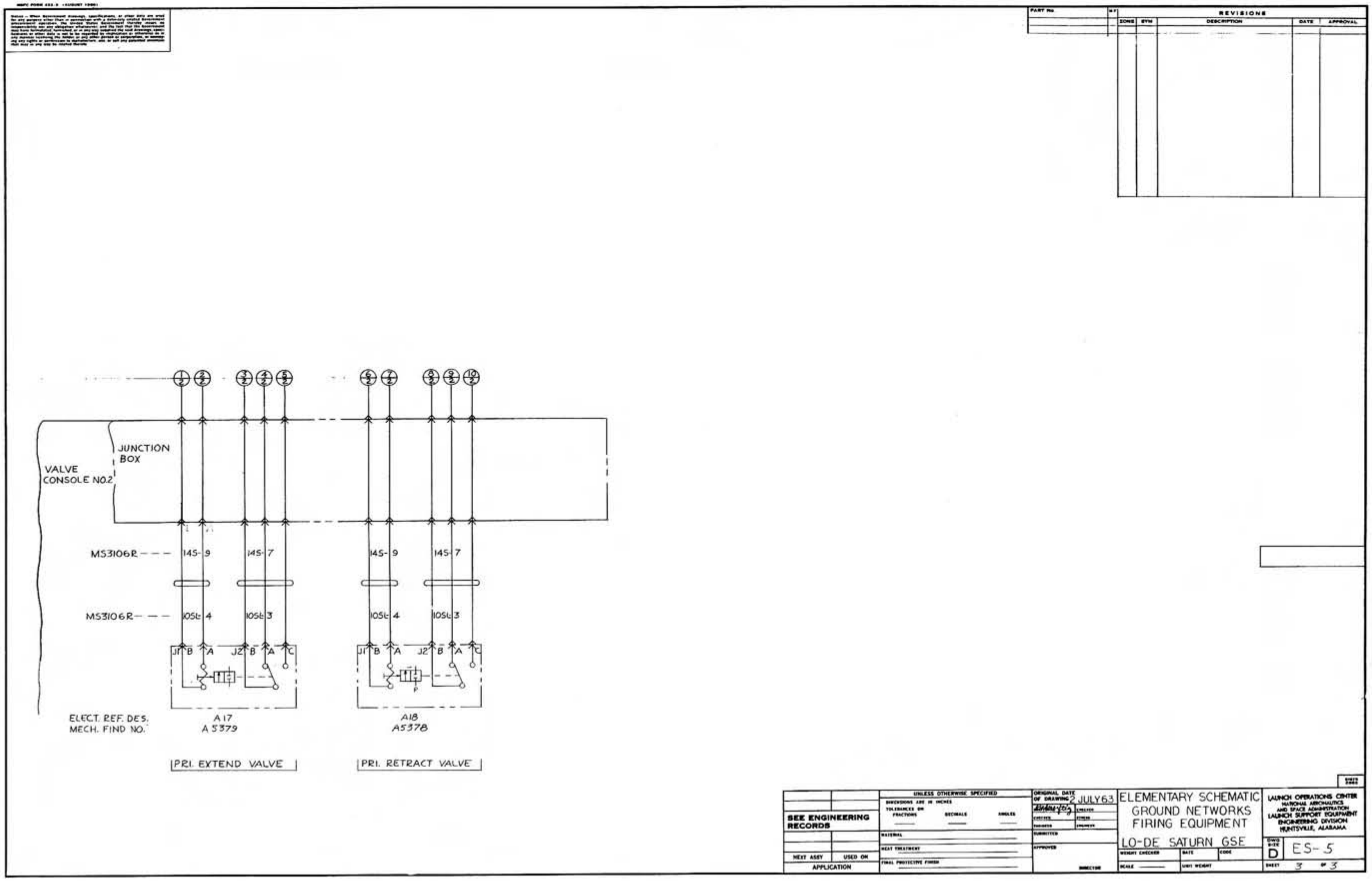
ELEMENTARY SCHEMATIC
GROUND NETWORKS
FIRING EQUIPMENT
LO-DE SATURN GSE
ES-4
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA
SEE ENGINEERING RECORDS
REVISIONS
SERVICE ARM MONITOR PANEL
RELAY DISTR.
L-UT BASE TERMINAL DISTR.
TOWER TERMINAL DISTR.
SERVICE ARM DISTR. A4
VALVE CONSOLE NO.1
JUNCTION BOX
MS3106R
ELECT. REF. DES
MECH. FIND NO.
A78
A5358
LATCHBACK SUPPLY VALVE
"J" BOX CONSOLE #2
A104
LATCHBACK POSITION SWITCH
A105
TOWER MOUNTED CYL. RETRACTED SWITCH
A109
ARM FULLY EXTENDED SWITCH
40-53

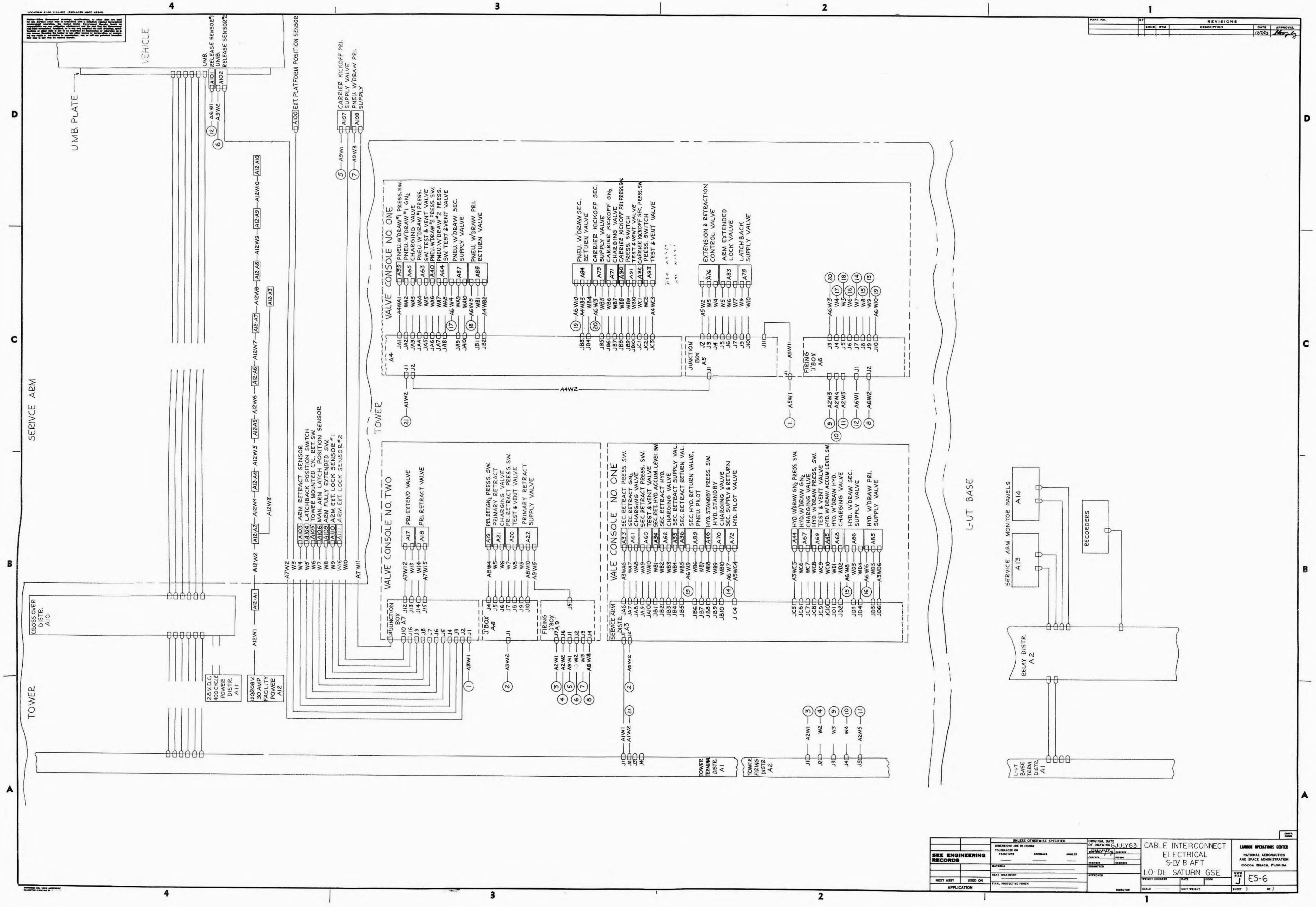

SERVICE ARM MONITOR PANEL
RELAY DISTR.
L-UT BASE TERMINAL DISTR.
TOWER TERMINAL DISTR.
SERVICE ARM DISTR. A4
VALVE CONSOLE NO.1
JUNCTION BOX
VAL. CONSOLE #2
"J" BOX
MS3106R
MS3106R
ELECT. REF. DES.
MECH. FIND NO.
40-53
40-53
A17
A5379
PRI. EXTEND VALVE
A18
A5378
PRI. RETRACT VALVE
REVISIONS
SEE ENGINEERING RECORDS
UNLESS OTHERWISE SPECIFIED
ELEMENTARY SCHEMATIC
GROUND NETWORKS
FIRING EQUIPMENT
LO-DE SATURN GSE
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA
D
ES-4
18 OF 19

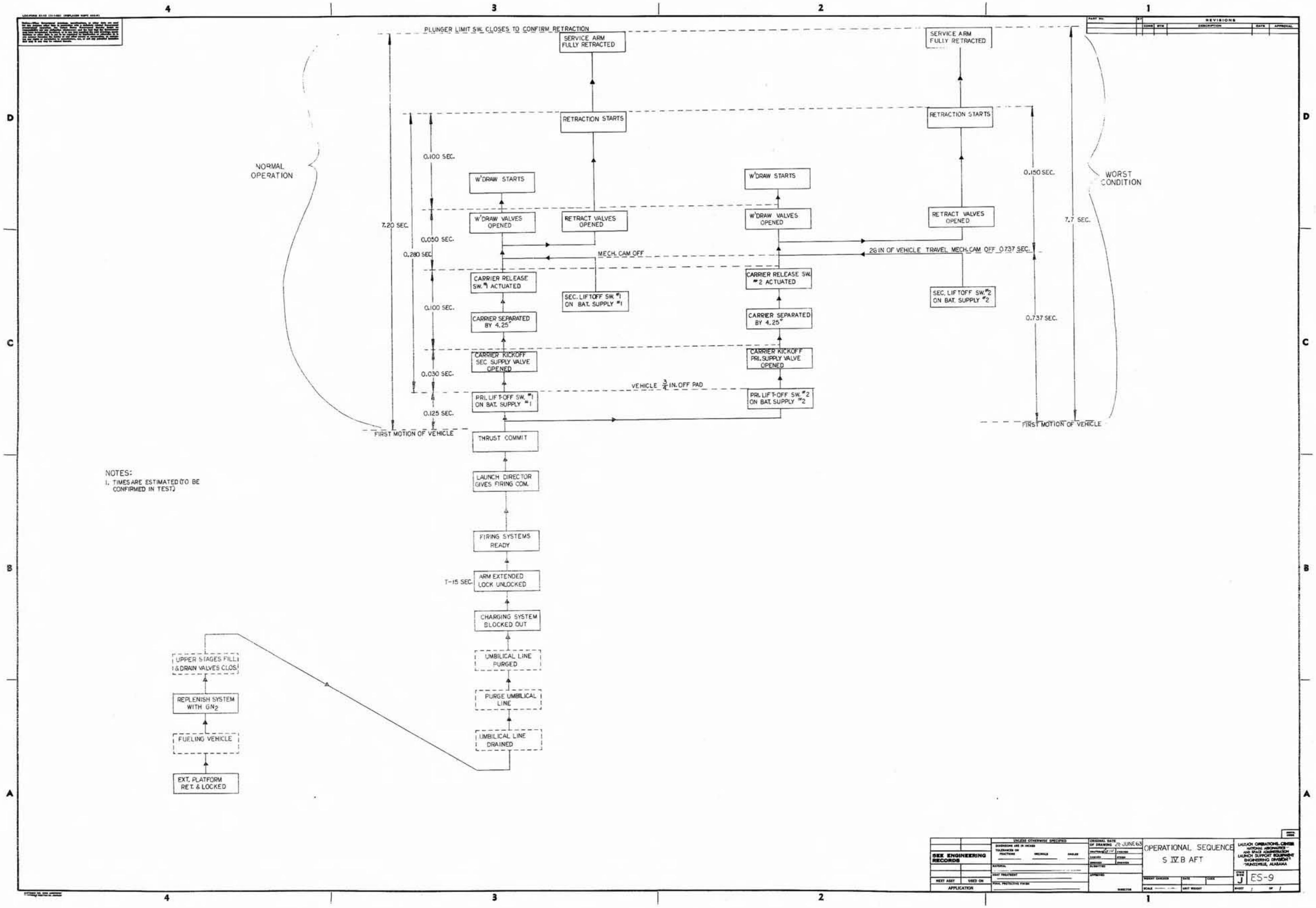

ELEMENTARY SCHEMATIC
GROUND NETWORKS
FIRING EQUIPMENT
LO-DE SATURN GSE
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA
ES-4
SHEET 19 OF 19
1 JULY 63
SEE ENGINEERING RECORDS
REVISIONS
SERVICE ARM MONITOR PANEL
RELAY DISTR.
L-UT BASE TERMINAL DISTR.
TOWER TERMINAL DISTR.
SERVICE ARM DISTR. A4
VALVE CONSOLE NO. 1
MS3106R
ELECT. REF. DES.
MECH. FIND NO.
40-53
CARRIER KICKOFF PRI. PRESS. SWITCH
A90
A5517
PRESS. SWITCH TEST & VENT VALVE
A91
A5514
CARRIER KICKOFF SEC. PRESS. SWITCH
A92
A5488
PRESS. SWITCH TEST & VENT VALVE
A93
A5484


REVISIONS
SEE ENGINEERING RECORDS
ELEMENTARY SCHEMATIC
GROUND NETWORKS
FIRING EQUIPMENT
LO-DE SATURN GSE
ES-5
ARM EXT LOCK SENSOR #2
ARM EXT. LOCK SENSOR #1
ARM EXTENDED LOCK VALVE
EXTENSION & RETRACTION CONTROL VALVE
PORTABLE ARM CONTROL BOX
JUNCTION BOX
VALVE CONSOLE #1
ELECT. REF. DES.
MECH. FIND. NO.
A76
A5309
A83
A5310
A110
A111
ARM EXT. LOCK UNLOCKED
ARM EXT. LOCK LOCKED
EXTEND
OFF
RETRACT

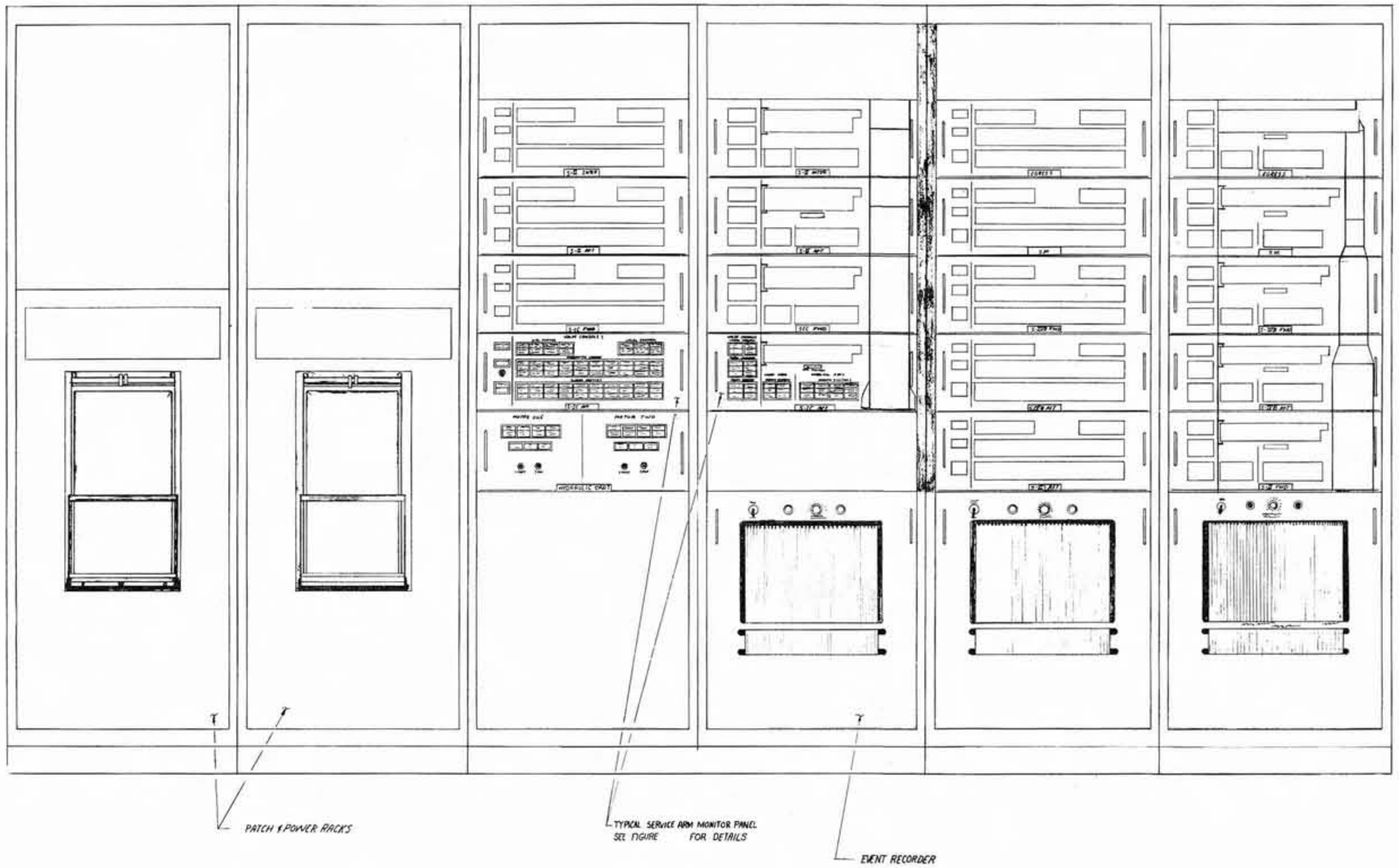

PORTABLE ARM CONTROL BOX
VALVE CONSOLE NO. 1
JUNCTION BOX
+D1(EXT)
+D2(EXT)
+D4(RET)
+D5
LATCHBACK UNLOCKED
LATCHBACK LOCKED
PNEU. HYD. CYL. RETRACTED
ARM FULLY EXTENDED
MS3106R----
"J" BOX VAL. CONSL #2
ELECT. REF. DES.
MECH. FIND NO.
A78
A5358
A104
A105
A109
LATCHBACK SUPPLY VALVE
LATCHBACK POSITION SWITCH
TOWER MOUNTED CYL. RETRACTED SWITCH
ARM FULLY EXTENDED SWITCH
REVISIONS
SEE ENGINEERING RECORDS
UNLESS OTHERWISE SPECIFIED
ORIGINAL DATE OF DRAWING 2 JULY 63
ELEMENTARY SCHEMATIC
GROUND NETWORKS
FIRING EQUIPMENT
LO-DE SATURN GSE
LAUNCH OPERATIONS CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LAUNCH SUPPORT EQUIPMENT ENGINEERING DIVISION
HUNTSVILLE, ALABAMA
D
ES-5
SHEET 2 OF 3


JUNCTION BOX
VALVE CONSOLE NO.2
MS3106R
14S-9
14S-7
MS3106R
10SL-4
10SL-3
J1 B A J2 B A C
ELECT. REF. DES.
MECH. FIND NO.
A17
A5379
A18
A5378
PRI. EXTEND VALVE
PRI. RETRACT VALVE
REVISIONS
ZONE SYM DESCRIPTION DATE APPROVAL
PART No.
SEE ENGINEERING RECORDS
NEXT ASSY USED ON
APPLICATION
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACTIONS DECIMALS ANGLES
MATERIAL
HEAT TREATMENT
FINAL PROTECTIVE FINISH
ORIGINAL DATE OF DRAWING 2 JULY63
SUBMITTED
APPROVED
DIRECTOR
ELEMENTARY SCHEMATIC
GROUND NETWORKS
FIRING EQUIPMENT
LO-DE SATURN GSE
WEIGHT CHECKER DATE CODE
SCALE UNIT WEIGHT
LAUNCH OPERATIONS CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LAUNCH SUPPORT EQUIPMENT ENGINEERING DIVISION
HUNTSVILLE, ALABAMA
DWG SIZE D
ES-5
SHEET 3 OF 3


CABLE INTERCONNECT
ELECTRICAL
S-IV B AFT
LO-DE SATURN GSE
J
E5-6
LAUNCH OPERATIONS CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
COCOA BEACH, FLORIDA
SEE ENGINEERING RECORDS
VALVE CONSOLE NO. ONE
VALVE CONSOLE NO. TWO
TOWER
SERVICE ARM
L-UT BASE
UMB. PLATE
VEHICLE

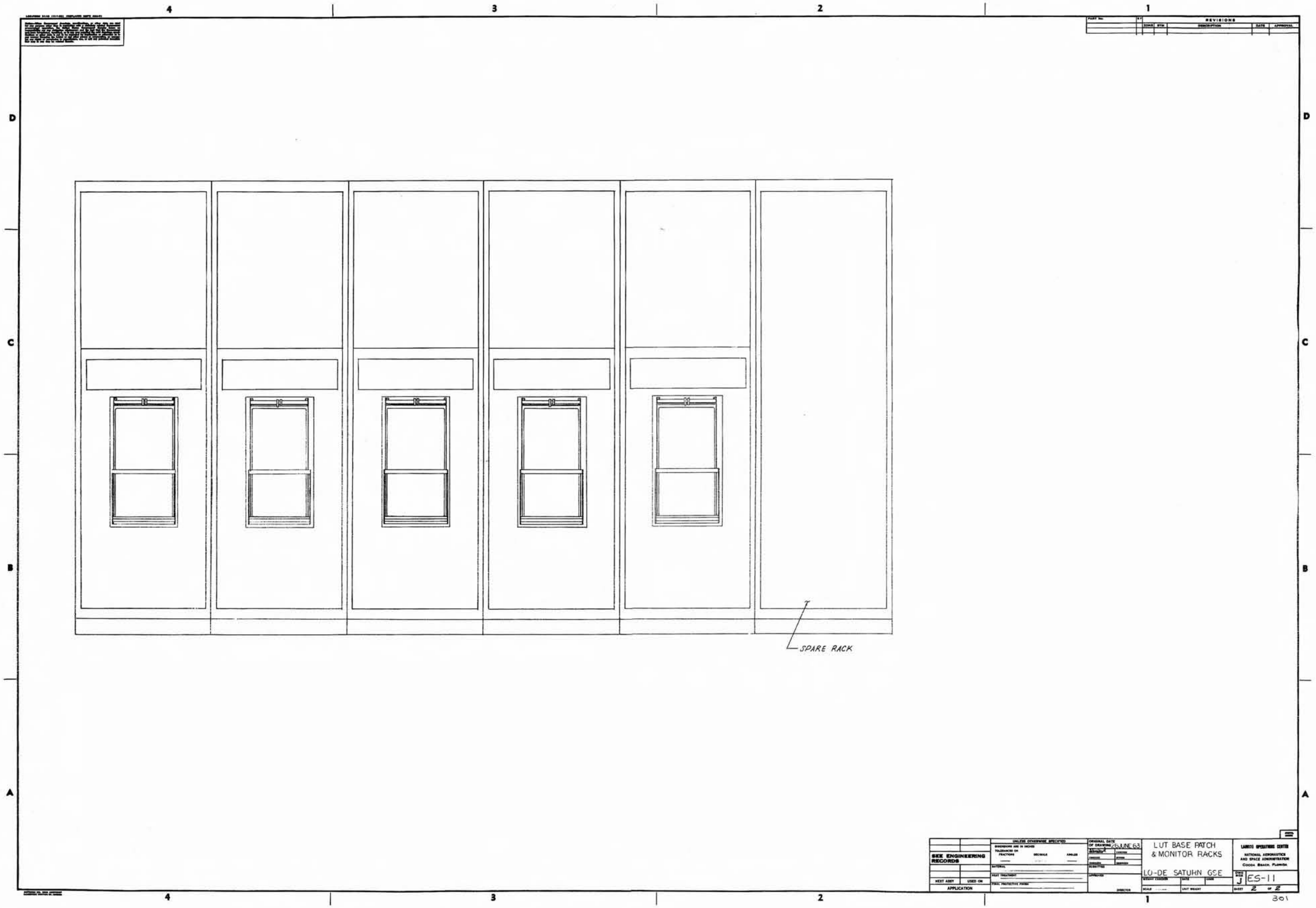


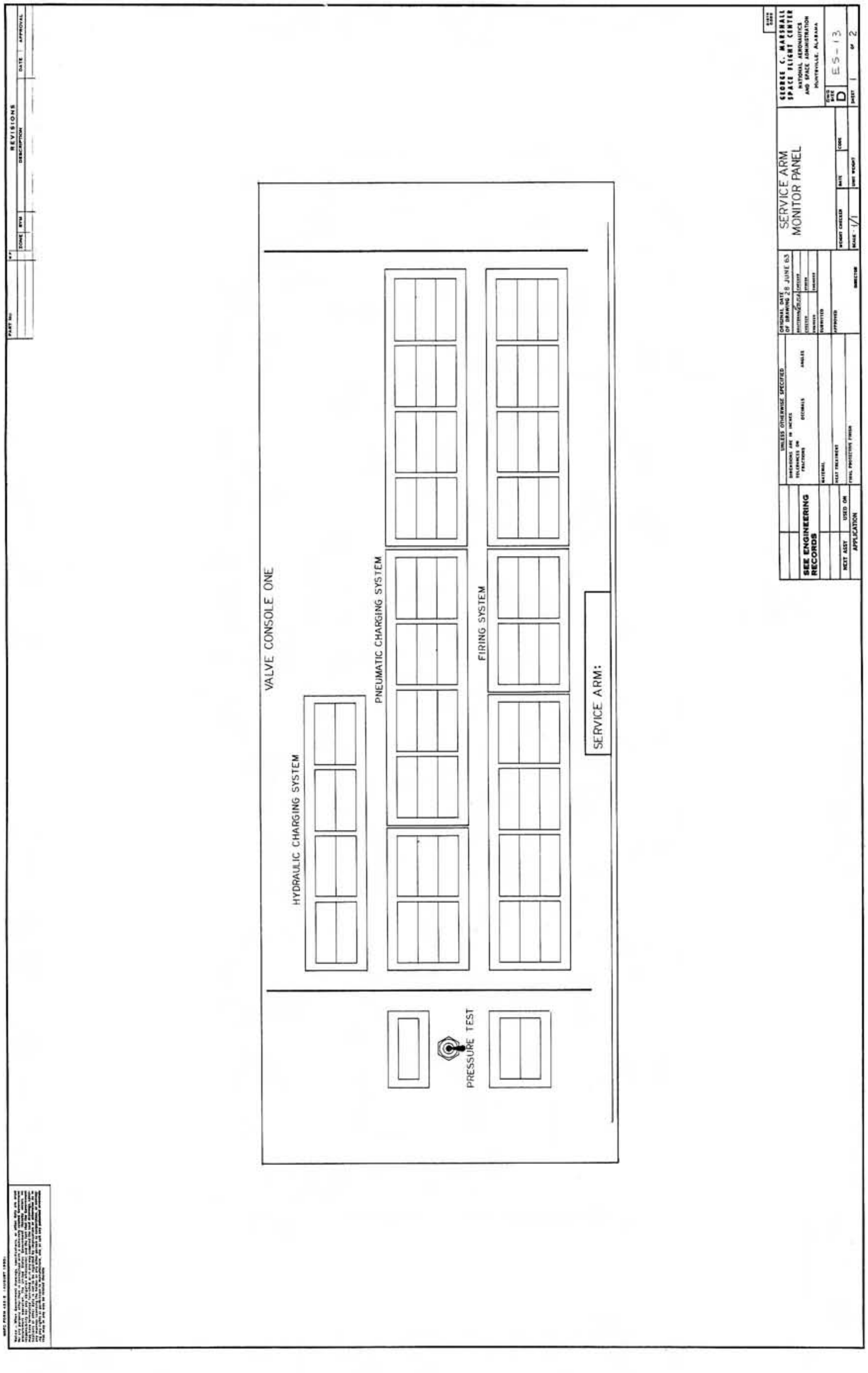
PLUNGER LIMIT SW. CLOSES TO CONFIRM RETRACTION
SERVICE ARM FULLY RETRACTED
RETRACTION STARTS
NORMAL OPERATION
WORST CONDITION
0.100 SEC.
W'DRAW STARTS
W'DRAW VALVES OPENED
RETRACT VALVES OPENED
7.20 SEC.
0.050 SEC.
0.280 SEC.
MECH. CAM OFF
26 IN OF VEHICLE TRAVEL MECH. CAM OFF 0.737 SEC.
0.150 SEC.
7.7 SEC.
CARRIER RELEASE SW. #1 ACTUATED
CARRIER RELEASE SW. #2 ACTUATED
SEC. LIFTOFF SW. #1 ON BAT. SUPPLY #1
SEC. LIFTOFF SW. #2 ON BAT. SUPPLY #2
0.100 SEC.
CARRIER SEPARATED BY 4.25"
0.737 SEC.
CARRIER KICKOFF SEC SUPPLY VALVE OPENED
CARRIER KICKOFF PRI. SUPPLY VALVE OPENED
0.030 SEC.
VEHICLE 3/4 IN. OFF PAD
PRI. LIFT-OFF SW. #1 ON BAT. SUPPLY #1
PRI. LIFT-OFF SW. #2 ON BAT. SUPPLY #2
0.125 SEC.
FIRST MOTION OF VEHICLE
THRUST COMMIT
NOTES:
1. TIMES ARE ESTIMATED (TO BE CONFIRMED IN TEST)
LAUNCH DIRECTOR GIVES FIRING COM.
FIRING SYSTEMS READY
T-15 SEC.
ARM EXTENDED LOCK UNLOCKED
CHARGING SYSTEM BLOCKED OUT
UPPER STAGES FILL & DRAIN VALVES CLOS.
UMBILICAL LINE PURGED
REPLENISH SYSTEM WITH GN2
PURGE UMBILICAL LINE
FUELING VEHICLE
UMBILICAL LINE DRAINED
EXT. PLATFORM RET. & LOCKED
REVISIONS
SEE ENGINEERING RECORDS
UNLESS OTHERWISE SPECIFIED
26 JUNE 63
OPERATIONAL SEQUENCE
S IV B AFT
LAUNCH OPERATIONS CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LAUNCH SUPPORT EQUIPMENT ENGINEERING DIVISION
HUNTSVILLE, ALABAMA
J
ES-9
NEXT ASSY
USED ON
APPLICATION

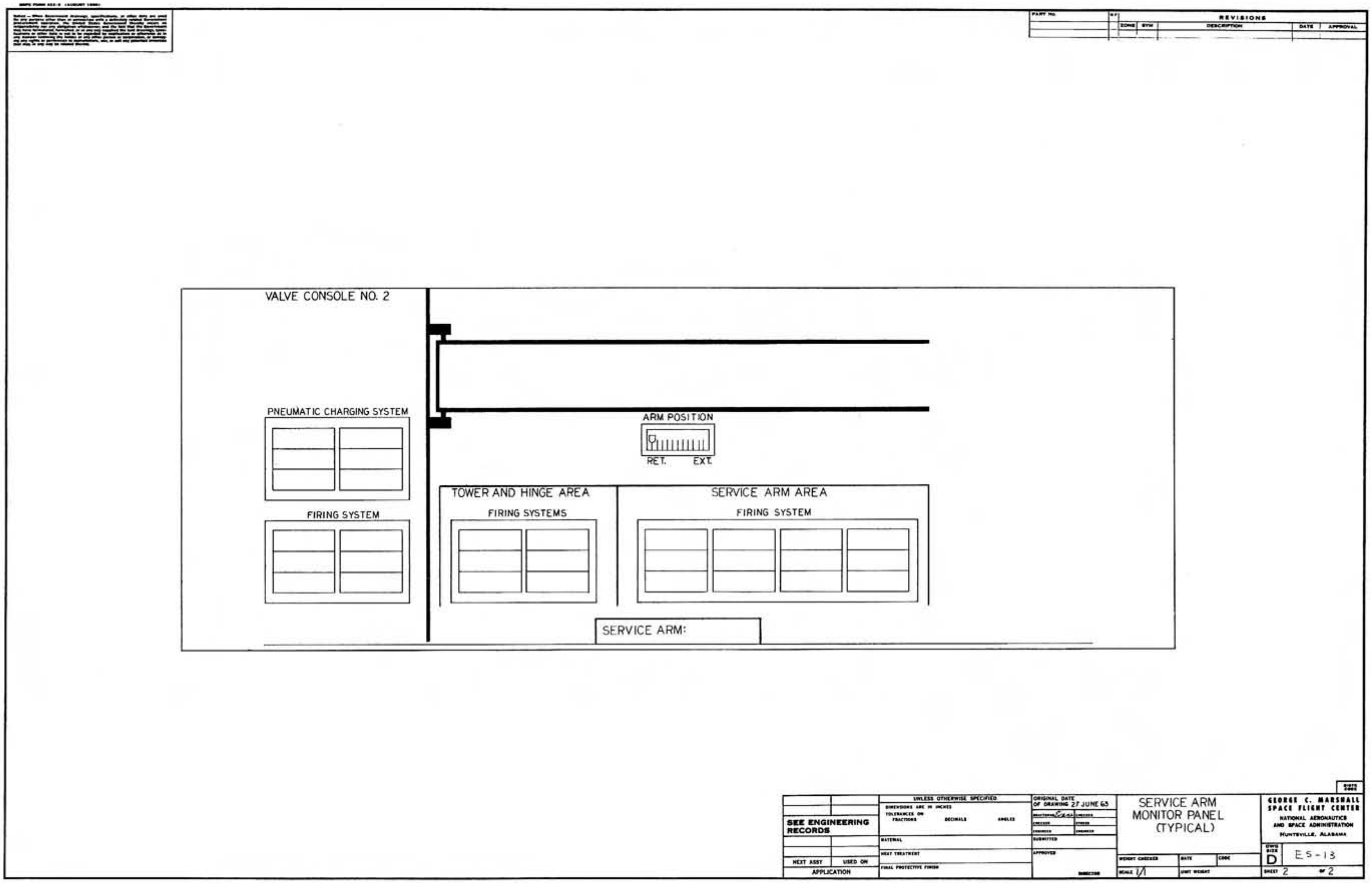


UNLESS OTHERWISE SPECIFIED	DIMENSIONS ARE IN INCHES
ORIGINAL DATE OF DRAWING	26 JUNE 63
Title	L-UT BASE PATCH & MONITOR RACKS
	LO DE SATURN GSE
	LAUNCH OPERATIONS CENTER, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, LAUNCH SUPPORT EQUIPMENT ENGINEERING DIVISION, HUNTSVILLE, ALABAMA
DWG SIZE	J
Drawing No.	ES-11
SHEET	1 OF 2

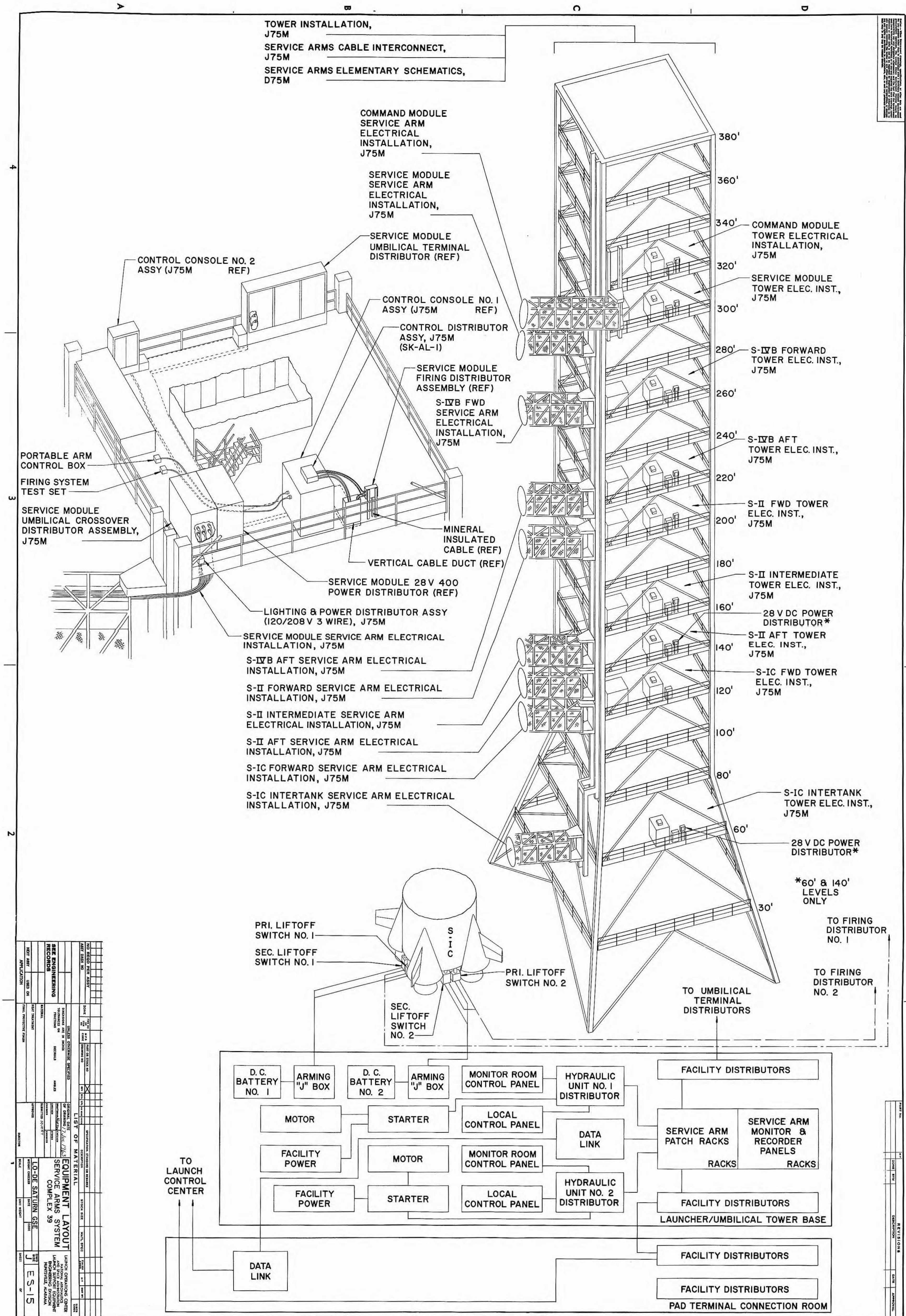
SEE ENGINEERING RECORDS


SPARE RACK
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
FRACTIONS
DECIMALS
ANGLES
SEE ENGINEERING RECORDS
MATERIAL
HEAT TREATMENT
FINAL PROTECTIVE FINISH
NEXT ASSY
USED ON
APPLICATION
ORIGINAL DATE OF DRAWING 26 JUNE 63
SUBMITTED
APPROVED
DIRECTOR
LUT BASE PATCH & MONITOR RACKS
LO-DE SATURN GSE
SCALE
UNIT WEIGHT
LAUNCH OPERATIONS CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
COCOA BEACH, FLORIDA
J
ES-11
SHEET 2 OF 2
301

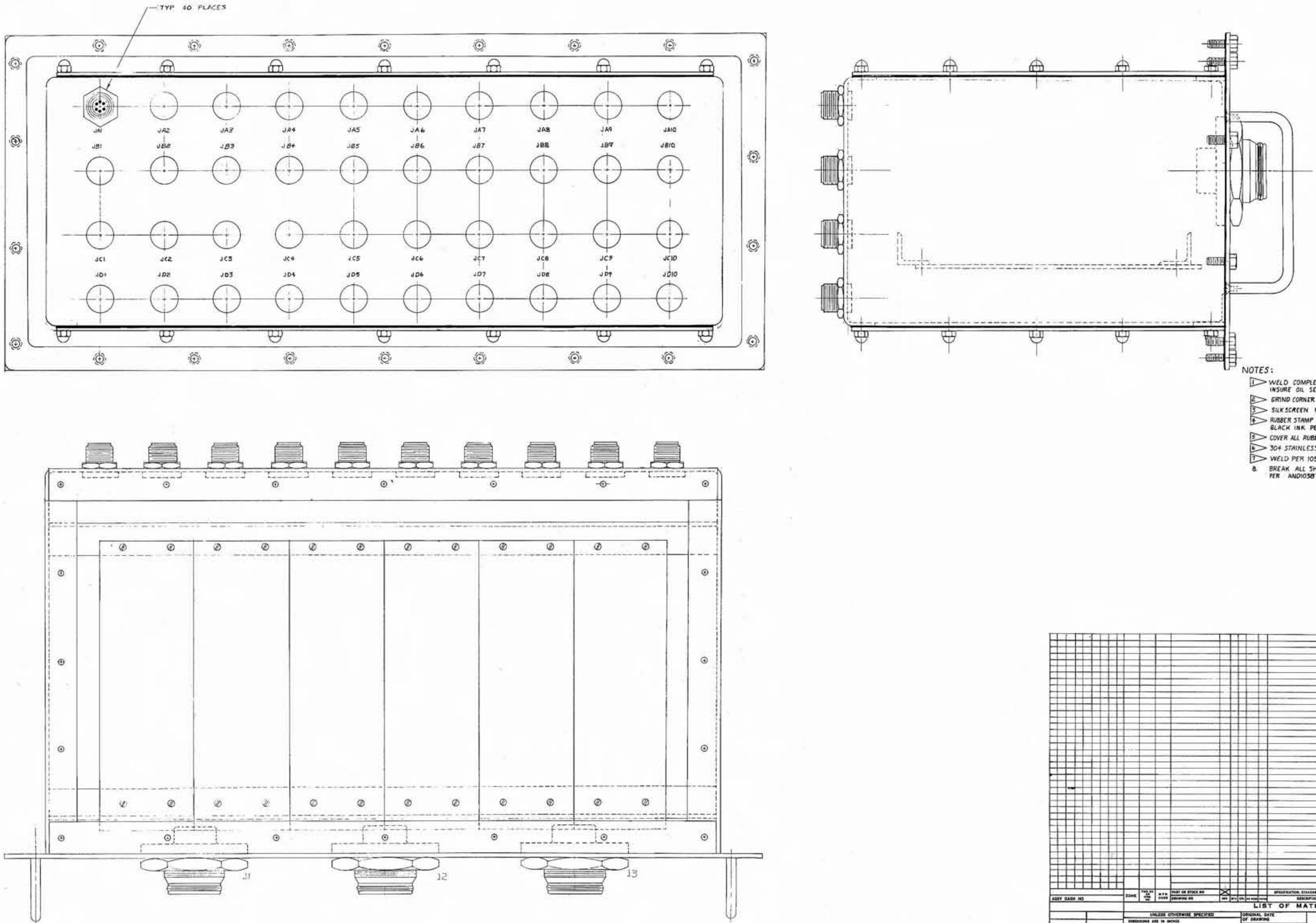

VALVE CONSOLE ONE
HYDRAULIC CHARGING SYSTEM
PNEUMATIC CHARGING SYSTEM
FIRING SYSTEM
PRESSURE TEST
SERVICE ARM:
REVISIONS
SEE ENGINEERING RECORDS
ORIGINAL DATE OF DRAWING 28 JUNE 63
SERVICE ARM MONITOR PANEL
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA
D
ES-13
SHEET 1 OF 2



VALVE CONSOLE NO. 2
PNEUMATIC CHARGING SYSTEM
FIRING SYSTEM
ARM POSITION
RET.
EXT.
TOWER AND HINGE AREA
FIRING SYSTEMS
SERVICE ARM AREA
FIRING SYSTEM
SERVICE ARM:
REVISIONS
SEE ENGINEERING RECORDS
ORIGINAL DATE OF DRAWING 27 JUNE 63
SERVICE ARM
MONITOR PANEL
(TYPICAL)
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA
D
ES-13
SHEET 2 OF 2



TOWER INSTALLATION, J75M
SERVICE ARMS CABLE INTERCONNECT, J75M
SERVICE ARMS ELEMENTARY SCHEMATICS, D75M
COMMAND MODULE SERVICE ARM ELECTRICAL INSTALLATION, J75M
SERVICE MODULE SERVICE ARM ELECTRICAL INSTALLATION, J75M
SERVICE MODULE UMBILICAL TERMINAL DISTRIBUTOR (REF)
CONTROL CONSOLE NO. 2 ASSY (J75M REF)
CONTROL CONSOLE NO. I ASSY (J75M REF)
CONTROL DISTRIBUTOR ASSY, J75M (SK-AL-I)
SERVICE MODULE FIRING DISTRIBUTOR ASSEMBLY (REF)
S-IVB FWD SERVICE ARM ELECTRICAL INSTALLATION, J75M
PORTABLE ARM CONTROL BOX
FIRING SYSTEM TEST SET
SERVICE MODULE UMBILICAL CROSSOVER DISTRIBUTOR ASSEMBLY, J75M
MINERAL INSULATED CABLE (REF)
VERTICAL CABLE DUCT (REF)
SERVICE MODULE 28 V 400 POWER DISTRIBUTOR (REF)
LIGHTING & POWER DISTRIBUTOR ASSY (120/208 V 3 WIRE), J75M
SERVICE MODULE SERVICE ARM ELECTRICAL INSTALLATION, J75M
S-IVB AFT SERVICE ARM ELECTRICAL INSTALLATION, J75M
S-II FORWARD SERVICE ARM ELECTRICAL INSTALLATION, J75M
S-II INTERMEDIATE SERVICE ARM ELECTRICAL INSTALLATION, J75M
S-II AFT SERVICE ARM ELECTRICAL INSTALLATION, J75M
S-IC FORWARD SERVICE ARM ELECTRICAL INSTALLATION, J75M
S-IC INTERTANK SERVICE ARM ELECTRICAL INSTALLATION, J75M
380'
360'
340'
320'
300'
280'
260'
240'
220'
200'
180'
160'
140'
120'
100'
80'
60'
30'
COMMAND MODULE TOWER ELECTRICAL INSTALLATION, J75M
SERVICE MODULE TOWER ELEC. INST., J75M
S-IVB FORWARD TOWER ELEC. INST., J75M
S-IVB AFT TOWER ELEC. INST., J75M
S-II FWD TOWER ELEC. INST., J75M
S-II INTERMEDIATE TOWER ELEC. INST., J75M
28 V DC POWER DISTRIBUTOR*
S-II AFT TOWER ELEC. INST., J75M
S-IC FWD TOWER ELEC. INST., J75M
S-IC INTERTANK TOWER ELEC. INST., J75M
28 V DC POWER DISTRIBUTOR*
*60' & 140' LEVELS ONLY
TO FIRING DISTRIBUTOR NO. I
TO FIRING DISTRIBUTOR NO. 2
TO UMBILICAL TERMINAL DISTRIBUTORS
S-I-C
PRI. LIFTOFF SWITCH NO. I
SEC. LIFTOFF SWITCH NO. I
PRI. LIFTOFF SWITCH NO. 2
SEC. LIFTOFF SWITCH NO. 2
D.C. BATTERY NO. I
ARMING "J" BOX
D.C. BATTERY NO. 2
ARMING "J" BOX
MONITOR ROOM CONTROL PANEL
HYDRAULIC UNIT NO. I DISTRIBUTOR
MOTOR
STARTER
LOCAL CONTROL PANEL
DATA LINK
FACILITY POWER
MOTOR
MONITOR ROOM CONTROL PANEL
FACILITY POWER
STARTER
LOCAL CONTROL PANEL
HYDRAULIC UNIT NO. 2 DISTRIBUTOR
FACILITY DISTRIBUTORS
SERVICE ARM PATCH RACKS
RACKS
SERVICE ARM MONITOR & RECORDER PANELS
RACKS
FACILITY DISTRIBUTORS
LAUNCHER/UMBILICAL TOWER BASE
TO LAUNCH CONTROL CENTER
DATA LINK
FACILITY DISTRIBUTORS
FACILITY DISTRIBUTORS
PAD TERMINAL CONNECTION ROOM
LIST OF MATERIAL
SEE ENGINEERING RECORDS
EQUIPMENT LAYOUT
SERVICE ARMS SYSTEM
COMPLEX 39
LO-DE SATURN GSE
LAUNCH OPERATIONS CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LAUNCH SUPPORT EQUIPMENT ENGINEERING DIVISION
HUNTSVILLE, ALABAMA
J
ES-15
REVISIONS



NOTES:

1. WELD COMPLETELY AROUND JUNCTION OF CHASSIS TO INSURE OIL SEAL
2. GRIND CORNER SURFACES TO CONTOUR AFTER WELDING
3. SILKSCREEN PER 10423785, OUTSIDE ONLY
4. RUBBER STAMP DESIGNATIONS .125 HIGH INSIDE ONLY, USING BLACK INK PER TT-I-558
5. COVER ALL RUBBER STAMPING WITH THIN COAT HYSOL
6. 304 STAINLESS STEEL
7. WELD PER 10509308
8. BREAK ALL SHARP EDGES .02 × 45°, ALL DRILLED HOLES PER AND10387

LIST OF MATERIAL

SEE ENGINEERING RECORDS

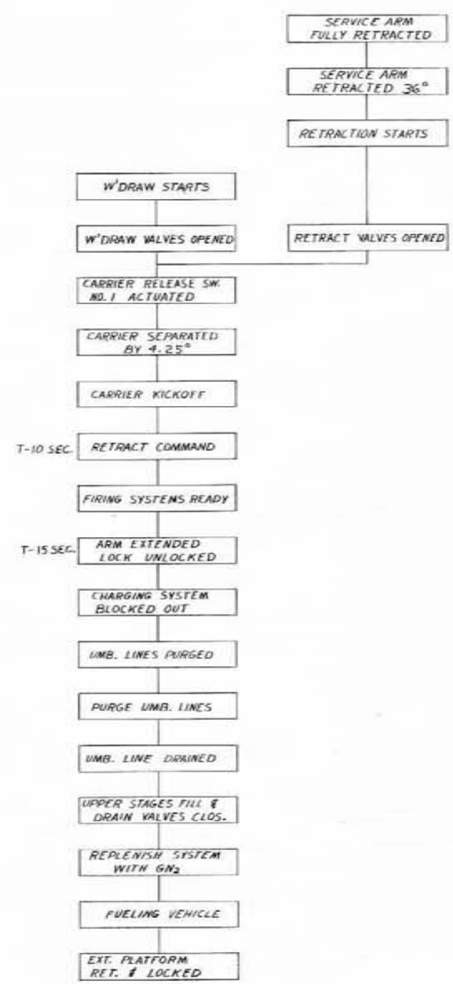
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACTIONS — DECIMALS .XX ±.03 ANGLES —

DISTRIBUTOR ASSEMBLY

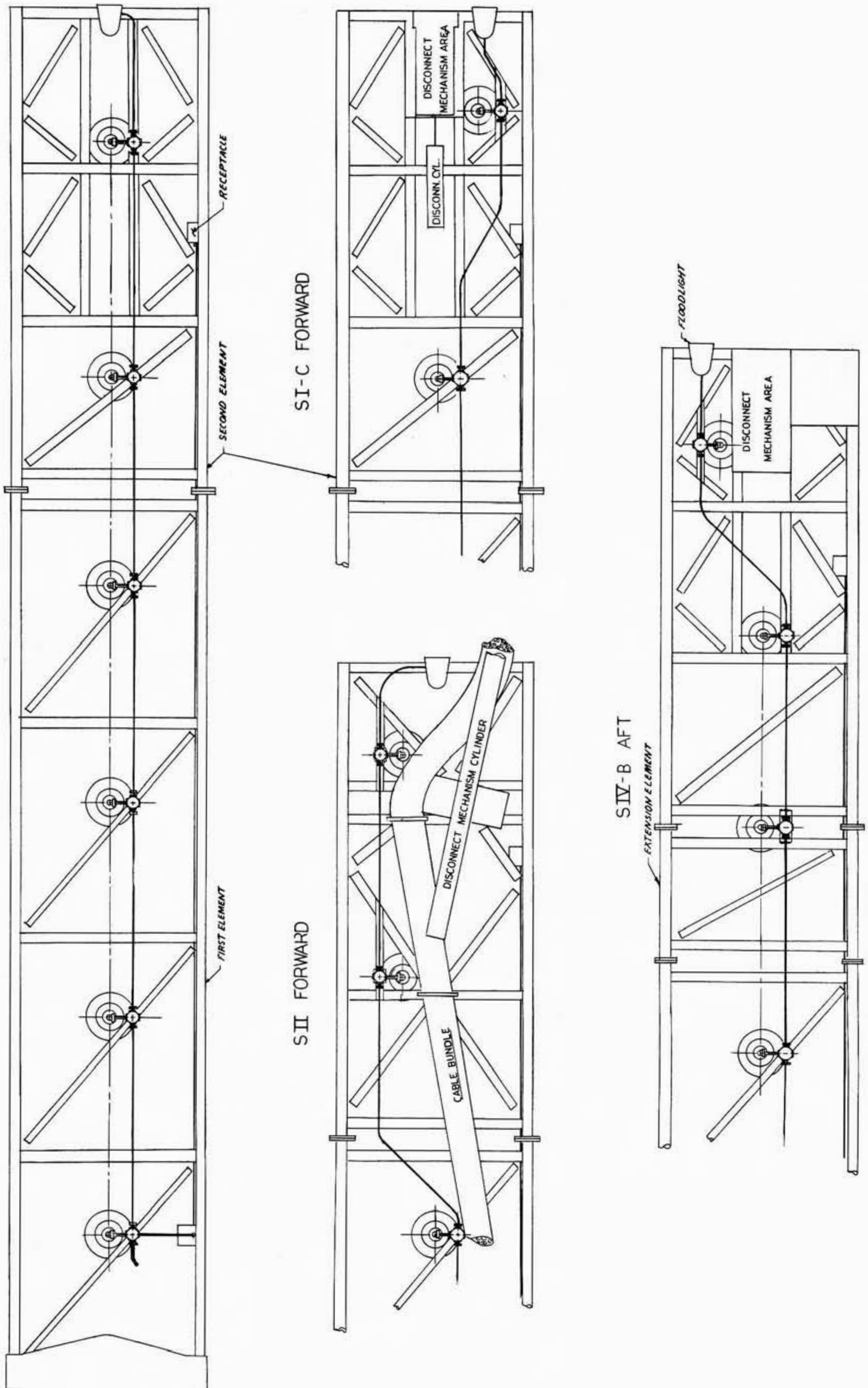
LAUNCH OPERATIONS CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LAUNCH SUPPORT EQUIPMENT ENGINEERING DIVISION
HUNTSVILLE, ALABAMA

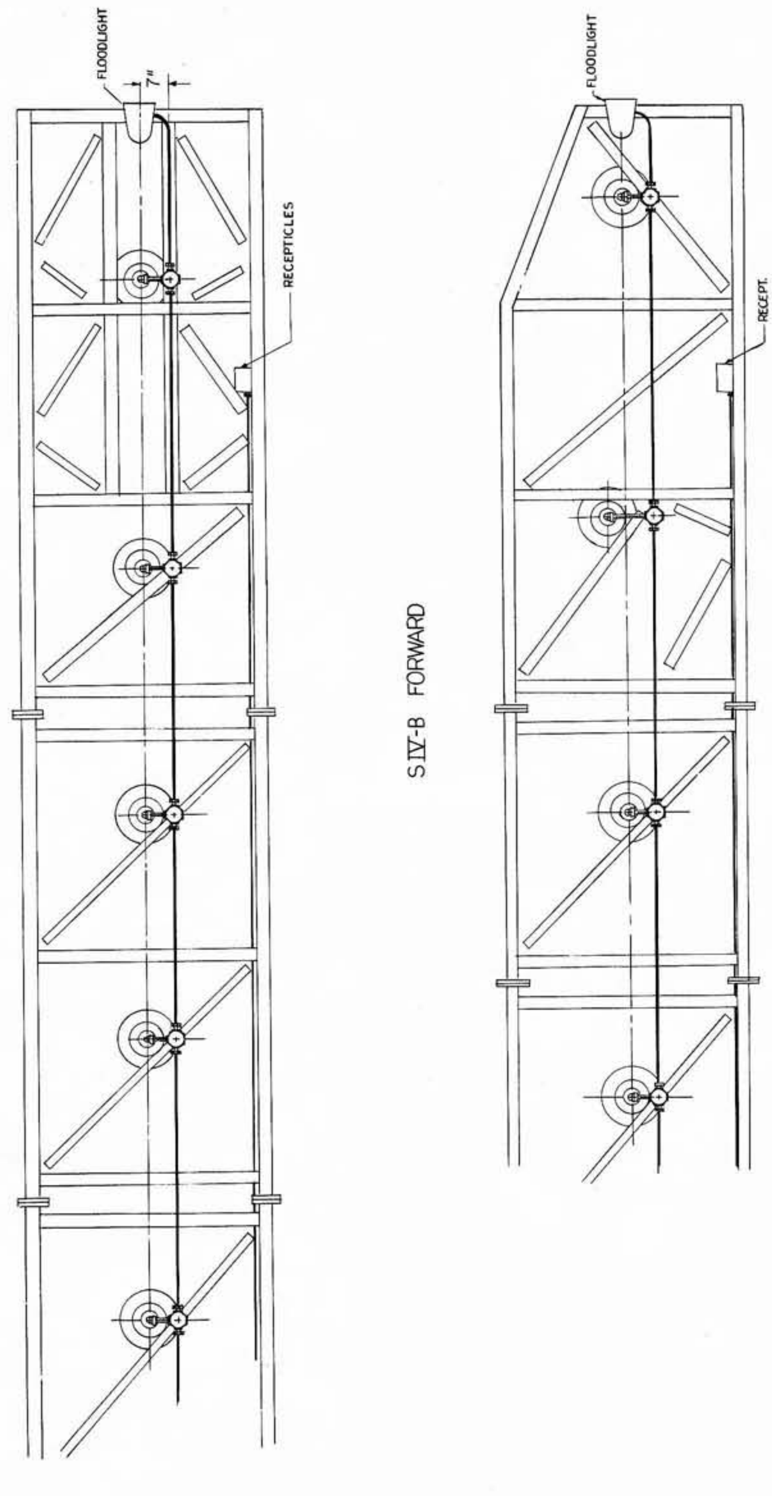
DWG SIZE J — AL-1

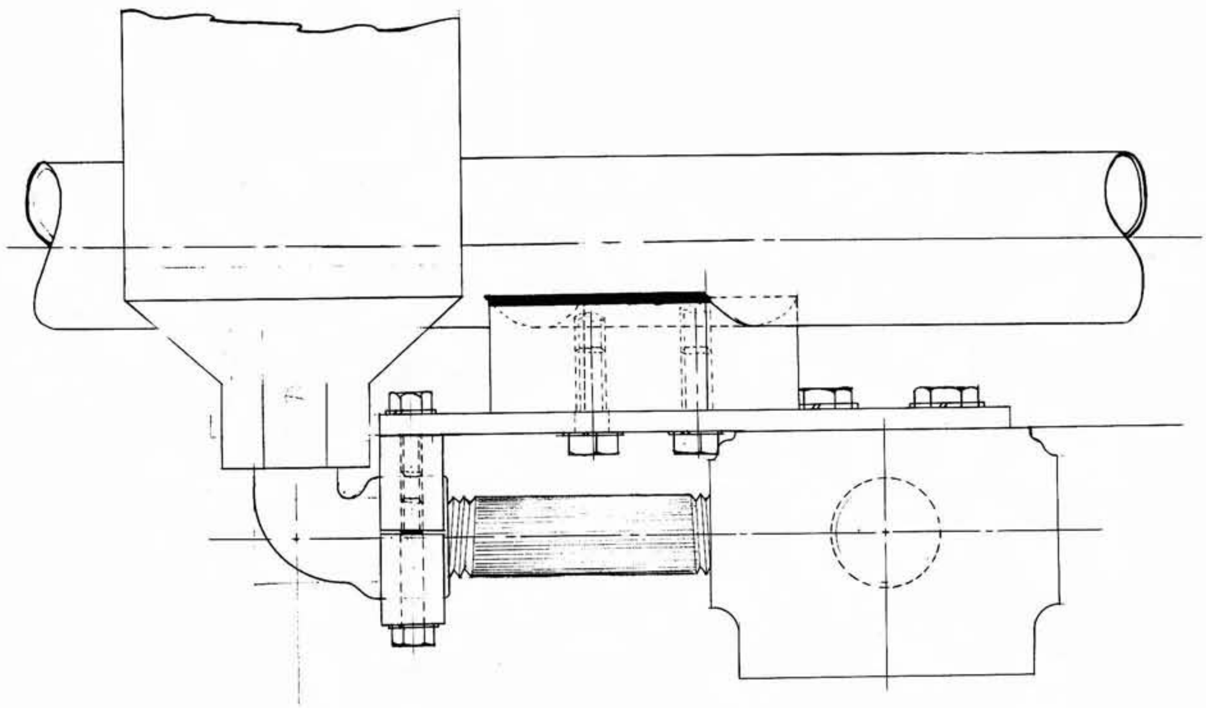
SCALE 1/1

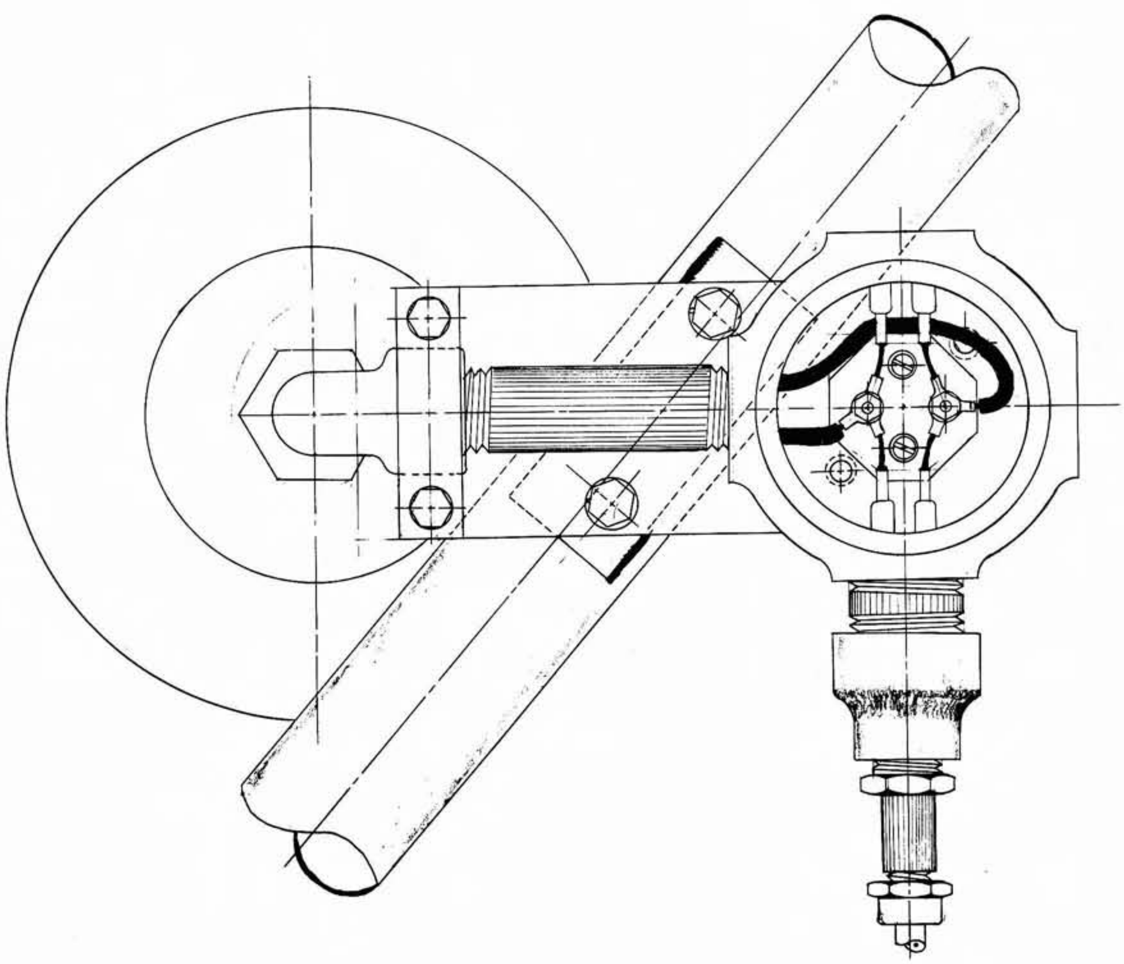


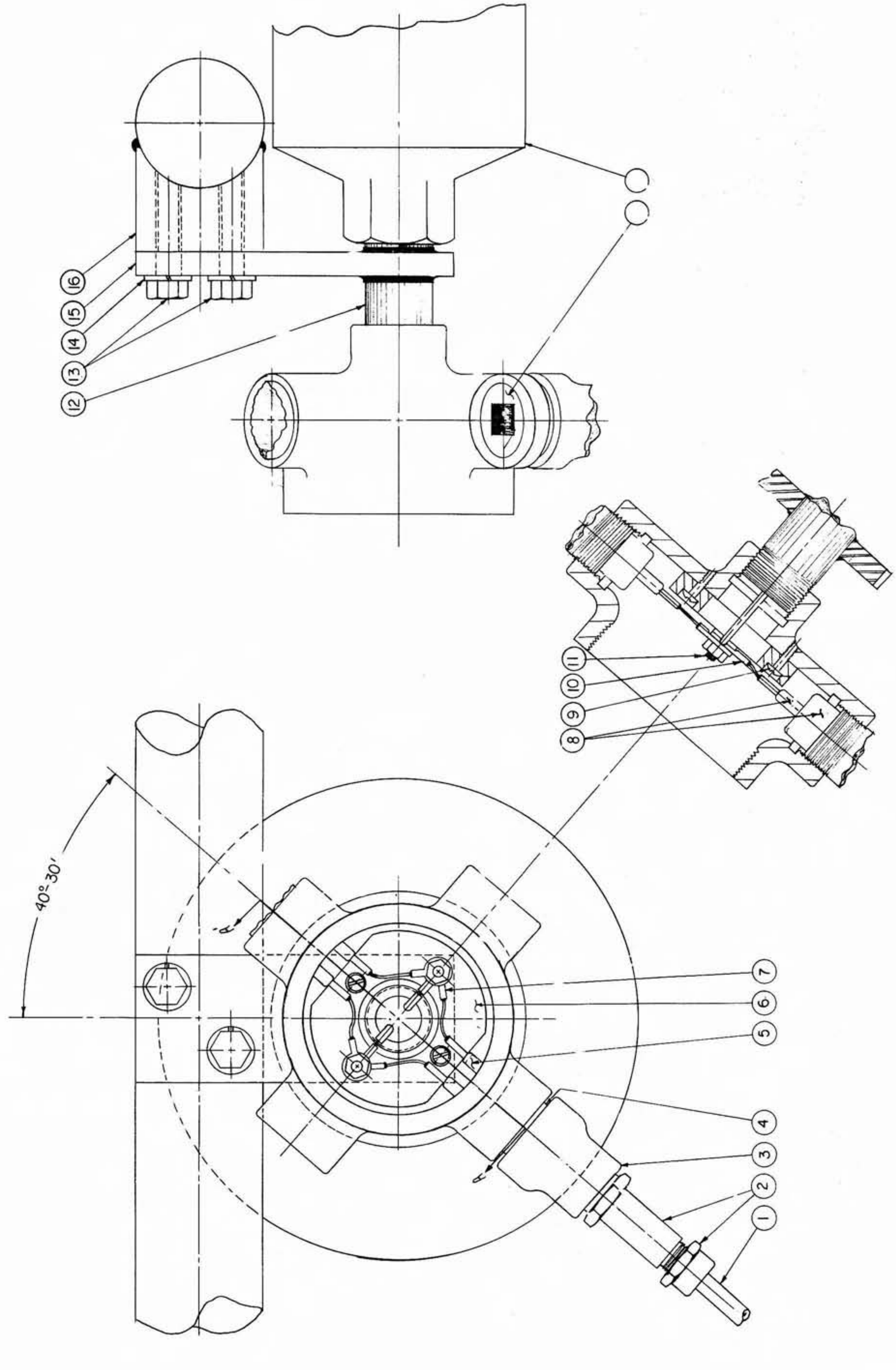
SEE ENGINEERING RECORDS	
ORIGINAL DATE OF DRAWING	3 JULY 63
Title	OPERATIONAL SEQUENCE PRELAUNCH
	GEORGE C. MARSHALL SPACE FLIGHT CENTER, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, HUNTSVILLE, ALABAMA
DWG SIZE	D
Drawing No.	ES-14

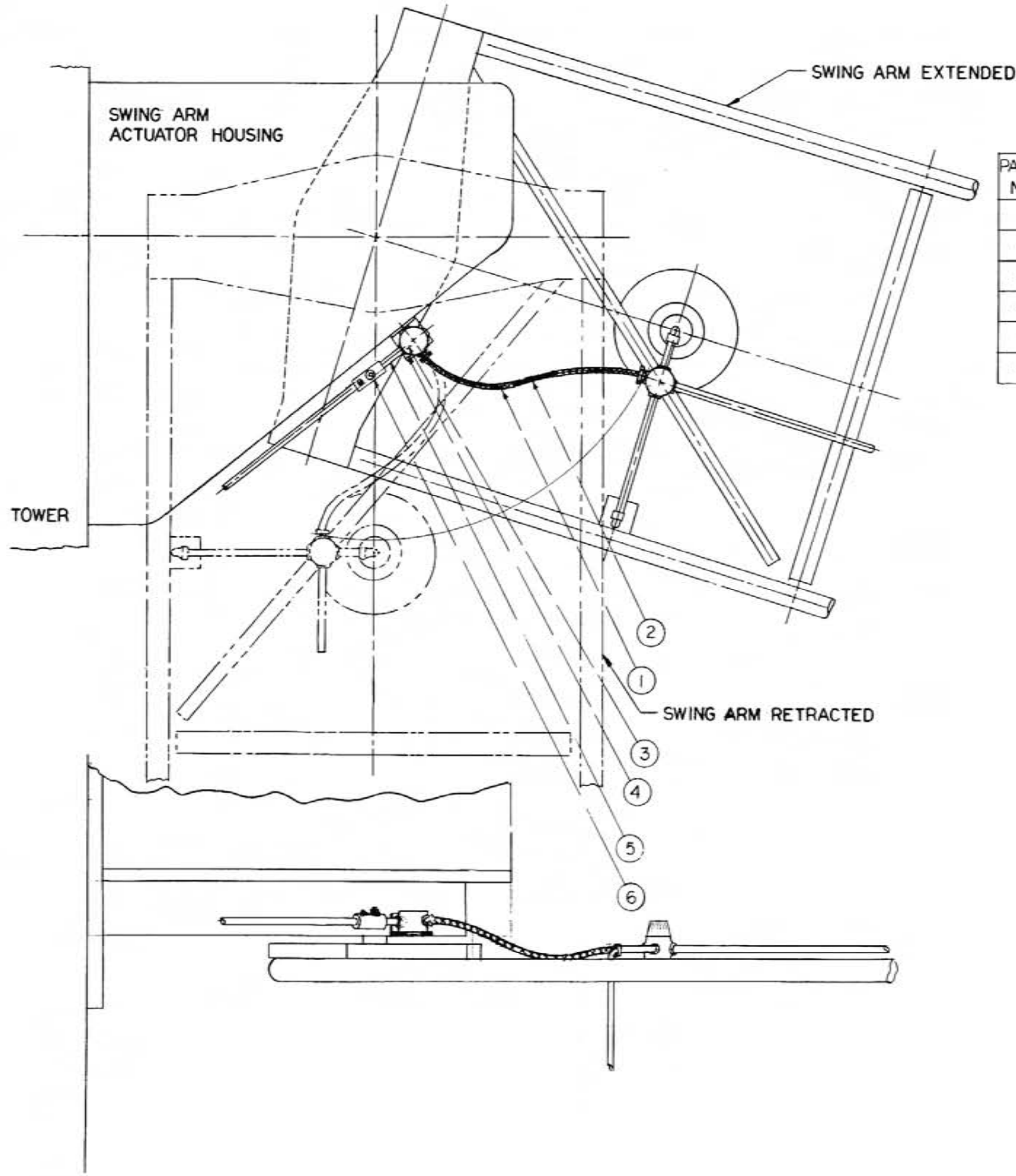

S II AFT
RECEPTACLE
SECOND ELEMENT
FIRST ELEMENT
S I-C FORWARD
DISCONNECT MECHANISM AREA
DISCONN. CYL.
S II FORWARD
DISCONNECT MECHANISM CYLINDER
CABLE BUNDLE
S IV-B AFT
FLOODLIGHT
DISCONNECT MECHANISM AREA
EXTENSION ELEMENT


FLOODLIGHT
7"
RECEPTICLES
SM
FLOODLIGHT
RECEPT.
SIV-B FORWARD

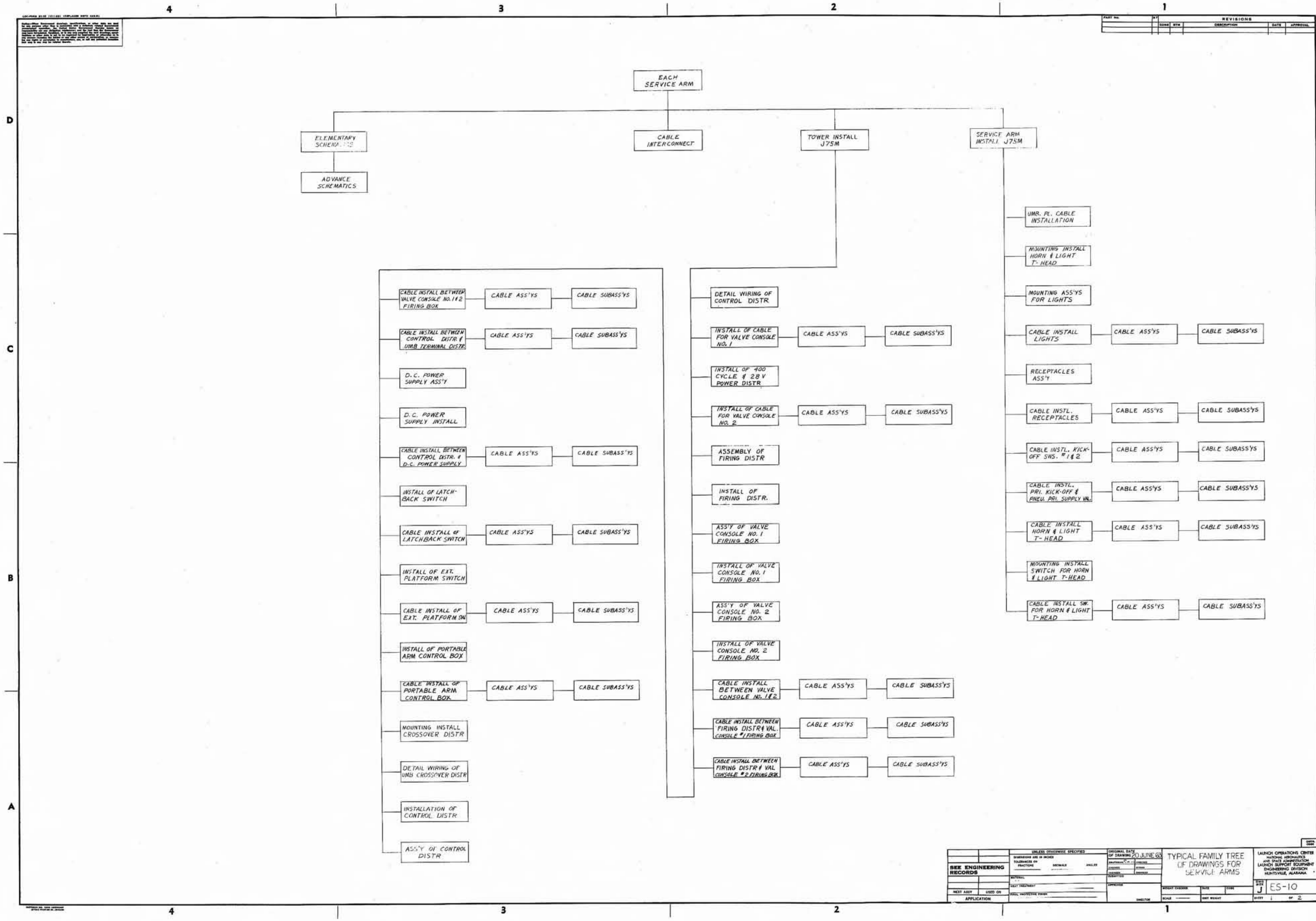


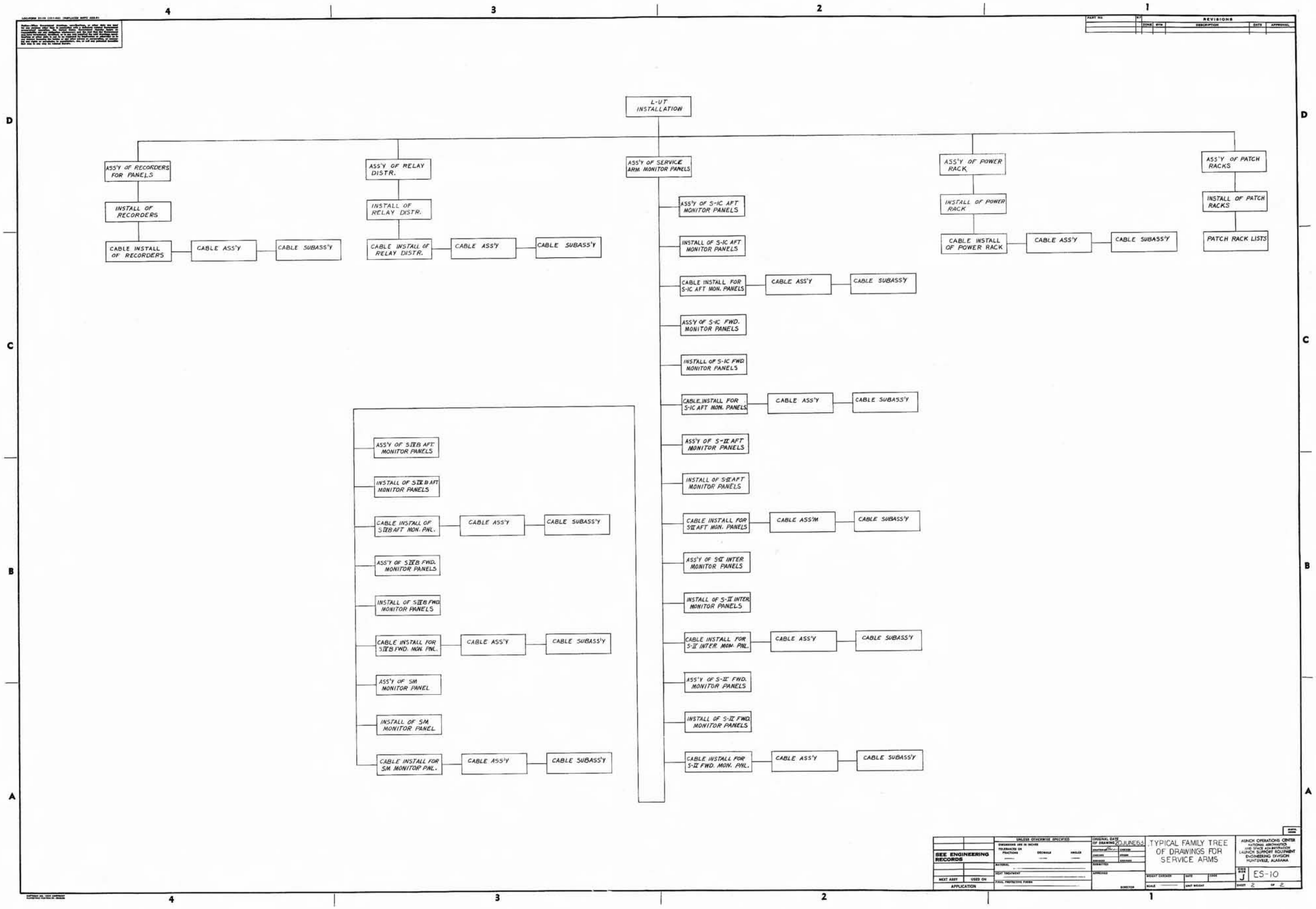



40°-30'
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16



PART NO.	DESCRIPTION	VENDOR	VENDOR PART NO.	NUMBER REQ'D
1	FLEXIBLE CONDUIT 3/4" - 36"	PYLE NATIONAL	FYMM-2236	8
2	TEFLON CABLE 1/12 600V.	GENERAL CABLE	TYPE-E 12 AWG	40 FT.
3	JUNCTION BOX	PYLE NATIONAL	VAML 23	8
4	MOUNTING PLATE 4 X 3 X 1/4 ANGLE - 4" LONG			8
5	RIDGID CONDUIT 3/4"			
6	SEALING PYLET 1 1/4"	PYLE NATIONAL	VY4-S128	8


EACH SERVICE ARM
ELEMENTARY SCHEMATICS
ADVANCE SCHEMATICS
CABLE INTERCONNECT
TOWER INSTALL J75M
SERVICE ARM INSTALL J75M
CABLE INSTALL BETWEEN VALVE CONSOLE NO. 1 & 2 FIRING BOX
CABLE ASS'YS
CABLE SUBASS'YS
CABLE INSTALL BETWEEN CONTROL DISTR. & UMB TERMINAL DISTR.
D.C. POWER SUPPLY ASS'Y
D.C. POWER SUPPLY INSTALL
CABLE INSTALL BETWEEN CONTROL DISTR. & D.C. POWER SUPPLY
INSTALL OF LATCH-BACK SWITCH
CABLE INSTALL OF LATCHBACK SWITCH
INSTALL OF EXT. PLATFORM SWITCH
CABLE INSTALL OF EXT. PLATFORM SW
INSTALL OF PORTABLE ARM CONTROL BOX
CABLE INSTALL OF PORTABLE ARM CONTROL BOX
MOUNTING INSTALL CROSSOVER DISTR
DETAIL WIRING OF UMB CROSSOVER DISTR
INSTALLATION OF CONTROL DISTR
ASS'Y OF CONTROL DISTR
DETAIL WIRING OF CONTROL DISTR
INSTALL OF CABLE FOR VALVE CONSOLE NO. 1
INSTALL OF 400 CYCLE & 28V POWER DISTR
INSTALL OF CABLE FOR VALVE CONSOLE NO. 2
ASSEMBLY OF FIRING DISTR
INSTALL OF FIRING DISTR.
ASS'Y OF VALVE CONSOLE NO. 1 FIRING BOX
INSTALL OF VALVE CONSOLE NO. 1 FIRING BOX
ASS'Y OF VALVE CONSOLE NO. 2 FIRING BOX
INSTALL OF VALVE CONSOLE NO. 2 FIRING BOX
CABLE INSTALL BETWEEN VALVE CONSOLE NO. 1 & 2
CABLE INSTALL BETWEEN FIRING DISTR & VAL. CONSOLE #1 FIRING BOX
CABLE INSTALL BETWEEN FIRING DISTR & VAL CONSOLE #2 FIRING BOX
UMB. PL. CABLE INSTALLATION
MOUNTING INSTALL HORN & LIGHT T-HEAD
MOUNTING ASS'YS FOR LIGHTS
CABLE INSTALL LIGHTS
RECEPTACLES ASS'Y
CABLE INSTL. RECEPTACLES
CABLE INSTL. KICK-OFF SWS. #1 & 2
CABLE INSTL. PRI. KICK-OFF & PNEU. PRI. SUPPLY VAL.
CABLE INSTALL HORN & LIGHT T-HEAD
MOUNTING INSTALL SWITCH FOR HORN & LIGHT T-HEAD
CABLE INSTALL SW. FOR HORN & LIGHT T-HEAD
REVISIONS
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON FRACTIONS DECIMALS ANGLES
SEE ENGINEERING RECORDS
NEXT ASSY USED ON
APPLICATION
MATERIAL
HEAT TREATMENT
FINAL PROTECTIVE FINISH
ORIGINAL DATE OF DRAWING 20 JUNE 63
SUBMITTED
APPROVED
DIRECTOR
TYPICAL FAMILY TREE OF DRAWINGS FOR SERVICE ARMS
LAUNCH OPERATIONS CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LAUNCH SUPPORT EQUIPMENT ENGINEERING DIVISION
HUNTSVILLE, ALABAMA
J
ES-10
SHEET 1 OF 2


L-UT INSTALLATION
ASS'Y OF RECORDERS FOR PANELS
INSTALL OF RECORDERS
CABLE INSTALL OF RECORDERS
CABLE ASS'Y
CABLE SUBASS'Y
ASS'Y OF RELAY DISTR.
INSTALL OF RELAY DISTR.
CABLE INSTALL OF RELAY DISTR.
CABLE ASS'Y
CABLE SUBASS'Y
ASS'Y OF SERVICE ARM MONITOR PANELS
ASS'Y OF S-IC AFT MONITOR PANELS
INSTALL OF S-IC AFT MONITOR PANELS
CABLE INSTALL FOR S-IC AFT MON. PANELS
CABLE ASS'Y
CABLE SUBASS'Y
ASS'Y OF S-IC FWD. MONITOR PANELS
INSTALL OF S-IC FWD. MONITOR PANELS
CABLE INSTALL FOR S-IC AFT MON. PANELS
CABLE ASS'Y
CABLE SUBASS'Y
ASS'Y OF S-II AFT MONITOR PANELS
INSTALL OF S-II AFT MONITOR PANELS
CABLE INSTALL FOR S-II AFT MON. PANELS
CABLE ASS'M
CABLE SUBASS'Y
ASS'Y OF S-II INTER MONITOR PANELS
INSTALL OF S-II INTER MONITOR PANELS
CABLE INSTALL FOR S-II INTER. MON. PNL.
CABLE ASS'Y
CABLE SUBASS'Y
ASS'Y OF S-II FWD. MONITOR PANELS
INSTALL OF S-II FWD. MONITOR PANELS
CABLE INSTALL FOR S-II FWD. MON. PNL.
CABLE ASS'Y
CABLE SUBASS'Y
ASS'Y OF S-IVB AFT MONITOR PANELS
INSTALL OF S-IVB AFT MONITOR PANELS
CABLE INSTALL OF S-IVB AFT MON. PNL.
CABLE ASS'Y
CABLE SUBASS'Y
ASS'Y OF S-IVB FWD. MONITOR PANELS
INSTALL OF S-IVB FWD. MONITOR PANELS
CABLE INSTALL FOR S-IVB FWD. MON. PNL.
CABLE ASS'Y
CABLE SUBASS'Y
ASS'Y OF SM MONITOR PANEL
INSTALL OF SM MONITOR PANEL
CABLE INSTALL FOR SM MONITOR PNL.
CABLE ASS'Y
CABLE SUBASS'Y
ASS'Y OF POWER RACK
INSTALL OF POWER RACK
CABLE INSTALL OF POWER RACK
CABLE ASS'Y
CABLE SUBASS'Y
ASS'Y OF PATCH RACKS
INSTALL OF PATCH RACKS
PATCH RACK LISTS
SEE ENGINEERING RECORDS
NEXT ASSY
USED ON
APPLICATION
UNLESS OTHERWISE SPECIFIED
ORIGINAL DATE OF DRAWING 20JUNE63
TYPICAL FAMILY TREE OF DRAWINGS FOR SERVICE ARMS
LAUNCH OPERATIONS CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
LAUNCH SUPPORT EQUIPMENT ENGINEERING DIVISION
HUNTSVILLE, ALABAMA
J
ES-10
SHEET 2 OF 2

APPENDIX D

Preface

Appendix D contains drawings which show the Umbilical Arm-Tower Interfaces. The following changes, which affect the drawings, are in progress:

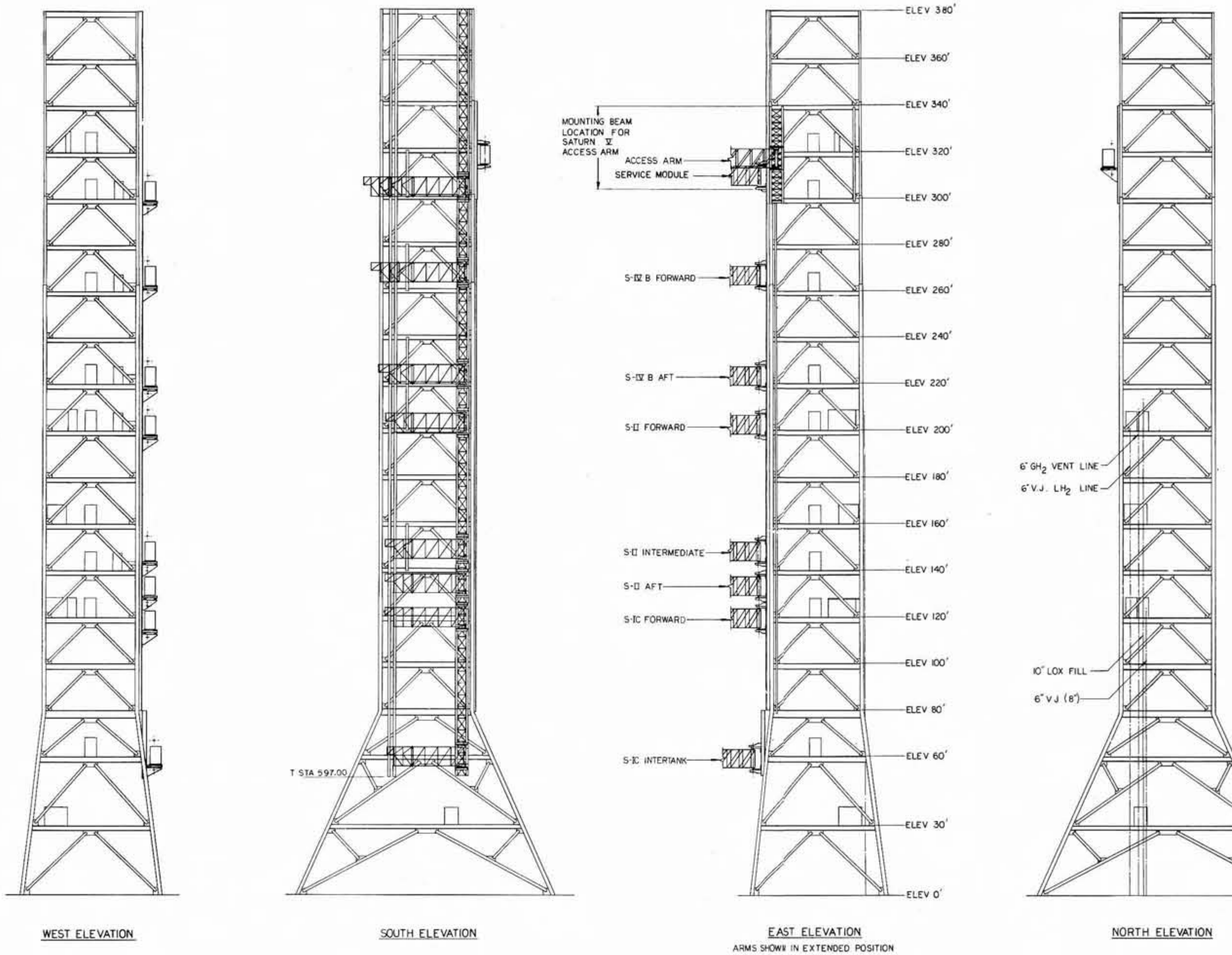
(1) LOX line elevation shown as station 648.000 on sheet 2 will be lowered.

(2) Umbilical distributor will be relocated to provide a 48-inch clearance between distributor and column centerlines. Clearance is required for installation and maintenance of umbilical and service lines. This change will affect sheets where distributor is shown.

(3) Umbilical distributor at the 140-foot level, shown on sheet 4, will be removed.

(4) All umbilical distributors will be limited to maximum height of 72 inches.

(5) S-II INTERMEDIATE arm accessway, shown on sheet 11, may be changed from vertical ladder to stairs entering into the 140-foot level deck space.



NOTES:

1. HORIZONTAL BOLT HOLE CENTERS (GAGE LINE) ON ANY MOUNTING BEAM TO HAVE A TOLERANCE OF ±.03.
2. TOWER STRUCTURE SHOWN IN PHANTOM ON ALL DRAWINGS EXCEPT SHEET NO. 1, LO-DEM SUPPLIED ITEMS SHOWN SOLID.
3. BOLT HOLES ON ALL GAGE LINES TO BE IN SAME ELEVATION PLANE AND SPACED VERTICALLY (5) INCHES ON CENTERS UNLESS OTHERWISE NOTED.
4. MAXIMUM MISALIGNMENT OF BOLT HOLES IN THE SAME HORIZONTAL PLANE BETWEEN ANY TWO MOUNTING BEAMS TO BE ±.25 IN VERTICAL DIRECTION.
5. VERTICAL BOLT HOLE CENTERS ON ANY MOUNTING BEAM TO HAVE A MAXIMUM TOLERANCE OF ±0.06 IN ANY 12 FOOT LENGTH.
6. ALL DIMENSIONS ARE IN INCHES UNLESS OTHERWISE SHOWN.
7. FOR SERVICE ARM ACCESS DETAILS SEE SHEETS 11, 12, 13, & 14
8. ARMS ARE SHOWN IN RETRACTED POSITION EXCEPT AS NOTED.
9. SEE SHEET 2 FOR SERVICE ARM HINGE BOLT HOLE GAGE.

DRAWING INDEX

DESCRIPTION	SHEET NO.
GENERAL ELEVATION	1
S-IC AFT TOWER ELEV 60'	2
S-IC FORWARD TOWER ELEV 120'	3
S-II AFT TOWER ELEV 140'	4
S-II INTERMEDIATE TOWER ELEV 160'	5
S-II FORWARD TOWER ELEV 200'	6
S-IVB AFT TOWER ELEV 220'	7
S-IVB FORWARD TOWER ELEV 260'	8
SERVICE MODULE TOWER ELEV 300'	9
ACCESS ARM TOWER ELEV 320	10
ACCESS PLATFORM DETAILS	11
ACCESS PLATFORM DETAILS	12
ACCESS PLATFORM DETAILS	13
ACCESS PLATFORM DETAILS	14

LIST OF MATERIAL

SEE ENGINEERING RECORDS

COMPLEX 39 — USED ON — APPLICATION

ORIGINAL DATE OF DRAWING 24 JAN 63

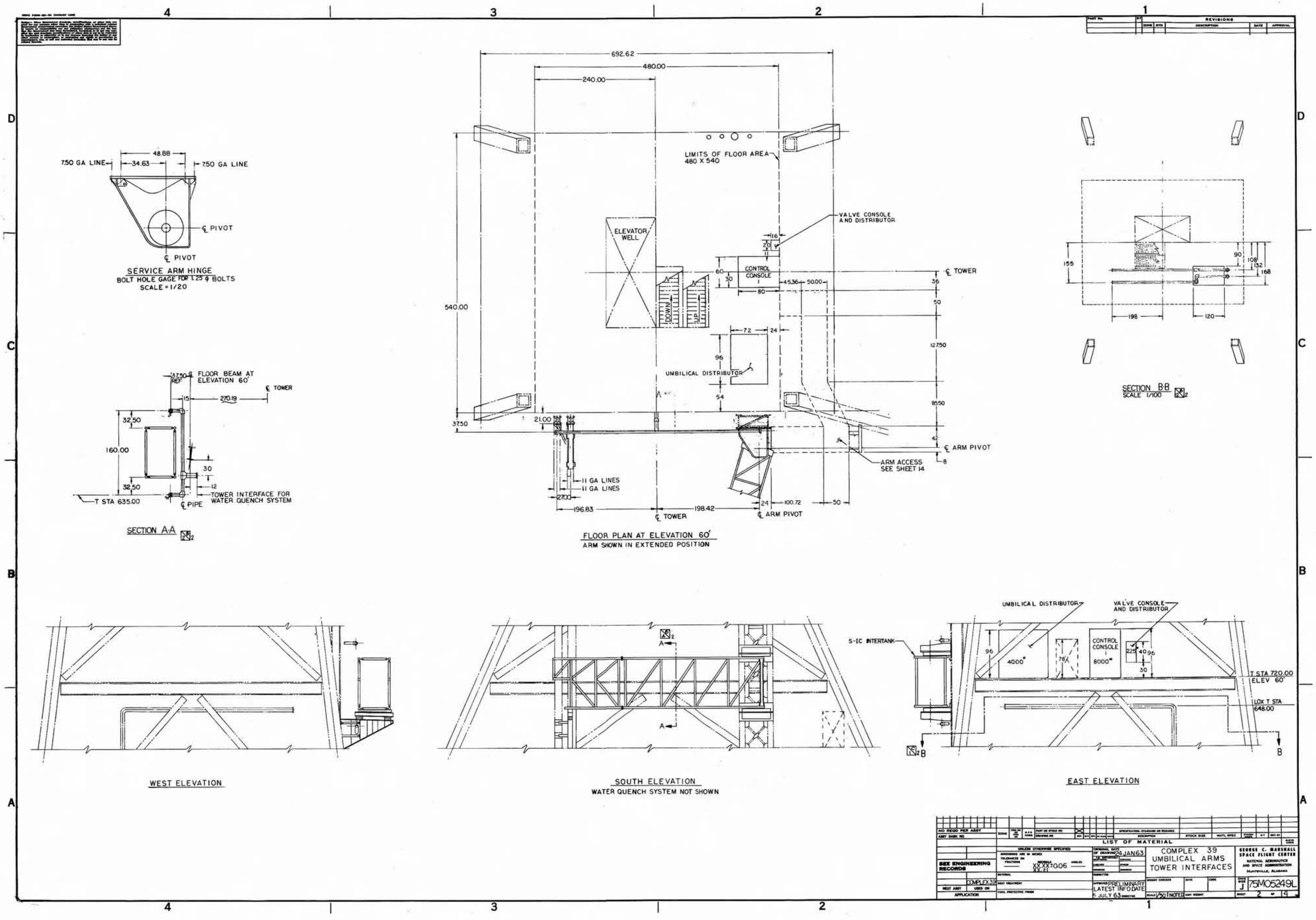
PRELIMINARY LATEST INFO DATE

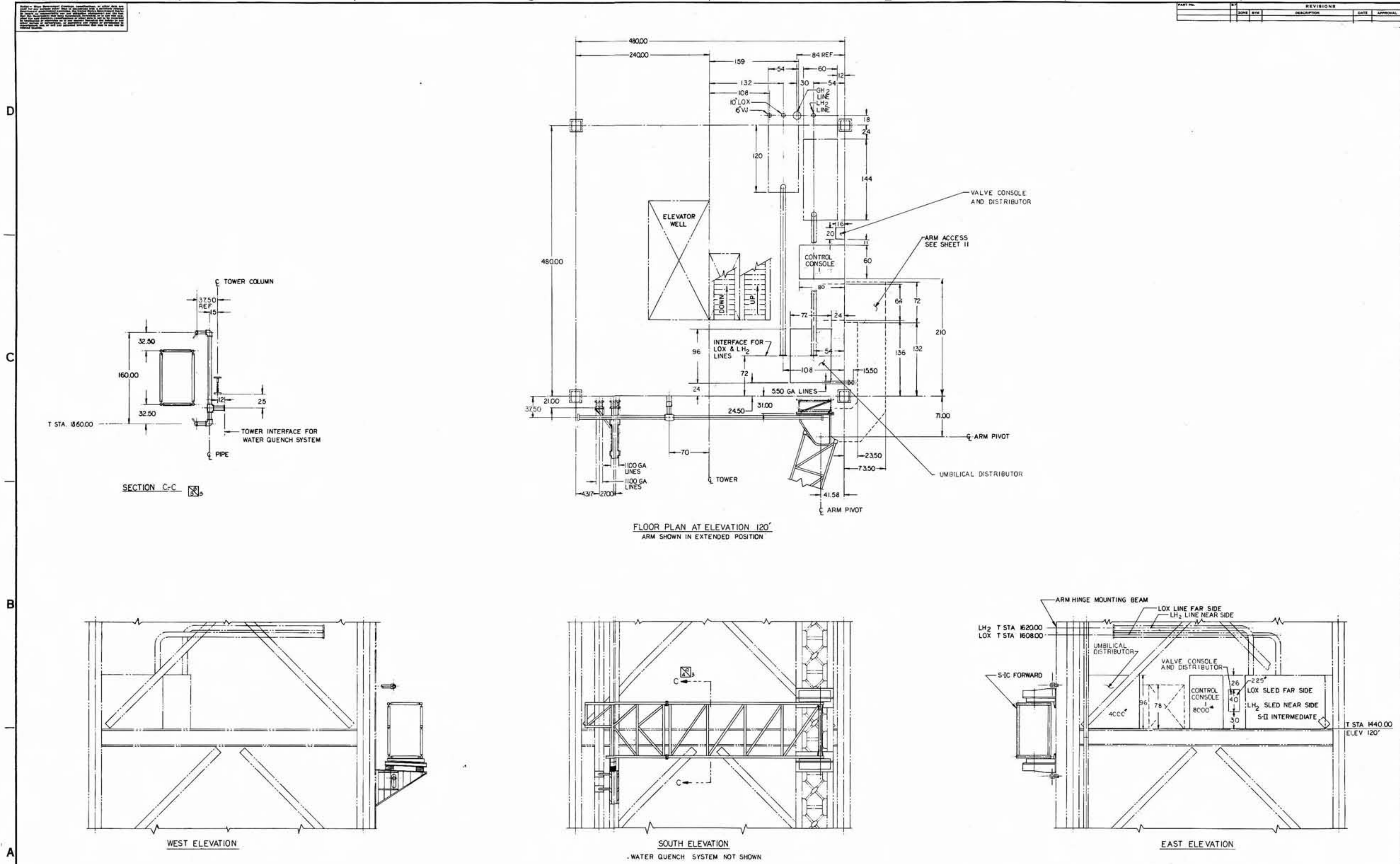
COMPLEX 39 UMBILICAL ARM TOWER INTERFACES

GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

SIZE J 75M05249L

SCALE 1/200 — SHEET 1 OF 14


SERVICE ARM HINGE
BOLT HOLE GAGE FOR 1.25 φ BOLTS
SCALE = 1/20
7.50 GA LINE
48.88
34.63
℄ PIVOT
SECTION A-A
℄ FLOOR BEAM AT ELEVATION 60'
℄ TOWER
270.19
160.00
32.50
T STA 635.00
℄ PIPE
TOWER INTERFACE FOR WATER QUENCH SYSTEM
FLOOR PLAN AT ELEVATION 60'
ARM SHOWN IN EXTENDED POSITION
692.62
480.00
240.00
540.00
LIMITS OF FLOOR AREA 480 X 540
ELEVATOR WELL
DOWN
UP
VALVE CONSOLE AND DISTRIBUTOR
CONTROL CONSOLE
UMBILICAL DISTRIBUTOR
℄ TOWER
℄ ARM PIVOT
ARM ACCESS SEE SHEET 14
11 GA LINES
196.83
198.42
100.72
SECTION B-B
SCALE 1/100
WEST ELEVATION
SOUTH ELEVATION
WATER QUENCH SYSTEM NOT SHOWN
EAST ELEVATION
S-IC INTERTANK
UMBILICAL DISTRIBUTOR
VALVE CONSOLE AND DISTRIBUTOR
CONTROL CONSOLE
4000#
8000#
T STA 720.00
ELEV 60'
LOX T STA 648.00
LIST OF MATERIAL
COMPLEX 39
UMBILICAL ARMS
TOWER INTERFACES
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA
24 JAN 63
PRELIMINARY
LATEST INFO DATE
5 JULY 63
SEE ENGINEERING RECORDS
COMPLEX 39
75M05249L
SHEET 2 OF 4

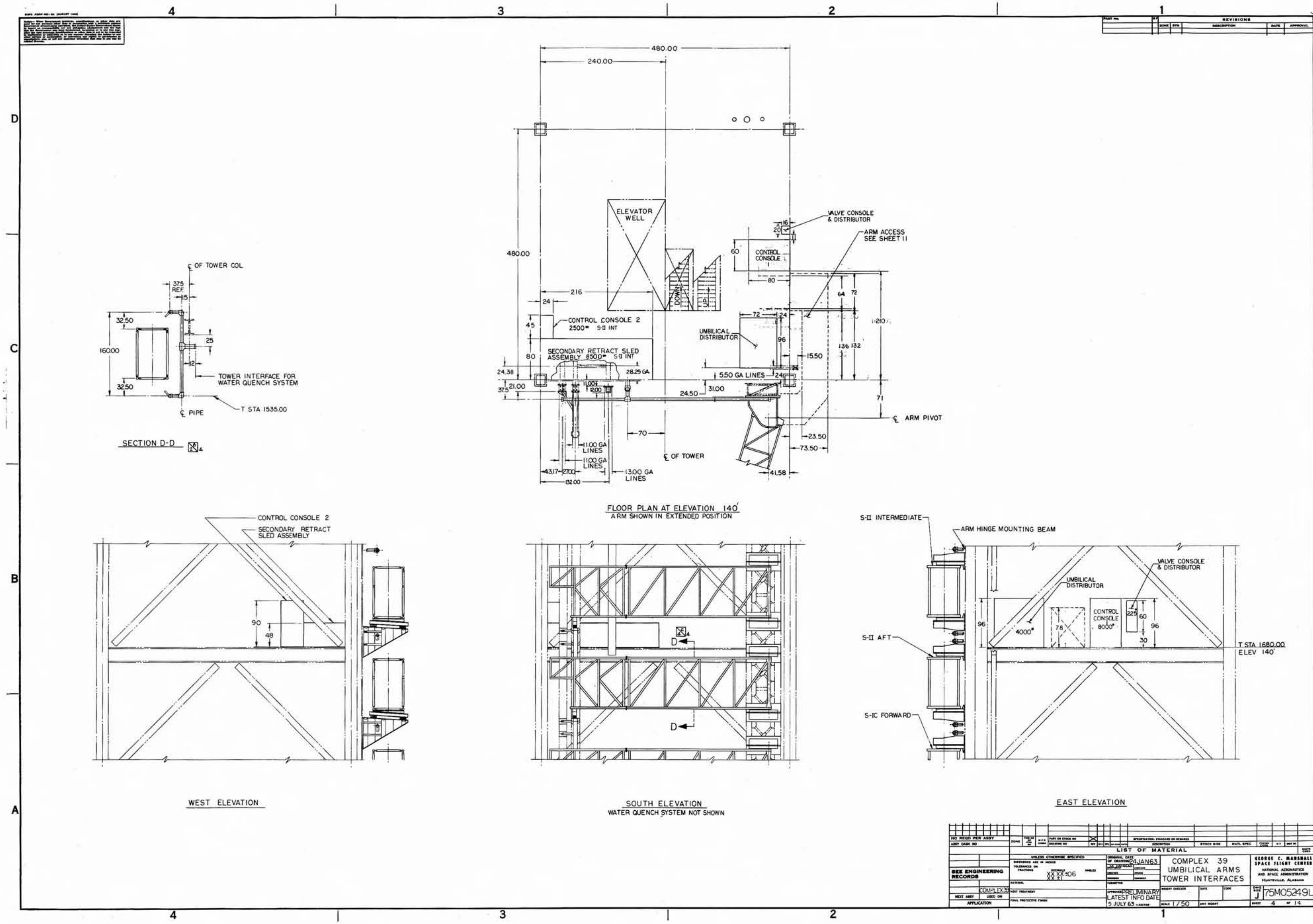


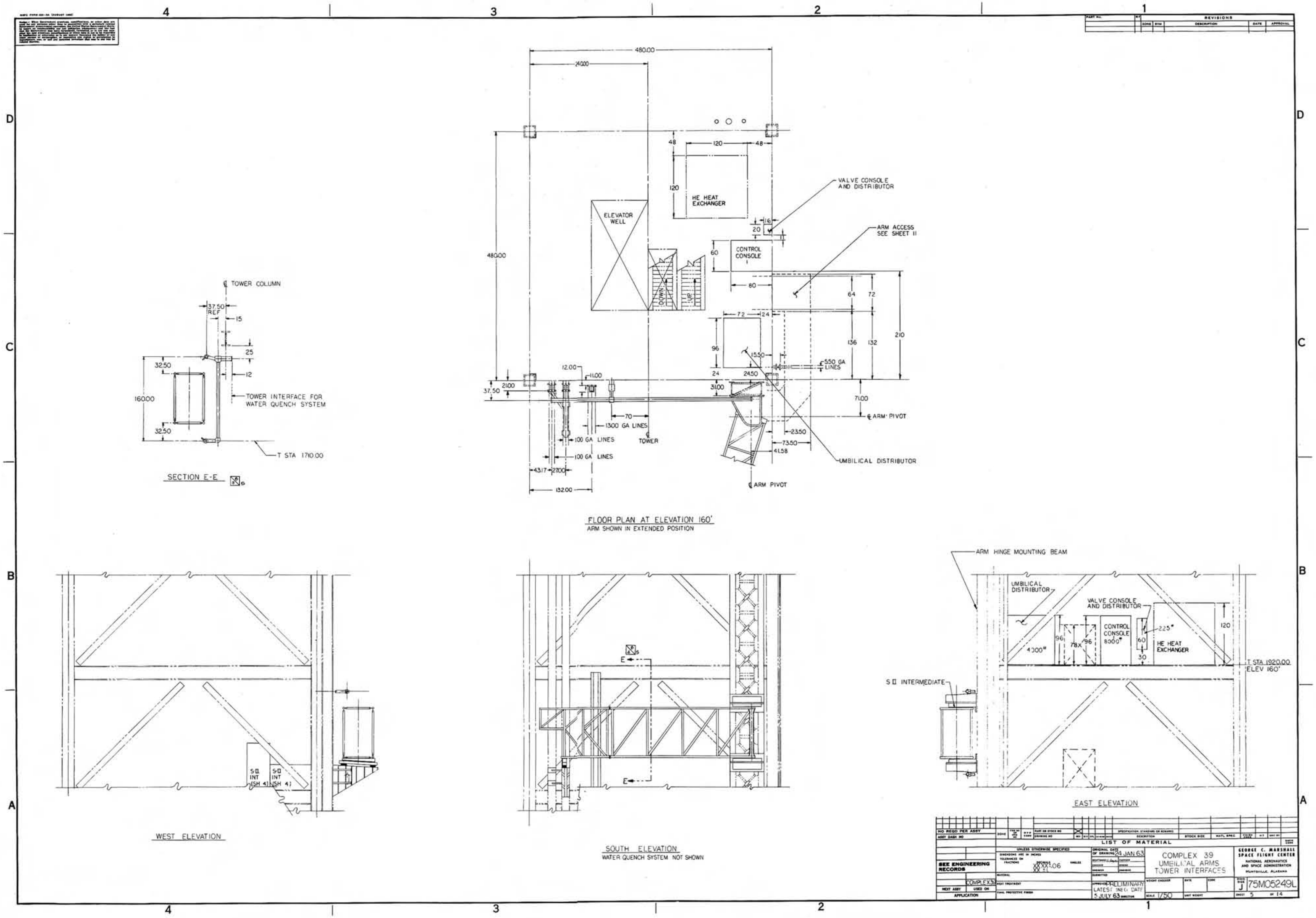
ORIGINAL DATE OF DRAWING 24 JAN 63	COMPLEX 39 UMBILICAL ARMS TOWER INTERFACES	GEORGE C. MARSHALL SPACE FLIGHT CENTER, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, HUNTSVILLE, ALABAMA
APPROVED PRELIMINARY LATEST INFO DATE 5 JULY 63	SCALE 1/50	DWG SIZE J 75M05249L, SHEET 3 OF 14

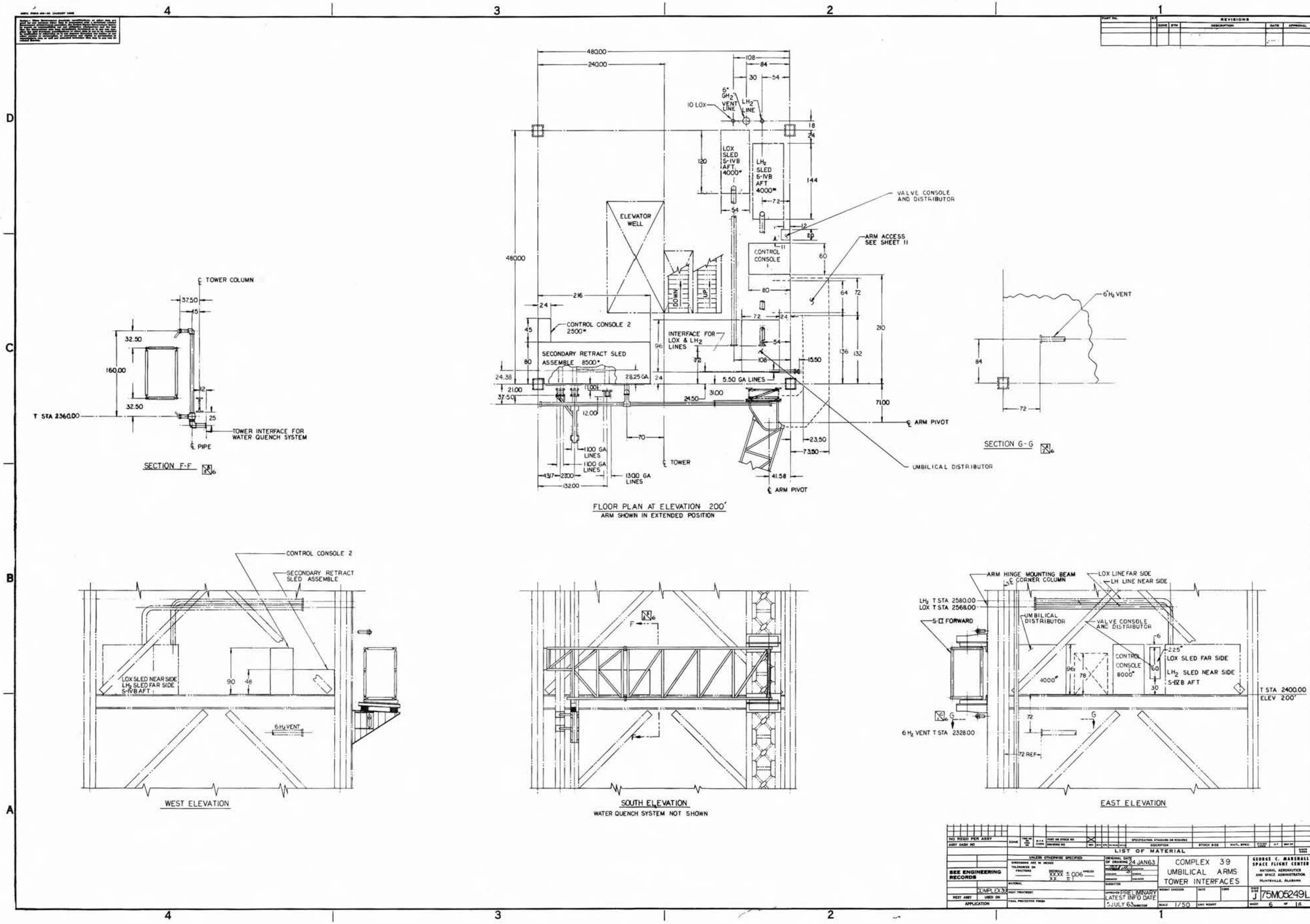
SEE ENGINEERING RECORDS

USED ON: COMPLEX 39

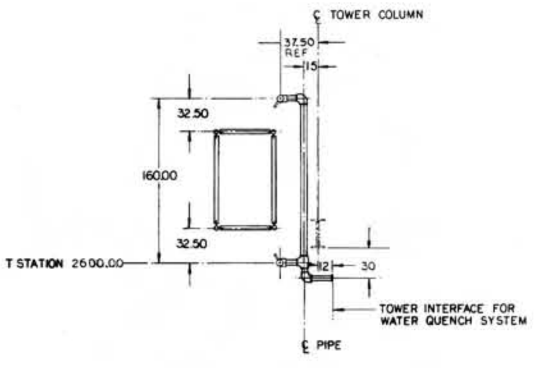
UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN INCHES. TOLERANCES ON DECIMALS XX.XX ±.006, XX ±1


480.00
240.00
ELEVATOR WELL
DOWN
UP
VALVE CONSOLE & DISTRIBUTOR
ARM ACCESS SEE SHEET 11
CONTROL CONSOLE
CONTROL CONSOLE 2 2500# S-II INT
SECONDARY RETRACT SLED ASSEMBLY 8500# S-II INT
UMBILICAL DISTRIBUTOR
5.50 GA LINES
1.00 GA LINES
11.00 GA LINES
13.00 GA LINES
℄ OF TOWER
℄ ARM PIVOT
℄ OF TOWER COL
TOWER INTERFACE FOR WATER QUENCH SYSTEM
℄ PIPE
T STA 1535.00
SECTION D-D
FLOOR PLAN AT ELEVATION 140'
ARM SHOWN IN EXTENDED POSITION
CONTROL CONSOLE 2
SECONDARY RETRACT SLED ASSEMBLY
WEST ELEVATION
SOUTH ELEVATION
WATER QUENCH SYSTEM NOT SHOWN
S-II INTERMEDIATE
ARM HINGE MOUNTING BEAM
UMBILICAL DISTRIBUTOR
VALVE CONSOLE & DISTRIBUTOR
CONTROL CONSOLE 8000#
4000#
S-II AFT
S-IC FORWARD
T STA 1680.00 ELEV 140'
EAST ELEVATION
LIST OF MATERIAL
SEE ENGINEERING RECORDS
COMPLEX 39
ORIGINAL DATE OF DRAWING 24JAN63
PRELIMINARY LATEST INFO DATE 5 JULY 63
COMPLEX 39 UMBILICAL ARMS TOWER INTERFACES
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA
SCALE 1/50
J 75M05249L
SHEET 4 OF 14

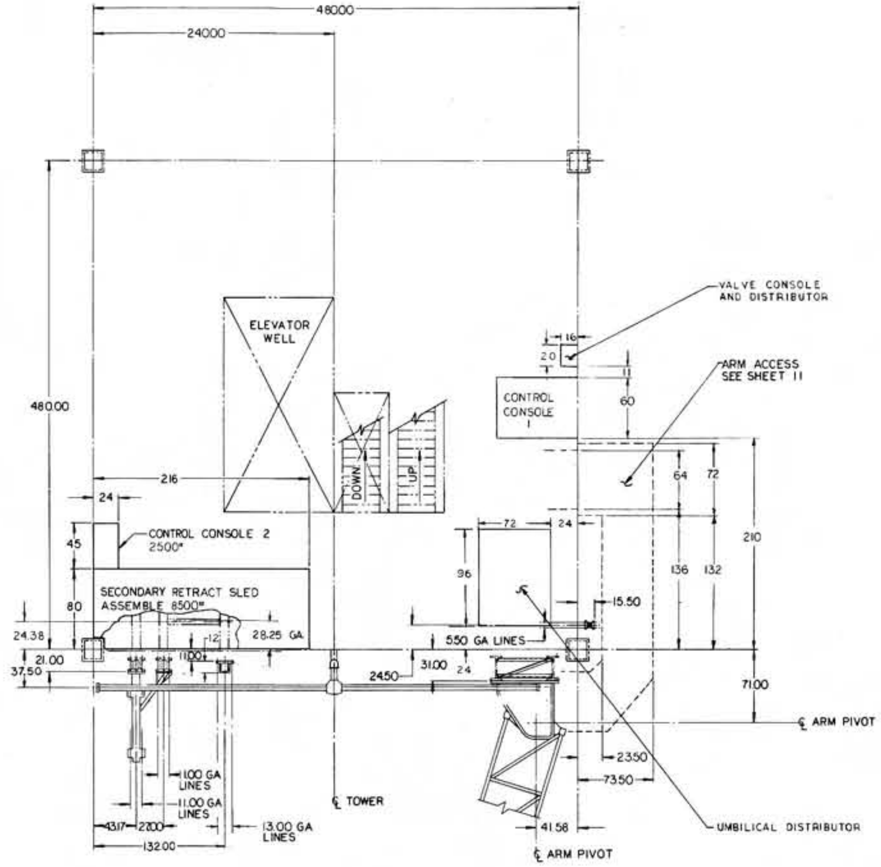

REVISIONS
480.00
240.00
48
120
48
120
HE HEAT EXCHANGER
VALVE CONSOLE AND DISTRIBUTOR
ELEVATOR WELL
16
20
ARM ACCESS SEE SHEET 11
480.00
60
CONTROL CONSOLE
80
DOWN
UP
64
72
72
24
210
136
132
96
15.50
5.50 GA LINES
24
24.50
12.00
11.00
21.00
37.50
31.00
71.00
ARM PIVOT
70
1300 GA LINES
TOWER
100 GA LINES
100 GA LINES
23.50
73.50
41.58
UMBILICAL DISTRIBUTOR
43.17
27.00
132.00
ARM PIVOT
FLOOR PLAN AT ELEVATION 160'
ARM SHOWN IN EXTENDED POSITION
TOWER COLUMN
37.50 REF
15
25
12
32.50
160.00
32.50
TOWER INTERFACE FOR WATER QUENCH SYSTEM
T STA 1710.00
SECTION E-E
WEST ELEVATION
S II INT (SH 4)
SOUTH ELEVATION
WATER QUENCH SYSTEM NOT SHOWN
ARM HINGE MOUNTING BEAM
UMBILICAL DISTRIBUTOR
VALVE CONSOLE AND DISTRIBUTOR
CONTROL CONSOLE 8000#
HE HEAT EXCHANGER
225#
4000#
96
78X
96
60
30
120
T STA 1920.00 ELEV 160'
S II INTERMEDIATE
EAST ELEVATION
LIST OF MATERIAL
SEE ENGINEERING RECORDS
COMPLEX 39
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
ORIGINAL DATE OF DRAWING 24 JAN 63
PRELIMINARY
LATEST ENG. DATE 5 JULY 63
COMPLEX 39
UMBILICAL ARMS
TOWER INTERFACES
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA
J 75M05249L
SCALE 1/50
SHEET 5 OF 14



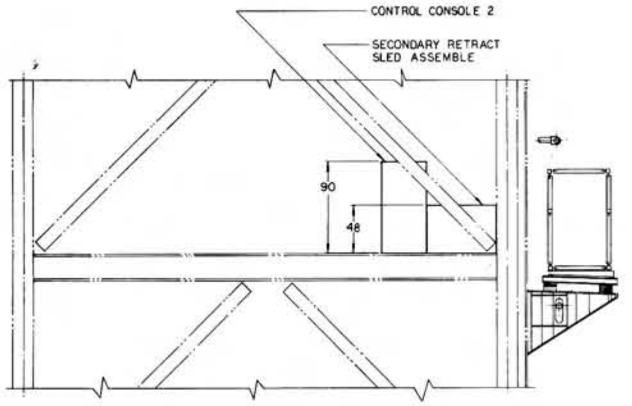
SECTION F-F
FLOOR PLAN AT ELEVATION 200'
ARM SHOWN IN EXTENDED POSITION
SECTION G-G
WEST ELEVATION
SOUTH ELEVATION
WATER QUENCH SYSTEM NOT SHOWN
EAST ELEVATION
LIST OF MATERIAL
COMPLEX 39
UMBILICAL ARMS
TOWER INTERFACES
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA
75M05249L



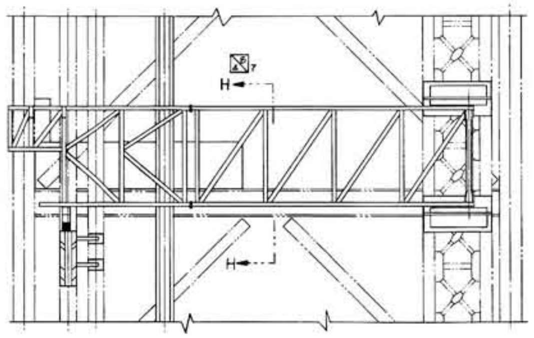
SECTION H-H



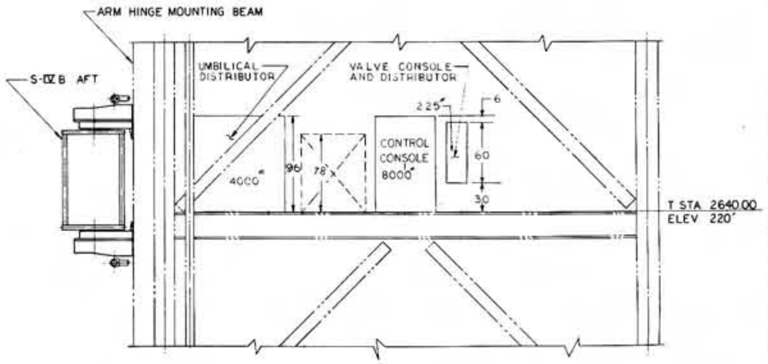
FLOOR PLAN AT ELEVATION 220'
ARM SHOWN IN EXTENDED POSITION



WEST ELEVATION



SOUTH ELEVATION
WATER QUENCH SYSTEM NOT SHOWN



EAST ELEVATION

LIST OF MATERIAL

SEE ENGINEERING RECORDS

COMPLEX 39

UNLESS OTHERWISE SPECIFIED

ORIGINAL DATE OF DRAWING 24 JAN 63

PRELIMINARY LATEST INFO DATE 5 JULY 63

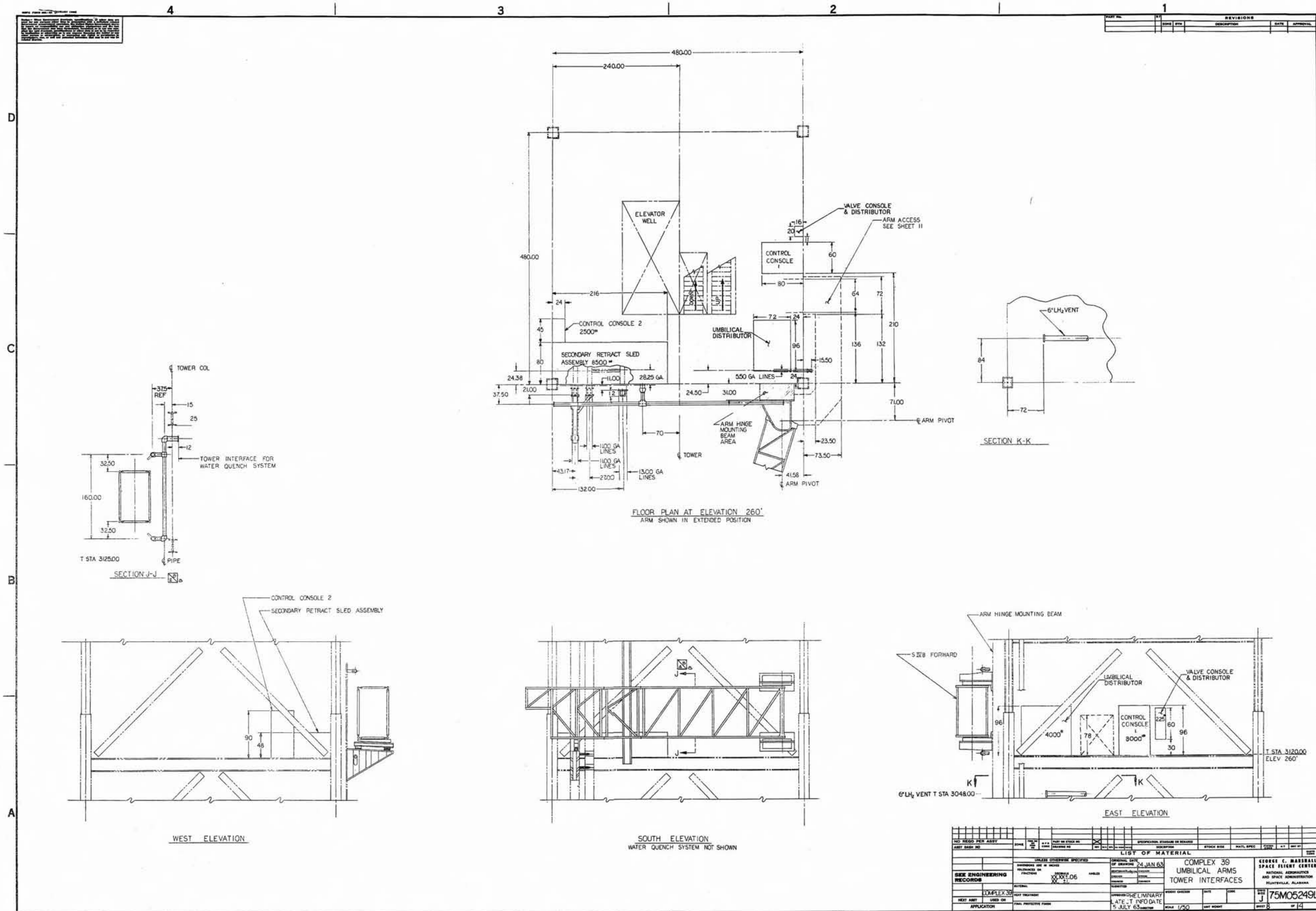
COMPLEX 39 UMBILICAL ARMS TOWER INTERFACES

GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA

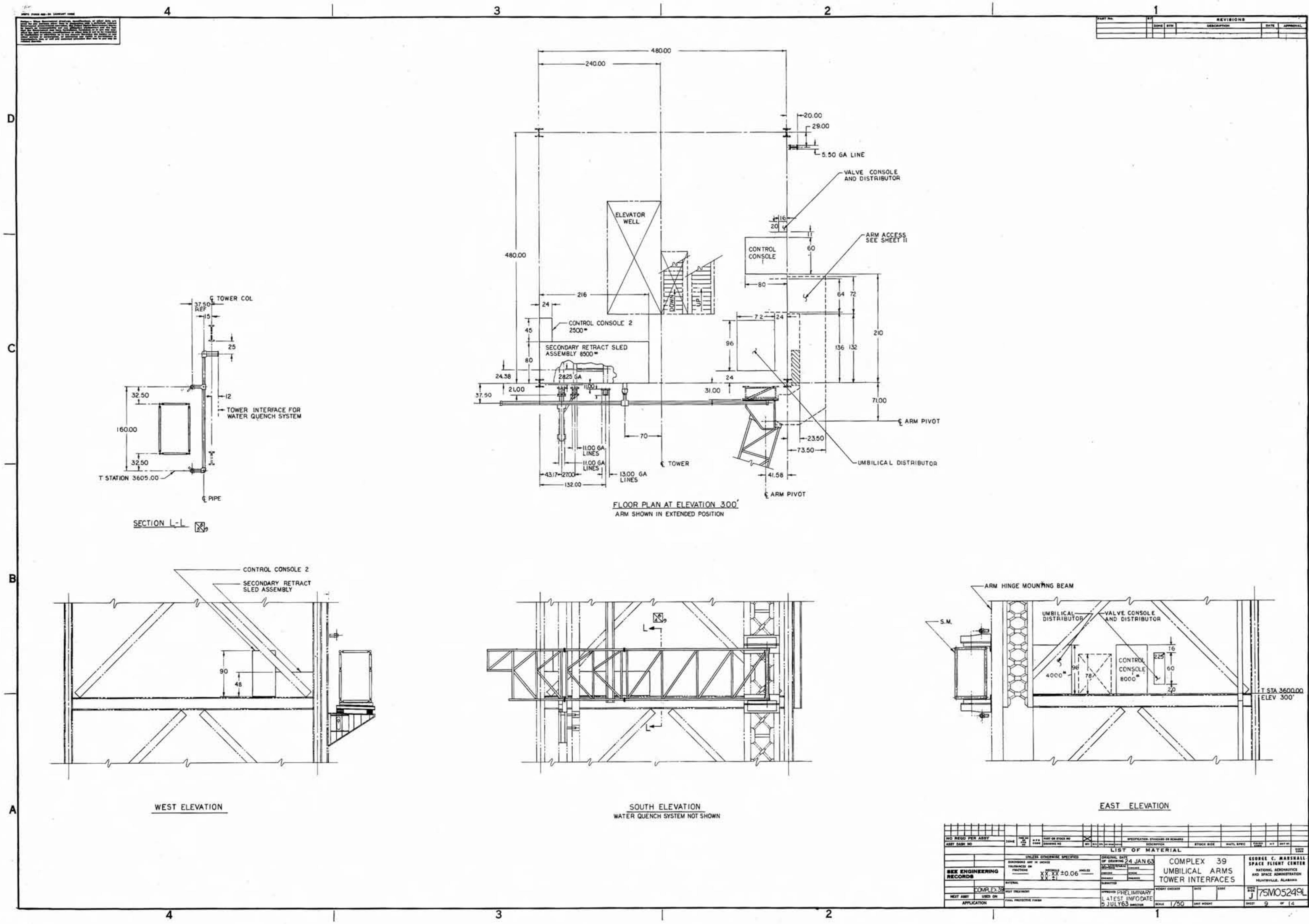
SCALE 1/50

J 75M05249L

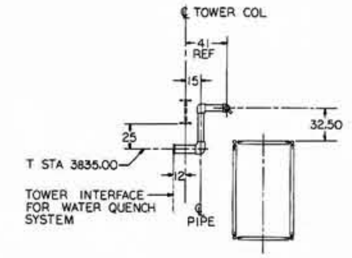
SHEET 7 OF 14



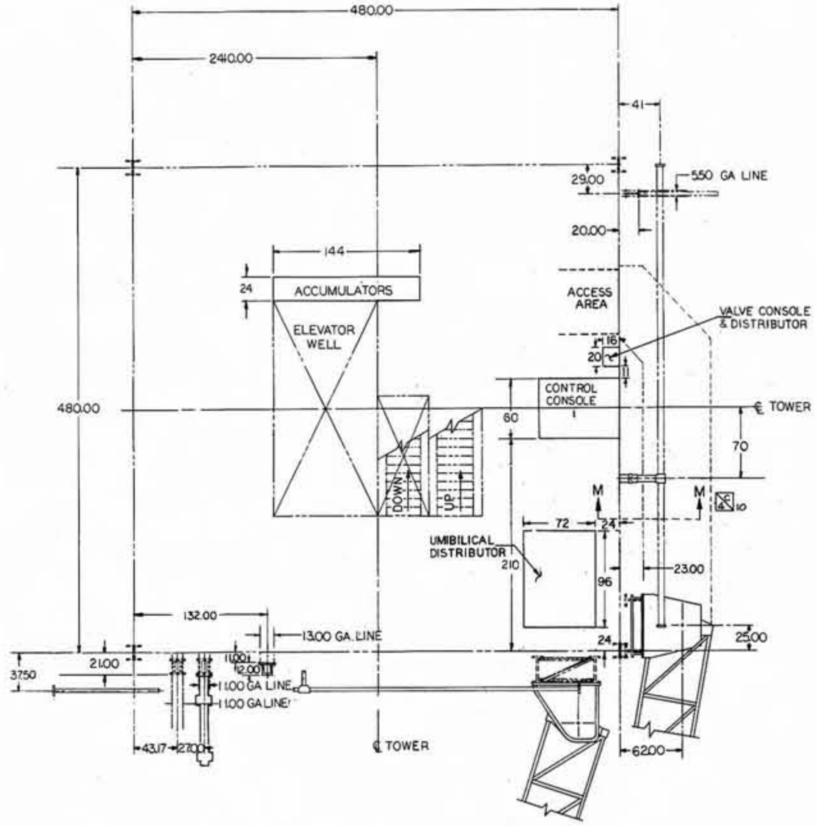
FLOOR PLAN AT ELEVATION 260'
ARM SHOWN IN EXTENDED POSITION
ELEVATOR WELL
CONTROL CONSOLE 1
CONTROL CONSOLE 2 2500#
SECONDARY RETRACT SLED ASSEMBLY 6500#
UMBILICAL DISTRIBUTOR
VALVE CONSOLE & DISTRIBUTOR
ARM ACCESS SEE SHEET 11
ARM HINGE MOUNTING BEAM AREA
ARM PIVOT
TOWER
550 GA LINES
13.00 GA LINES
DOWN
UP
SECTION K-K
6" LH2 VENT
SECTION J-J
TOWER COL
TOWER INTERFACE FOR WATER QUENCH SYSTEM
PIPE
T STA 3125.00
WEST ELEVATION
CONTROL CONSOLE 2
SECONDARY RETRACT SLED ASSEMBLY
SOUTH ELEVATION
WATER QUENCH SYSTEM NOT SHOWN
EAST ELEVATION
ARM HINGE MOUNTING BEAM
S-IVB FORWARD
UMBILICAL DISTRIBUTOR
VALVE CONSOLE & DISTRIBUTOR
CONTROL CONSOLE 1 8000#
4000#
T STA 3120.00
ELEV 260'
6" LH2 VENT T STA 3048.00
LIST OF MATERIAL
SEE ENGINEERING RECORDS
COMPLEX 39
COMPLEX 39 UMBILICAL ARMS TOWER INTERFACES
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA
24 JAN 63
PRELIMINARY LATEST INFO DATE 5 JULY 63
1/50
J
75M05249L
SHEET 8 OF 14



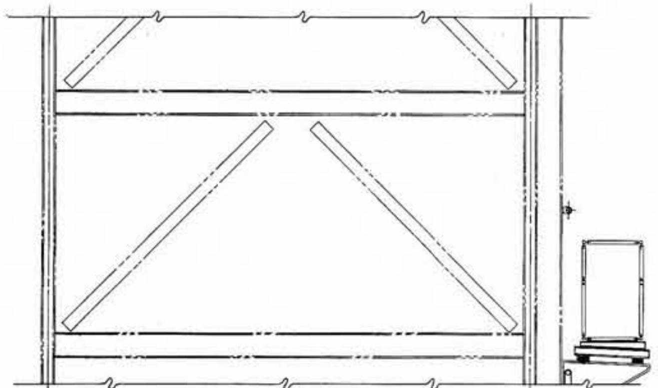
FLOOR PLAN AT ELEVATION 300'
ARM SHOWN IN EXTENDED POSITION
ELEVATOR WELL
CONTROL CONSOLE
CONTROL CONSOLE 2 2500#
SECONDARY RETRACT SLED ASSEMBLY 8500#
VALVE CONSOLE AND DISTRIBUTOR
ARM ACCESS SEE SHEET 11
5.50 GA LINE
ARM PIVOT
UMBILICAL DISTRIBUTOR
TOWER
11.00 GA LINES
13.00 GA LINES
DOWN
UP
SECTION L-L
TOWER COL
TOWER INTERFACE FOR WATER QUENCH SYSTEM
T STATION 3605.00
PIPE
CONTROL CONSOLE 2
SECONDARY RETRACT SLED ASSEMBLY
WEST ELEVATION
SOUTH ELEVATION
WATER QUENCH SYSTEM NOT SHOWN
ARM HINGE MOUNTING BEAM
S.M.
UMBILICAL DISTRIBUTOR
VALVE CONSOLE AND DISTRIBUTOR
CONTROL CONSOLE 8000#
T STA 3600.00
ELEV 300'
EAST ELEVATION
REVISIONS
LIST OF MATERIAL
SEE ENGINEERING RECORDS
24 JAN 63
COMPLEX 39
UMBILICAL ARMS
TOWER INTERFACES
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA
PRELIMINARY
LATEST INFO DATE 5 JULY 63
COMPLEX 39
1/50
J
75M05249L
9 OF 14



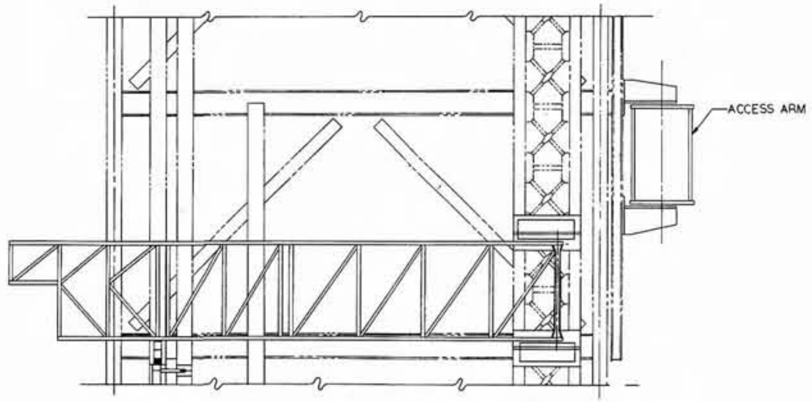
SECTION M-M



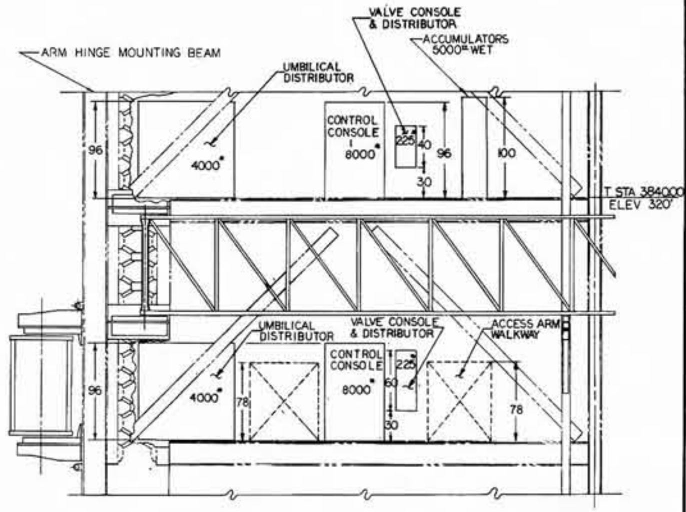
FLOOR PLAN AT ELEVATION 320'
ARMS SHOWN IN EXTENDED POSITION



WEST ELEVATION

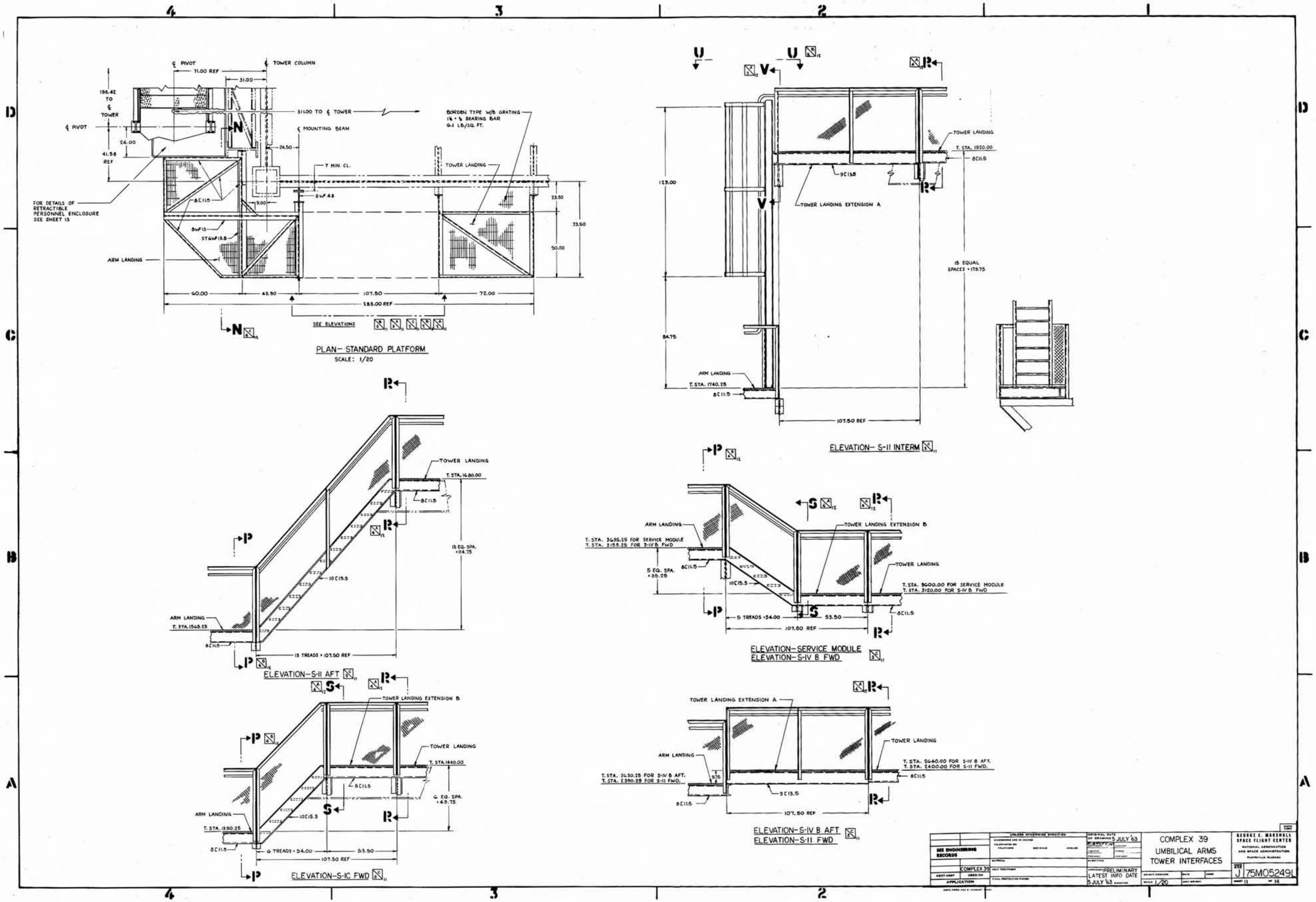


SOUTH ELEVATION

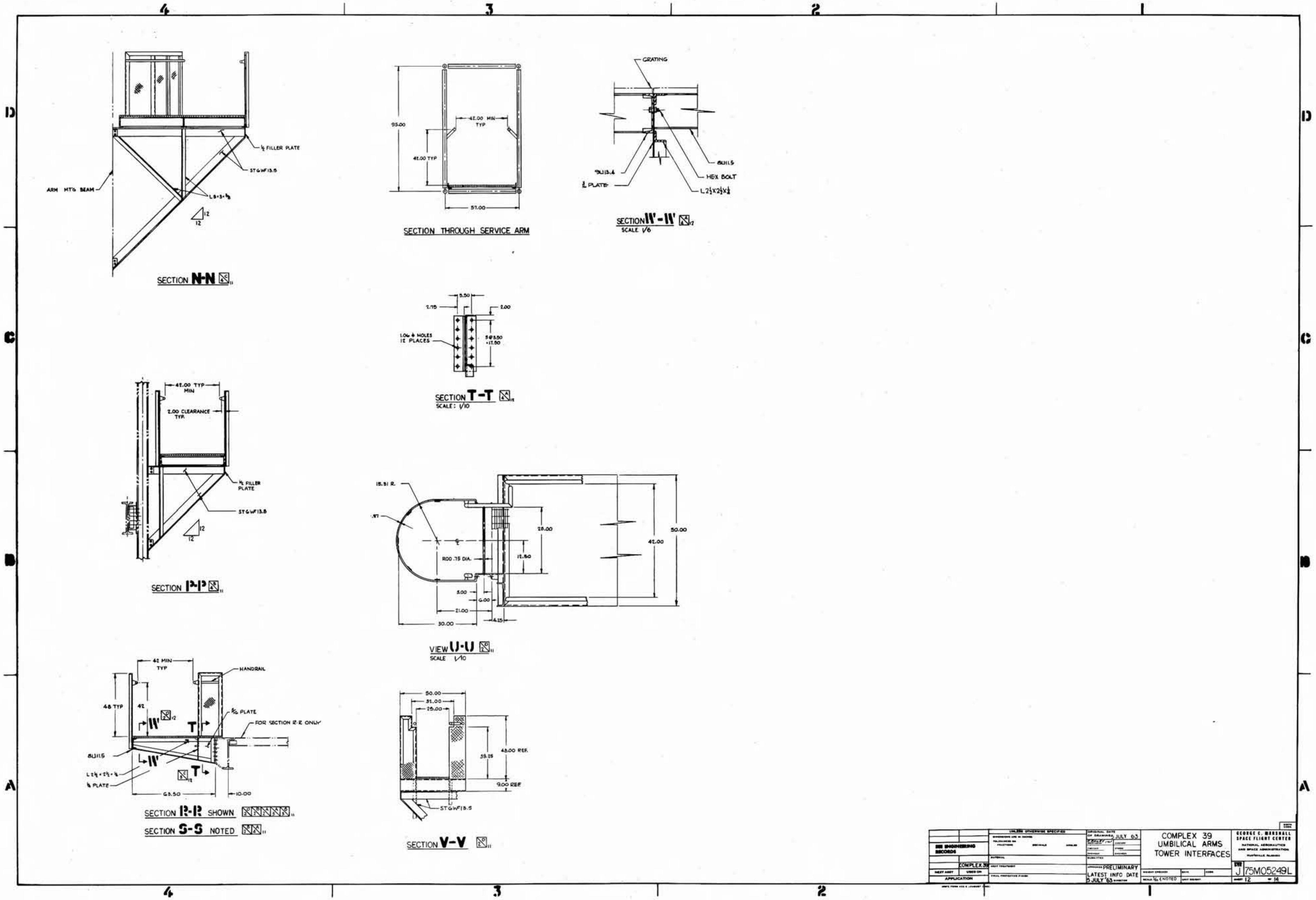


EAST ELEVATION

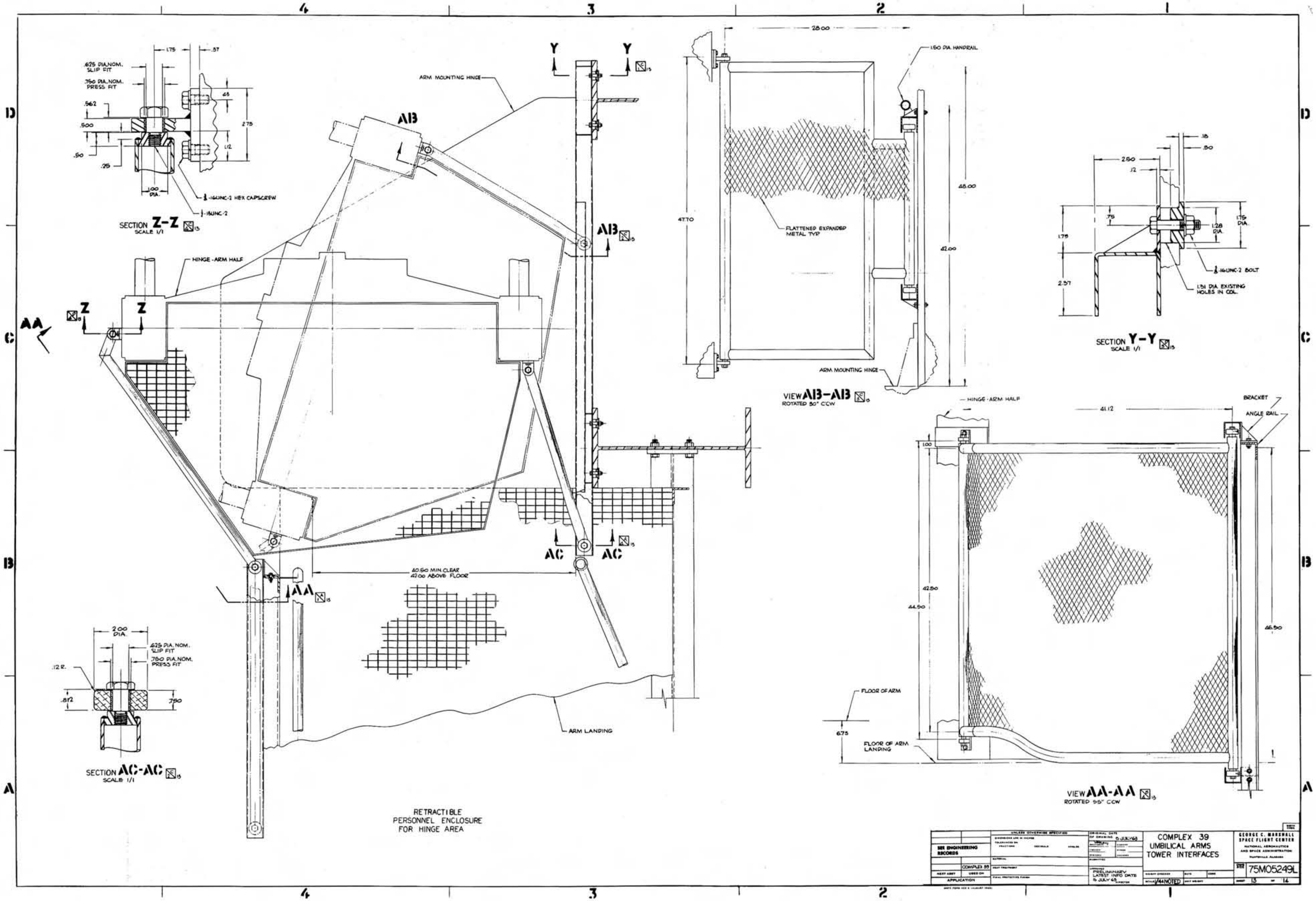
LIST OF MATERIAL			
SEE ENGINEERING RECORDS	UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON FRACTIONS DECIMALS ANGLES XX.XX ±.06 XX. ±1	ORIGINAL DATE OF DRAWING 24 JAN '63	COMPLEX 39 UMBILICAL ARMS TOWER INTERFACES
COMPLEX 39	APPROVED PRELIMINARY LATEST INFO DATE 5 JULY 63	SCALE 1/50	GEORGE C. MARSHALL SPACE FLIGHT CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE, ALABAMA
NEXT ASSY / USED ON / APPLICATION		SHEET 10 OF 14	DWG SIZE J 750M5249L



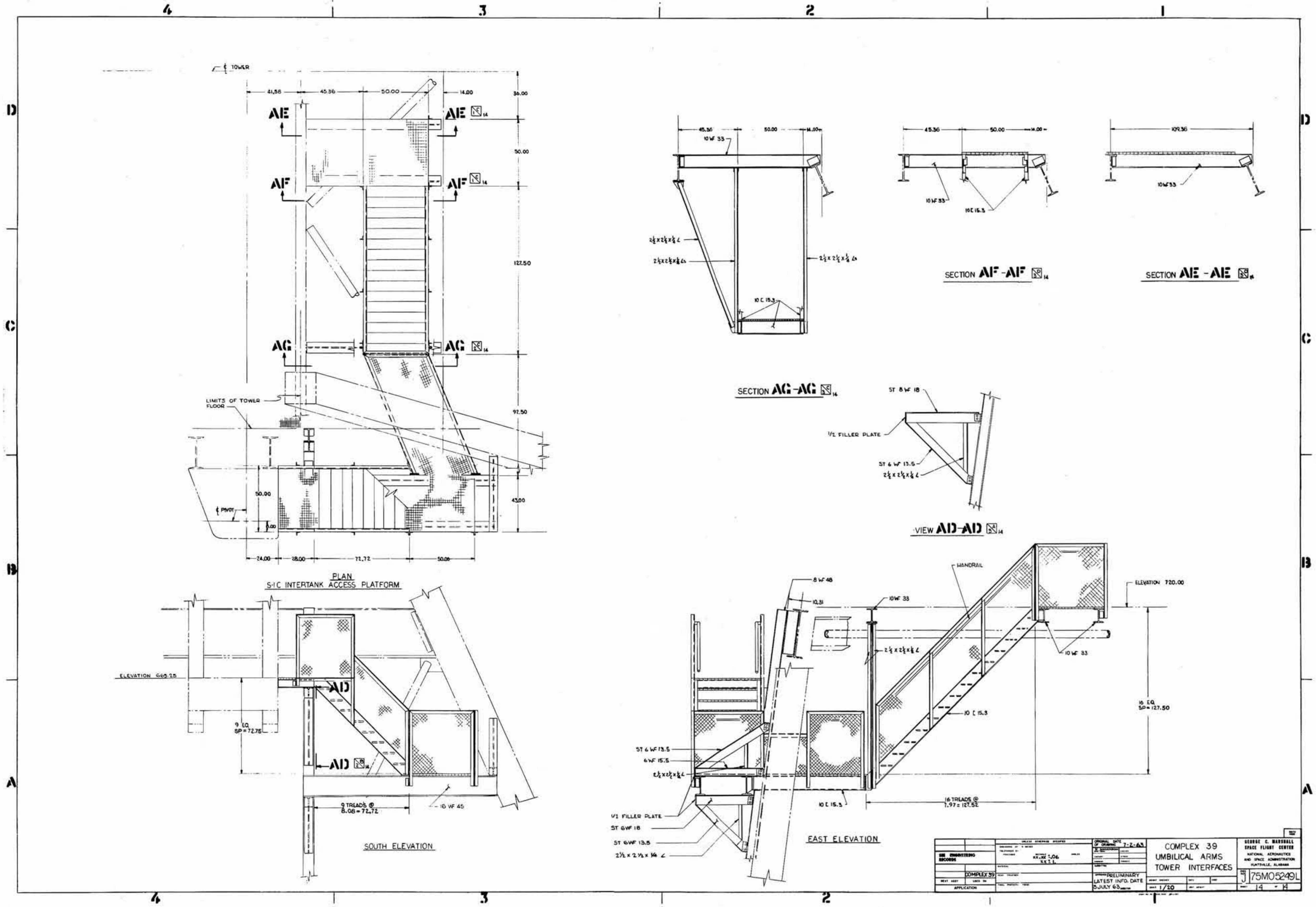
PLAN- STANDARD PLATFORM
SCALE: 1/20
ELEVATION- S-II INTERM
ELEVATION-S-II AFT
ELEVATION-SERVICE MODULE
ELEVATION-S-IV B FWD
ELEVATION-S-IC FWD
ELEVATION-S-IV B AFT
ELEVATION-S-II FWD
TOWER LANDING
ARM LANDING
TOWER LANDING EXTENSION A
TOWER LANDING EXTENSION B
COMPLEX 39
UMBILICAL ARMS
TOWER INTERFACES
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
PRELIMINARY
5 JULY '63
J 75M05249L



SECTION N-N
ARM MTG BEAM
½ FILLER PLATE
ST6WF13.5
SECTION THROUGH SERVICE ARM
95.00
42.00 MIN TYP
42.00 TYP
57.00
GRATING
SECTION W-W
SCALE 1/6
HEX BOLT
SECTION T-T
SCALE: 1/10
1.06 ⌀ HOLES 12 PLACES
SECTION P-P
42.00 TYP MIN
2.00 CLEARANCE TYP
½ FILLER PLATE
ST6WF13.5
VIEW U-U
SCALE 1/10
15.31 R.
50.00
42.00
28.00
12.50
21.00
30.00
HANDRAIL
42 MIN TYP
48 TYP
FOR SECTION R-R ONLY
63.50
10.00
SECTION R-R SHOWN
SECTION S-S NOTED
SECTION V-V
50.00
31.00
28.00
48.00 REF.
9.00 REF
ST6WF13.5
UNLESS OTHERWISE SPECIFIED
ENGINEERING RECORDS
COMPLEX 39
NEXT ASSY
USED ON
APPLICATION
MATERIAL
HEAT TREATMENT
FINAL PROTECTIVE FINISH
ORIGINAL DATE OF DRAWING 5 JULY 63
PRELIMINARY
LATEST INFO DATE 5 JULY '63
COMPLEX 39
UMBILICAL ARMS
TOWER INTERFACES
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA
J
75M05249L
SHEET 12 OF 14



SECTION Z-Z
SCALE 1/1
.625 DIA. NOM. SLIP FIT
.750 DIA. NOM. PRESS FIT
1/2-16UNC-2 HEX CAPSCREW
1/2-16UNC-2
ARM MOUNTING HINGE
HINGE-ARM HALF
FLATTENED EXPANDED METAL TYP
1.50 DIA. HANDRAIL
ARM MOUNTING HINGE
VIEW AB-AB
ROTATED 50° CCW
SECTION Y-Y
SCALE 1/1
1/2-16UNC-2 BOLT
1.31 DIA. EXISTING HOLES IN COL.
HINGE-ARM HALF
BRACKET
ANGLE RAIL
FLOOR OF ARM
FLOOR OF ARM LANDING
VIEW AA-AA
ROTATED 95° CCW
40.50 MIN. CLEAR
47.00 ABOVE FLOOR
ARM LANDING
SECTION AC-AC
SCALE 1/1
.625 DIA. NOM. SLIP FIT
.750 DIA. NOM. PRESS FIT
RETRACTIBLE
PERSONNEL ENCLOSURE
FOR HINGE AREA
SEE ENGINEERING RECORDS
COMPLEX 39
NEXT ASSY
USED ON
APPLICATION
UNLESS OTHERWISE SPECIFIED
ORIGINAL DATE OF DRAWING 5 JULY 63
PRELIMINARY
LATEST INFO DATE
5 JULY 63
COMPLEX 39
UMBILICAL ARMS
TOWER INTERFACES
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA
75M05249L
SCALE 1/4 & NOTED
SHEET 13 OF 14


PLAN
S-IC INTERTANK ACCESS PLATFORM
LIMITS OF TOWER FLOOR
SOUTH ELEVATION
ELEVATION 665.25
9 TREADS @ 8.08 = 72.72
16 WF 45
SECTION AG-AG
SECTION AF-AF
SECTION AE-AE
VIEW AD-AD
1/2 FILLER PLATE
ST 8 WF 18
ST 6 WF 13.5
EAST ELEVATION
HANDRAIL
ELEVATION 720.00
8 WF 48
10 WF 33
10 C 15.3
16 TREADS @ 7.97 = 127.52
16 EQ. SP = 127.50
ST 6WF 18
ST 6WF 13.5
COMPLEX 39
UMBILICAL ARMS
TOWER INTERFACES
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA
PRELIMINARY
LATEST INFO. DATE
5 JULY 63
7-2-63
1/20
75M05249L
14 of 14

APPENDIX E

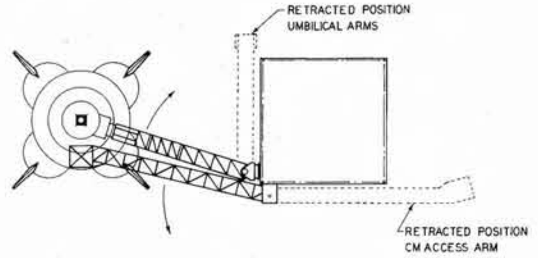
Preface

Appendix E contains drawings which show the VAB and Arming Tower Interface locations of the Service and Access Arms. The following changes, which will affect the drawings, are in progress:

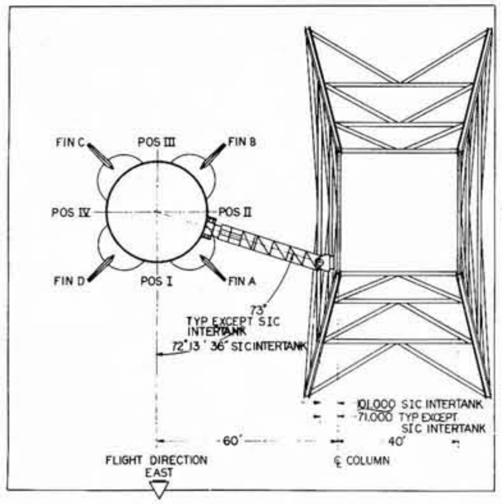
(1) Extendable service platform being added to the S-II AFT arm. Platform will provide access to S-II INTERMEDIATE umbilical carrier. This change affects sheets 2, 4, 5 and 6.

(2) Extension platform configuration on S-II INTERMEDIATE arm will be changed. This change will affect sheets 2, 4, 5 and 6.

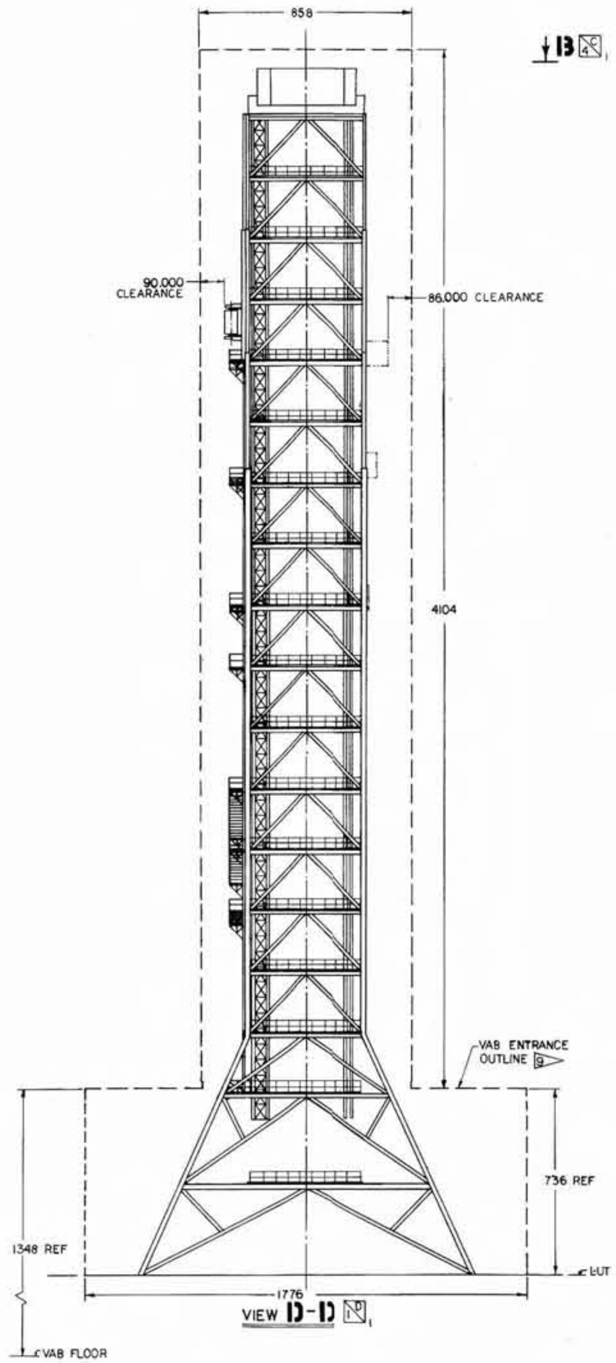
(3) General revisions to all withdrawal mechanisms for configuration changes which affect the clearance envelopes.



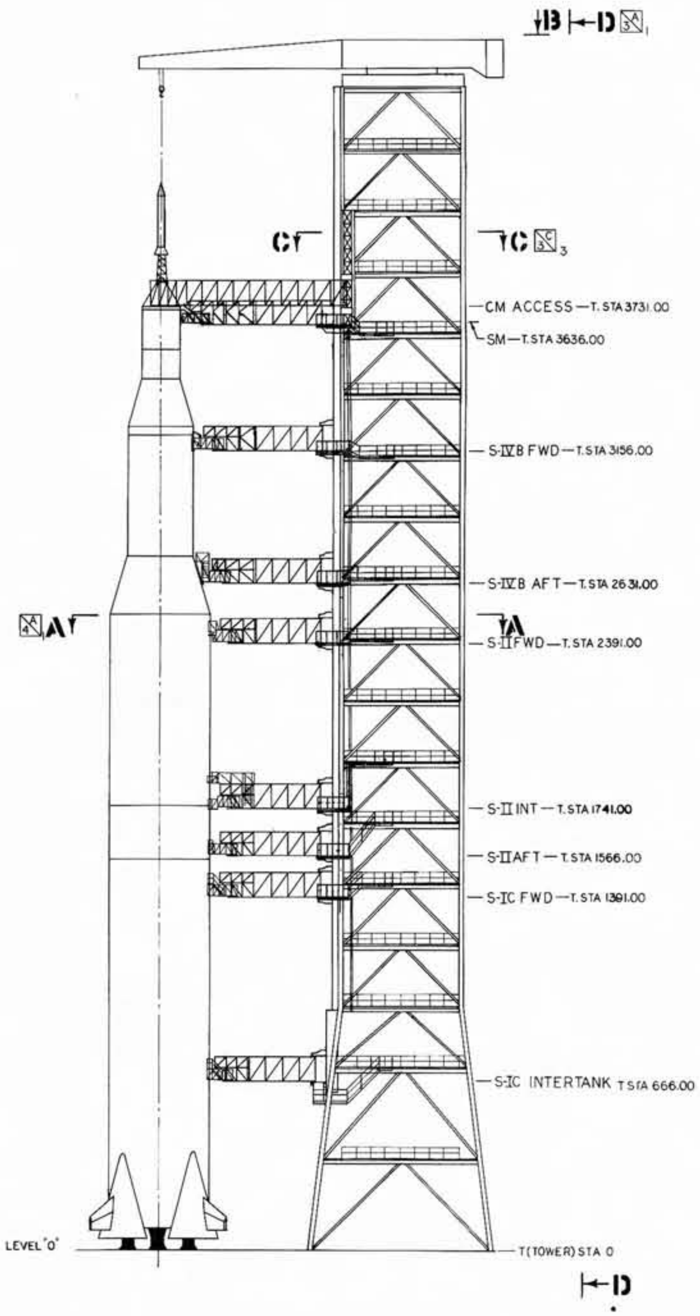
VIEW B-B
CRANE REMOVED FOR CLARITY



SECTION A-A



VIEW D-D



GROUND RULES FOR VAB OPERATIONS

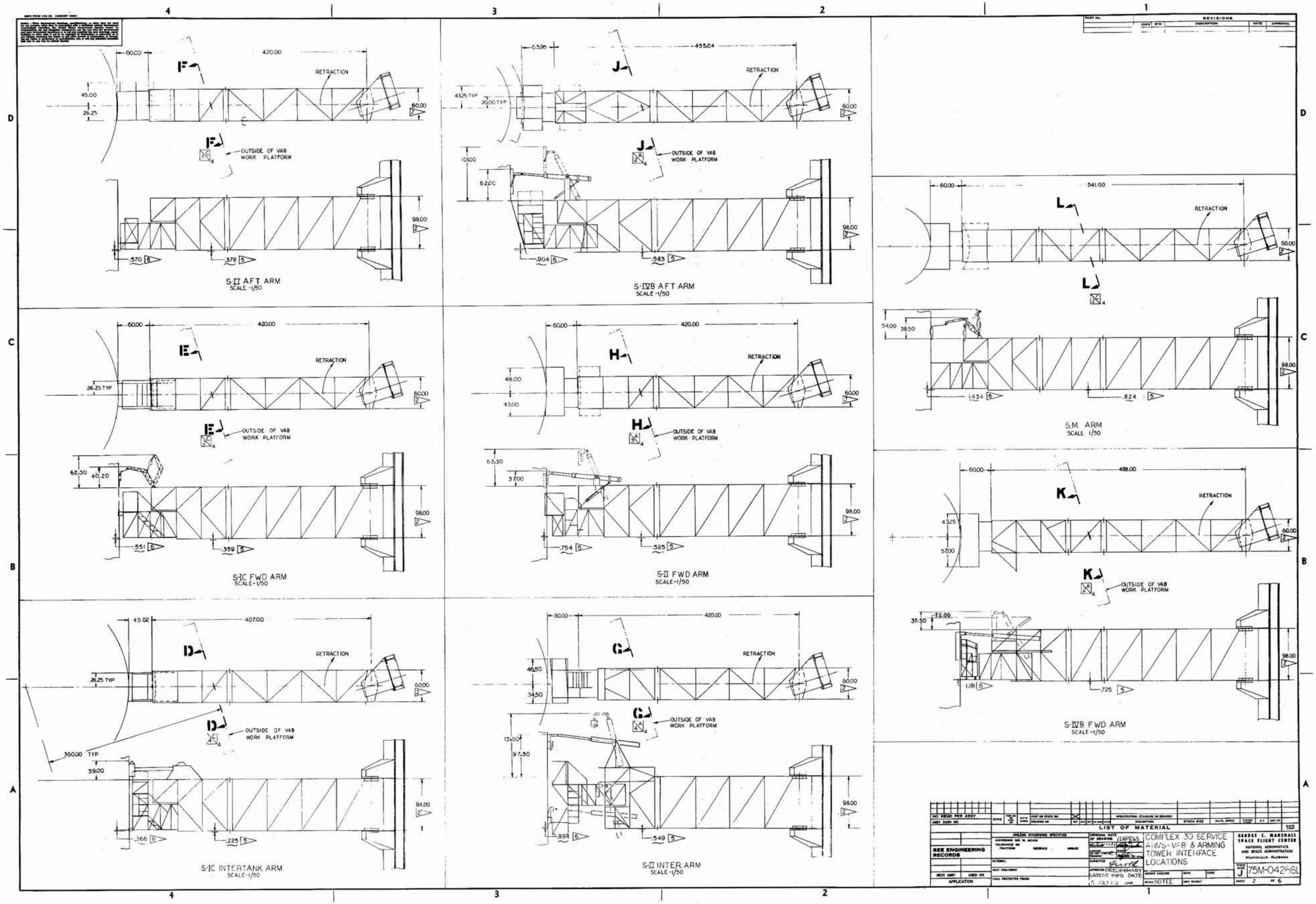
1. LUT ENTERS VAB WITH WITHDRAWAL MECHANISMS WITHDRAWN, SERVICE ARMS RETRACTED AGAINST TOWER FACE, AND CM ACCESS ARM IN EXTENDED POSITION.
2. CM ACCESS ARM IS ROTATED TO THE SIDE OF THE VAB INTERIOR TO PERMIT STAGE ASSY.
3. AS STAGES ARE ASSEMBLED (STACKED), THE RESPECTIVE SERVICE ARMS ARE EXTENDED (WITHDRAWAL MECHANISMS IN WITHDRAWN POSITION). VAB WORK PLATFORMS FOR STAGES ARE THEN POSITIONED.
4. EXTENSION OF WITHDRAWAL MECHANISMS AND CONNECTION OF UMBILICALS IS ACCOMPLISHED FROM VAB WORK PLATFORMS.
5. SERVICE ARM EXTENSION PLATFORMS WILL NOT BE USED IN VAB EXCEPT FOR ALIGNMENT.
6. UMBILICAL DISCONNECT, WITHDRAWAL, AND ARM RETRACTION WILL HAVE COMPLETE FUNCTIONAL TESTS PERFORMED WITHIN VAB.
7. IF CM ACCESS ARM IS TO BE TESTED IN VAB, ITS ROTATION WILL BE LIMITED TO SPACE AVAILABLE.
8. CM ACCESS ARM WILL BE ROTATED TO THE RETRACTED POSITION AFTER REMOVAL FROM THE VAB AND PRIOR TO TRANSPORTING TO THE FIRING SITE.

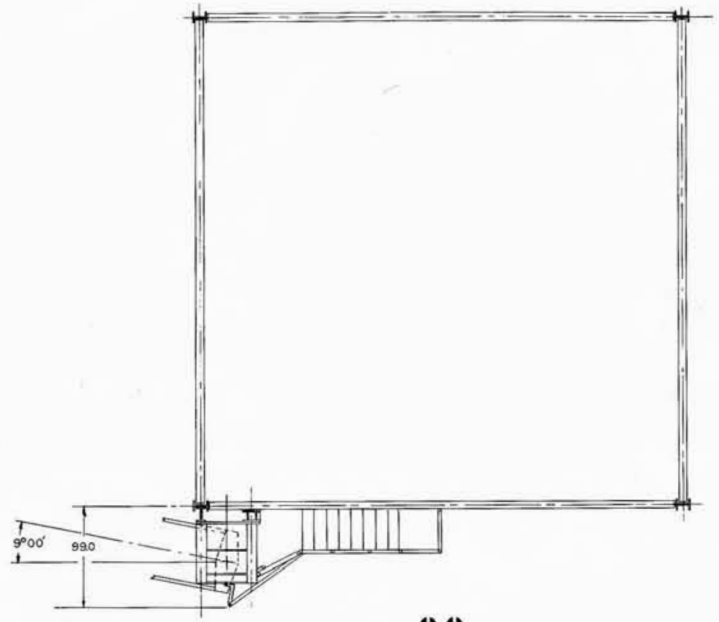
GROUND RULES FOR ARMING TOWER OPERATIONS

WHEN THE LUT IS PREPARED FOR THE ARMING TOWER THE FOLLOWING CONDITIONS ARE APPLICABLE:
1. SERVICE ARMS ARE EXTENDED AND LOCKED, CM ACCESS ARM IS RETRACTED AND LOCKED.
2. EXTENSION PLATFORMS ARE RETRACTED AND LOCKED.
3. WITHDRAWAL MECHANISMS ARE EXTENDED AND ALL UMBILICALS ARE CONNECTED TO THE VEHICLE.

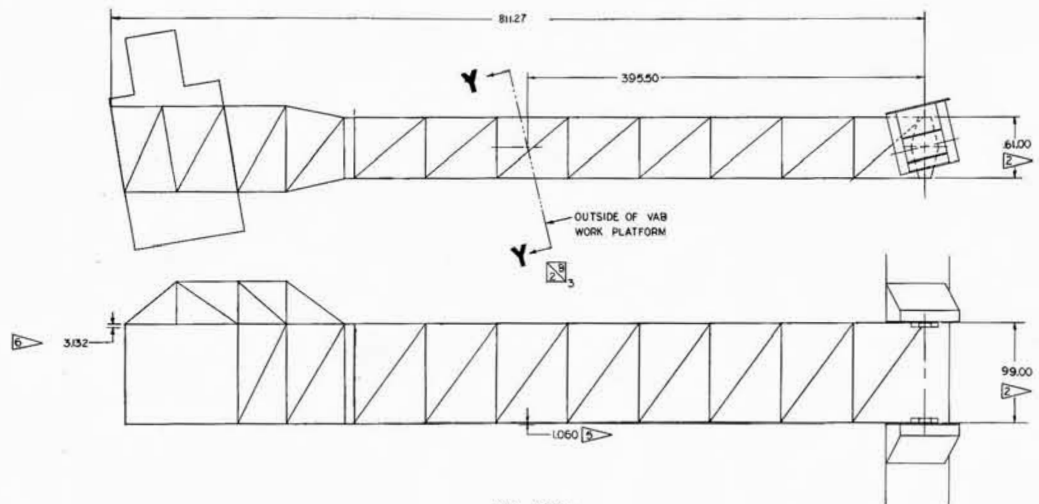
NOTES:
1. T. (TOWER) STATIONS SHOWN FOR ARMS ARE THE ELEVATIONS AT THE OUTSIDE OF THE LOWER CHORDS. FLOORS OF STANDARD T-HEAD ACCESS AREAS ARE 17.750 ABOVE THESE ELEVATIONS.
2. THESE ARE OUTSIDE UMBILICAL ARM DIMENSIONS.
3. ALL SECTIONS SHOWN ON SHEET 4 ARE ROTATED 107° CW.
4. INCOMPLETE-DESIGN FOR PRELIMINARY CONFIGURATION IS IN PROGRESS.
5. MAX. DEFLECTION AT INTERSECTION OF ARM ℄ AND OUTSIDE OF VAB WORK PLATFORM.
6. MAX. DEFLECTION AT VEHICLE END OF EXTENSION PLATFORM.
7. MAX. DEFLECTION AT VEHICLE END OF ARM.
8. ARMING TOWER DIMENSIONS AND CONFIGURATIONS SCALED FROM DWGS NO 1-6, 1-7, 1-8, "CRITERIA FOR ARMING TOWER COMPLEX 39-NASA-LOC DATED 28-MAR-63.
9. VAB ENTRANCE DIMENSIONS OBTAINED FROM URSAM SK-LYO-75 DATED 4-MAR-63.
10. DESIGN HOLD FOR S-II INTERMEDIATE

SEE ENGINEERING RECORDS	ORIGINAL DATE OF DRAWING 14 SEPT 62	COMPLEX 39 SERVICE ARMS - VAB AND ARMING TOWER INTERFACE LOCATION
APPLICATION	PRELIMINARY; LATEST INFO DATE 3 JULY 63	SCALE 1/200 NOTED
GEORGE C. MARSHALL SPACE FLIGHT CENTER, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, HUNTSVILLE, ALABAMA	J 75M-04266L	SHEET 1 OF 6

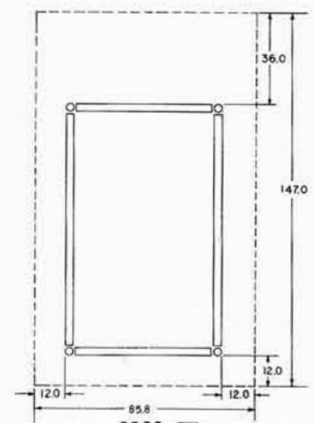

S-II AFT ARM
SCALE -1/50
S-IVB AFT ARM
SCALE -1/50
S-IC FWD ARM
SCALE -1/50
S-II FWD ARM
SCALE -1/50
S-IC INTERTANK ARM
SCALE -1/50
S-II INTER ARM
SCALE -1/50
S.M. ARM
SCALE 1/50
S-IVB FWD ARM
SCALE -1/50
RETRACTION
OUTSIDE OF VAB WORK PLATFORM
LIST OF MATERIAL
SEE ENGINEERING RECORDS
COMPLEX 39 SERVICE ARMS-VAB & ARMING TOWER INTERFACE LOCATIONS
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA
PRELIMINARY
LATEST INFO DATE
SCALE NOTED
75M-04266L
SHEET 2 OF 6



SECT C-C
SCALE -1/50



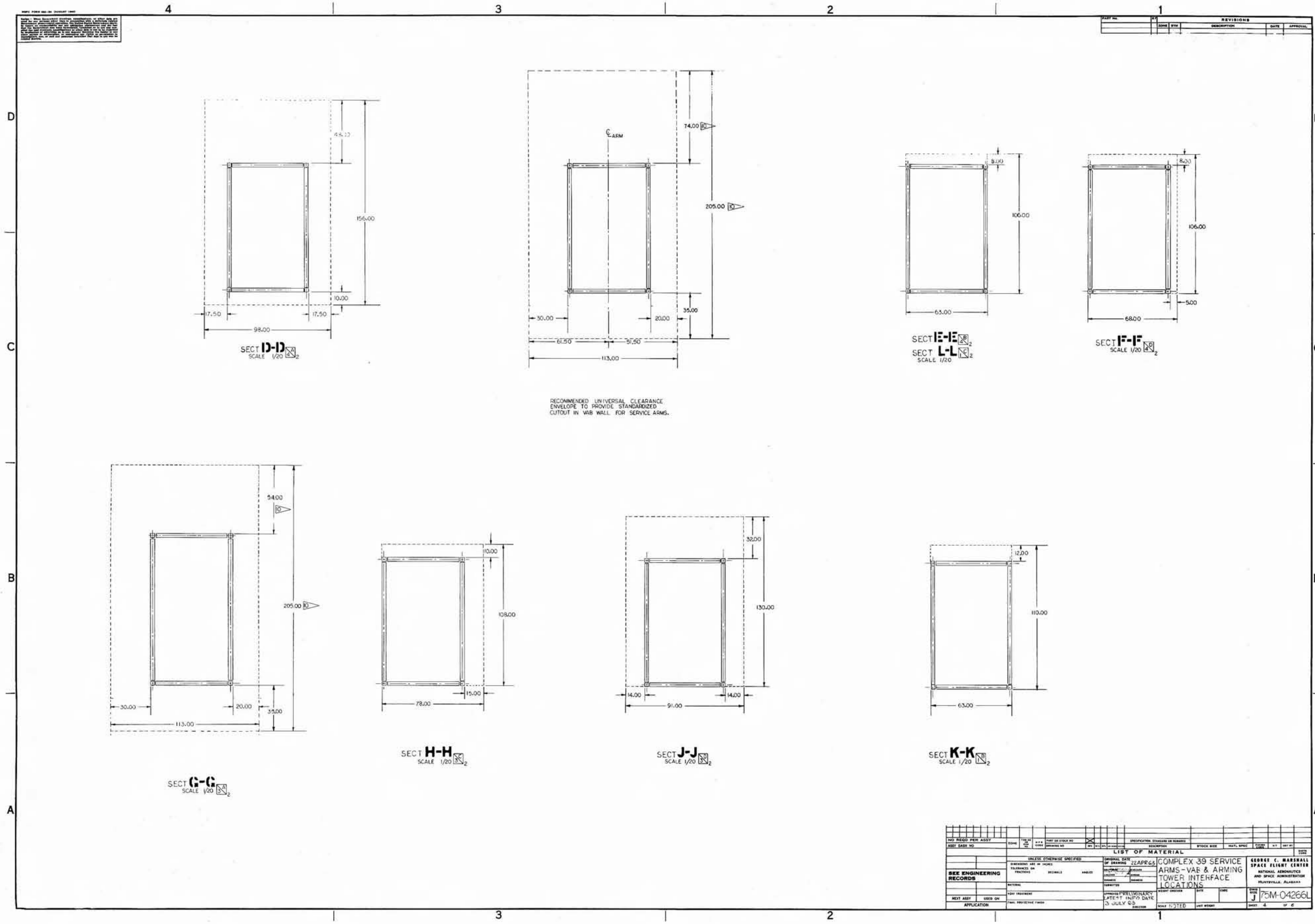
C.M. ARM
SCALE -1/50

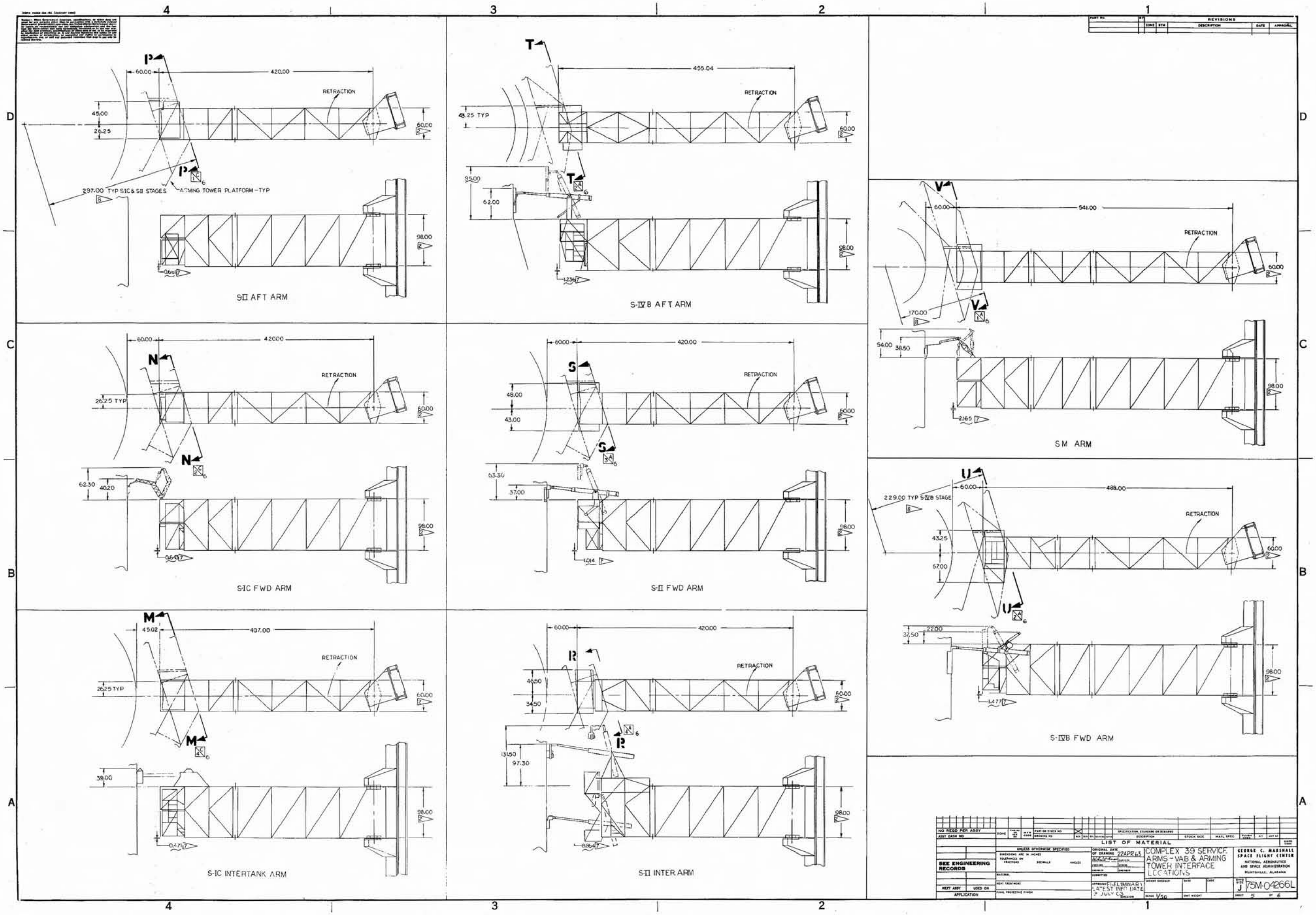


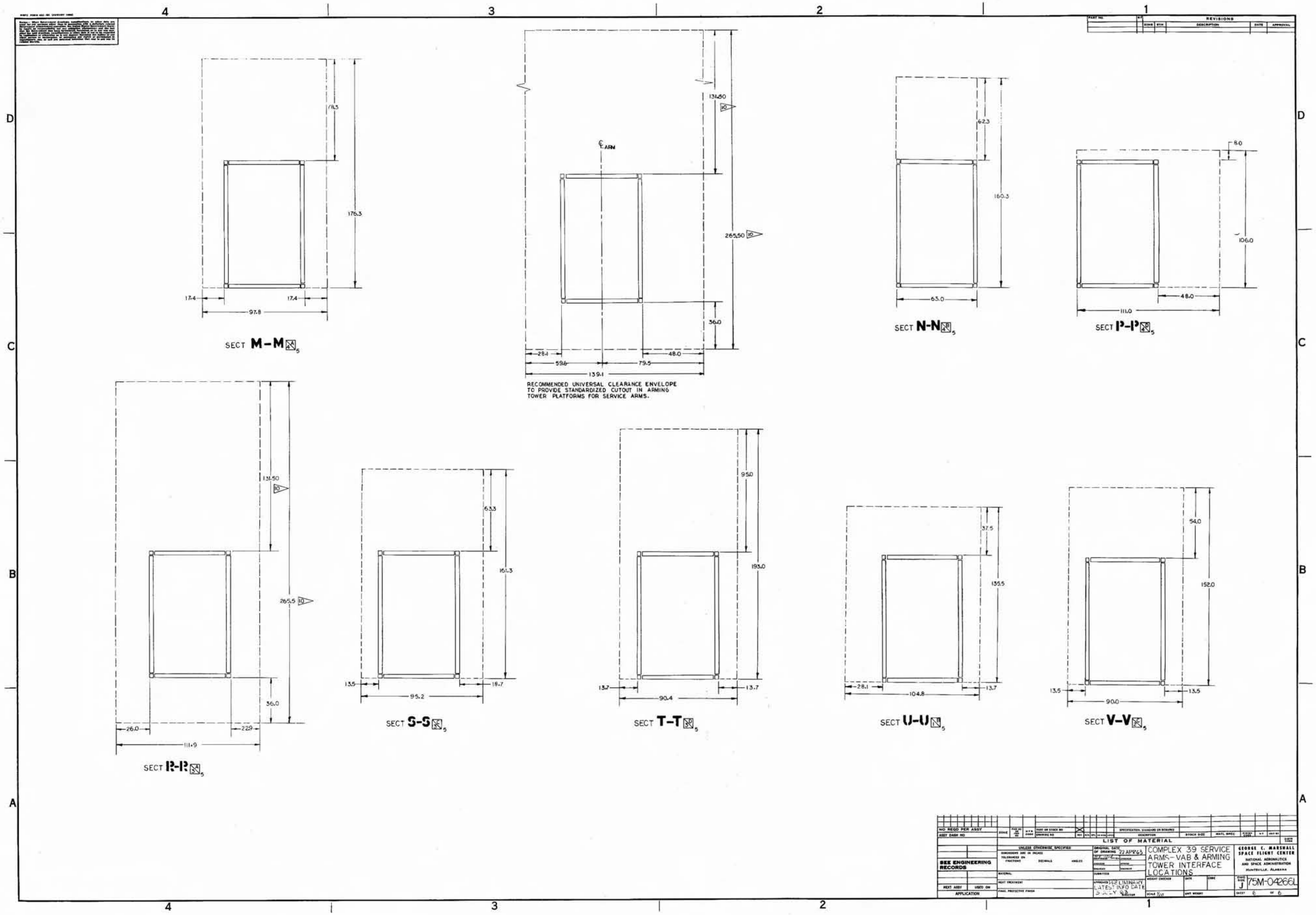
SECT. Y-Y

LIST OF MATERIAL		
ORIGINAL DATE OF DRAWING 22APR.63	COMPLEX 39 SERVICE ARMS-VAB & ARMING TOWER INTERFACE LOCATIONS	GEORGE C. MARSHALL SPACE FLIGHT CENTER NATIONAL AERONAUTICS AND SPACE ADMINISTRATION HUNTSVILLE, ALABAMA
APPROVED PRELIMINARY LATEST INFO DATE 3 JULY 63	SCALE NOTED	DWG SIZE J 75M-04266L SHEET 3

SEE ENGINEERING RECORDS


SECT D-D
SCALE 1/20
46.00
156.00
10.00
17.50
17.50
98.00
C ARM
74.00
205.00
30.00
20.00
35.00
61.50
51.50
113.00
RECOMMENDED UNIVERSAL CLEARANCE ENVELOPE TO PROVIDE STANDARDIZED CUTOUT IN VAB WALL FOR SERVICE ARMS.
SECT E-E
SECT L-L
SCALE 1/20
8.00
106.00
63.00
SECT F-F
SCALE 1/20
8.00
106.00
5.00
68.00
SECT G-G
SCALE 1/20
54.00
205.00
30.00
20.00
35.00
113.00
SECT H-H
SCALE 1/20
10.00
108.00
15.00
78.00
SECT J-J
SCALE 1/20
32.00
130.00
14.00
91.00
14.00
SECT K-K
SCALE 1/20
12.00
110.00
63.00
REVISIONS
LIST OF MATERIAL
SEE ENGINEERING RECORDS
NEXT ASSY
USED ON
APPLICATION
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
ORIGINAL DATE OF DRAWING 22APR63
PRELIMINARY
LATEST INFO DATE 3 JULY 63
COMPLEX 39 SERVICE ARMS-VAB & ARMING TOWER INTERFACE LOCATIONS
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA
J
75M-04266L
SCALE NOTED
SHEET 4 OF 6


S-II AFT ARM
S-IVB AFT ARM
SM ARM
S-IC FWD ARM
S-II FWD ARM
S-IVB FWD ARM
S-IC INTERTANK ARM
S-II INTER ARM
RETRACTION
297.00 TYP S-IC & S-II STAGES
ARMING TOWER PLATFORM - TYP
229.00 TYP S-IVB STAGE
43.25 TYP
26.25 TYP
420.00
455.04
541.00
488.00
407.00
60.00
98.00
LIST OF MATERIAL
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
SEE ENGINEERING RECORDS
ORIGINAL DATE OF DRAWING 22APR63
PRELIMINARY LATEST INFO DATE 3 JULY 63
COMPLEX 39 SERVICE ARMS - VAB & ARMING TOWER INTERFACE LOCATIONS
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA
J 75M-04266L
SCALE 1/50
SHEET 5 OF 6

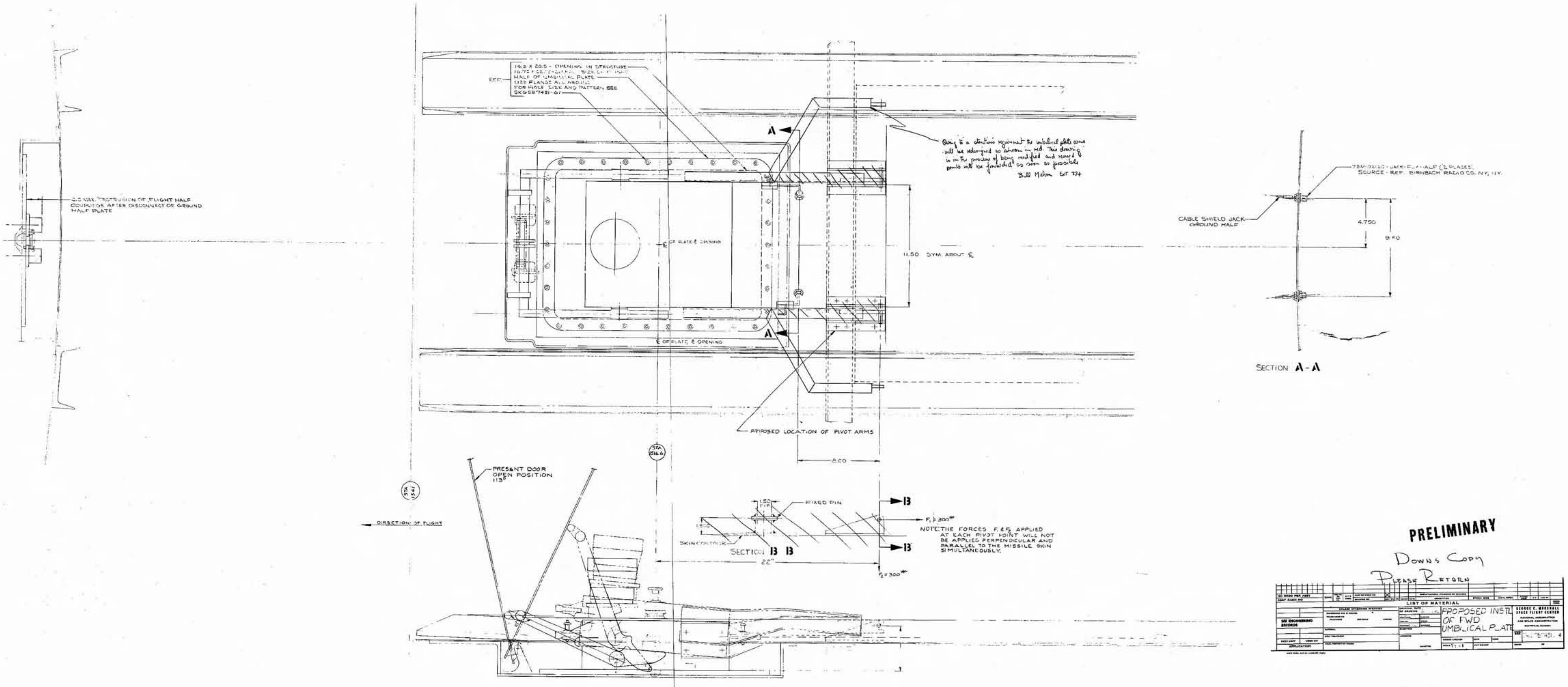


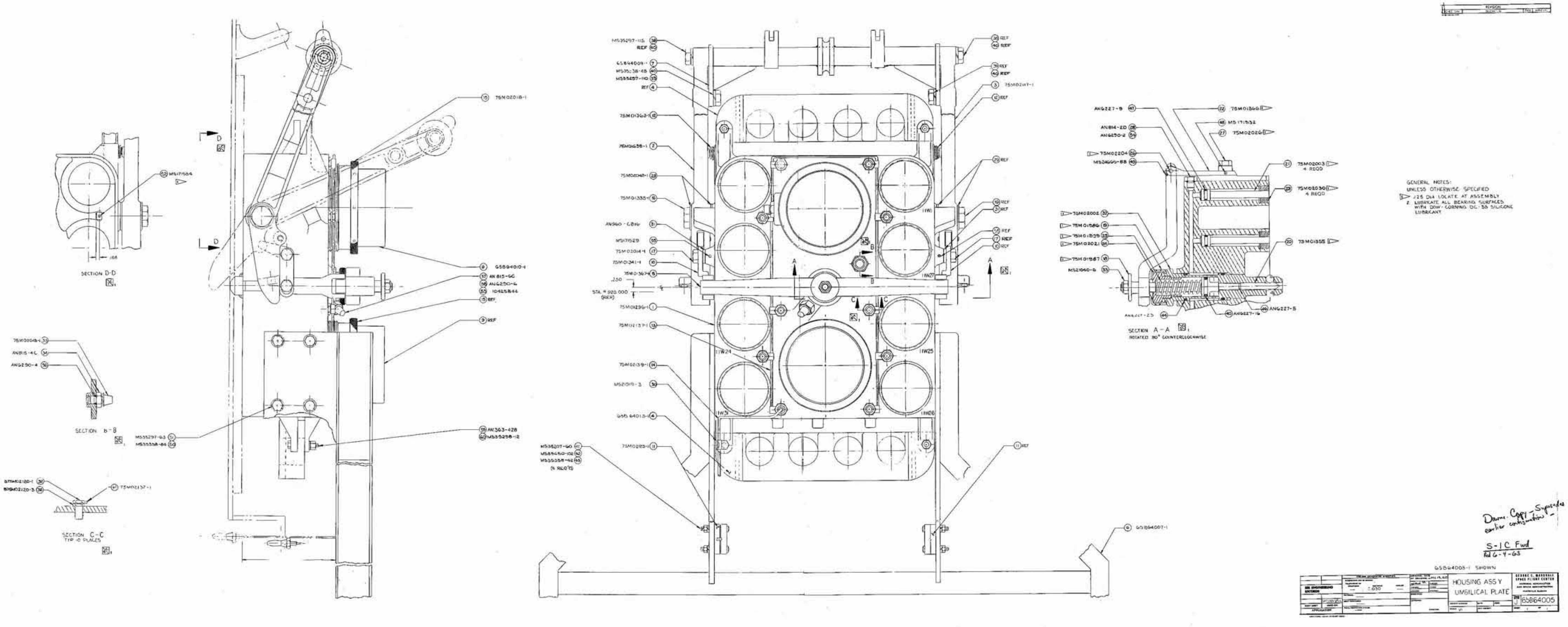
SECT M-M
SECT N-N
SECT P-P
SECT R-R
SECT S-S
SECT T-T
SECT U-U
SECT V-V
RECOMMENDED UNIVERSAL CLEARANCE ENVELOPE TO PROVIDE STANDARDIZED CUTOUT IN ARMING TOWER PLATFORMS FOR SERVICE ARMS.
LIST OF MATERIAL
SEE ENGINEERING RECORDS
COMPLEX 39 SERVICE ARMS-VAB & ARMING TOWER INTERFACE LOCATIONS
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA
PRELIMINARY
J 75M-04266L

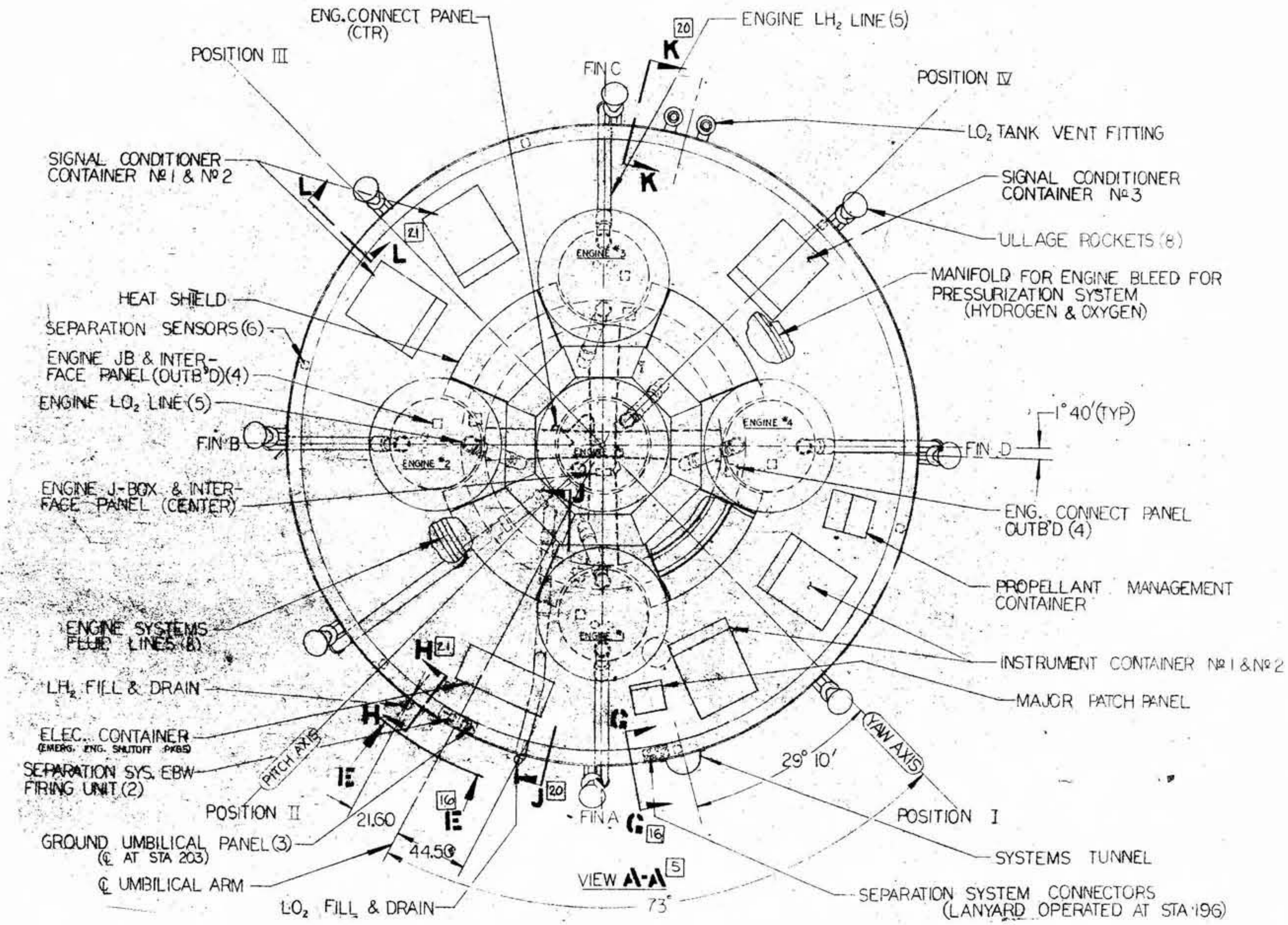
APPENDIX F

Preface

Appendix F contains information which has been received from the various stage contractors. The design of all service arms up until July 10, 1963, has been based upon the information provided on drawings presented on pages F-1 through F-63. Future design will be based upon drawings received after that date. Pages F-64 through F-69 indicate such drawings that have been received after July 10, 1963, and up until publication closing time July 22, 1963. The recently received drawings are recognized to contain information that dictates changes that must be made to designs displayed in this preliminary engineering report.


14.5 X 20.5 - OPENING IN STRUCTURE
HALF OF UMBILICAL PLATE
FLANGE ALL AROUND
FOR HOLE SIZE AND PATTERN SEE
SKG58-7431-67
REF.
A
Owing to a structural requirement the umbilical plate area will be redesigned as shown in red. This drawing is in the process of being modified and revised points will be forwarded as soon as possible
Bill Melon Ext 774
11.50 SYM. ABOUT ℄
℄ OF PLATE & OPENING
PROPOSED LOCATION OF PIVOT ARMS
8.00
CABLE SHIELD JACK-GROUND HALF
SOURCE - REF. BIRNBACH RADIO CO. NY, N.Y.
4.750
9.50
SECTION A-A
DIRECTION OF FLIGHT
PRESENT DOOR OPEN POSITION 113°
STA 1516.6
FIXED PIN
SKIN CONTOUR
SECTION B B
22"
B
NOTE: THE FORCES F1 & F2 APPLIED AT EACH PIVOT POINT WILL NOT BE APPLIED PERPENDICULAR AND PARALLEL TO THE MISSILE SKIN SIMULTANEOUSLY.
PRELIMINARY
Downs Copy
Please Return
LIST OF MATERIAL
SEE ENGINEERING RECORDS
APPLICATION
PROPOSED INSTL OF FWD UMBILICAL PLATE
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION


SECTION D-D
SECTION B-B
SECTION C-C
TYP 10 PLACES
SECTION A-A
ROTATED 90° COUNTERCLOCKWISE
GENERAL NOTES:
UNLESS OTHERWISE SPECIFIED
1 .125 DIA LOCATE AT ASSEMBLY
2. LUBRICATE ALL BEARING SURFACES WITH DOW-CORNING DC-55 SILICONE LUBRICANT
65B64005-1 SHOWN
HOUSING ASS'Y
UMBILICAL PLATE
GEORGE C. MARSHALL SPACE FLIGHT CENTER
J 65B64005
Dawn. Copy - Supersedes earlier configuration -
S-IC Fwd
Rd 6-4-63



REVISIONS

ZONE		DESCRIPTION	DATE / APPROVED
		1. MAY BE REWORKED 3. RECORD CHANGE 2. CANNOT BE REWORKED 4. NOW SHOP PRACTICE 5. PARTS MADE OK	
A		1. 5 ENGINE VERSION (WAS) 4 ENGINE VERSION	R. MANUBAG 30 JAN 62
		1. REVISED AND REDRAWN	[illegible]
		1. RELOCATED: [illegible] SYSTEMS TUNNEL, LOX [illegible]	
	4	2. ENGINE THRUST RING WIDTH: 15.00 (WAS) 30.00	
	6,8	3. REDESIGNED LOX AND LH_2 DIFFUSERS	
	6	4. RELOCATED: LH_2 EMERGENCY SHUTOFF VALVE	
	6	5. RELOCATED SEP. JOINT: STA 196 (WAS) STA 186	
	10	6. REDESIGNED AND RELOCATED: ANTENNA, FWD BLACK BOXES, LH_2 VENT FITTING AND PRESS. LINES	
	10	7. RELOCATED FWD ACCESS DOOR	
		8. FOR C8 AND C9 SEE SHEET 2	R. MANUBAG 19 AUG 62
	4	10. REDESIGNED HEAT SHIELD	
	4D	11. REMOVED RETRO ROCKETS	
	6	12. ADD SLOSH BAFFLES TO LOX TANK	
	12	13. ADD GN_2 PURGE SYSTEM IN SECTION C-C	
	3	14. RELOCATED ULLAGE ROCKETS	
D	5 & 4	1. LOCATED ULLAGE ROCKETS RADIALLY AND STATIONWISE.	
	5	2. LOCATED SYSTEMS TUNNEL RADIALLY AND STATIONWISE.	
	4	3. LOCATED LO_2 & LH_2 FILL & DRAIN VALVES RADIALLY AND STATIONWISE.	
	5	4. ADDED DUAL PLANE SEPARATION TRAJECTORIES.	
	7	5. ADDED 396 DIA DIM	
	11 & 15	6. ADDED S-IC BKHD (REF)	
	11	7. LOCATED FWD ACCESS DOOR RADIALLY AND STATIONWISE	
	11	8. LOCATED AFT ACCESS DOOR RADIALLY AND STATIONWISE	R. MANUBAG 15 JAN 63
	11, 12, 13	9. LOCATED GN_2 PURGE & CHILLDOWN SYS. RADIALLY AND STATIONWISE.	

OBSOLETE

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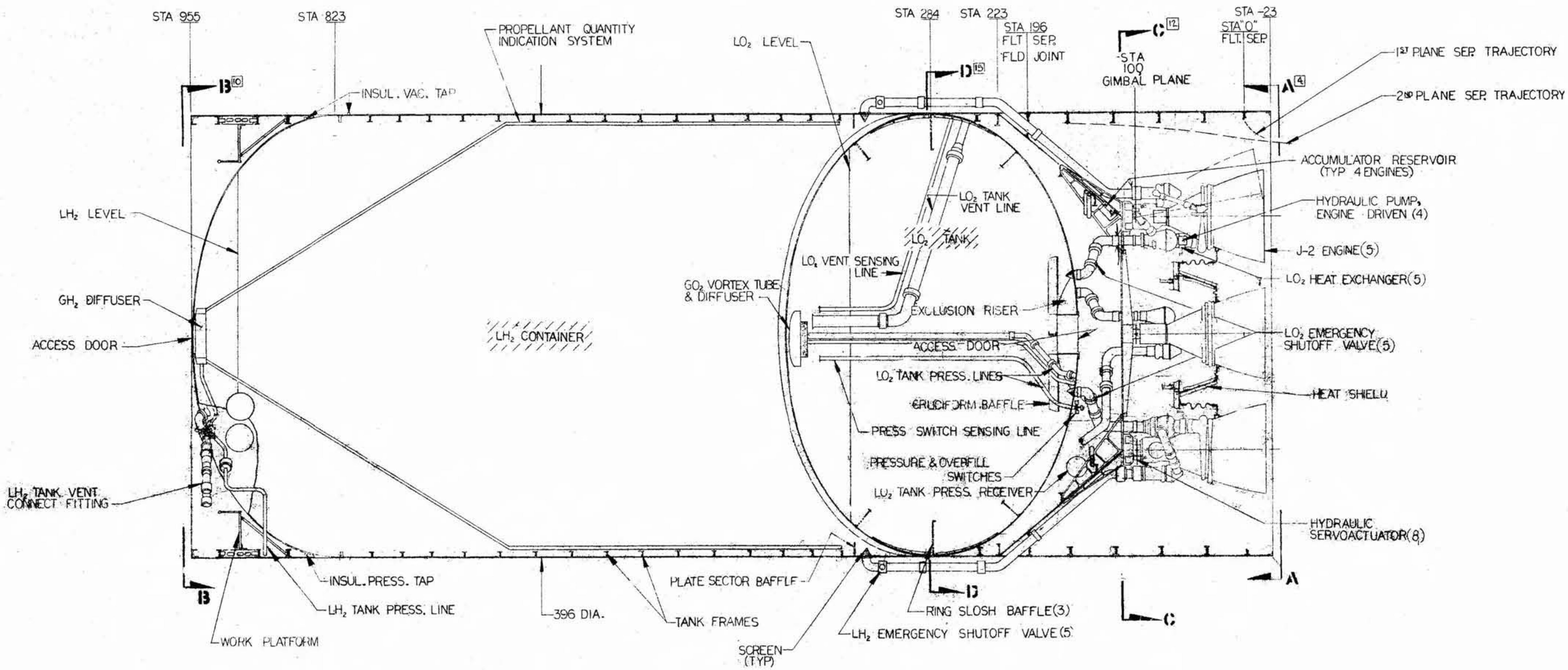
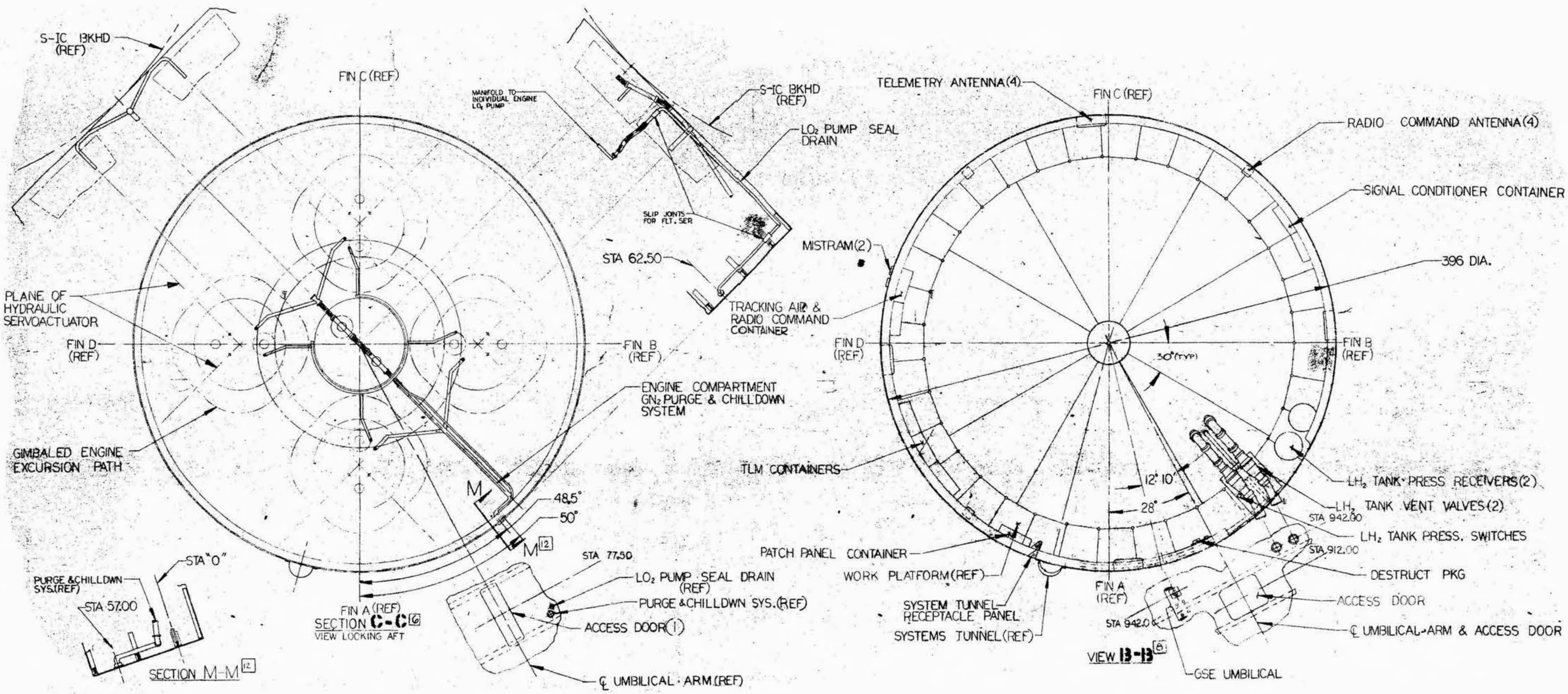
Please Return

RECEIVED FEB 7 1963 M-MS-AD

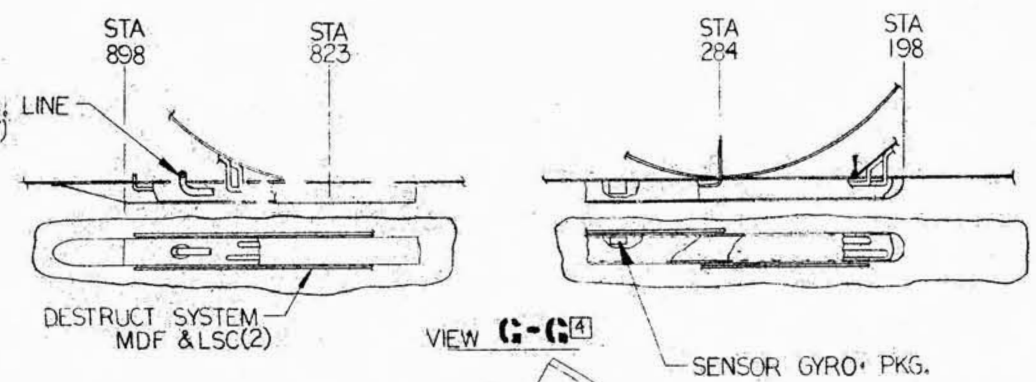
NASA S-II CONTROL DRAWING PHASE I REV. D

HEAT TREAT	
FINISH	
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ON: DECIMALS .XX = ± .03, .XXX = ± .010; ANGLES ± 30'. HOLES NOTED "DRILL": .013 THRU .040 +.001 −.001; .041 THRU .130 +.002 −.001; .131 THRU .220 +.003 −.001; .221 THRU .500 +.004 −.001; .501 THRU .750 +.005 −.001; .751 THRU 1.000 +.007 −.001; 1.001 THRU 2.000 +.010 −.001	DO NOT SCALE PRINT
DR BY	FAUGHNDER 11-5-61
CHK BY	
APPROVED BY	
NORTH AMERICAN AVIATION, INC. SPACE and INFORMATION SYSTEMS DIVISION 12214 LAKEWOOD BLVD., DOWNEY, CALIFORNIA	
TITLE	INBOARD PROFILE (V7-1)
CODE IDENT NO.	03953
DRAWING NO.	V7-000003
ITEM / QTY REQD PER END ITEM / MODEL / NEXT USING DRAWING / END ITEM NO. THRU EFFECTIVE ON	APPLICATION (USAGE) DATA

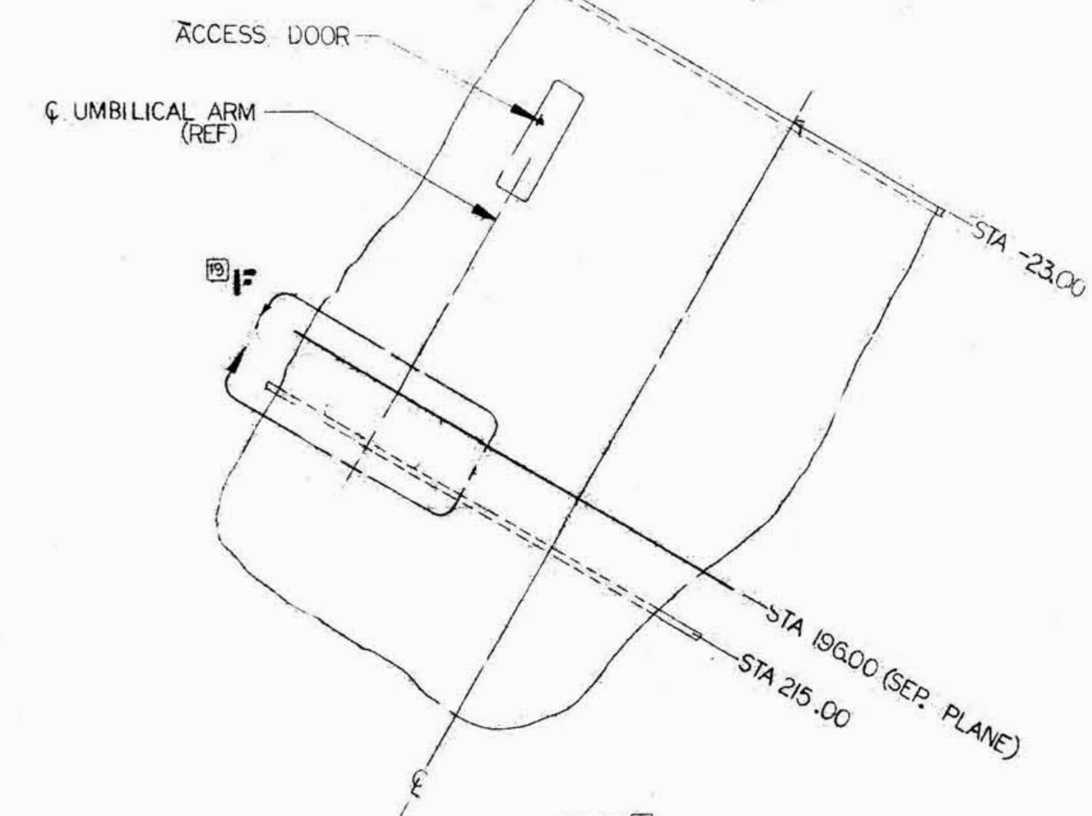

STA 955
STA 823
PROPELLANT QUANTITY INDICATION SYSTEM
INSUL. VAC. TAP
LO2 LEVEL
STA 284
STA 223
STA 196
FLT SEP.
FLD JOINT
STA 100
GIMBAL PLANE
STA -23
STA "0"
FLT. SEP.
1ST PLANE SEP. TRAJECTORY
2ND PLANE SEP. TRAJECTORY
ACCUMULATOR RESERVOIR (TYP 4 ENGINES)
HYDRAULIC PUMP, ENGINE DRIVEN (4)
J-2 ENGINE (5)
LO2 HEAT EXCHANGER (5)
LO2 EMERGENCY SHUTOFF VALVE (5)
HEAT SHIELD
HYDRAULIC SERVOACTUATOR (8)
LH2 LEVEL
GH2 DIFFUSER
ACCESS DOOR
LH2 TANK VENT CONNECT FITTING
LH2 CONTAINER
LO2 TANK VENT LINE
LO2 TANK
LO2 VENT SENSING LINE
GO2 VORTEX TUBE & DIFFUSER
EXCLUSION RISER
ACCESS DOOR
LO2 TANK PRESS. LINES
CRUCIFORM BAFFLE
PRESS SWITCH SENSING LINE
PRESSURE & OVERFILL SWITCHES
LO2 TANK PRESS. RECEIVER
INSUL. PRESS. TAP
LH2 TANK PRESS. LINE
WORK PLATFORM
396 DIA.
TANK FRAMES
PLATE SECTOR BAFFLE
SCREEN (TYP)
RING SLOSH BAFFLE (3)
LH2 EMERGENCY SHUTOFF VALVE (5)


S-IC BKHD (REF)
FIN C (REF)
MANIFOLD TO INDIVIDUAL ENGINE LO2 PUMP
S-IC BKHD (REF)
LO2 PUMP SEAL DRAIN
SLIP JOINTS FOR FLT. SER.
STA 62.50
TRACKING AIR & RADIO COMMAND CONTAINER
PLANE OF HYDRAULIC SERVOACTUATOR
FIN D (REF)
FIN B (REF)
ENGINE COMPARTMENT GN2 PURGE & CHILLDOWN SYSTEM
GIMBALED ENGINE EXCURSION PATH
M
48.5°
50°
M 12
STA "O"
PURGE & CHILLDWN SYS.(REF)
STA 57.00
SECTION M-M 12
FIN A (REF)
SECTION C-C 6
VIEW LOOKING AFT
STA 77.50
LO2 PUMP SEAL DRAIN (REF)
PURGE & CHILLDWN SYS. (REF)
ACCESS DOOR (1)
℄ UMBILICAL ARM (REF)
TELEMETRY ANTENNA (4)
FIN C (REF)
RADIO COMMAND ANTENNA (4)
SIGNAL CONDITIONER CONTAINER
MISTRAM (2)
396 DIA.
FIN D (REF)
FIN B (REF)
30° (TYP)
TLM CONTAINERS
12° 10'
28°
LH2 TANK PRESS RECEIVERS (2)
LH2 TANK VENT VALVES (2)
STA 942.00
LH2 TANK PRESS. SWITCHES
PATCH PANEL CONTAINER
STA 912.00
WORK PLATFORM (REF)
DESTRUCT PKG
SYSTEM TUNNEL RECEPTACLE PANEL
FIN A (REF)
ACCESS DOOR
STA 942.00
SYSTEMS TUNNEL (REF)
℄ UMBILICAL ARM & ACCESS DOOR
VIEW B-B 6
GSE UMBILICAL

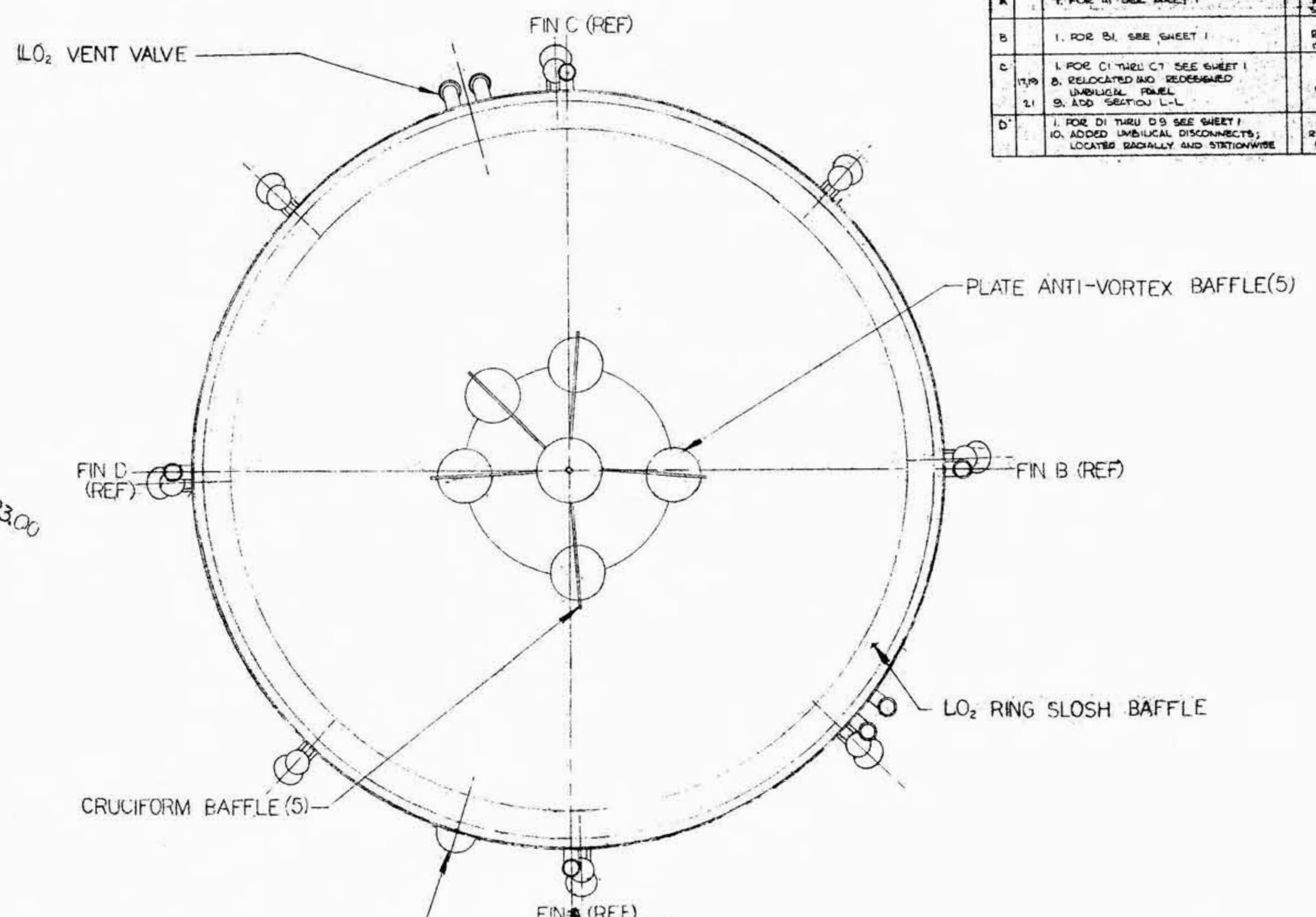
ZONE		DESCRIPTION	DATE
		1. MAY BE REWORKED 3. RECORD CHANGE 2. CANNOT BE REWORKED 4. NOW SHOP PRACTICE	
A		1. FOR A1 SEE SHEET 1	R. [illegible] 30 JAN 62
B		1. FOR B1 SEE SHEET 1	R. [illegible] 17 APR 62
C	17,19 21	1. FOR C1 THRU C7 SEE SHEET 1 8. RELOCATED AND REDESIGNED UMBILICAL PANEL 9. ADD SECTION L-L	R. [illegible] 11 JUL 62
D		1. FOR D1 THRU D9 SEE SHEET 1 10. ADDED UMBILICAL DISCONNECTS; LOCATED RADIALLY AND STATIONWISE	R. [illegible] 16 JAN 63



VIEW G-G [4]

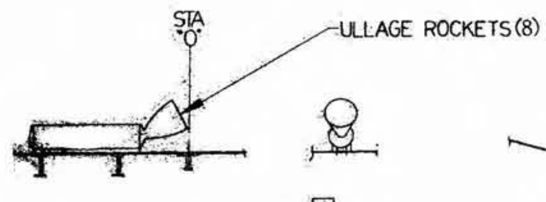


VIEW E-E [4]

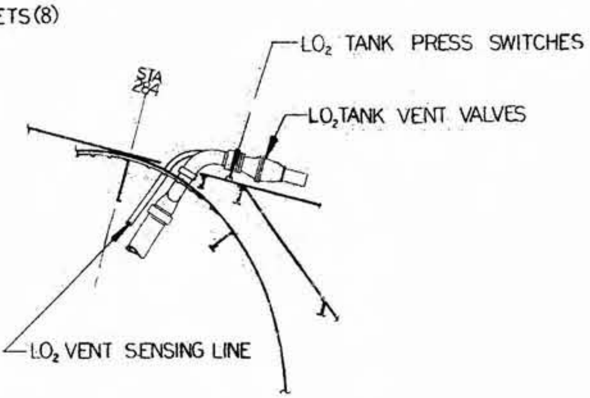


SECTION D-D [6]
VIEW LOOKING AFT

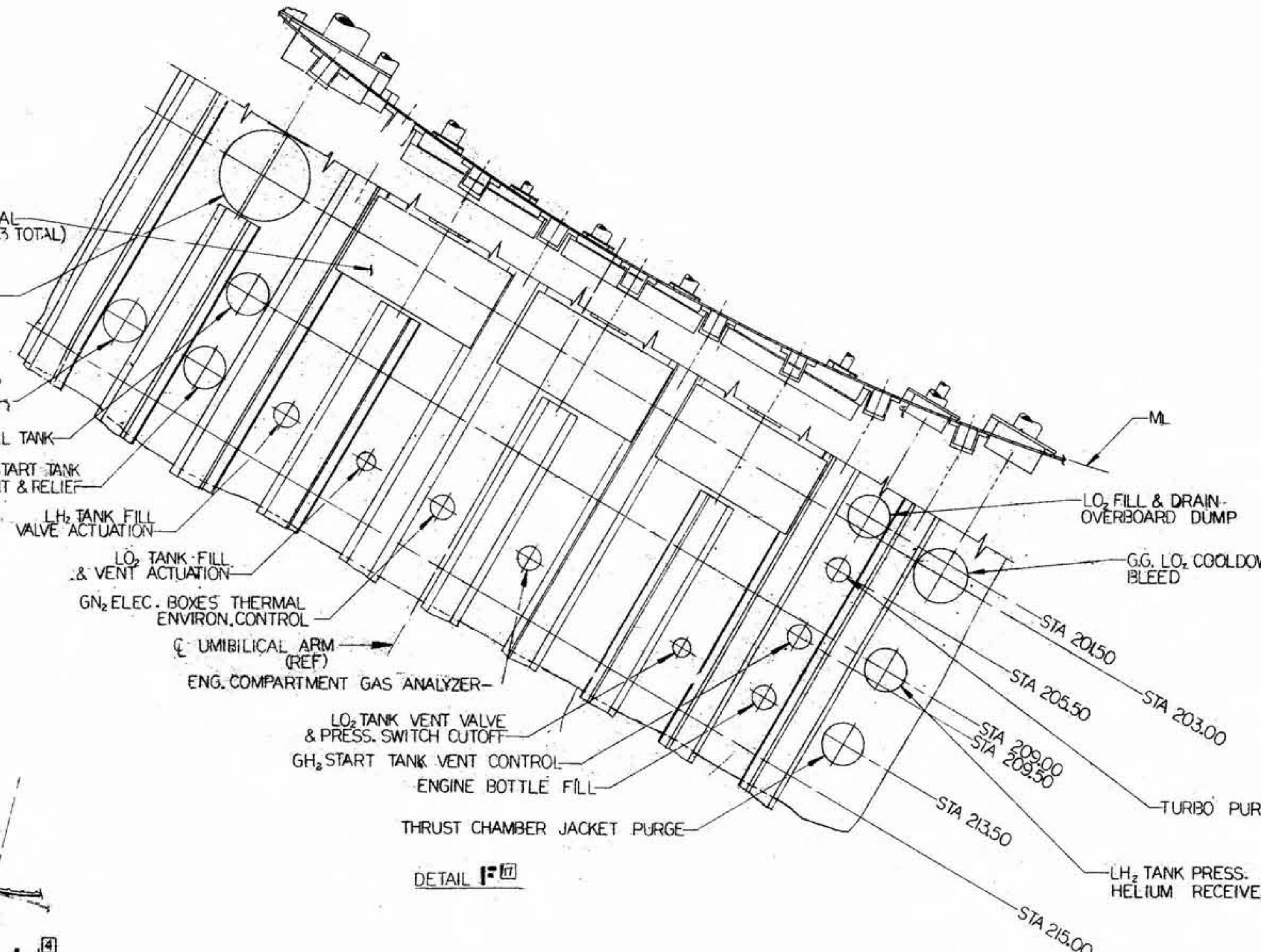
DOWNEY, CALIFORNIA
V7-000003



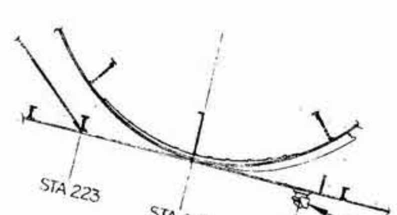
SECTION L-L [4]
(ROTATED HORIZONTALLY)



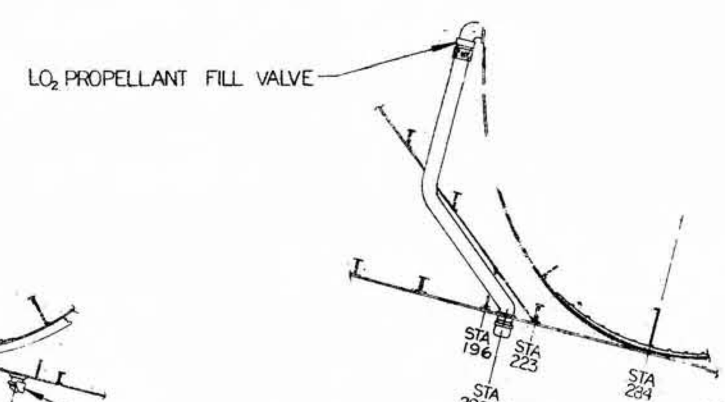
SECTION K-K [5]



DETAIL F [17]



SECTION H-H [4]



SECTION J-J [4]

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Rec'd 7-15-63 R.H.

Rcd 7-12-63

SATURN C-5 STAGE II GSE

UMBILICAL SERVICE REQUIREMENTS

15 November 1962

UMBILICAL ARM NO. 4

Revised

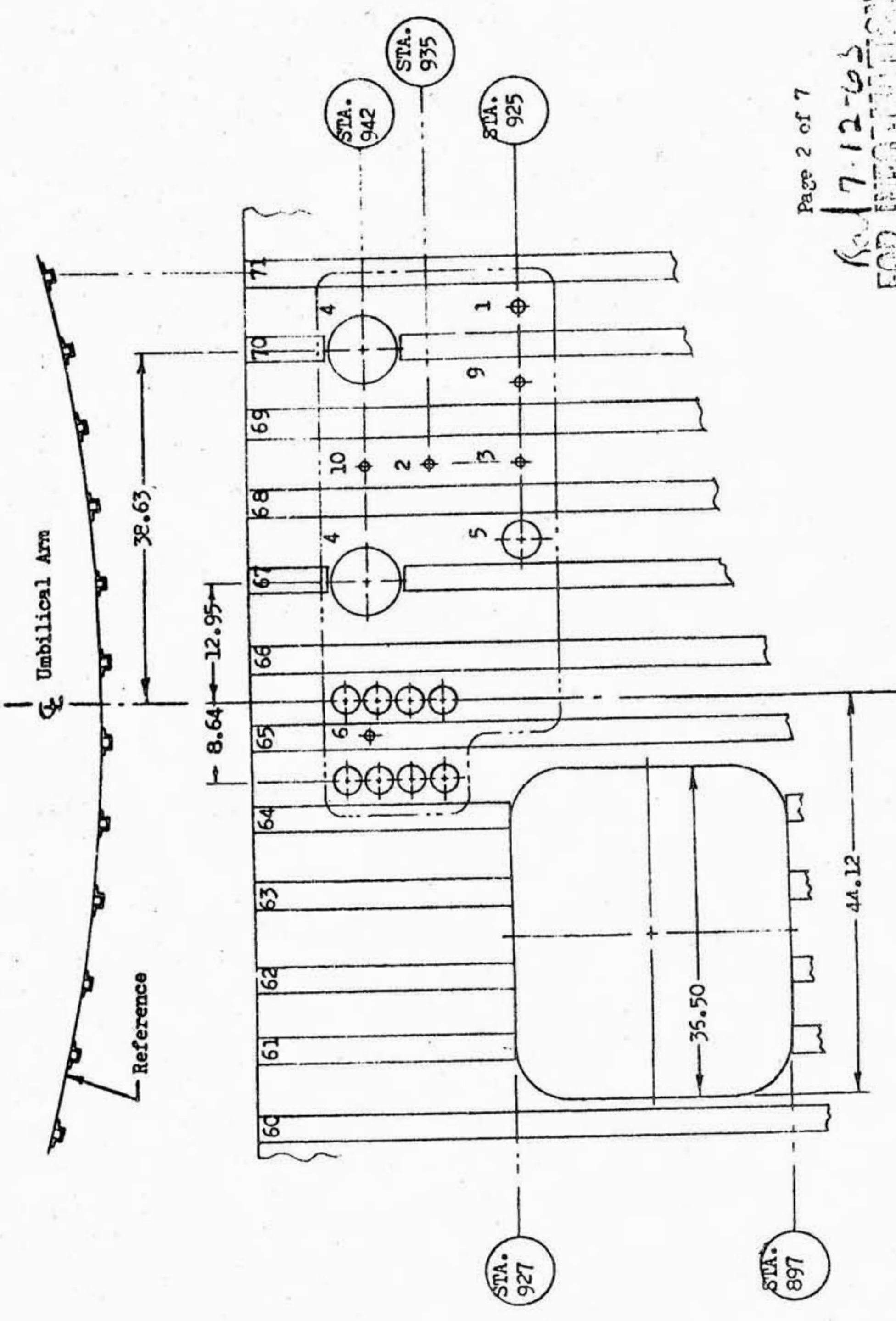
15 January 1963
1 March 1963
1 April 1963
15 June 1963

	DISCONNECT SIZE	MAX. PRESS. PSIG	MEDIUM	SPEC. NO.
1. LH_2 Tank He Pre-Press & Receiver Press.	1"	3250	He	MC273-0013
2. LH_2 Tank Press. Switch & Vent Valve C/O	1/2	22	He	MC144-0010
3. LH_2 Tank Vent Valve Actuation	1/2	750	He	MC144-0010
4. LH_2 Tank Vent Valve Disconnect (2)	7	22	GH_2	MC273-0017
5. Electrical Equipment Purge	4	2	GN_2	MC273-0016
6. Electrical Disconnect Purge	1/2 (1)	2	He	
7.				
8.				
9. Press. System Press. Reg. Checkout	1/2	1000	GN_2	MC144-0010
10. GSE Actuation	1/2 (1)	750	GN_2	

(1) To Umbilical Plate Only

FOR INFORMATION ONLY

UMBILICAL ARM NO. 4 LOCATION OF DISCONNECTS



Page 2 of 7

7-12-63

FOR INFORMATION ONLY

UMBILICAL ARM NO. 3-A

		Disconnect Size	Max. Press. Psig.	Medium	Spec. No.
1.	LH_2 Fill and Drain	8	132	LH_2	MC144-0005
2.	LO_2 Fill and Drain	8	132	LO_2	MC144-0005
3.	LO_2 Tank Fill & Vent Valve Actuation	1/2	750	He	MC144-0010
4.	LO_2 Tank Vent Valve & Press. Switch C/O	1/2	37	He	MC144-0010
5.					
6.	Turbo Purge	1/2	100	He	MC144-0010
7.	GH_2 Start Tank Vent Control	1/2	500	He	MC144-0010
8.	Engine Helium Bottle Fill	1/2	3200	He	MC144-0010
9.	LO_2 Tank He Pre.-Press & Receiver Press	1"	3250	He	MC273-0013
10.	GH_2 Start Tank Fill	1"	1300	GH_2	MC144-0011
11.	LH_2 Pump Seal Drain	1"	130	LH_2/GH_2	MC144-0011
12.	GH_2 Start Tank Vent and Relief	1"	1300	GH_2	MC144-0011
13.	Thrust Chamber Jacket Purge	1"	750	He	MC144-0011
14..	LO_2 Recirculation He Bubbling	1	400	He	MC144-0011
15.	LO_2 Fill & Drain Overboard Dump	1	132	LO_2/He	MC144-0011
16.	GG LO_2 Cool Down Bleed	2	35	LO_2/GO_2	MC144-0014
17.	Recirculation Pneum. Control System	1	3250	He	MC273-0013
18.	Electrical Equipment Purge	2.25 x 5.81	2	GN_2	
19.	Electrical Disconnect Purge	1/2 (1)	2	He	
20.	GH_2 Pressurization Systems Purge	1/2	750	He	MC144-0010
21.					
22.					
23.	Press. Syst. Press. Reg. Checkout	1/2	1000	GN_2	MC144-0010
24.	Recirculation Press. Reg. Checkout	1/2	1000	GN_2	MC144-0010

Rcd 7-12-63

FOR INFORMATION ONLY

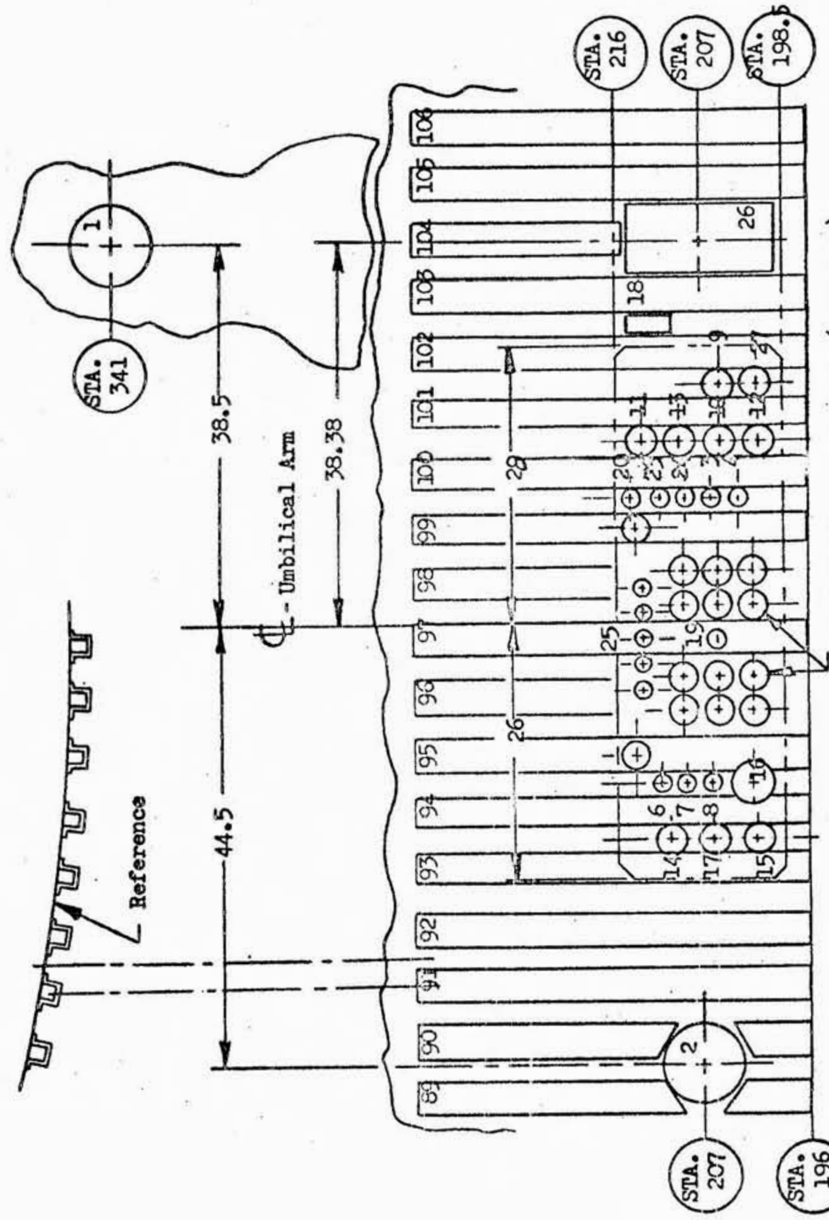
UMBILICAL ARM NO. 3-A

	Disconnect Size	Max. Press. Psig.	Medium	Spec. No.
25. GSE Actuation	1/2 (1)	750	GN_2	
26. Engine Compartment Purge	8 X 17	2.5	GN_2	
27. Recirc. LH_2 Ret. Line Purge Bleed	1	50	GH_2/GN_2	MC144-0011

(1) To Umbilical Plate Only

Rcd 7-12-63
FOR INFORMATION ONLY

UMBILICAL ARM NO. 3A LOCATION OF DISCONNECTS



Page 5 of 7

Rcd 7-12-63
FOR INFORMATION ONLY

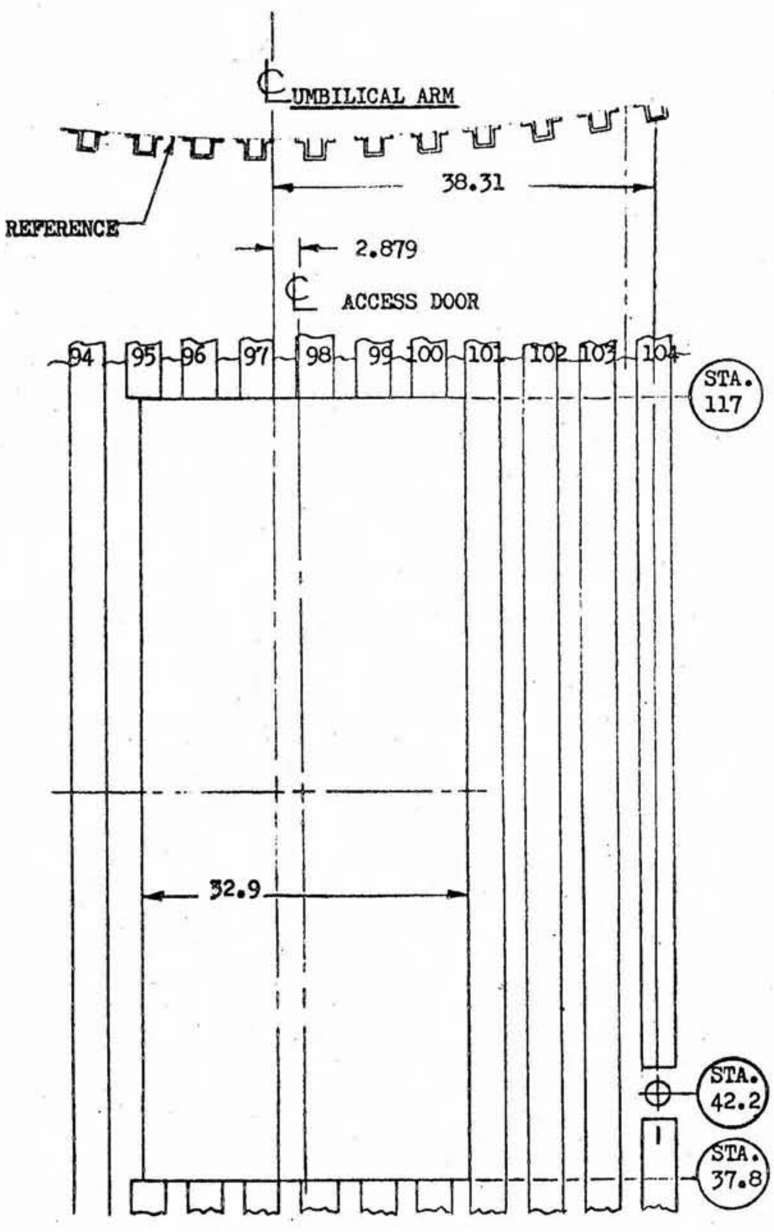
UMBILICAL ARM NO. 3 ACCESS ARM

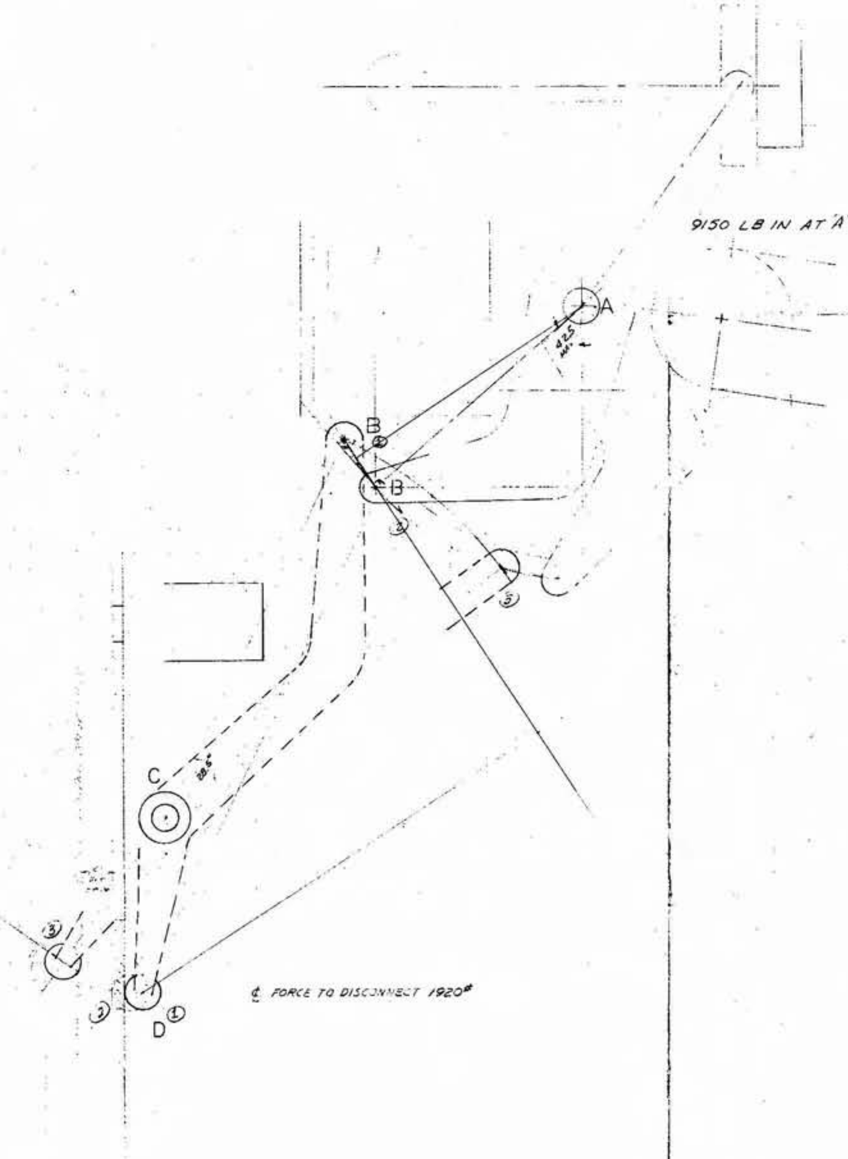
	Disconnect Size	Max. Press. Psig	Medium	Spec. No.
1. LO_2 Pump Seal Drain	2"	5	LO_2/GO_2	MC144-0014

Rcd 7-12-63
FOR INFORMATION ONLY

Rcd 7-12-63

UMBILICAL ARM NO. 3 (ACCESS ARM)





36 DISCONNECTS { 12 ELECTRICAL DISCONNECTS / 24 PNEUMATIC DISCONNECTS

FORCE REQD TO DISCONNECT

ELECT @ 60# EA = 720#
PNEU @ 50# EA = 1200#
BALL LOCK @ 25# EA: 50#

TOTAL FORCE REQD 1970#

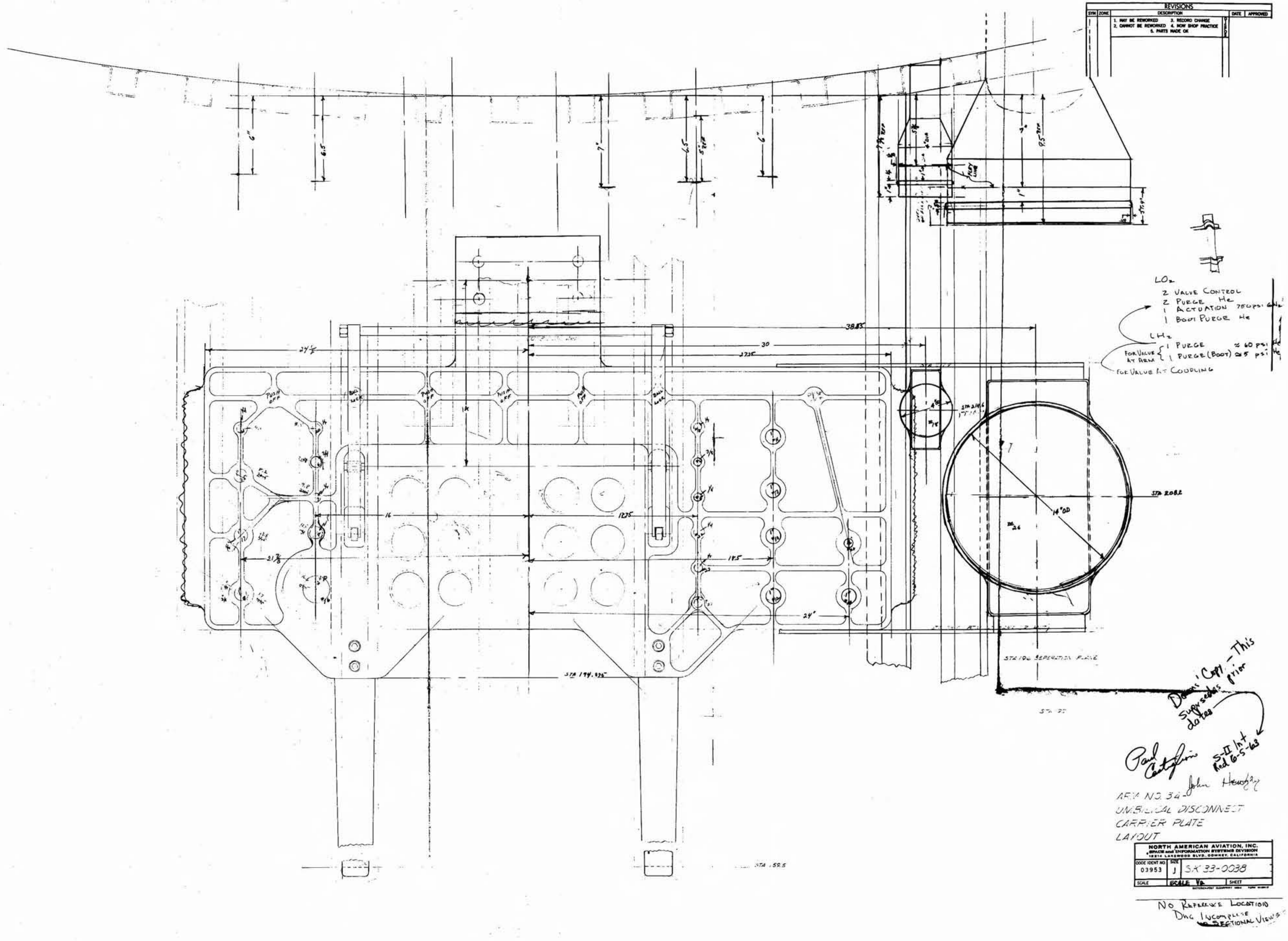
(POSITION 1) INITIAL FORCE AT "B" = 1090#
INITIAL FORCE AT "D" = 2570#

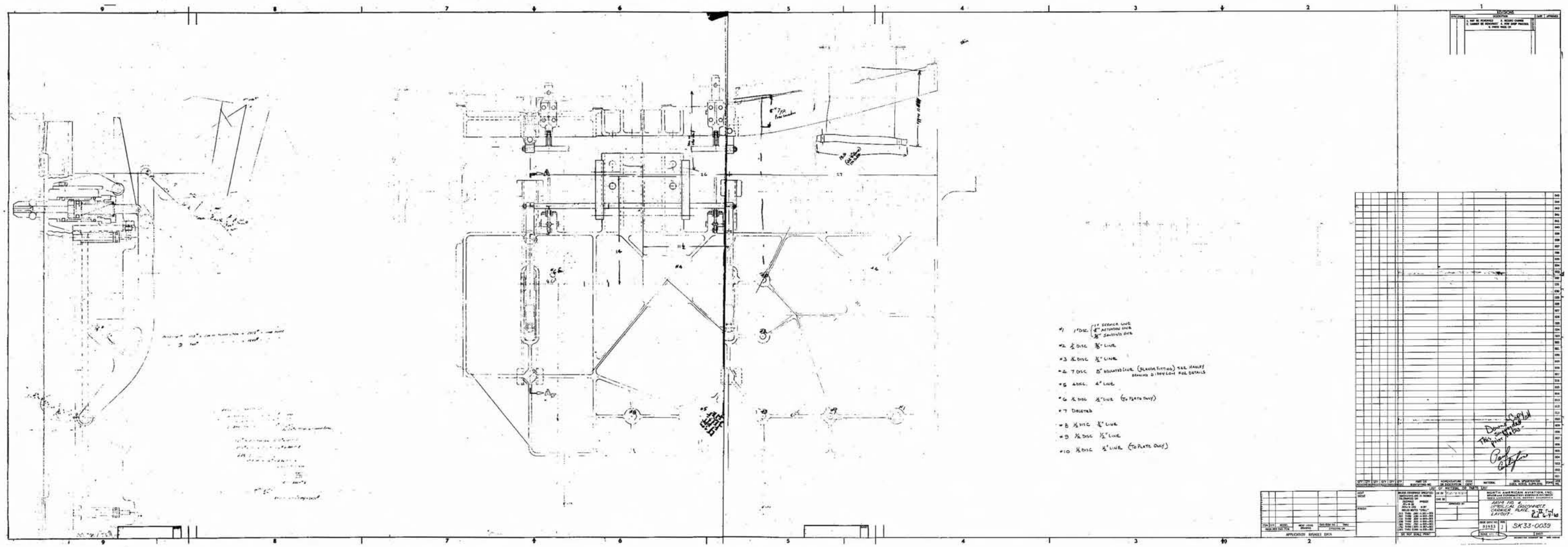
(POSITION 2) 1" TRAVEL — FORCE AT "B" = 1020#; FORCE AT "D" = 2380#

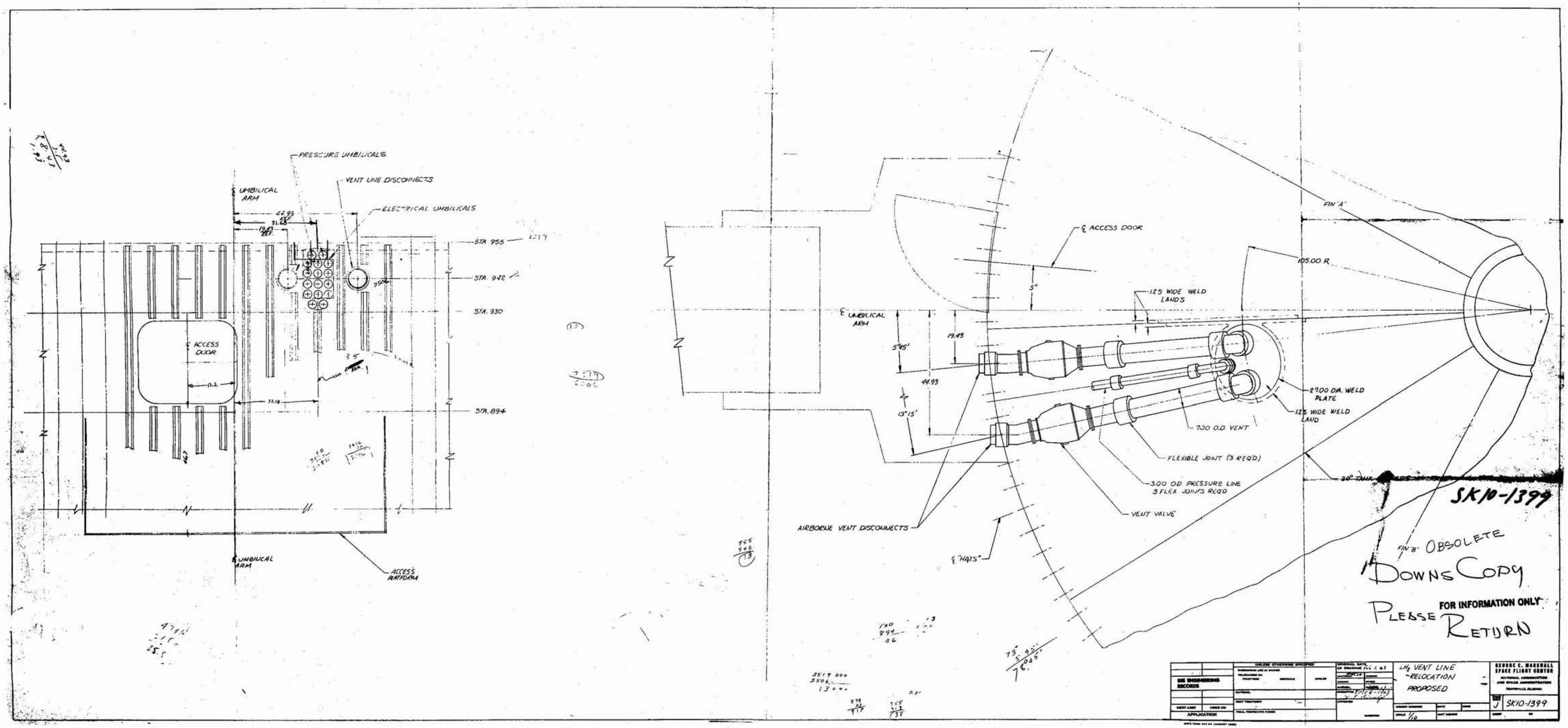
(POSITION 3) END OF TRAVEL — FORCE AT "B" = 995#; FORCE AT "D" = 1950#

Hockey Stick Motion
S-II Intermed
Rcd 6-4-63

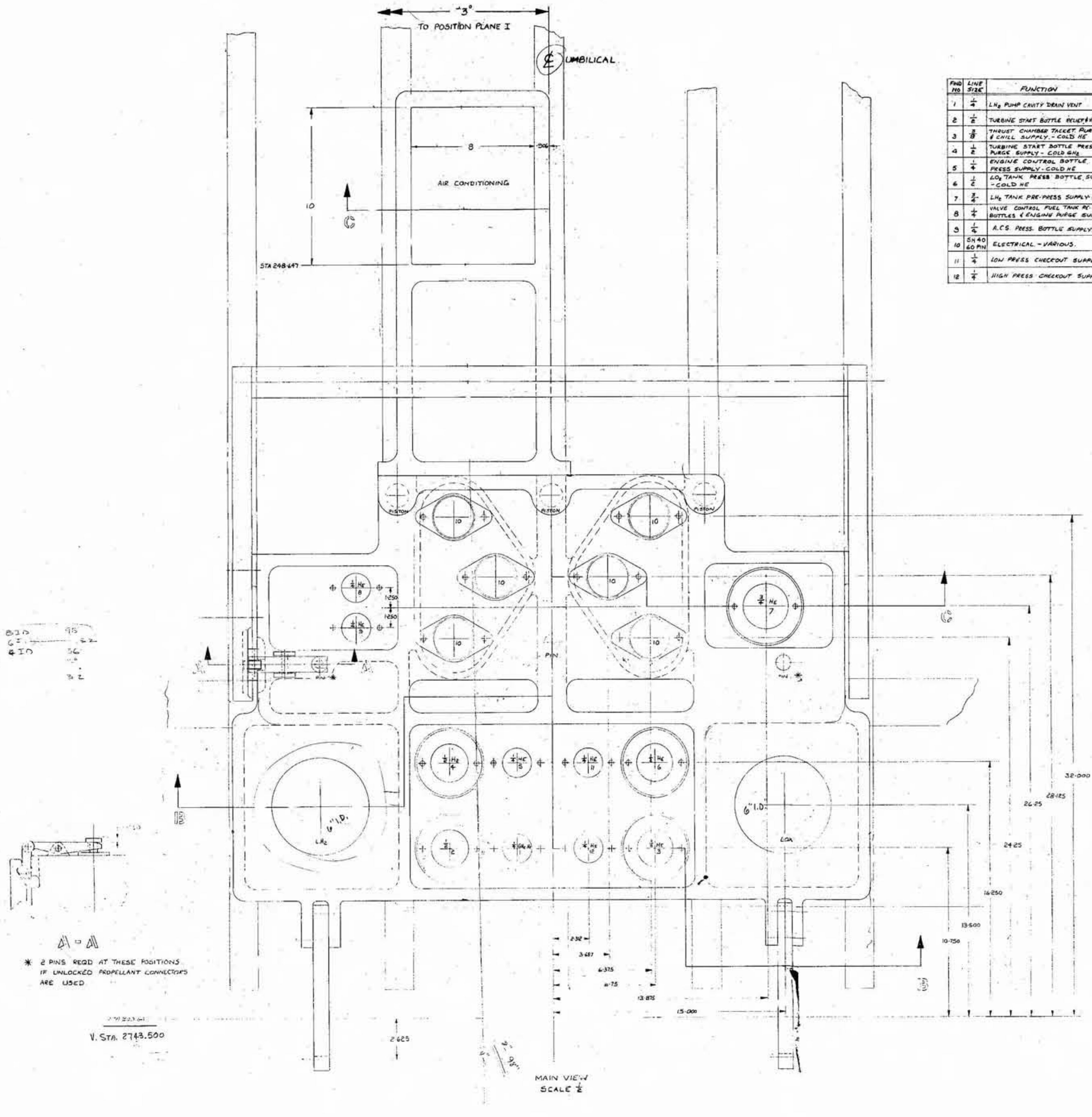
ARM NO. 3A
UMBILICAL DISCONNECT
CARRIER PLATE


REVISIONS
1. MAY BE REWORKED 3. RECORD CHANGE
2. CANNOT BE REWORKED 4. NOW SHOP PRACTICE
5. PARTS MADE OK
LO2
2 VALVE CONTROL
2 PURGE He
1 ACTUATION 750psi
1 BOOT PURGE He
LH2
1 PURGE ≈ 60 psi
1 PURGE (BOOT) ≈ 5 psi
FOR VALVE AT ARM
FOR VALVE AT COUPLING
STA 196 SEPERATION PLANE
STA 194.375"
14" OD
Dennis' Copy - This supersedes prior dates
S-II Int Rcd 6-5-63
ARM NO. 34 -
UMBILICAL DISCONNECT
CARRIER PLATE
LAYOUT
NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION
12214 LAKEWOOD BLVD., DOWNEY, CALIFORNIA
CODE IDENT NO. 03953
SIZE J
SK 33-0038
SCALE
SCALE 1/2
SHEET
NO REFERENCE LOCATION
DWG INCOMPLETE
NO SECTIONAL VIEWS


#1 1" DISC. 1" SERVICE LINE
ACTUATION LINE
SENSING LINE
#2 DISC LINE
#3 DISC LINE
#4 7 DISC 8" INSULATED LINE (FLANGE FITTING) SEE HANLEY DRAWING D1344LO-1 FOR DETAILS
#5 4 DISC. 4" LINE
#6 DISC LINE (TO PLATE ONLY)
#7 DELETED
#8 DISC LINE
#9 ½ DISC ½" LINE
#10 DISC LINE (TO PLATE ONLY)
LIST OF MATERIAL OR PARTS LIST
DO NOT SCALE PRINT
APPLICATION
NORTH AMERICAN AVIATION, INC.
AREA NO. 4
UMBILICAL DISCONNECT
CARRIER PLATE
LAYOUT
S-II T-1
03953
SK33-0039

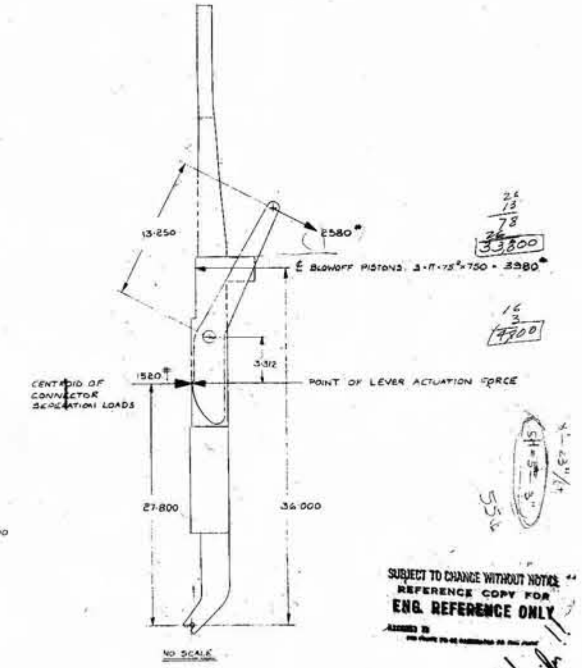


PRESSURE UMBILICALS
VENT LINE DISCONNECTS
ELECTRICAL UMBILICALS
℄ UMBILICAL ARM
STA. 955
STA. 942
STA. 930
STA. 894
℄ ACCESS DOOR
ACCESS PLATFORM
℄ ACCESS DOOR
105.00 R
FIN "A"
.125 WIDE WELD LANDS
℄ UMBILICAL ARM
27.00 DIA. WELD PLATE
.125 WIDE WELD LAND
7.00 O.D. VENT
FLEXIBLE JOINT (3 REQ'D)
3.00 OD PRESSURE LINE 3 FLEX JOINTS REQ'D
VENT VALVE
AIRBORNE VENT DISCONNECTS
℄ "HATS"
FIN "B"
SK10-1399
OBSOLETE
DOWNS COPY
FOR INFORMATION ONLY
PLEASE RETURN
SEE ENGINEERING RECORDS
NEXT ASSY
USED ON
APPLICATION
UNLESS OTHERWISE SPECIFIED
ORIGINAL DATE OF DRAWING Feb 1, 63
LH2 VENT LINE -RELOCATION PROPOSED
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA
J
SK10-1399
SCALE 1/10



✱ 2 PINS REQD AT THESE POSITIONS IF UNLOCKED PROPELLANT CONNECTORS ARE USED

FIND NO	LINE SIZE	FUNCTION	PRESS PSI	TEMP °F	SERVICE	DISCONNECT FORCE LBS (MAX)
1	1/4	LH2 PUMP CAVITY DRAIN VENT	—	-300	GH2 & HE	40
2	1/2	TURBINE START BOTTLE RELIEF & VENT	800	-200	GH2 & HE	40
3	3/8	THRUST CHAMBER JACKET PURGE & CHILL SUPPLY - COLD HE		-200	HE	40
4	1/2	TURBINE START BOTTLE PRESS & PURGE SUPPLY - COLD GH2	800	-200	GH2	40
5	1/4	ENGINE CONTROL BOTTLE PRESS SUPPLY - COLD HE	3000	-200	HE	40
6	1/2	LO2 TANK PRESS BOTTLE SUPPLY - COLD HE	3000	-400	HE	40
7	3/4	LH2 TANK PRE-PRESS SUPPLY - COLD HE	500	-360	HE	40
8	1/4	VALVE CONTROL FUEL TANK RE-PRESS BOTTLES & ENGINE PURGE SUPPLY	3000	AMB	HE	40
9	1/4	A.C.S. PRESS. BOTTLE SUPPLY	3000	AMB	HE	40
10	5H 40 60 PIN	ELECTRICAL - VARIOUS.	—	—	—	180
11	1/4	LOW PRESS CHECKOUT SUPPLY	50	AMB	HE	40
12	1/4	HIGH PRESS CHECKOUT SUPPLY	3000	AMB	HE	40



SUBJECT TO CHANGE WITHOUT NOTICE
REFERENCE COPY FOR
ENG. REFERENCE ONLY

PRIMARY SYSTEM. BLOWOFF PISTONS RESTRAINING MOMENT
1520 × 27.8 = 42300 INS/lbs
SEPERATION MOMENT
3980 × 36 = 143000 INS/lbs
FACTOR = 143000 / 42300 = 3.4

SECONDARY SYSTEM. LEVERS
SECONDARY SYSTEM = PRIMARY SYSTEM × 2.
FACTOR = 3.4 × 2 = 6.8
PULL OFF FORCE = (1520 × 6.8 × 3.312) / 13.250 = 2580 lbs

WRONG!! [signature]

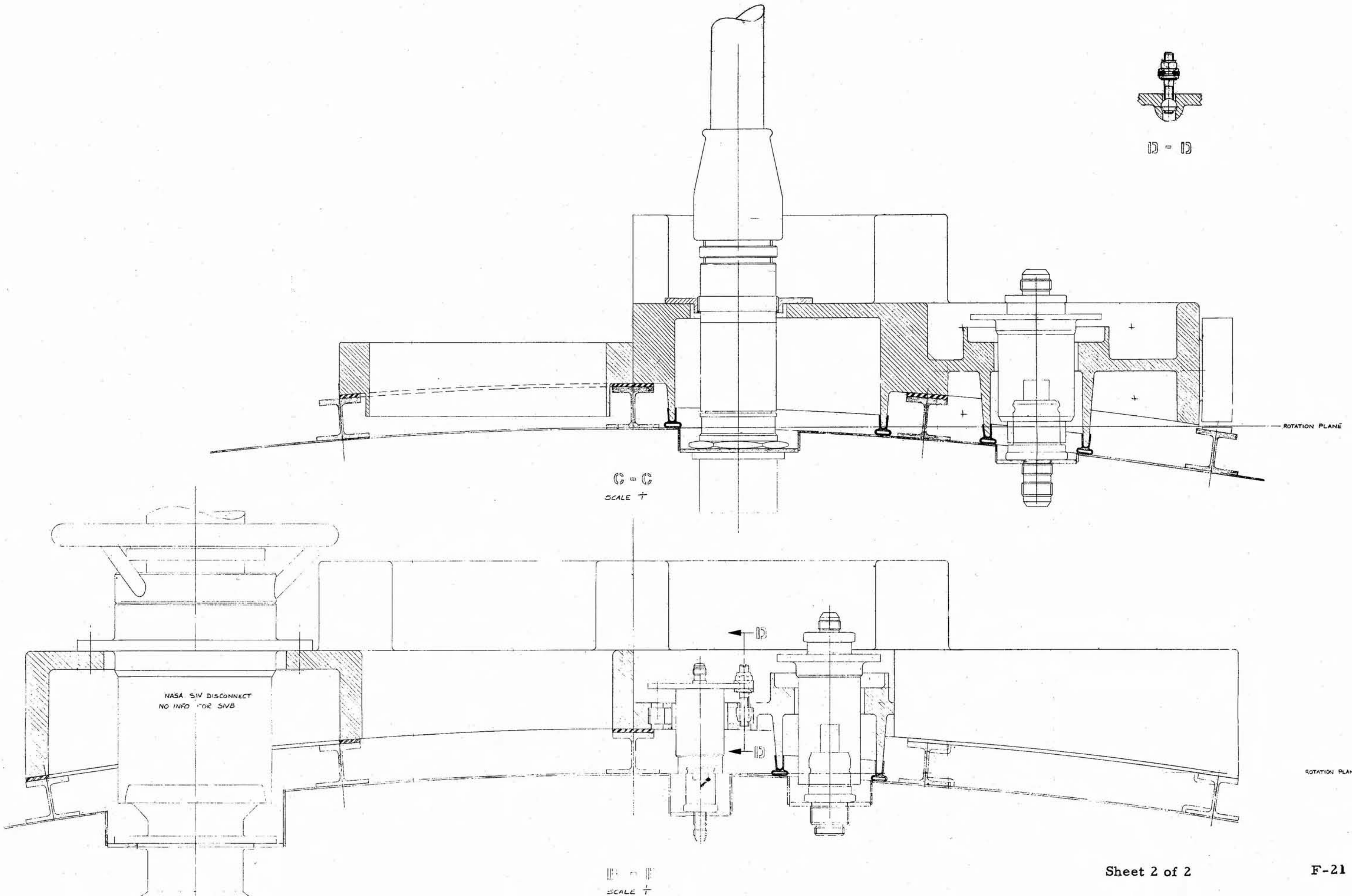
Delvd by: W.O. Mulford 12 Feb 1963

OBSOLETE

L.O. SIVB AFT UMBILICAL
F.G. APPLEBY SMSES/DAC.

1A66274

Sheet 1 of 2


D - D
C - C
ROTATION PLANE
NASA SIV DISCONNECT
NO INFO FOR SIVB
ROTATION PLANE

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60-999

REVISIONS

SYM	DESCRIPTION	DATE	APPROVED

SUBJECT TO CHANGE WITHOUT NOTICE

REFERENCE COPY FOR

ENG. REFERENCE ONLY

ASSIGNED TO

NO PARTS TO BE FABRICATED TO THIS PRINT

NOTE: PRINTS HAVE BEEN RELEASED FOR PROCUREMENT ANALYSIS. ANY REVISIONS MUST BE RECORDED ON AN "A" CHANGE 'FIRST RECORD ISSUE.'

PREPARED FOR NASA-MSFC

PART OR IDENTIFYING NO.		
DASH NUMBERS OF THIS DRAWING ODD DASH NUMBERS SHOWN EVEN DASH NUMBERS OPPOSITE	MATERIAL —	
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES FRACTIONS ± DECIMALS ± — ANGLES ± —	FINISH —	SEE ENGINEERING RECORDS FOR USAGE DATA; ORIG SECT. 1154-61; REL CODE; FIRST REL OF PRINTS; ORIG DATE OF DWG OCT 15 '62

MATL		
WT CHK		
STR CHK		
CHECK		
PR ENGR		
DES ENGR		
GR ENGR		
PREP BY		3 8 63

DOUGLAS AIRCRAFT COMPANY, INC — SANTA MONICA, CALIFORNIA

DISCONNECT, FILL AND DRAIN, OXIDIZER TANK

S-IV B

SPECIFICATION CONTROL DRAWING

DESIGN ACTIVITY APPROVAL

CUSTOMER APPROVAL

CODE IDENT NO.	SIZE	
18355	A	1A49970
SCALE —		SHEET 1

60-999-1

TABLE OF CONTENTS AND CHANGE LETTER RECORD

SYM

DOUGLAS AIRCRAFT COMPANY, INC	CODE IDENT NO. 18355	SIZE A	1A49970
			SHEET 2.

60-999-1

TABLE OF CONTENTS AND CHANGE LETTER RECORD

SYM

DOUGLAS AIRCRAFT COMPANY, INC	CODE IDENT NO.	SIZE	
	18355	A	1A49970
			SHEET 2.1

SYM

1. SCOPE

This Specification Control drawing defines the design, test, and data requirements for the design and procurement of a disconnect, which will be used in a liquid oxygen fill line in a space vehicle.

2. APPLICABLE DOCUMENTS

The following specifications and standards (including subsidiaries thereof), drawings, and publications of the issue in effect on 7 September 1961, except as otherwise noted or controlled on an individual basis, form a part of this drawing to the extent specified herein.

2.1 Douglas Prepared Documents

Drawings and Other Publications

7696938	Materials, Compatible, Liquid Oxygen Service
7869555	General Procurement Specification

Standards

1P00041	Cleanliness, Components, Oxidizer-Fuel-Pneumatic System

SYM

2.2 Government Controlled Documents

Specifications

ABMA-PD-R-27A	Radiographic Inspection; Soundness Requirements for Fusion Welds on Aluminum and Magnesium Missile Components
ABMA-PD-R-527 (5-22-59)	Radiographic Inspection Procedures and Acceptance Standards for Fusion Welded Joints in Stainless Steel and Heat Resistant Steels, Procedure for
ABMA-PD-W-40 (5-1-58)	Welding, Carbon, Low Alloy, and Stainless Steel, Manual or Automatic, for Guided Missile Use
ABMA-PD-W-45A	Welding, Fusion Shielded Arc, Missile Components, Aluminum and Magnesium Manual or Automatic
MIL-A-8625A	Anodic Coatings, for Aluminum and Aluminum Alloys
MIL-C-5541 (3-28-50) Amend. 1	Chemical Films for Aluminum and Aluminum Alloys
MIL-I-6865B Amend. 1	Inspection, Radiographic
MIL-N-6011 (3-14-50)	Nitrogen, Liquid and Gas
MIL-P-25508C	Propellant, Oxygen
MIL-R-11468 (9-24-51)	Radiographic Inspection, Soundness Requirements for Arc and Gas Welds in Steel
MIL-S-5002 (10-23-56) Amend. 2	Surface Treatments (Except Priming and Painting) for Metal and Metal Parts in Aircraft
MIL-T-152B	Treatment, Moisture and Fungus Resistant, of Communications, Electronic, and Associated Electrical Equipment

SYM

Standards

MIL-STD-8B	Dimensions and Tolerancing
MIL-STD-129C	Marking for Shipment and Storage
MIL-STD-130A	Identification Marking of U.S Military Property
MSFC-STD-100 (5-16-61)	Castings, Aluminum and Magnesium Alloy, Radiographic Inspection of, Acceptance Standard for

SYM

3. REQUIREMENTS

3.1 General

Unless otherwise specified, the contents of 7869555 are applicable.

3.2 Design

3.2.1 Configuration

3.2.1.1 Dimensions

The overall dimensions of the disconnect shall be within the limits specified in figures 1, 2, and 3.

3.2.1.2 Components

The assembly shall consist of two mating units (ground (-501) and airborne (-1)), which connect together with application of an axial mechanical force. The design shall also incorporate a self-aligning feature, effective during engagement of the mating halves, to assure proper mating. The disconnect shall allow angulation and axial motion of the ground half with respect to the airborne half when the two halves are connected together. One half shall be generally conical in shape, the other half spherical. A ~~visual indicator shall indicate when the assembly is~~ connected and sealed. ~~The mating seal between the two halves shall be~~ located on the airborne half. The mating seal shall be preloaded to provide a leakproof seal when one half is offset laterally 1/8 inch from the assembly centerline, and/or one half is angulated 2° from the other half.

3.2.1.3 Disassembly and Assembly for Cleaning

The design and construction of the disconnect shall allow for complete disassembly, cleaning for oxygen service, and assembly without impairing the operational performance parameters as specified herein, or causing replacement of non-standard parts. No special tools shall be required for assembly or disassembly.

3.2.1.4 Securing Devices

The disconnect shall be designed and constructed so that no parts shall work loose during installation or operation. All adjustments which may be provided shall be capable of being securely locked for all operation and test conditions specified herein.

SYM

3.2.2 Flow Medium

The flow medium shall be liquid oxygen in accordance with MIL-P-25508.

3.2.3. Operating Temperatures

3.2.3.1 External

The disconnect shall operate in an external environment of -65 to +160F.

3.2.3.2 Internal

The disconnect shall operate at an internal temperature of -320 to +160F.

3.2.4 Actuating Forces

3.2.4.1 Connection

The total applied force required to connect the two halves and to preload the mating seal shall not exceed 35 lbs.

3.2.4.2 Disconnection

The axial force required to disconnect the two halves shall not exceed 50 lbs.

3.2.5 Proof Pressure

The disconnect assembly shall withstand 175 ±2 psig internal proof pressure without leakage, distortion or failure with the two halves externally held in a fixed position.

SYM

3.2.6 Leakage

Leakage past the mating seal shall not exceed 100 sccm of oxygen gas, with the disconnect connected together, 0 to 110 psig internal oxygen pressure, the ground half rotated 2° in any direction and moved axially 1/4 inch in either direction from the airborne half, and the temperature at +160 to -300 $\pm$20F.

3.2.7 Performance

3.2.7.1 Connection

The disconnect shall connect when one half is offset laterally 1/8 inch from the assembly centerline, one half is angulated 2° in any direction from the other half, one half is moved axially 1/4 inch from the other half and 35 lbs maximum force is applied.

3.2.7.2 Disconnection

The disconnect shall uncouple when a force of 50 lbs maximum is applied along the axis.

3.2.7.3 Flow Rate

Flow through the disconnect assembly shall be a minimum of 1000 gpm of liquid oxygen with an inlet pressure of 36 psig.

3.2.7.4 Pressure Drop

Pressure drop across the disconnect assembly shall not exceed 1.5 psi with 36 psig inlet pressure and 1000 gpm liquid oxygen flow.

SYM

3.2.8 Structural

3.2.8.1 Outlet Flange

The outlet flange on the airborne half shall withstand an axial compressive force of 1000 lbs and a tensile force of 500 lbs, applied in any direction around the centerline at a 5° angle.

3.2.8.2 Inlet Flange

The inlet flange on the ground half shall withstand 150 lbs shear force applied along the flange face, and 1000 in-lbs moment applied any plane perpendicular to the flange face.

3.2.9 Service Life

The disconnect shall have a minimum service life of 200 cycles. One cycle shall consist of a complete connection and a disconnection.

SYM

3.3 Material

3.3.1 Castings

Castings shall be in accordance with MSFC-STD-100, Grade IIF and be of high quality, clean, sound, and free from blowholes, porosity, cracks, or any other defects.

3.3.2 Metals

All metals shall be of the corrosion resistant type unless suitably protected to prevent corrosion during the specified service life and storage life.

3.3.2.1 Non-Ferrous

Non-ferrous materials shall be used for all metallic parts of the disconnect except where ferrous materials are essential.

3.3.2.2 Non-Magnetic

Non-magnetic metals shall be used for all metallic parts of the disconnect except where magnetic metals are essential.

3.3.3 Non-Metallic Parts

Non-metallic parts shall not have a corrosive effect on other materials when exposed to conditions normally encountered in service. Fungus nutrient materials when used, shall be treated in accordance with MIL-T-152.

3.3.4 Lubricants

Lubricants shall be oxygen-safe, dry film type in accordance with 7696938.

3.4 Weight Control

The weight of the disconnect shall be the minimum weight attainable without degradation of performance or reliability, and shall not exceed 3 pounds, for the airborne half (-1) and 10 pounds for the ground half (-501).

SYM

3.5 Environmental

The disconnect shall function in accordance with all the requirements of this specification when subjected to the environmental conditions in the following paragraphs.

3.5.1 Shock

3.5.1.1 Thermal

The disconnect shall withstand a temperature drop from +160 to -320F at a rate of 15F per second, without failure or degradation of performance.

3.5.1.2 Operational

The disconnect shall withstand shocks of sawtooth pulse shape, 35 g's magnitude for 10 ±1 milliseconds without failure or degradation of performance. The shocks shall be applied three times in both directions, along each of the three mutually perpendicular axes.

3.5.1.3 Transportation

The disconnect in the shipping container, shall withstand 65 g's shocks of sawtooth form for 15 ±2 milliseconds, applied three times in each direction on each of the six sides of the shipping container.

3.5.2 Vibration

3.5.2.1 Operational

The disconnect shall withstand a sinusoidal vibration, with a logarithmic octave sweep rate of 3.5 minutes per octave over a frequency range of 5 to 2000 to 5 cps, at the following levels:

5 to 20 cps at	0.35	inch DA
20 to 96 cps at	7.0	g's (0 to peak or vector)
96 to 180 cps at	0.015	inch DA
180 to 2000 cps at	25.0	g's (vector)

The vibration shall be applied for 1 hour in each of the three orthogonal axes.

3.5.2.2 Transportation

The disconnect and shipping container shall withstand a sinusoidal logarithmic octave sweep rate vibration from 5 to 600 to 5 cps, at 2 minutes per octave for a period of 3 hours in each of the three principal axes in the "ready for shipment" condition, at the following levels:

5 to 17 cps at	0.4	inch DA
17 to 600 cps at	6.0	g's (0 to peak or vector)

3.5.3 Acoustics

The disconnect shall withstand a random noise environment with an overall sound pressure level (spl) of 158 decibels (db) (re. 0.0002 microbar) for 8 minutes. The random noise shall have an approximate Gaussian amplitude distribution and a peak-to-rms ratio of three or more. This overall spl shall have a spectrum shape, as measured with octave band filters, over the frequency range from 37.5 to 9600 cps as follows:

Octave Band	1	2	3	4	5	6	7	8
Center Frequency (cps)	53	106	212	424	848	1696	3392	6784
Sound Pressure Level (db)	144	149	150	151	150	149	148	147

3.5.4 Fungus

The disconnect shall be capable of withstanding an application of an equal mixture of separate spore suspension (active sporulating cultures between 7-21 days old) with a relative humidity of 96 per cent and temperature of 86F. The mixture of spore suspension shall contain equal parts of the following fungi:

1. Chaetomium Globosum or — S/N 6205
   Myrothecium Verrucaria — 9095
2. Memnoniella Echinata or — 9597
   Aspergillus Niger — 6275
3. Aspergillus Flavus or — 10836
   Aspergillus Terreus — 10690
4. Penicillium Citrinum or — 9849
   Penicillium Ochrochloron — 9112

3.5.5 Humidity

The disconnect shall withstand a relative humidity of 95 per cent for a period of 10 temperature cycles. A temperature cycle begins at +84F ±16F, gradually increases to +155F during a 2-hour period, is held at ±155F for 6 hours and is gradually decreased to +84F ±16F during a 16-hour period.

SYM

3.5.6 Salt Spray

The disconnect shall function within the mandatory performance requirements following exposure for 48 hours to a finely divided, wet, dense fog containing a 5 per cent salt solution, by weight, having a Ph value of 6.5 to 7.2 at 92F to 97F.

3.5.7 Sand and Dust

The disconnect shall be capable of withstanding a sand and dust density of 0.1 to 0.5 grams per cubic foot, at a velocity of 2500 $\pm$500 feet per minute, for 6 hours at +77F and 6 hours at +155F, with a relative humidity not to exceed 30 per cent.

Sand and dust shall be of angular structure, and have characteristics as follows:

a. 100 per cent of the sand and dust shall pass through a 100-mesh screen, U.S. Standard Sieve Series.

b. 98 $\pm$2 per cent of the sand and dust shall pass through a 140-mesh screen, U.S. Standard Sieve Series.

c. 90 $\pm$2 per cent of the sand and dust shall pass through a 200-mesh screen, U.S. Standard Sieve Series.

d. 75 $\pm$2 per cent of the sand and dust shall pass through a 325-mesh screen, U.S. Standard Sieve Series.

3.5.8 Storage Environment

All specified performance requirements for the disconnect shall be met after a minimum storage life of 730 days at temperatures between -65F and +155F with a relative humidity up to 100 per cent, including conditions wherein condensation takes place in forms of either water and/or frost. All openings on the units shall be sealed. This requirement shall be met in the "as received" condition.

SYM

3.6 Construction

The disconnect shall be so constructed that no parts shall work loose during installation or service. All adjustments which may be provided shall be capable of being securely locked under all service and test conditions.

3.6.1 Welding

3.6.1.1 Corrosion Resistant Steels

Corrosion resistant steels shall be inert gas shield arc welded in accordance with ABMA-PD-W-40, Class 1, and radiographically inspected 100 per cent according to MIL-I-6865, ABMA-PD-R-527, and/or MIL-R-11468.

3.6.1.2 Aluminum Alloys

Aluminum alloys shall be inert gas shield arc welded in accordance with ABMA-PD-W-45, and radiographically inspected 100 per cent according to MIL-I-6865 and ABMA-PD-R-27.

3.6.2 Finish

3.6.2.1 Corrosion Resistant Steel

Corrosion resistant steels shall be passivated in accordance with MIL-S-5002.

3.6.2.2 Aluminum Alloy

Aluminum alloy parts shall be anodically treated in accordance with MIL-A-8625. The aluminum oxide film formed by this treatment shall be removed from local areas under screws, nuts, etc., used for assembly or mounting purposes, to provide adequate bonding connections. Marman seal areas shall be masked to limit anodic treatment to specific areas as specified in figures 1, 2, and 3. Unanodized seal areas shall be chemically treated in accordance with MIL C-5541.

3.6.3 Plating

Cadmium or zinc plating shall not be used on any components.

3.6.4 Protective Treatment

Materials subject to deterioration when exposed to the climatic and environmental conditions occuring in service shall be protected in a manner that will not prevent compliance with the performance requirements of this specification. Protective coatings that ship, crack, or scale with age, or under the extreme climatic and environmental conditions specified herein, shall be avoided.

3.6.5 Processing

Process all surfaces in contact with the working media at a certified source and package in accordance with 1P00041.

SYM

3.7 Approval of Vendor Part

Final approval of the vendor part (to be accomplished prior to first shipment) shall be contingent upon submission, by the vendor to Douglas, of detailed outline and assembly drawings (including cross sectional views) and a list of materials, for review by, and approval of, the Douglas Missile & Space Systems Engineering Department. This requirement also applies to vendor changes.

3.8 Identification

The disconnect shall be permanently identified in accordance with MIL-STD-130, with the following minimum information:

Vendor name or trademark:
Vendor part number:
Specification control number: 1A49970-1 and 1A49970-501
Manufacturer's serial number:

3.9 Preparation of Vendor Drawing

Vendor drawings shall be prepared in accordance with 7869555, paragraph 3.8 with disassembly, adjustment, and assembly instructions for the article included in the top assembly drawing.

3.10 Reliability

The design, construction, and quality control of the disconnect assembly covered by this specification shall exhibit a probable reliability which will insure that the highest confidence level of field reliability is inherent in the disconnect assembly during its use in a space vehicle. Statistical demonstration of reliability by test shall not be required of the vendor. The probable reliability of the first article of the production configuration will be estimated by Douglas Aircraft Company Engineering.

SYM

4. QUALITY ASSURANCE PROVISIONS

4.1 Design Evaluation Tests

4.1.1 Definition

Design evaluation tests shall determine if the disconnect assembly is in compliance with design requirements.

4.1.2 Requirements

The following design evaluation tests shall be conducted by Douglas Aircraft Company. Tests shall be performed in sequence to attain the maximum utilization as well as the maximum evaluation of the disconnect. The least destructive test shall be performed first. The combining of tests is recommended where justifiable and practical.

4.1.2.1 Cleanliness

Disassembly, cleaning, and assembly of the disconnect shall take place before testing, unless the disconnect has been previously cleaned and packaged in accordance with 1P00041, at a certified source.

4.1.2.2 Test Medium

Nitrogen, liquid and gas, in accordance with MIL-N-6011.

4.1.2.3 Atmospheric Conditions

Tests shall be made at an atmospheric pressure of 29 +2 inches of mercury, a temperature of 70 +10F and a relative humidity of 40 +10 per cent, except for those environmental tests which specify extreme conditions to demonstrate compliance with design requirements. Tolerances on environmental conditions shall be as follows, unless otherwise specified:

a. Temperature . . . . + 4F
b. Vibration amplitude . . . . ±10%
c. Vibration frequency . . . . ± 2%
d. Humidity. . . . . ± 5%

SYM

4.1.3 Test Description

4.1.3.1 Proof Pressure

Couple the disconnect together and cap one end. Apply 175 +2 psig nitrogen gas pressure at the open end for 2 minutes. There shall be no evidence of structural failure or distortion.

4.1.3.2 Leakage

Couple the disconnect together and cap the outlet. Chill the assembly to -300 +20F Apply nitrogen gas pressure at the inlet varying the pressure from 0 to 110 psig. While varying the pressure, angulate the ground half 2° in any direction from the airborne half, and also move the ground half back and forth axially 1/4 inch from the airborne half. Leakage past the mating seal at any pressure shall not exceed 100 sccm during and after temperature reduction. Reduce the internal pressure to 5 psig. The leakage at 5 psig shall not exceed 100 sccm.

4.1.3.3 Functional

4.1.3.3.1 Connection

Place the two halves close to engagement, but with one half offset laterally 1/8 inch from the assembly centerline, and with one half axially displaced 1/4 inch and angulated 2° from the other half. Apply 35 lbs axial mechanical force. The two halves shall connect together and the visual indicator shall indicate a connection.

4.1.3.3.2 Disconnection

Apply 50 lbs axial mechanical force to the coupled disconnect. The disconnect shall uncouple.

4.1.3.3.3 Flow Rate and Pressure Drop

Couple the disconnect halves together. Apply 36 psig liquid nitrogen pressure at the inlet. The flow rate shall be 1000 gpm minimum. The pressure drop shall not exceed 1.5 psi.

SYM

4.1.3.4 Shock

4.1.3.4.1 Thermal

Stabilize the disconnect assembly at +160F then reduce the disconnect temperature to -320F at a rate of 15F per second. Test according to 4.1.3.2 through 4.1.3.3.3, after applying the thermal shock.

4.1.3.4.2 Operational

Subject the disconnect assembly to shocks of sawtooth pulse shape, 35 g's magnitude for 10 ±1 milliseconds. Apply the shock three times in both directions along each of the three mutually perpendicular axes. Test according to 4.1.3.2 through 4.1.3.3.3, after applying shock in all directions.

4.1.3.5 Vibration

4.1.3.5.1 Operational

Subject the disconnect assembly to a sinusoidal vibration, with a logarithmic octave rate of 3.5 minutes per octave over a frequency range from 5 to 2000 to 5 cps for 1 hour in each of the three orthogonal axes. The frequency range and levels shall be as follows:

5 to 20 cps at	0.35	inch DA
20 to 96 cps at	7.0	g's (0 to peak or vector)
96 to 180 cps at	0.015	inch DA
180 to 2000 cps at	25.0	g's (vector)

Test according to 4.1.3.2 through 4.1.3.3.3, before and after the vibration in all directions.

4.1.3.5.2 Transportation

Subject the shipping container and disconnect assembly to a sinusoidal logarithmic octave sweep rate of 5 to 600 to 5 cps at 2 minutes per octave for a period of 3 hours along each of the three principal axes in the "ready for shipment" condition, at the following levels.

5 to 17 cps at	0.4	inch DA
17 to 600 cps at	6.4	g's (0 to peak or vector)

There shall be no structural failure of the shipping container. Test the disconnect assembly in accordance with paragraph 4.1.3.2 through 4.1.3.3.3 after applying the vibration in all directions.

SYM

4.1.3.6 Service Life

Cycle the disconnect assembly 200 times at a temperature of -300 +20F. One cycle shall consist of a complete connection and a disconnection. After the last cycle, test according to 4.1.3.2 through 4.1.3.3.3.

4.1.3.7 Humidity

Subject the disconnect assembly to exposure in a relative humidity of 95 per cent for 10 temperature cycles. A temperature cycle shall begin at +84 +16F, be gradually increased to +155F over a 2 hour period, be held at +155F for 6 hours, then be gradually reduced to +84 +16F over a 16 hour period. Test according to 4.1.3.2 through 4.1.3.3.3 at the end of the 10 cycles.

SYM

4.2 Production Tests

4.2.1 Definition

Production tests shall be those tests which determine if production techniques adversely affect design.

4.2.2 Requirements

Every item submitted to Doulas for acceptance shall be proven by satisfactory demonstration of its capability to meet performance rating requirements by the following tests. In addition to the production test requirements listed herein, parts may be tested at the discretion of the Douglas Aircraft Company, Inc., to verify any or all performance requirements listed in this drawing.

4.2.2.1 Test Medium

Nitrogen gas in accordance with MIL-N-6011.

4.2.3 Test Description

4.2.3.1 Proof

Couple the disconnect assembly and cap one end. Apply 175 $\pm$2 psig nitrogen gas pressure at the open end for 2 minutes. There shall be no evidence of structural failure or distortion.

4.2.3.2 Leakage

Couple the disconnect together and cap the outlet. Chill the assembly to -300 $\pm$20F. Apply nitrogen gas pressure at the inlet varying the pressure from 0 to 110 psig. While varying the pressure, angulate the ground half 2° in any direction from the airborne half, and also move the ground half back and forth axially 1/4 inch from the airborne half. Leakage past the mating seal at any pressure shall not exceed 100 sccm during and after temperature reduction. Reduce the internal pressure to 5 psig. The leakage at 5 psig shall not exceed 100 sccm.

SYM

4.2.3.3 Functional

4.2.3.3.1 Connection

Place the two halves close to engagement, but with one half offset laterally 1/8 inch from the assembly centerline, and with one half axially displaced 1/4 inch and angulated 2° from the other half. Apply 35 lbs force. The two halves shall connect together and the visual indicator shall indicate a connection.

4.2.3.3.2 Disconnection

Apply 50 lbs axial mechanical force to the coupled disconnect. The disconnect shall uncouple.

SYM

5. PREPARATION FOR DELIVERY

The disconnect shall be prepared for delivery in accordance with 7869555, paragraph 5.

5.1 Cleaning, Processing, and Packaging

Cleaning, processing, and packaging procedures shall be in accordance with 1P00041. Articles shall be individually packaged, and marked for identification in accordance with MIL-STD-129. Plastic bags, when required, shall be clearly marked with identifying part number, in accordance with MIL-STD-130.

6. NOTES

6.1 Definitions

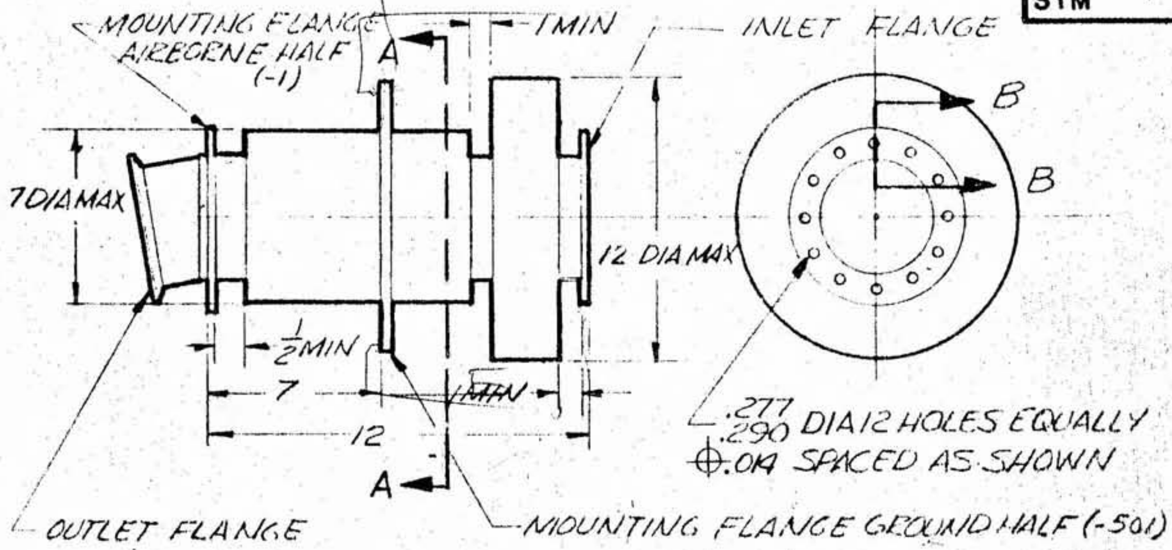
cps	Cycles per second
DA	Double amplitude
db	Decibels
F.	Degrees Fahrenheit
g	The acceleration due to gravity
gpm	Gallons per minute
mm Hg	Millimeters of mercury
psia	Pounds per square inch absolute
psig	Pounds per square inch gauge
sccm	Standard cubic centimeters per minute
scfm	Standard cubic feet per minute
spl	Sound pressure level, measured in decibels

SYM

6.2 Approved Sources

Spec Control Number	Vendor Part Number	Vendor Name and Address	Vendor Code
1A49970-1			
1A49970-501			

SYM



GENERAL NOTES: UNLESS OTHERWISE SPECIFIED

1. DIMENSIONS ARE IN INCHES.
2. TOLERANCES ARE AS FOLLOWS
   FRACTIONS $\pm\frac{1}{32}$
   DECIMALS $\pm$.010
3. DIMENSIONAL TOLERANCE SYMBOLS ARE IN ACCORDANCE WITH MIL-STD-8
4. PROPRIETARY REQUIREMENTS: THE CONOSEAL FLANGES AS DESCRIBED IN THIS DRAWING ARE PROPRIETARY PARTS OF THE AERO-QUIP CORPORATION, MARMAN DIVISION, 11214 EXPOSITION BLVD, LOS ANGELES 64, CALIFORNIA. THE DIMENSIONS AND/OR MACHINING OF THE CONOSEAL FLANGES MAY BE COORDINATED WITH THE AERO-QUIP CORPORATION, MARMAN DIVISION

FIGURE 1

DOUGLAS AIRCRAFT COMPANY, INC	CODE IDENT NO. 18355	SIZE A	1A49970
			SHEET 24

X60-999-3 (10-62)

SYM

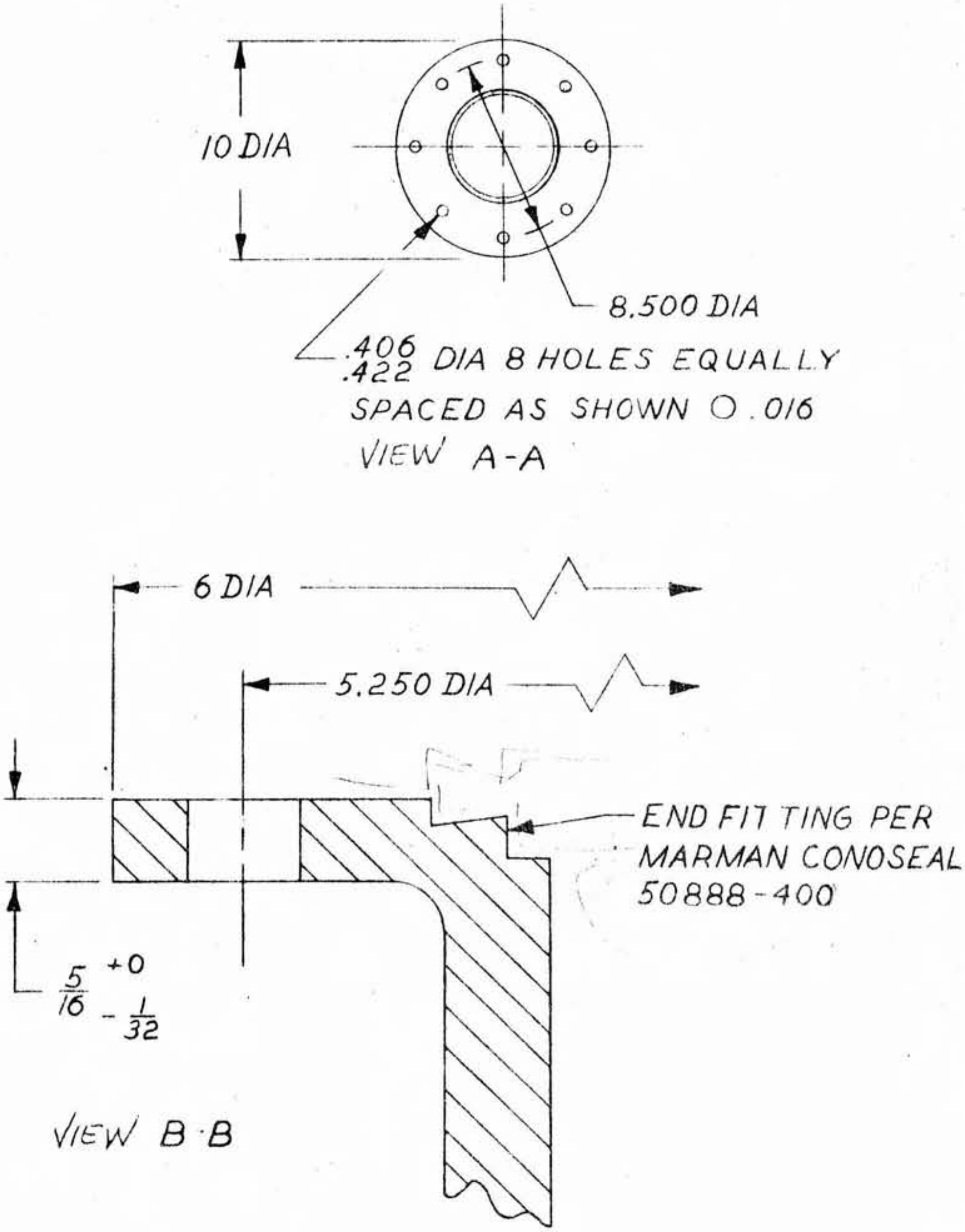
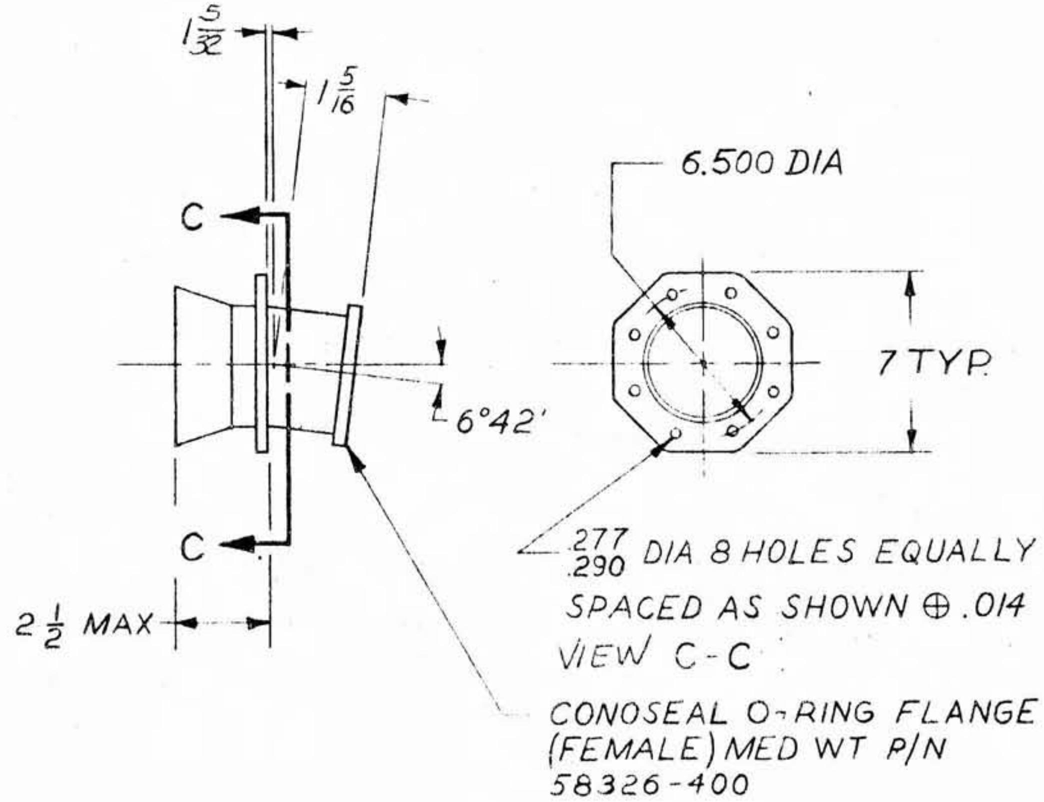


FIGURE 2

DOUGLAS AIRCRAFT COMPANY, INC	CODE IDENT NO. 18355	SIZE A	1A49970
			SHEET 25

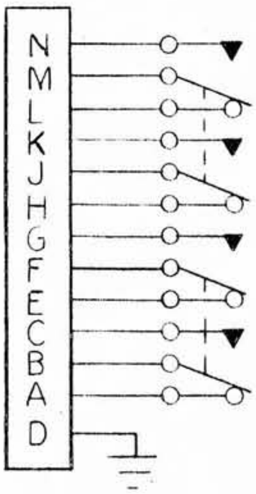
SYM



DOUGLAS AIRCRAFT COMPANY, INC	CODE IDENT NO. 18355	SIZE A	1A49970
			SHEET 26

60-999-3

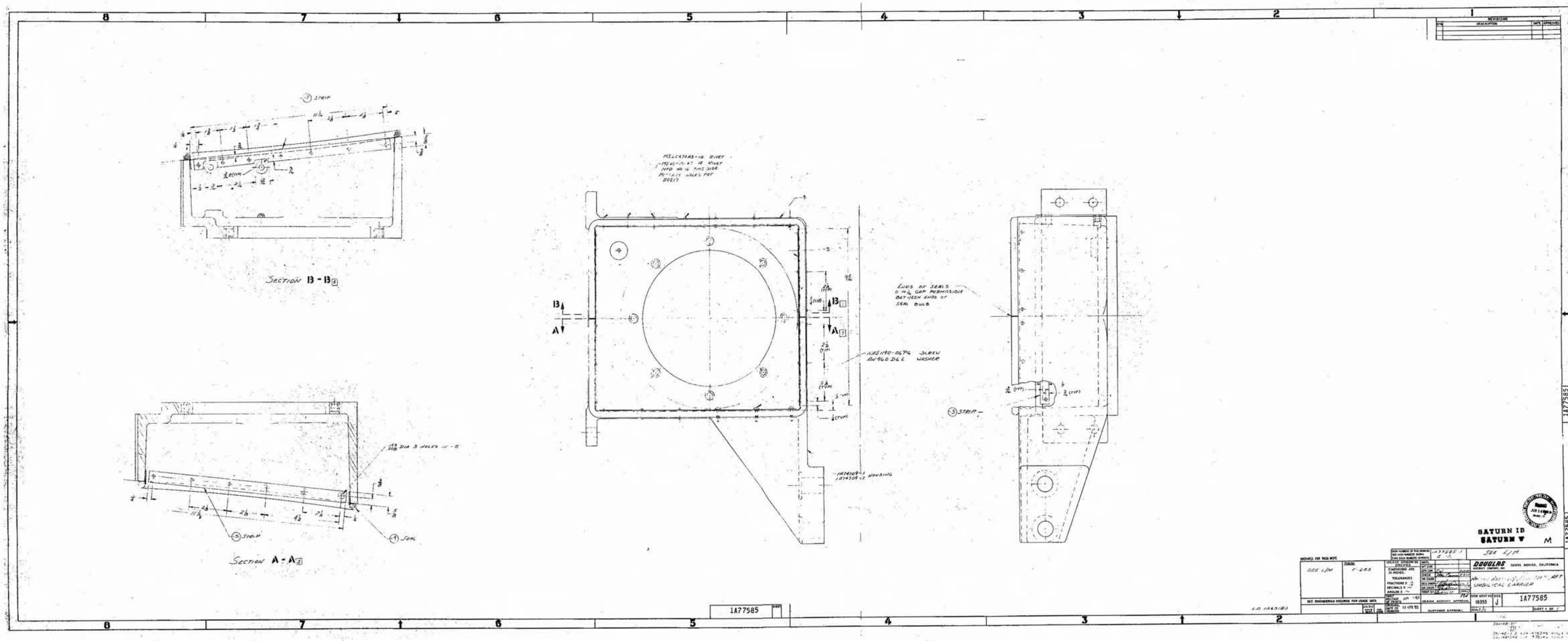
SYM

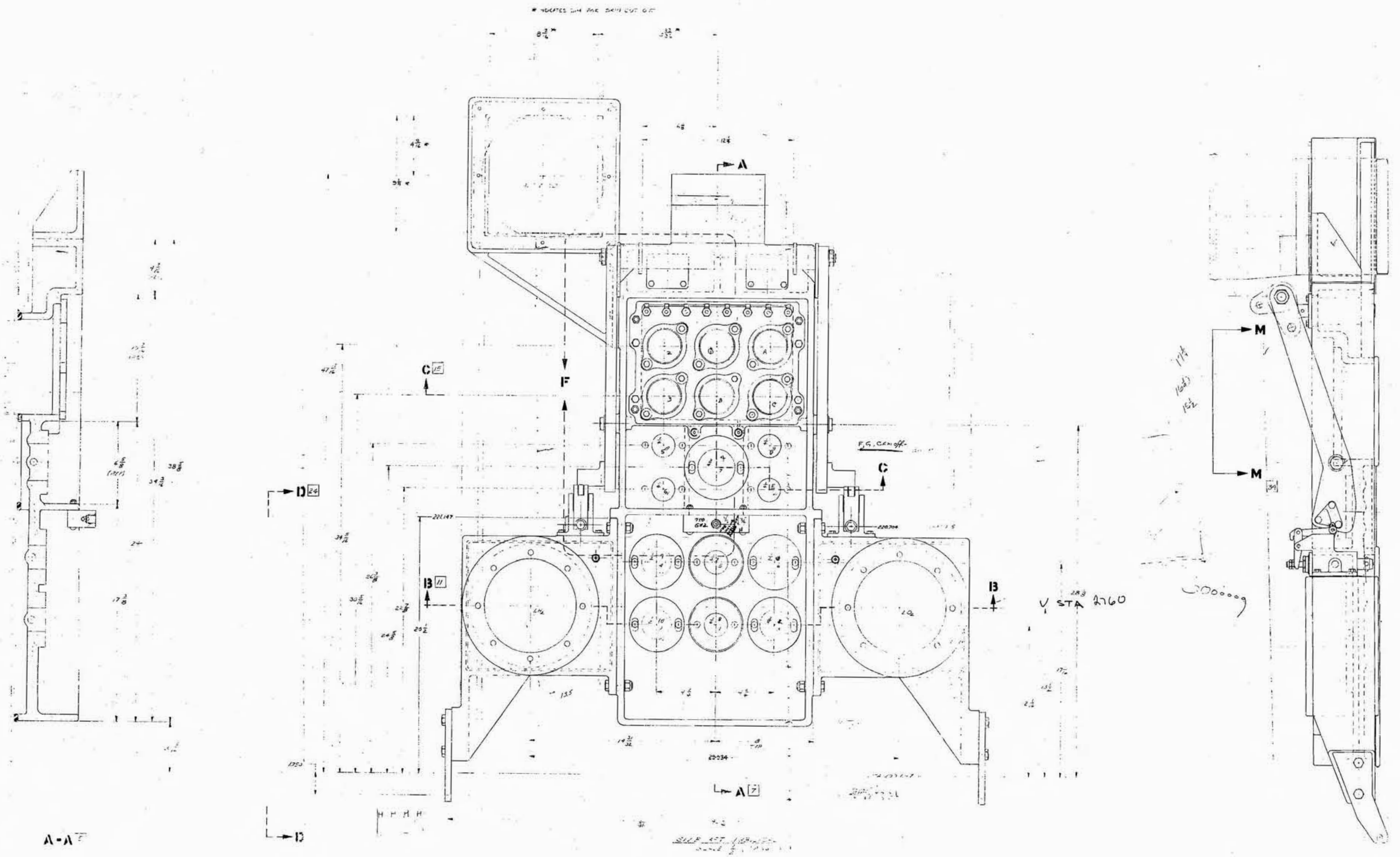


POSITION INDICATOR CONNECTOR

FIGURE 4

DOUGLAS AIRCRAFT COMPANY, INC	CODE IDENT NO. 18355	SIZE A	1A49970
			SHEET 27

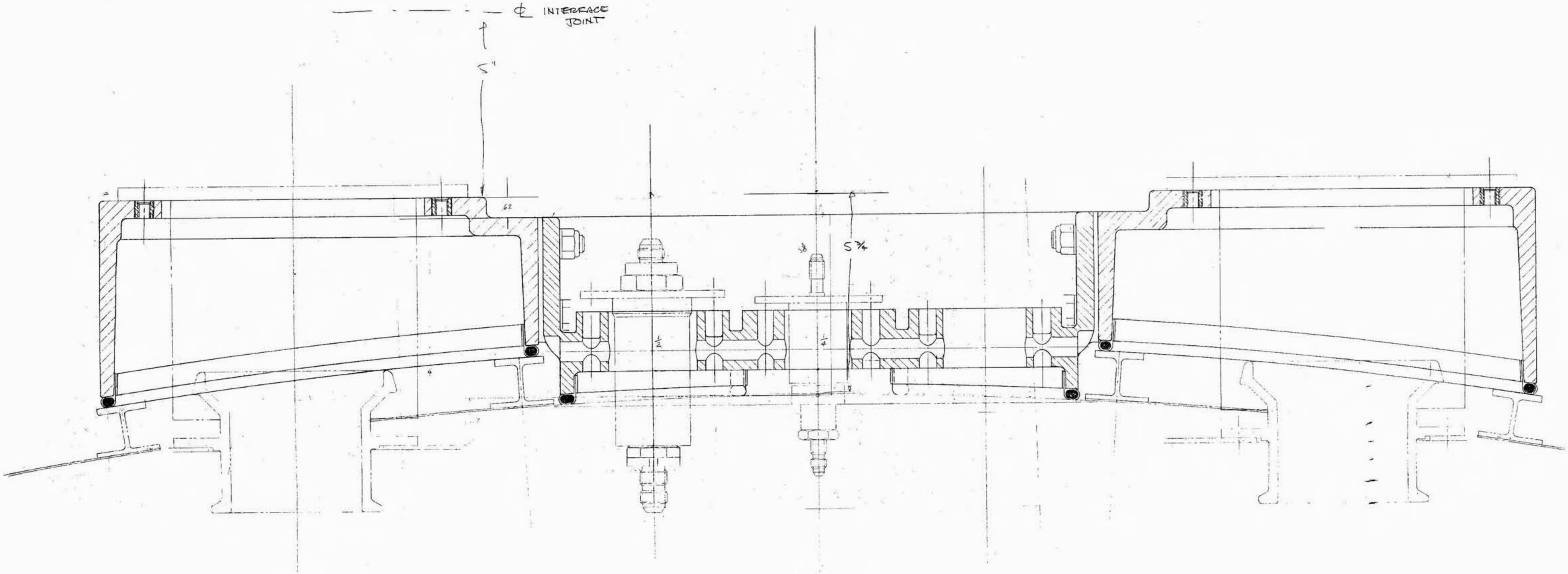

SECTION B-B
SECTION A-A
SATURN IB
SATURN V
DOUGLAS
UMBILICAL CARRIER
1A77585



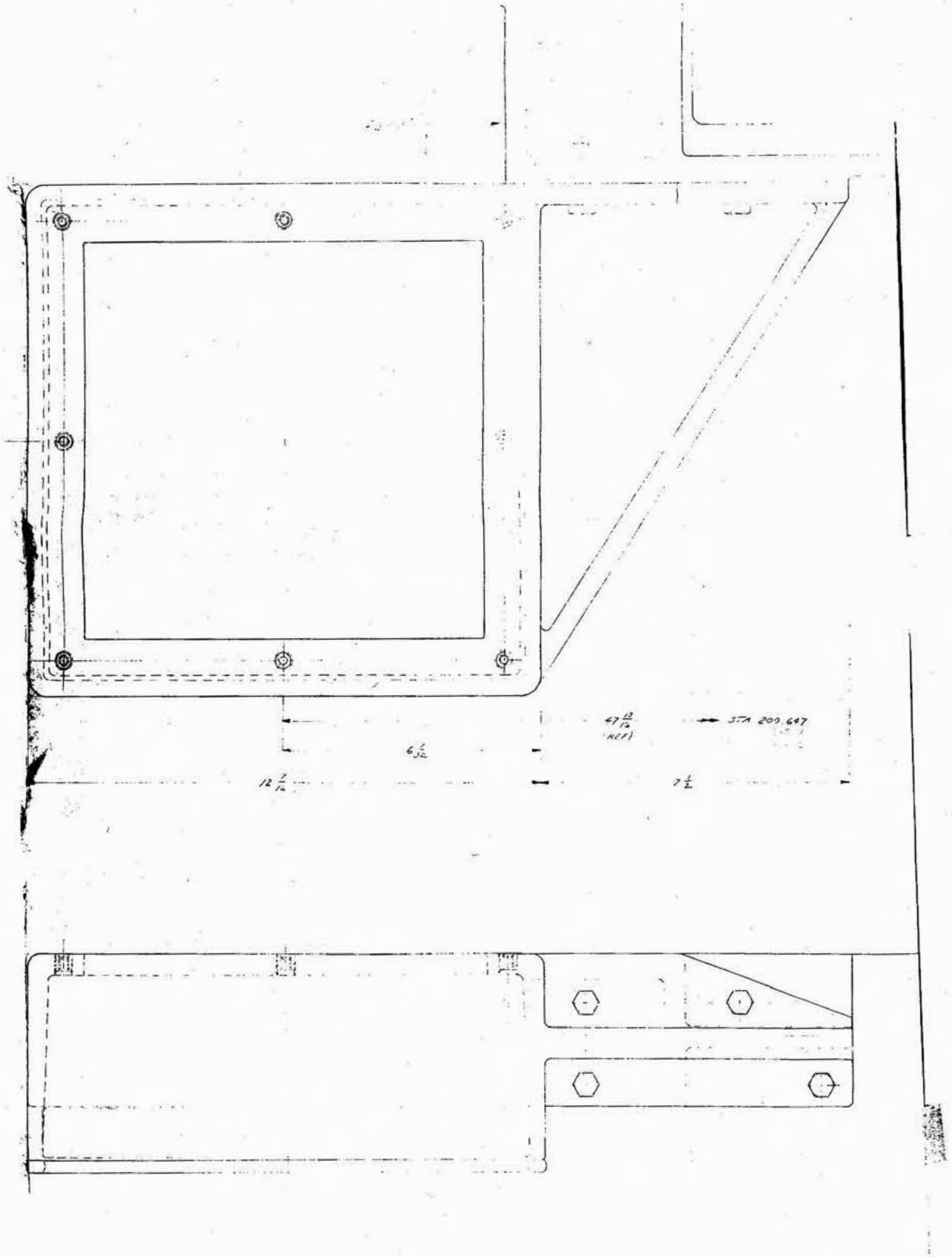
LINE NO.	LINE SIZE	FUNCTION	PRESS PSI	TEMP °F	FLUID	SURVIVAL TIME SEC.
1	[illegible]	[illegible] PUMP CAVITY DRAIN VENT	—	-350	[illegible]	[illegible]
2	[illegible]	TURBINE START BOTTLE RELIEF & VENT	400	-260	[illegible]	40
3	[illegible]	THRUST CHAMBER [illegible] PURGE & [illegible] SUPPLY [illegible]	—	[illegible]	HE	40
4	[illegible]	TURBINE START [illegible] PRESS & [illegible]	[illegible]	[illegible]	[illegible]	[illegible]
5	[illegible]	[illegible] BOTTLE PRESS [illegible]	3000	[illegible]	HE	40
6	[illegible]	[illegible]	[illegible]	-340	HE	[illegible]
7	[illegible]	[illegible] TANK PRE-PRESS SUPPLY [illegible]	[illegible]	-320	HE	40
8	[illegible]	[illegible] TANK PRE-PRESS & ENGINE [illegible] SUPPLY	[illegible]	AMB	HE	40
9	[illegible]	[illegible] PRESS [illegible] SUPPLY	[illegible]	AMB	HE	40
10	[illegible]	ELECTRICAL [illegible]	—		—	[illegible]
11	[illegible]	LOW PRESS [illegible] SUPPLY	[illegible]	AMB	HE	[illegible]
12	[illegible]	HIGH PRESS [illegible] SUPPLY	3000	AMB	HE	40

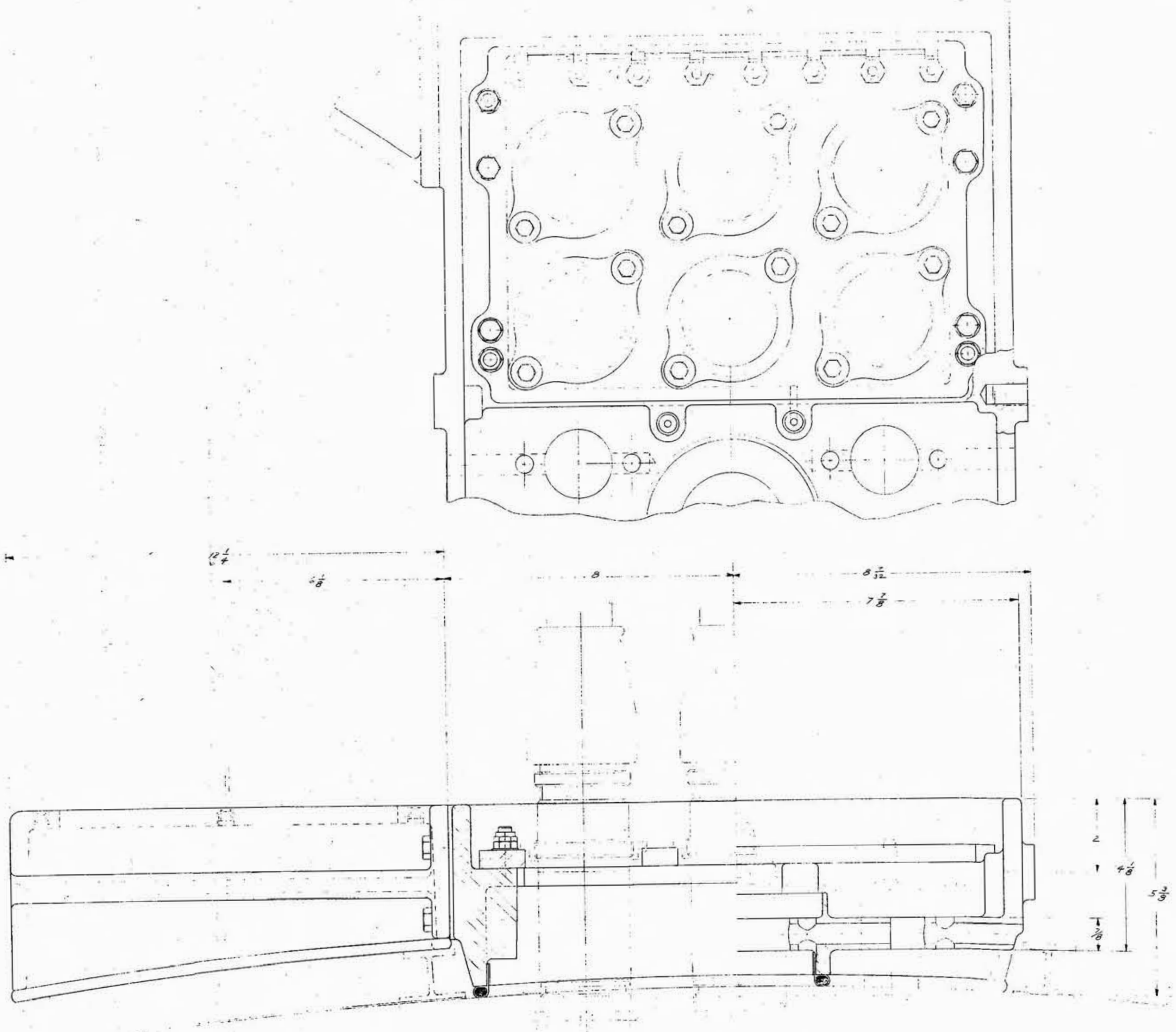
SUBJECT TO CHANGE WITHOUT NOTICE
REFERENCE COPY FOR
ENG. REFERENCE ONLY

PREPARED FOR NASA			DOUGLAS AIRCRAFT COMPANY, INC. SANTA MONICA, CALIFORNIA		
MATL.			LAYOUT, AFT UMBILICAL PLATE S-IVB		
WT CHK					
STR CHK					
CHECK					
PR ENGR					
DES ENGR					
GR ENGR					
PREP BY	[illegible] THOMASON	[illegible]			
DESIGN ACTIVITY APPROVAL			CODE IDENT NO. 18355	SIZE J	1A69183
CUSTOMER APPROVAL			SCALE [illegible]		SHEET 1 OF 2

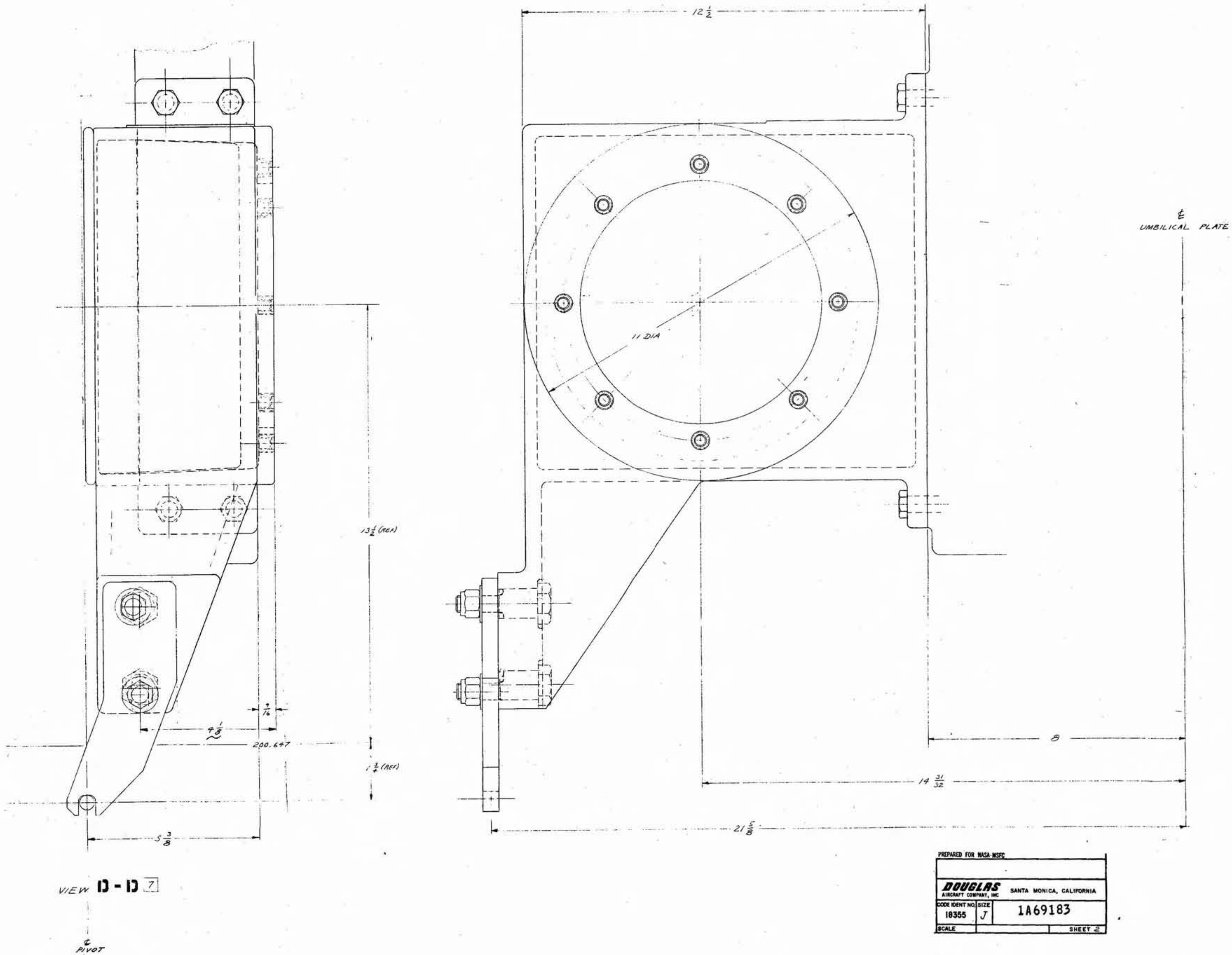


SECTION B-B 5
SCALE: 1/1

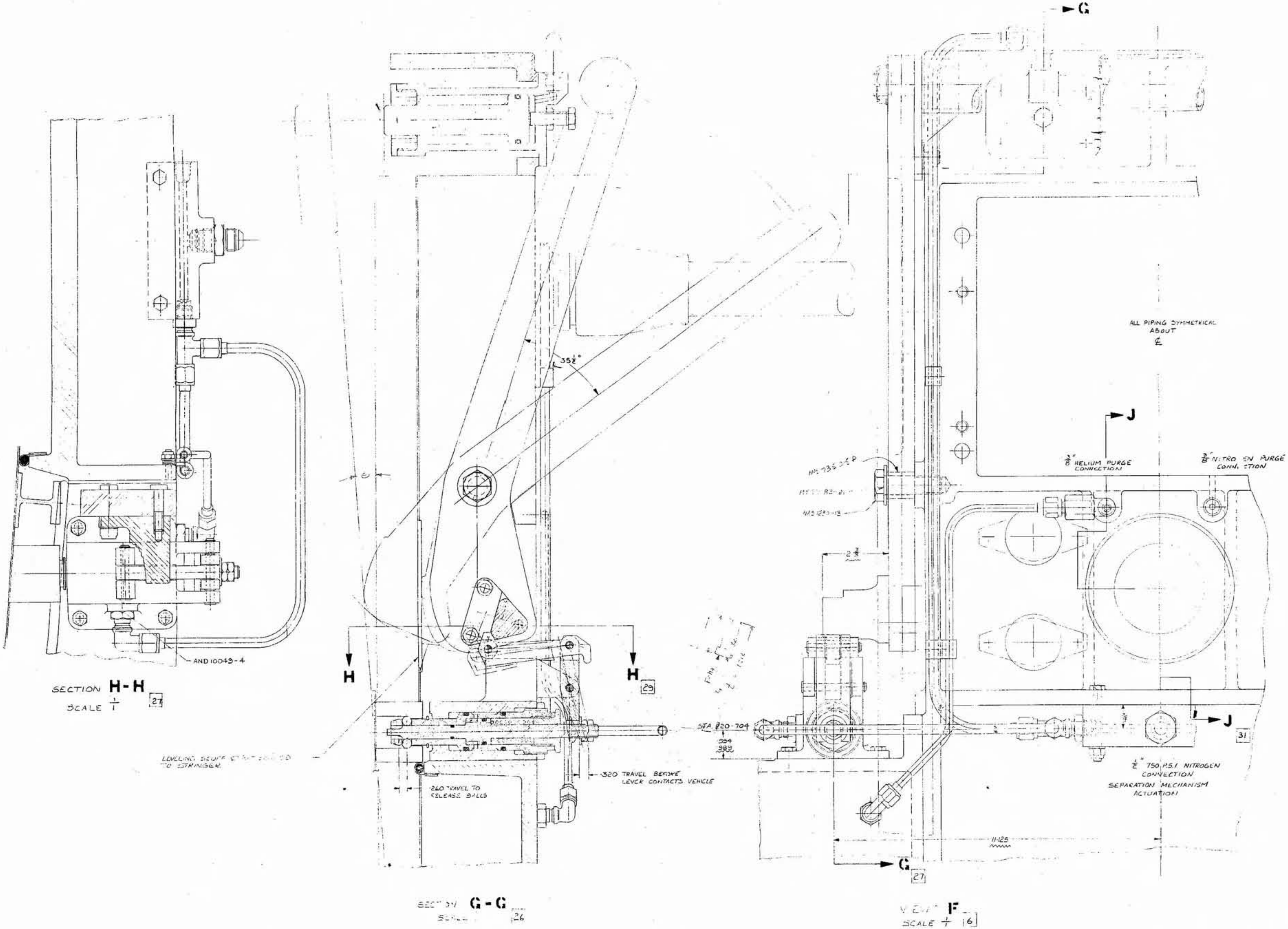


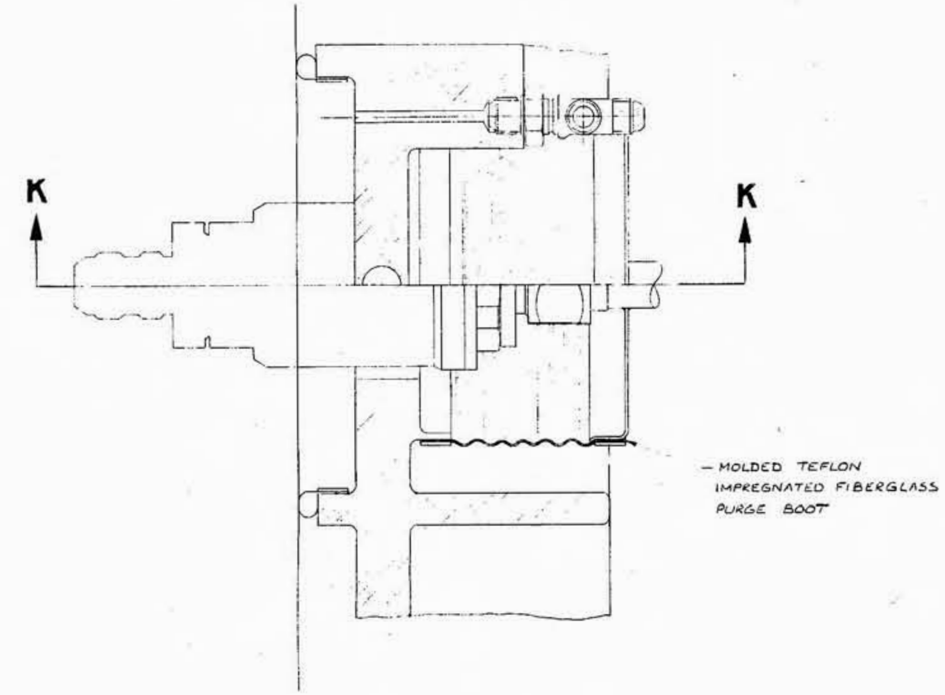


SECTION C-C

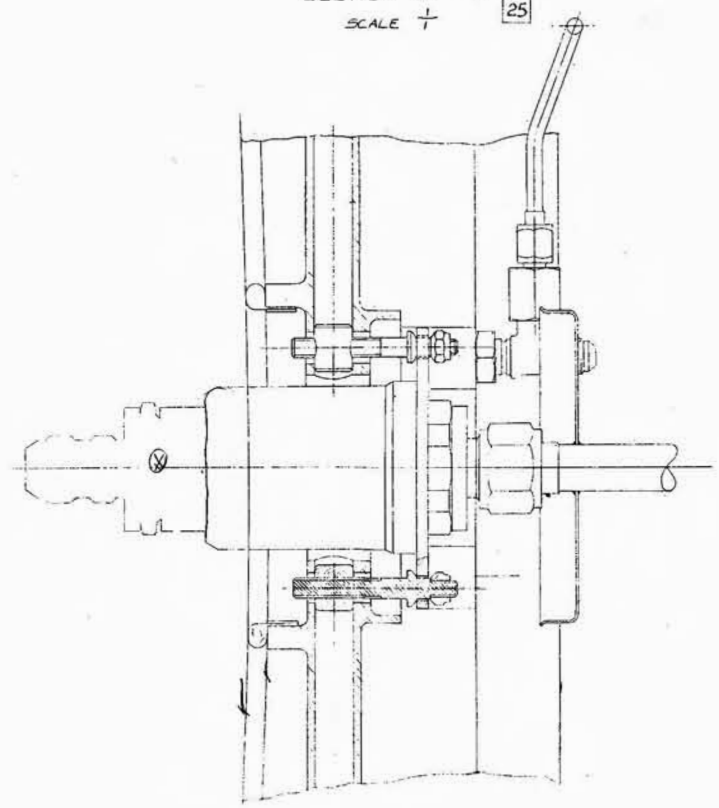


12 1/2
℄ UMBILICAL PLATE
11 DIA
13 1/2 (REF)
1 3/4 (REF)
7/16
4 1/8
200.647
5 3/8
8
14 31/32
21 5/8
VIEW D - D 7
℄ PIVOT
PREPARED FOR NASA-MSFC
DOUGLAS AIRCRAFT COMPANY, INC
SANTA MONICA, CALIFORNIA
CODE IDENT NO. 18355
SIZE J
1A69183
SCALE
SHEET 2

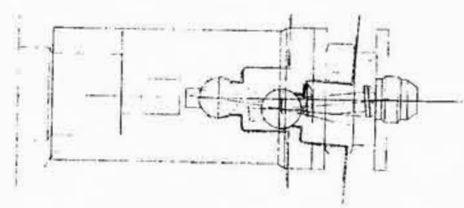

SECTION H-H
SCALE 1/1
27
AND 10049-4
H
H
29
G
G
27
J
J
31
ALL PIPING SYMMETRICAL ABOUT ℄
3/8" HELIUM PURGE CONNECTION
3/8" NITROGEN PURGE CONNECTION
1/2" 750 P.S.I. NITROGEN CONNECTION SEPARATION MECHANISM ACTUATION
.320 TRAVEL BEFORE LEVER CONTACTS VEHICLE
.260 TRAVEL TO RELEASE BALLS
STA. 820.704
11.125
SECTION G-G
26
VIEW F
SCALE 1/1
16



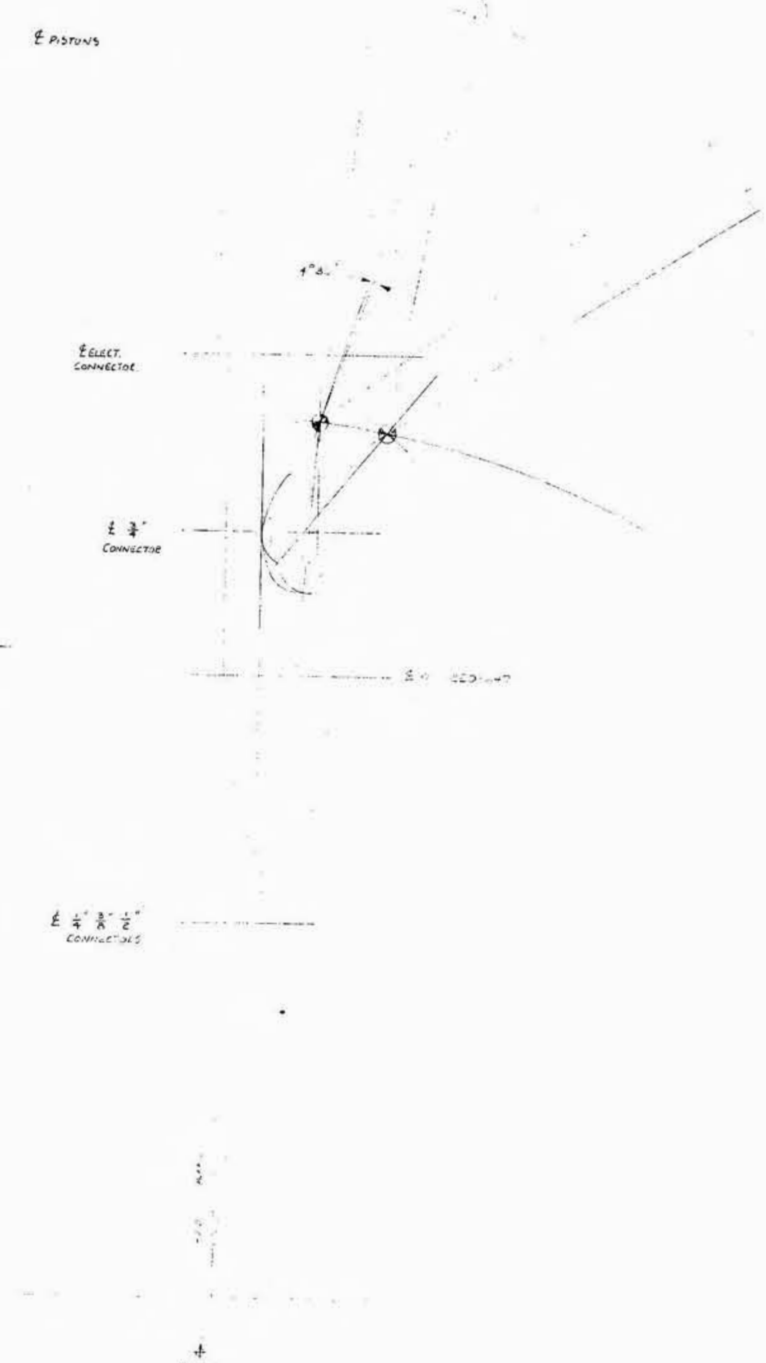
SECTION **J - J** 25
SCALE 1/1



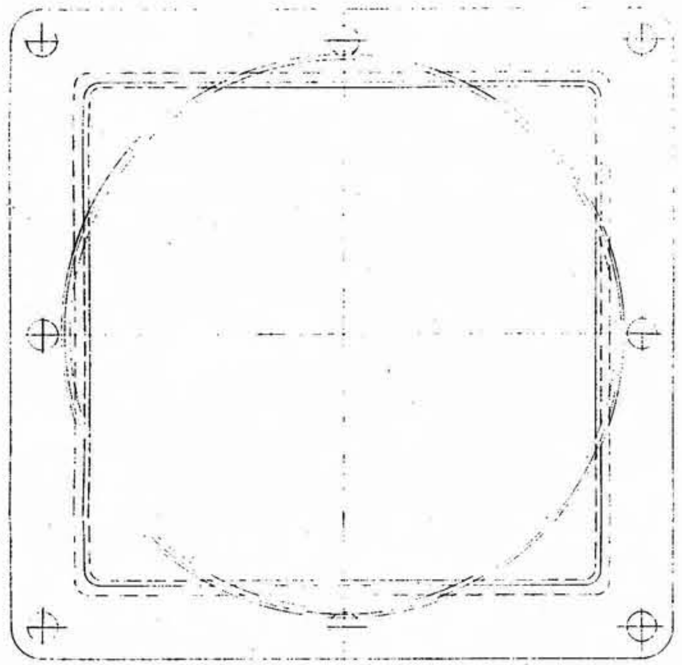
SECTION **K - K** 32
SCALE 1/1
TYPICAL DISCONNECT INSTALLATION
PURGE BOOT OMITTED

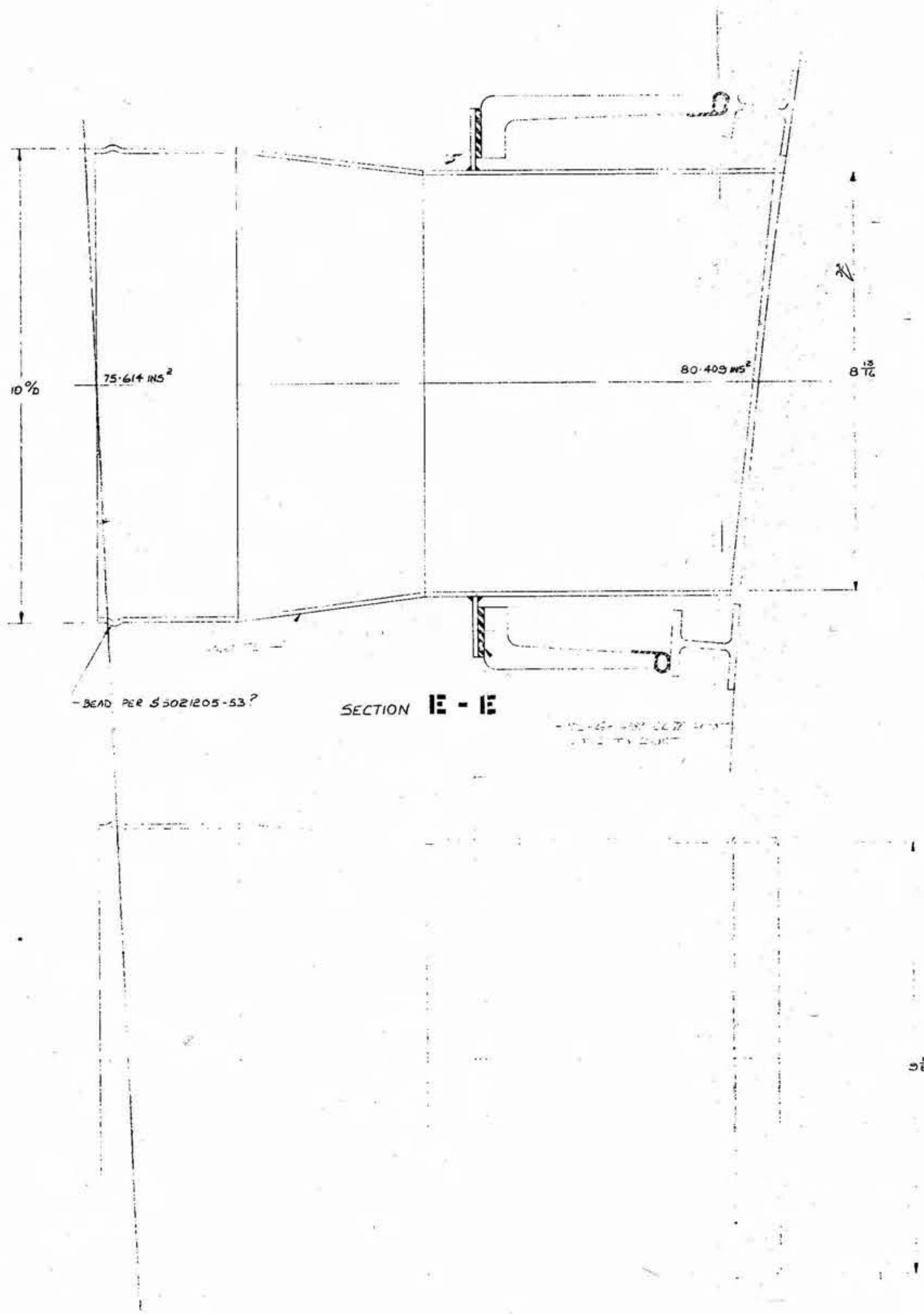


1/2" ℄ SHOWN
WORST SEPARATION MOTION

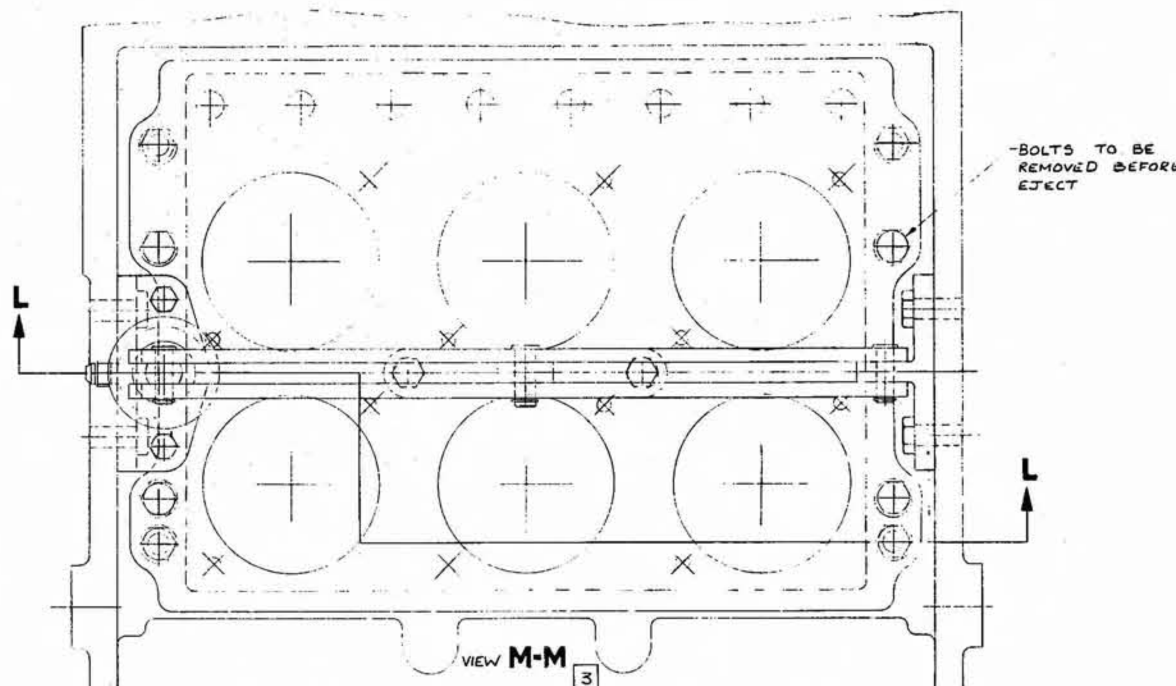


SEPARATION MECHANISM
GEOMETRY
SCALE 1/2



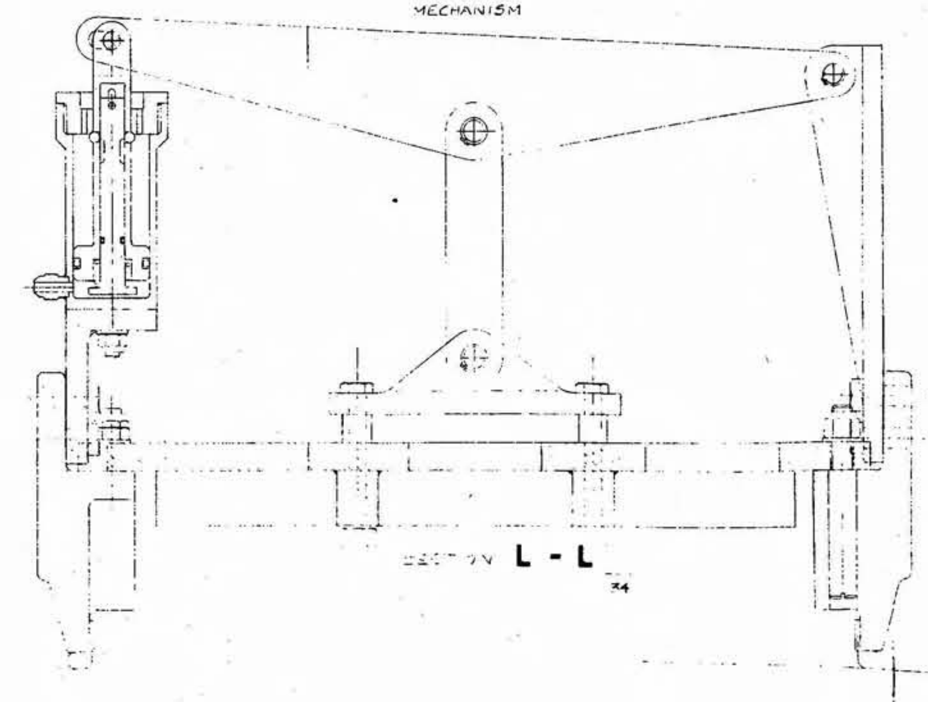


SECTION E - E

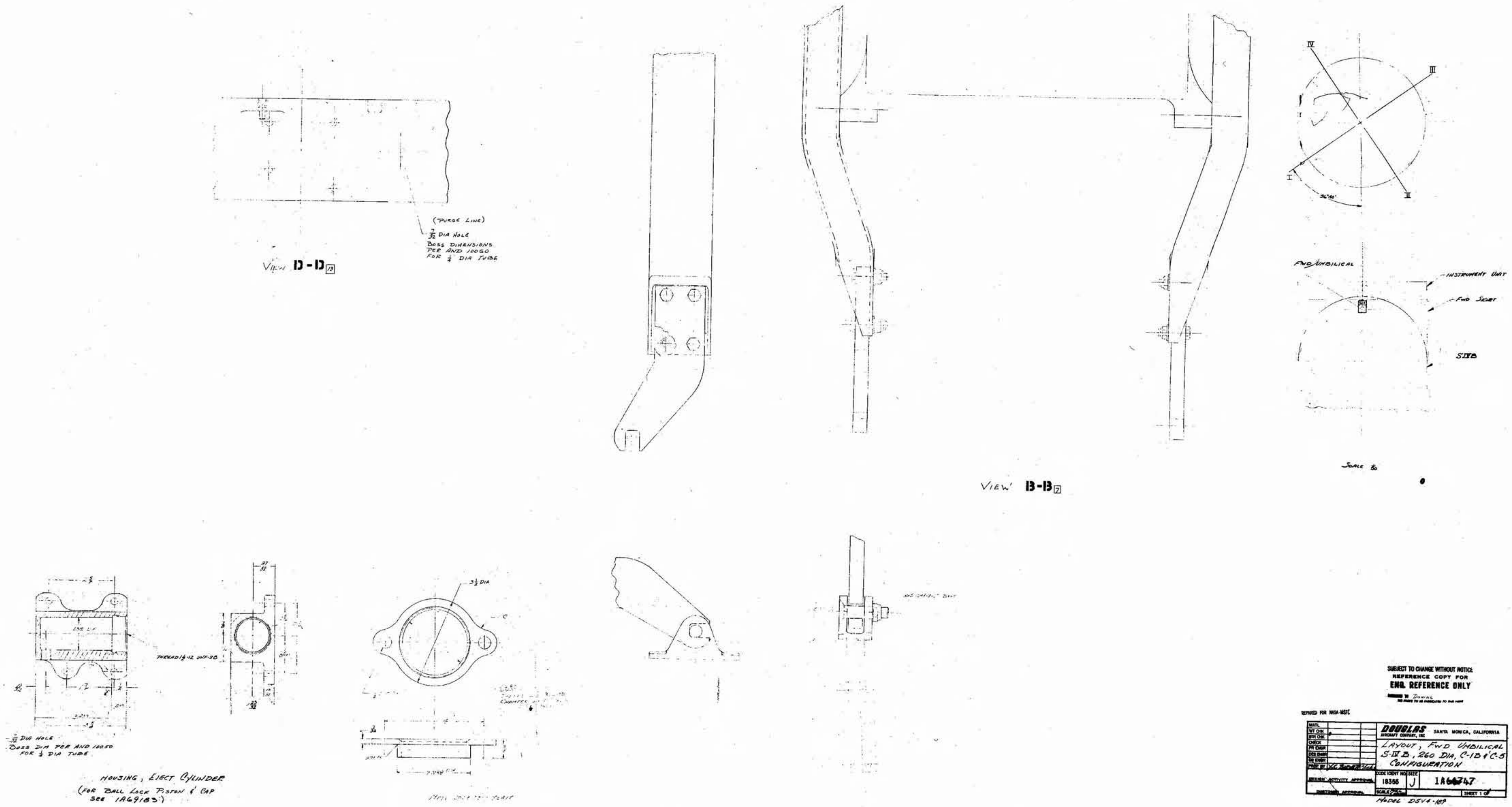


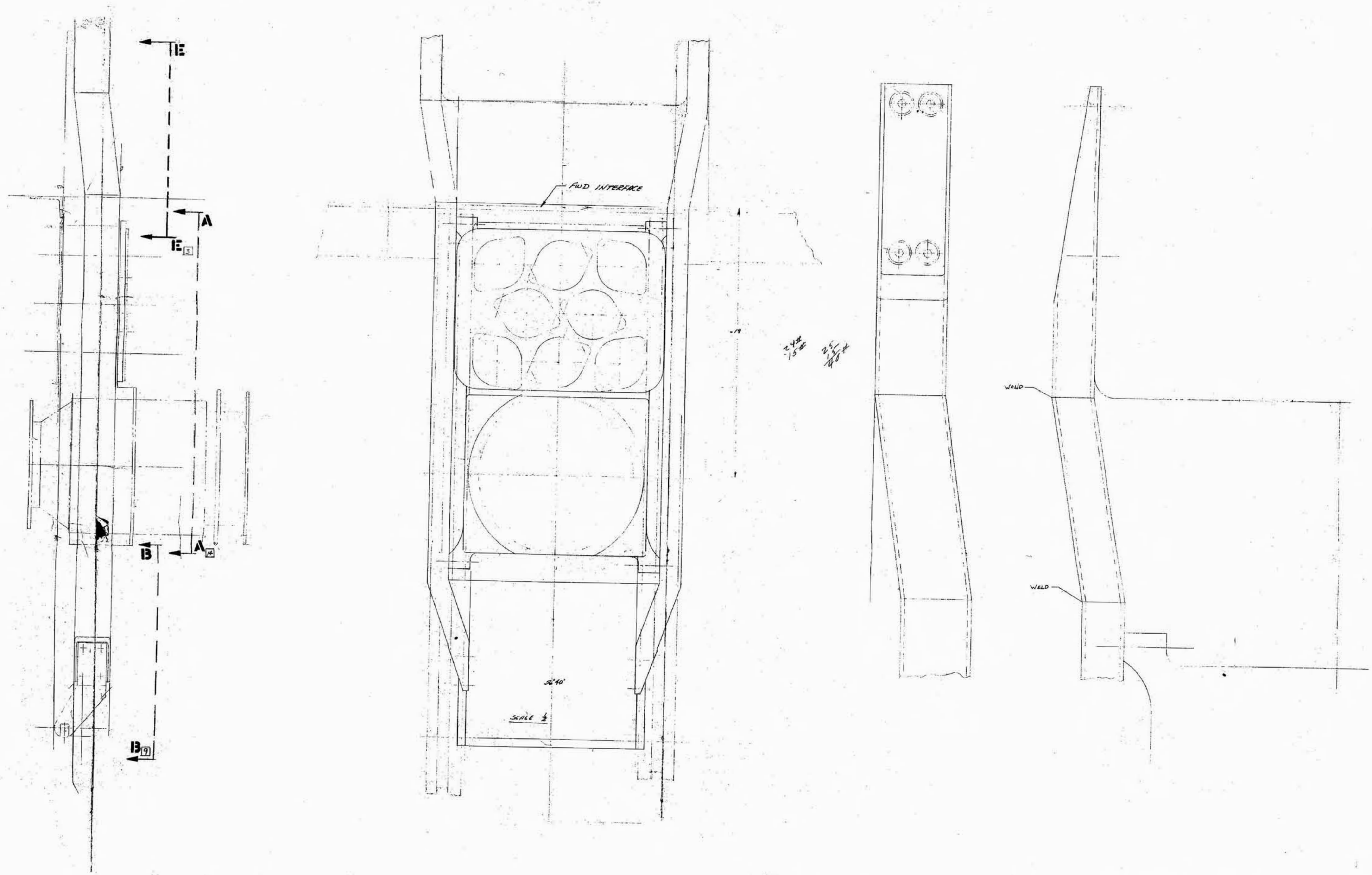
VIEW M-M [3]

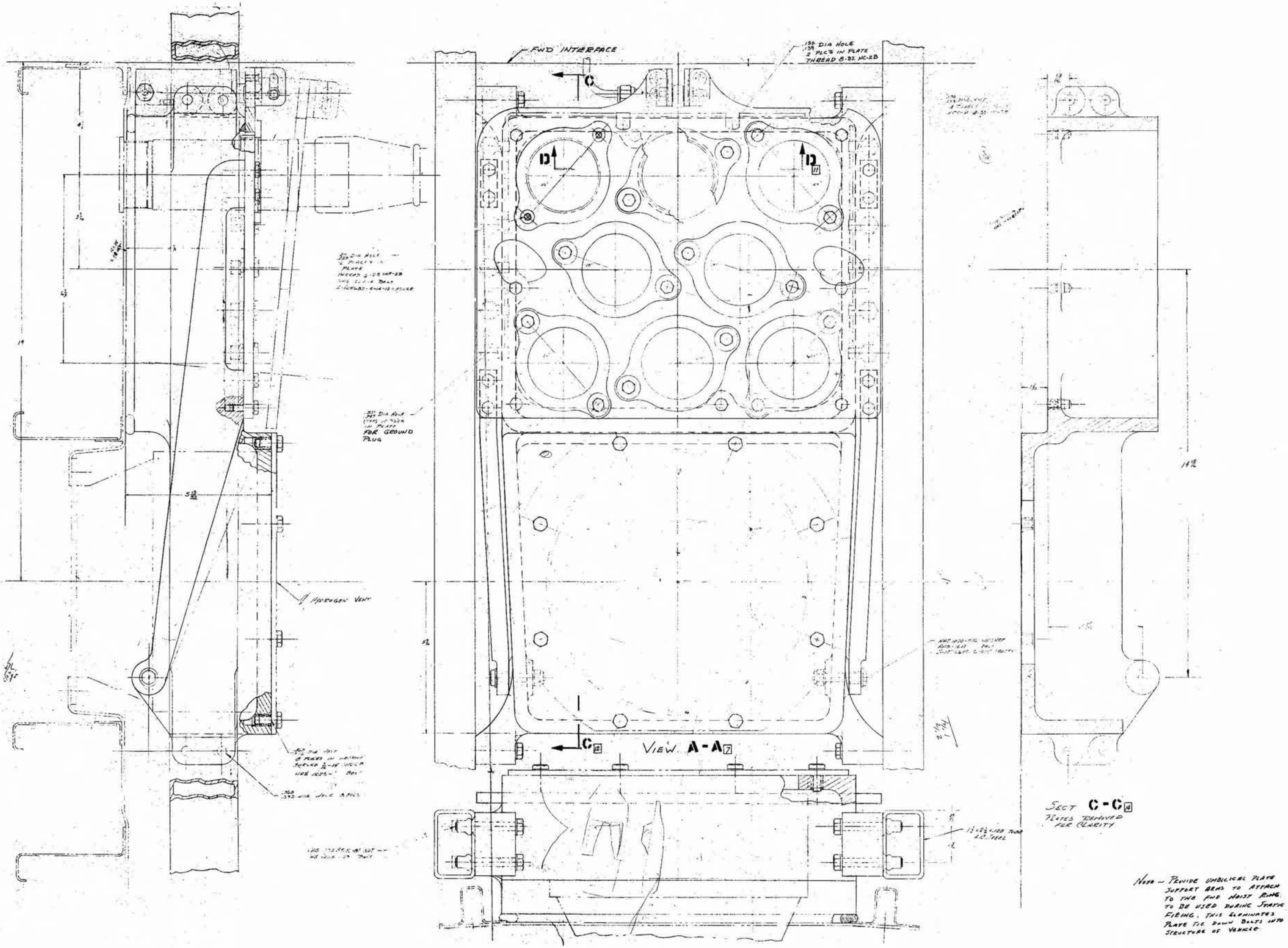
INSTALLATION OF EJECT MECHANISM

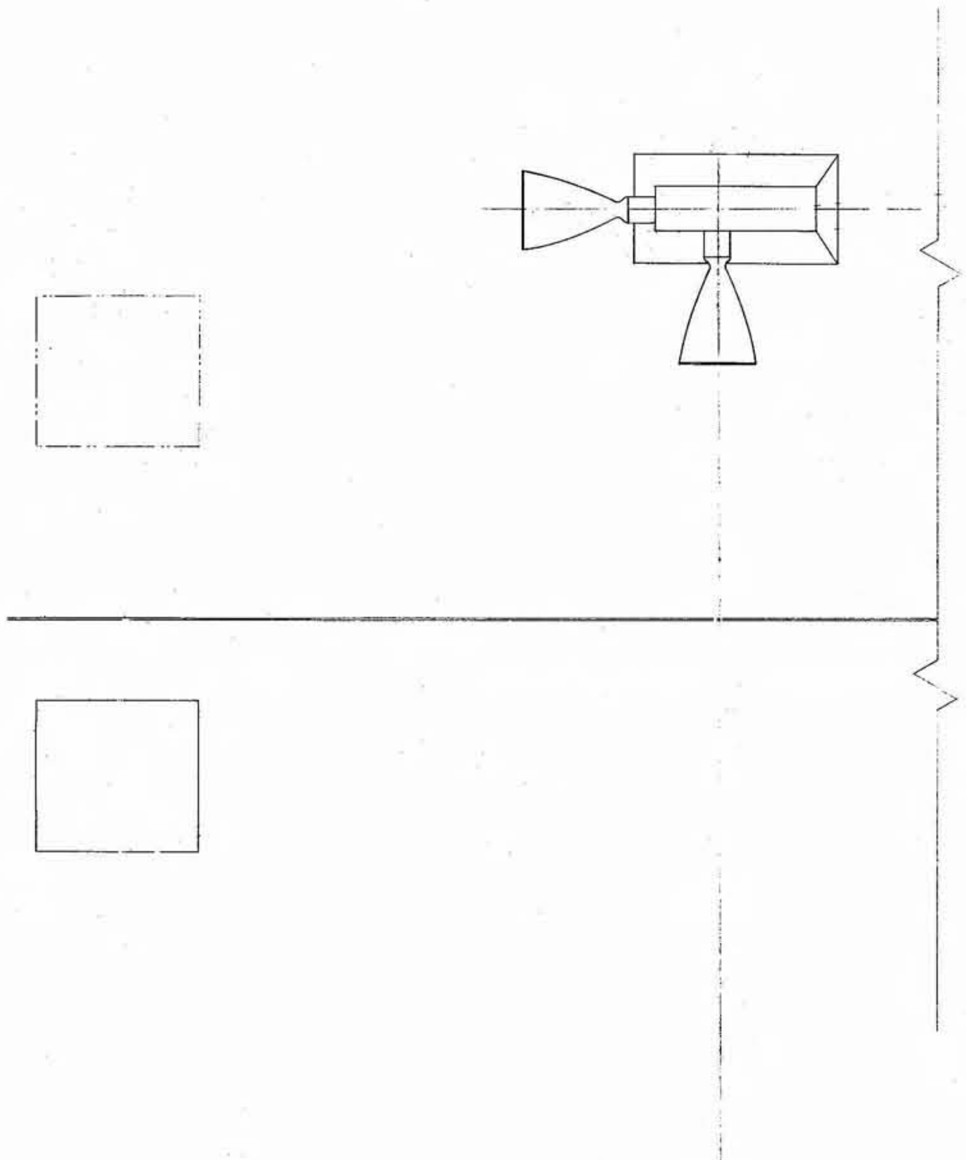


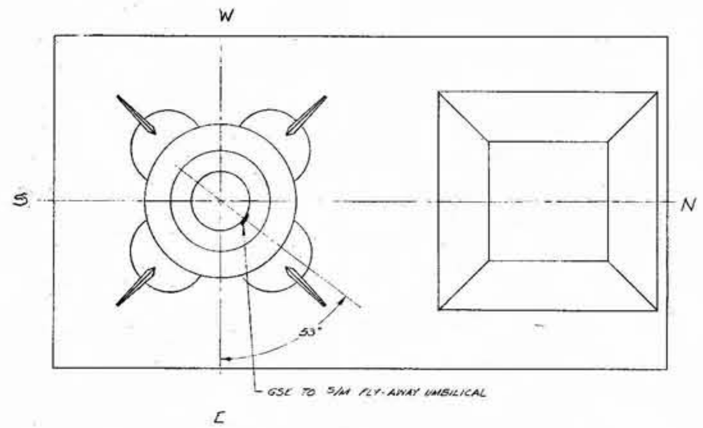
SECTION L - L


(PURGE LINE)
7/32 DIA HOLE
BOSS DIMENSIONS PER AND 10050 FOR 1/4 DIA TUBE
VIEW D-D
VIEW B-B
IV
III
I
II
FWD UMBILICAL
INSTRUMENT UNIT
FWD SKIRT
SIVB
THREAD 1 1/4-12 UNF-2B
3 1/2 DIA
DIA HOLE
BOSS DIM PER AND 10050 FOR 1/4 DIA TUBE
HOUSING, EJECT CYLINDER
(FOR BALL LOCK PISTON & CAP SEE 1A69183)
SUBJECT TO CHANGE WITHOUT NOTICE
REFERENCE COPY FOR
ENG. REFERENCE ONLY
PREPARED FOR NASA-MSFC
MATL
WT CHK
STR CHK
CHECK
PR ENGR
DES ENGR
GR ENGR
PREP BY
DESIGN ACTIVITY APPROVAL
CUSTOMER APPROVAL
DOUGLAS AIRCRAFT COMPANY, INC
SANTA MONICA, CALIFORNIA
LAYOUT, FWD UMBILICAL S-IVB, 260 DIA, C-1B & C-5 CONFIGURATION
CODE IDENT NO 18355
SIZE J
1A64747
SCALE
SHEET 1 OF
MODEL DSV4-189

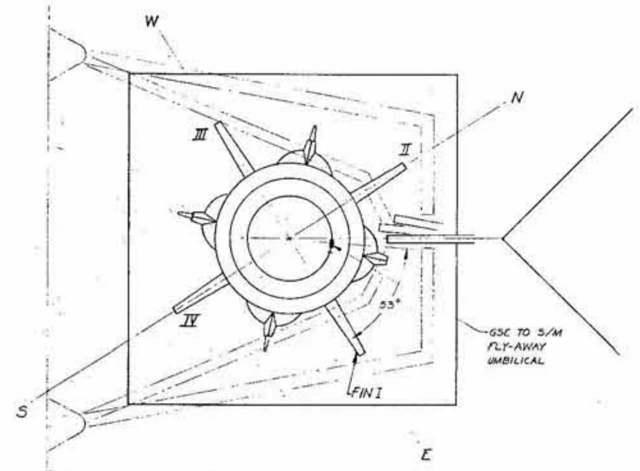

E
A
E
B
A
B
FWD INTERFACE
WELD
WELD


FWD INTERFACE
FOR GROUND PLUG
HYDROGEN VENT
VIEW A-A
SECT C-C
PLATES REMOVED FOR CLARITY
NOTE - PROVIDE UMBILICAL PLATE SUPPORT ARMS TO ATTACH TO THE FWD HOIST RING TO BE USED DURING STATIC FIRING. THIS ELIMINATES PLATE TIE DOWN BOLTS INTO STRUCTURE OF VEHICLE

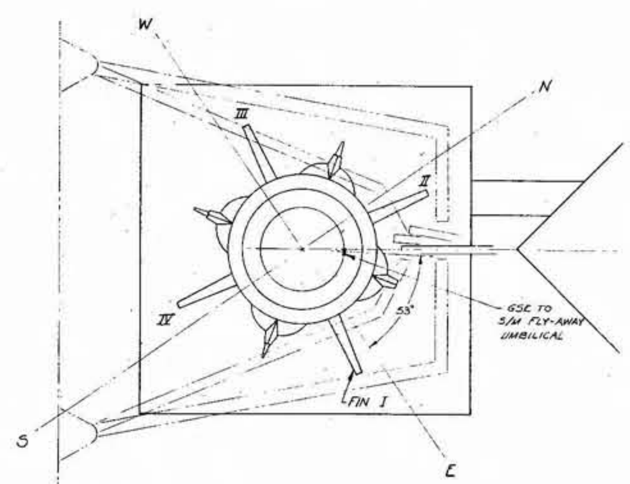




PAD 39



PAD 37

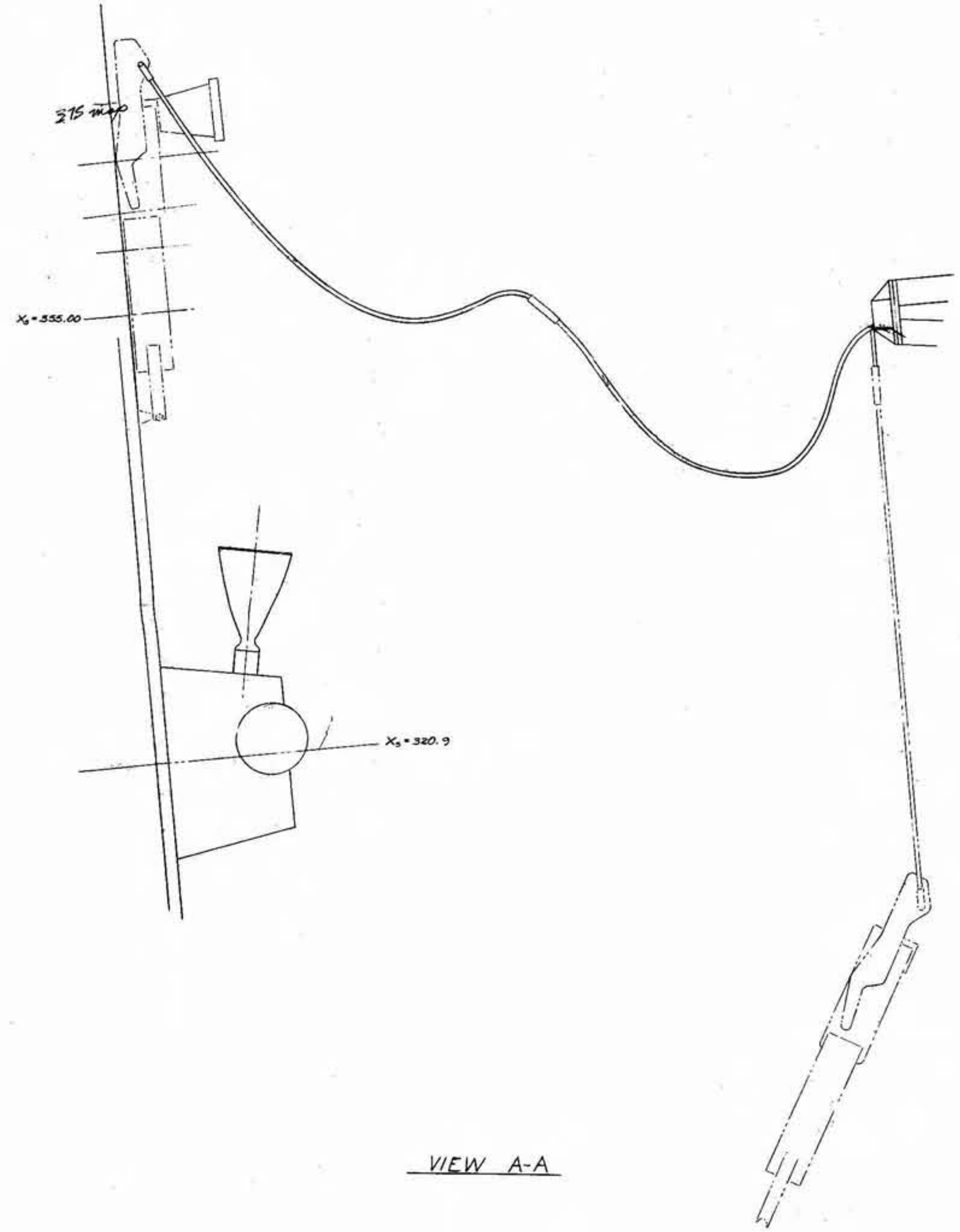


PAD 34

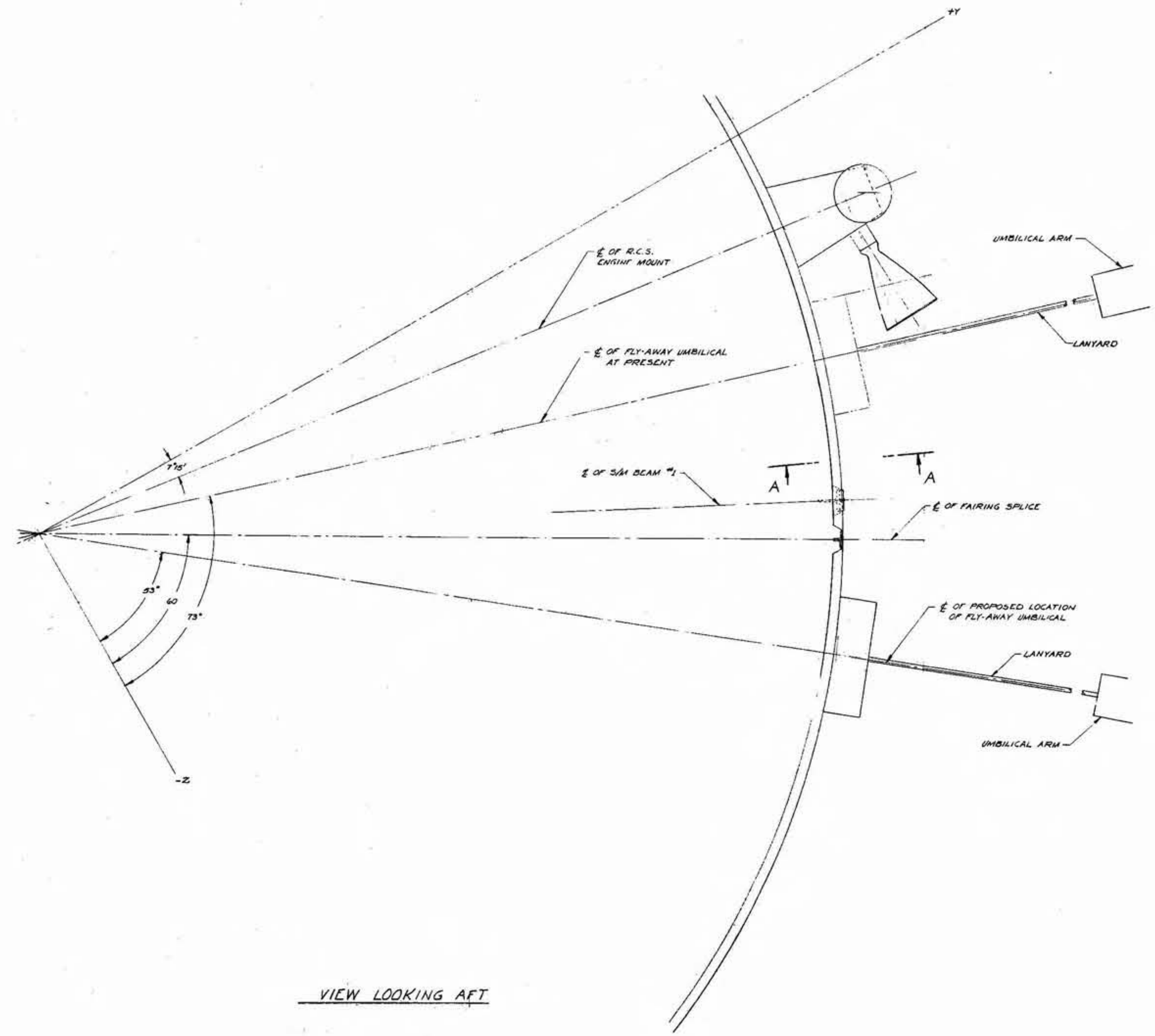
Downs' Copy
S. M.

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES. TOLERANCES ON: DECIMALS .XX = ±.03 .XXX = ±.010 ANGLES ±30' HOLES NOTED "DRILL" .013 THRU .040 : +.001 −.001 .041 THRU .130 : +.002 −.001 .131 THRU .229 : +.003 −.001 .230 THRU .500 : +.004 −.001 .501 THRU .750 : +.005 −.001 .751 THRU 1.000 : +.007 −.001 1.001 THRU 2.000 : +.010 −.001	DR BY	W. HENRY	3-5-63	NORTH AMERICAN AVIATION, INC. SPACE and INFORMATION SYSTEMS DIVISION 12214 LAKEWOOD BLVD., DOWNEY, CALIFORNIA
	CHK BY			PROPOSAL-RELOCATION OF SERVICING UMBILICAL 53° FROM -Z
	APPROVED BY			CODE IDENT NO. 03953 — SIZE J — V17-933411
DO NOT SCALE PRINT				SCALE — SHEET

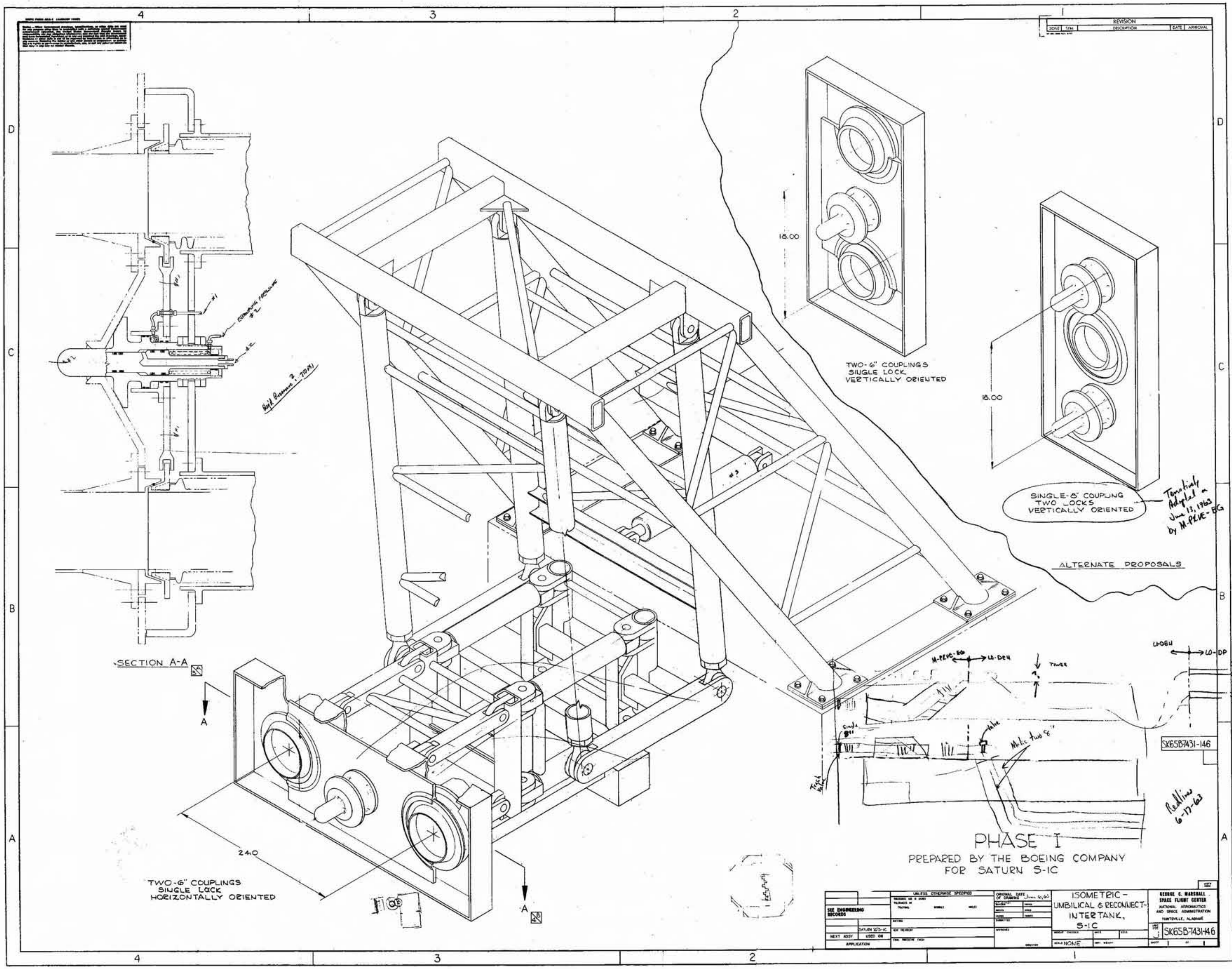
Sheet 1 of 2

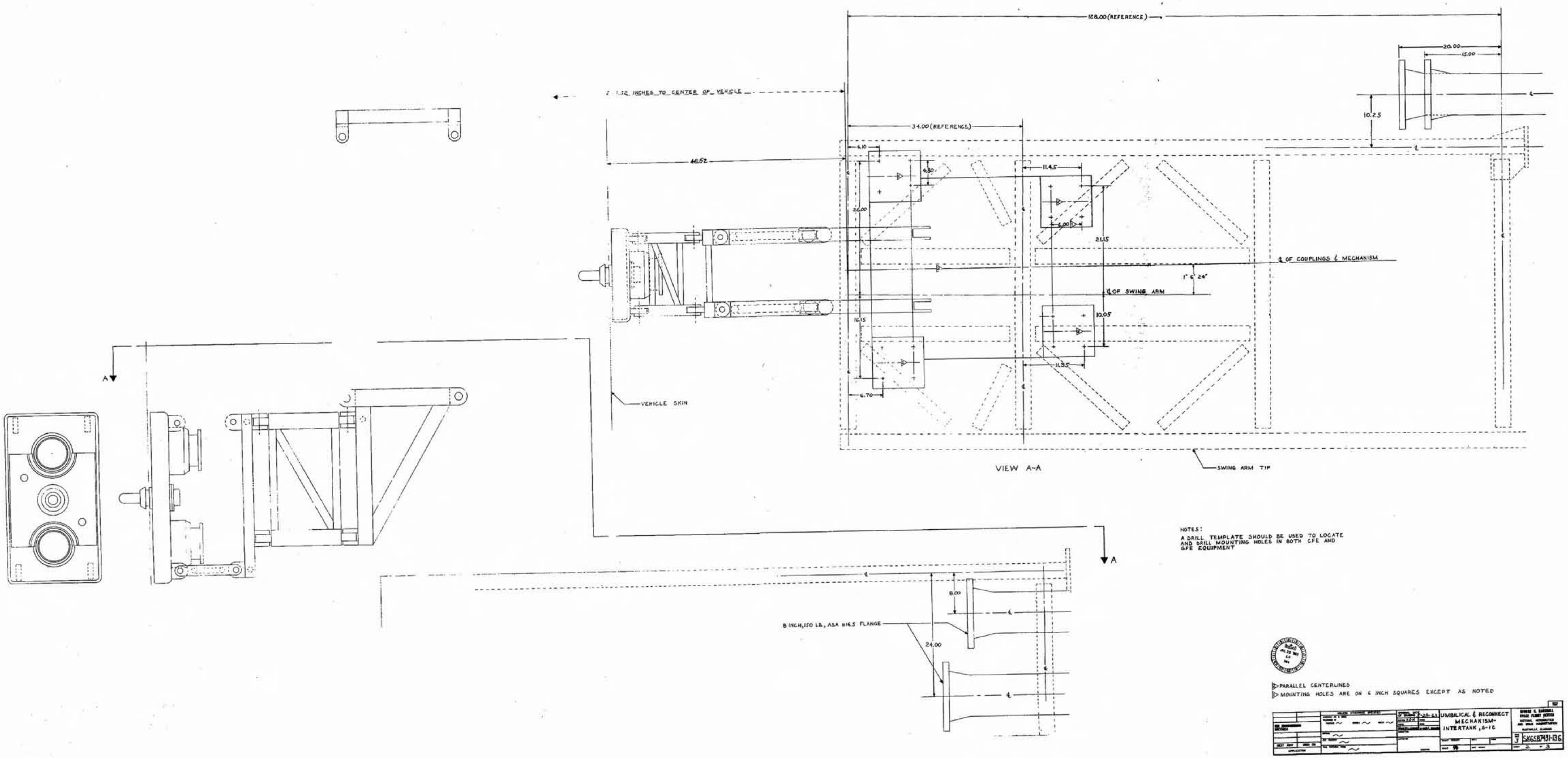


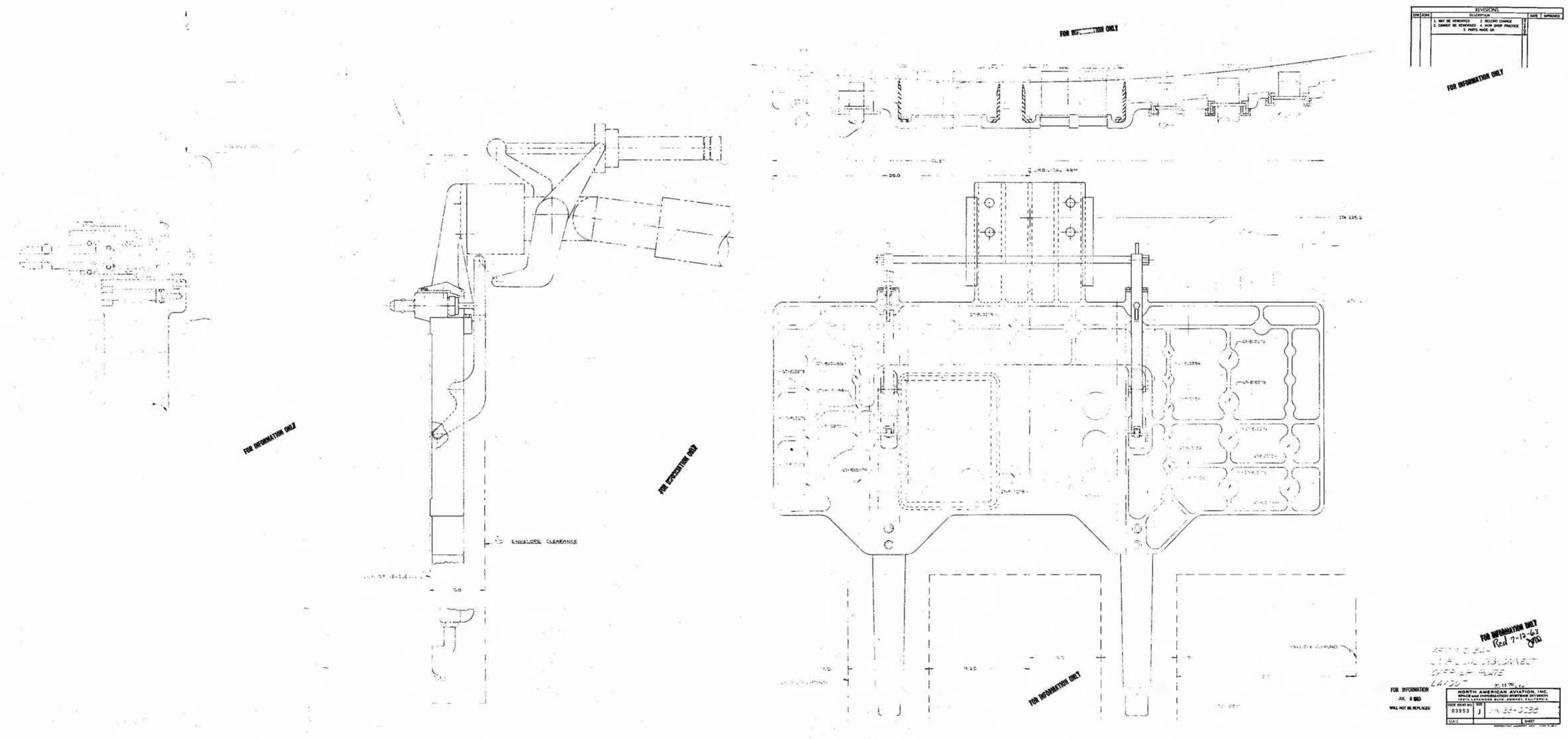
VIEW A-A

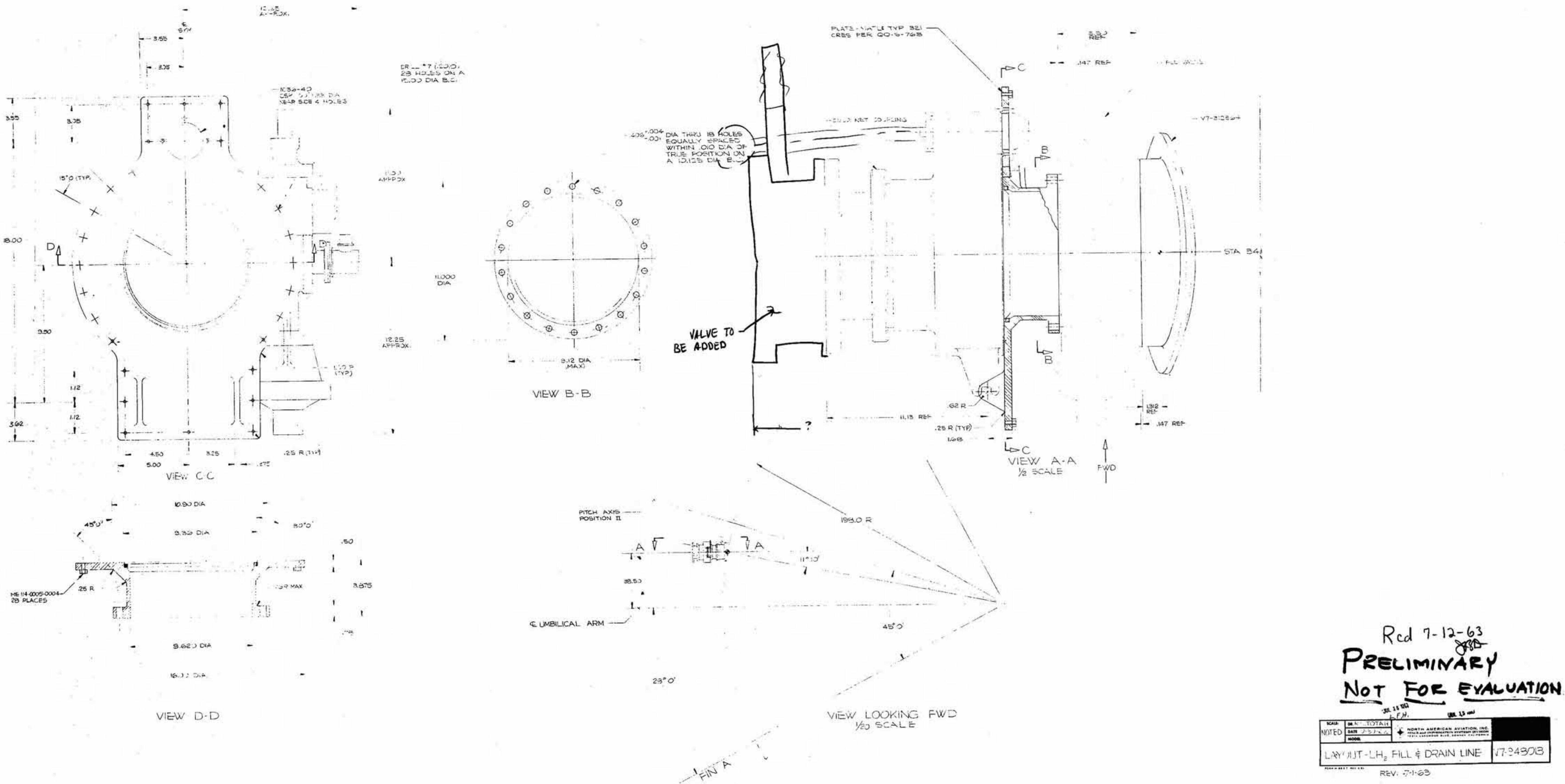


+Y
-Z
53°
60
73°
℄ OF R.C.S. ENGINE MOUNT
℄ OF FLY-AWAY UMBILICAL AT PRESENT
℄ OF S/M BEAM
A
℄ OF FAIRING SPLICE
℄ OF PROPOSED LOCATION OF FLY-AWAY UMBILICAL
UMBILICAL ARM
LANYARD
LANYARD
UMBILICAL ARM
VIEW LOOKING AFT

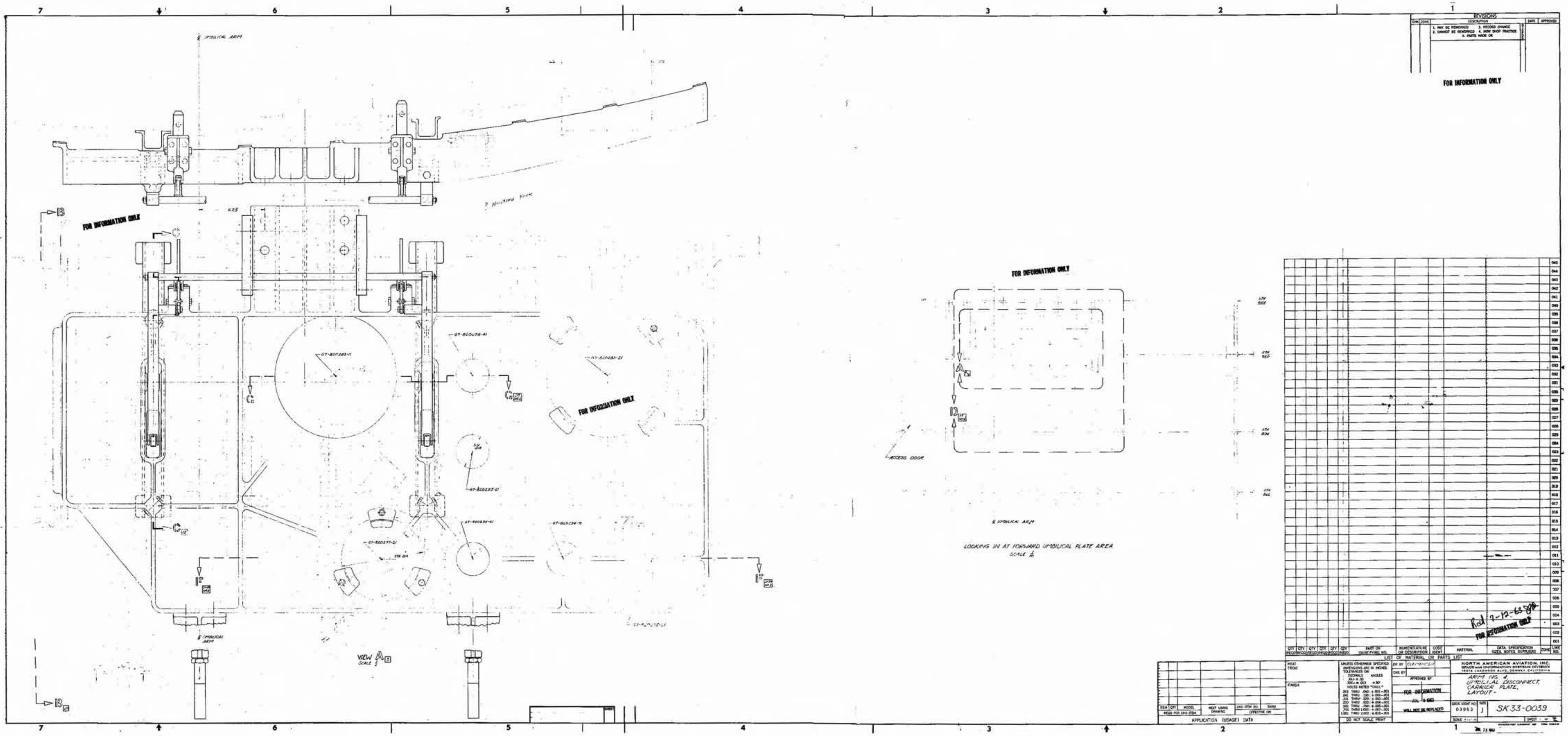

SECTION A-A
TWO-6" COUPLINGS
SINGLE LOCK
HORIZONTALLY ORIENTED
24.0
TWO-6" COUPLINGS
SINGLE LOCK
VERTICALLY ORIENTED
18.00
SINGLE-6" COUPLING
TWO LOCKS
VERTICALLY ORIENTED
Tentatively Adopted on June 13, 1963 by M-P&VE-EG
ALTERNATE PROPOSALS
REVISION
SK65B7431-146
Redline 6-17-63
PHASE I
PREPARED BY THE BOEING COMPANY
FOR SATURN S-IC
UNLESS OTHERWISE SPECIFIED
SEE ENGINEERING RECORDS
SATURN 323-IC
NEXT ASSY
USED ON
APPLICATION
ORIGINAL DATE OF DRAWING June 6, 63
ISOMETRIC -
UMBILICAL & RECONNECT-
INTERTANK,
S-IC
SCALE NONE
GEORGE C. MARSHALL SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUNTSVILLE, ALABAMA
SK65B7431-146

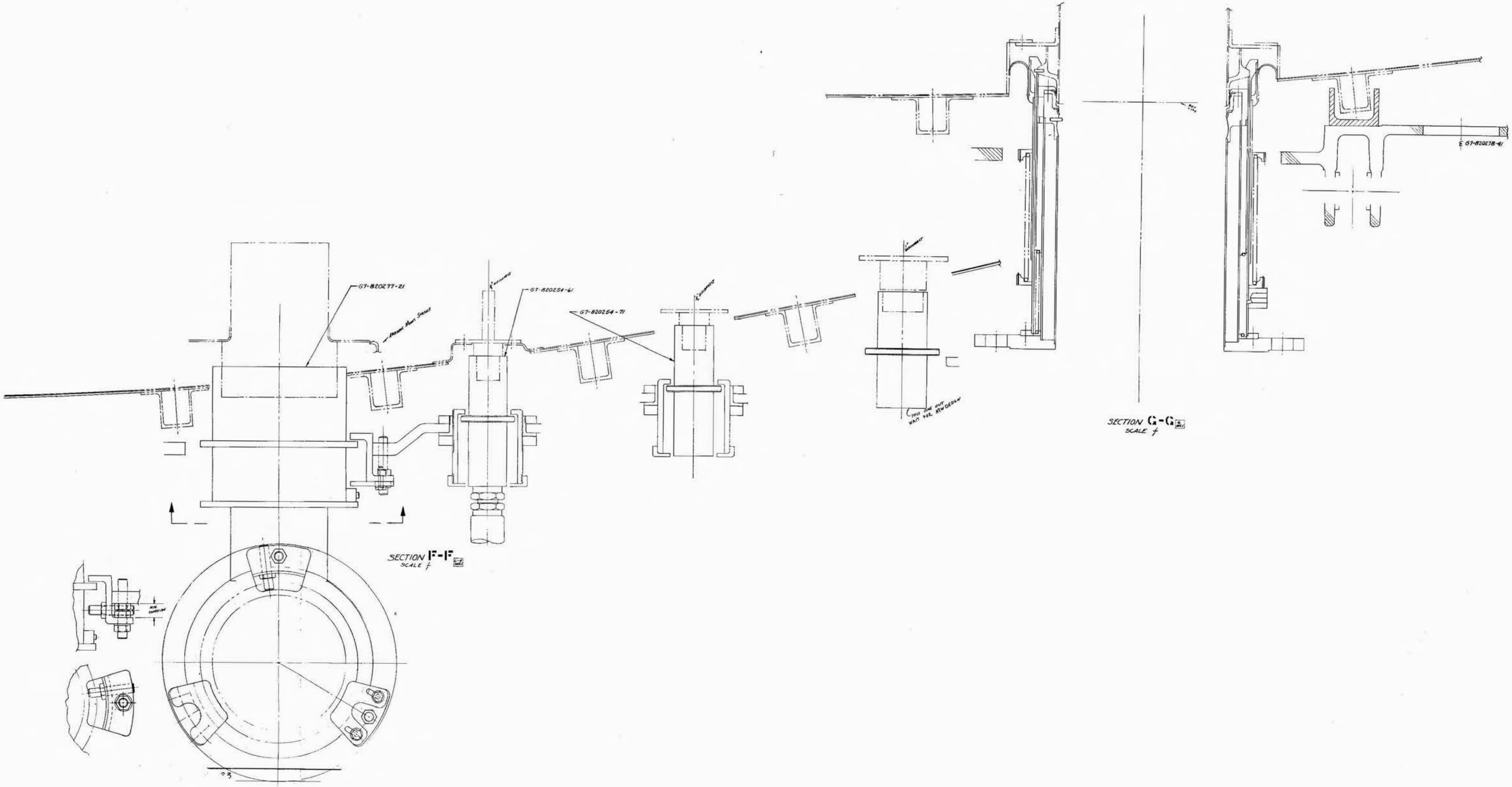

128.00 (REFERENCE)
20.00
15.00
10.25
INCHES TO CENTER OF VEHICLE
34.00 (REFERENCE)
46.52
6.10
4.50
11.45
26.00
6.00
21.15
℄ OF COUPLINGS ℄ MECHANISM
1' 6 24"
℄ OF SWING ARM
10.05
16.15
11.35
6.70
VEHICLE SKIN
VIEW A-A
SWING ARM TIP
A
NOTES:
A DRILL TEMPLATE SHOULD BE USED TO LOCATE AND DRILL MOUNTING HOLES IN BOTH CFE AND GFE EQUIPMENT
8.00
8 INCH, 150 LB., ASA B16.5 FLANGE
24.00
PARALLEL CENTERLINES
MOUNTING HOLES ARE ON 6 INCH SQUARES EXCEPT AS NOTED
UMBILICAL & RECONNECT MECHANISM-INTERTANK, S-IC
SK65B7431-136
2 of 3


REVISIONS
FOR INFORMATION ONLY
ENVELOPE CLEARANCE
UMBILICAL ARM
25.0
FOR INFORMATION ONLY
Red 7-12-63
LAYOUT
FOR INFORMATION
JUL 1963
WILL NOT BE REPLACED
NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION
CODE IDENT NO
03953
SIZE
J
SCALE
SHEET



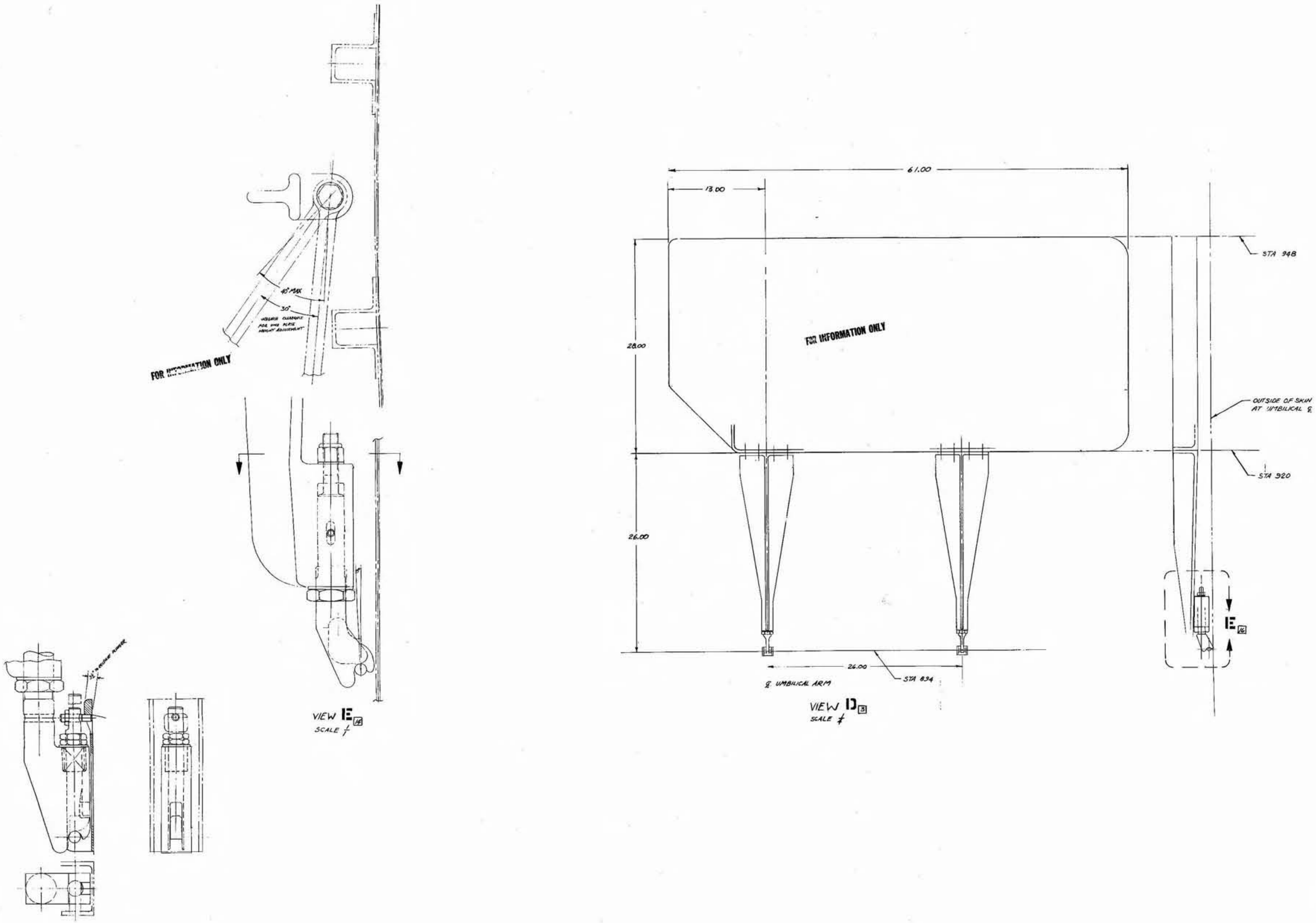
VIEW C-C
VIEW B-B
VIEW D-D
VIEW A-A
½ SCALE
VIEW LOOKING FWD
1/20 SCALE
VALVE TO BE ADDED
PITCH AXIS POSITION II
℄ UMBILICAL ARM
199.0 R
45°0'
23°0'
FIN A
FWD
Rcd 7-12-63
PRELIMINARY
NOT FOR EVALUATION
NORTH AMERICAN AVIATION, INC.
LAYOUT-LH2 FILL & DRAIN LINE
V7-248018
REV. 7-1-63


FOR INFORMATION ONLY
LOOKING IN AT FORWARD UMBILICAL PLATE AREA
ACCESS DOOR
VIEW A
REVISIONS
LIST OF MATERIAL OR PARTS LIST
APPLICATION (USAGE) DATA
UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES.
DO NOT SCALE PRINT
WILL NOT BE REPLACED
NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION
ARM NO. 4, UMBILICAL DISCONNECT, CARRIER PLATE, LAYOUT-
03953
J
SK 33-0039


GT-820277-21
GT-820254-61
GT-820254-71
GT-820278-41
SECTION F-F
SCALE ¼
SECTION G-G
SCALE ¼

REVISIONS					
SYM	ZONE	DESCRIPTION	DISPOS	DATE	APPROVED
		1. MAY BE REWORKED 3. RECORD CHANGE 2. CANNOT BE REWORKED 4. NOW SHOP PRACTICE 5. PARTS MADE OK			

FOR INFORMATION ONLY



Rcd 7-12-63

FOR INFORMATION ONLY

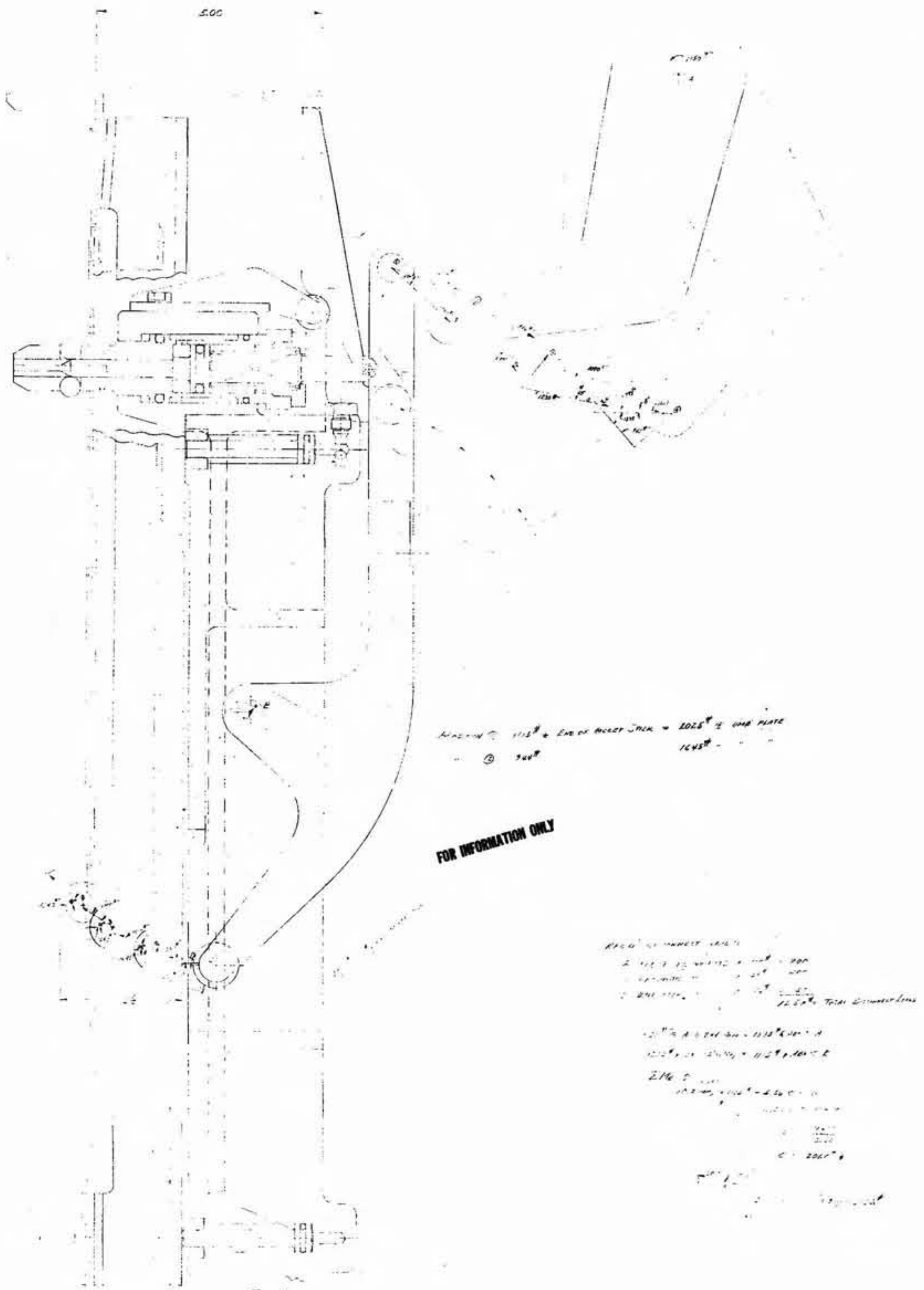
JUL 15 1963
L.F.H.

ARM NO. 4,
UMBILICAL DISCONNECT
CARRIER PLATE,
LAYOUT-

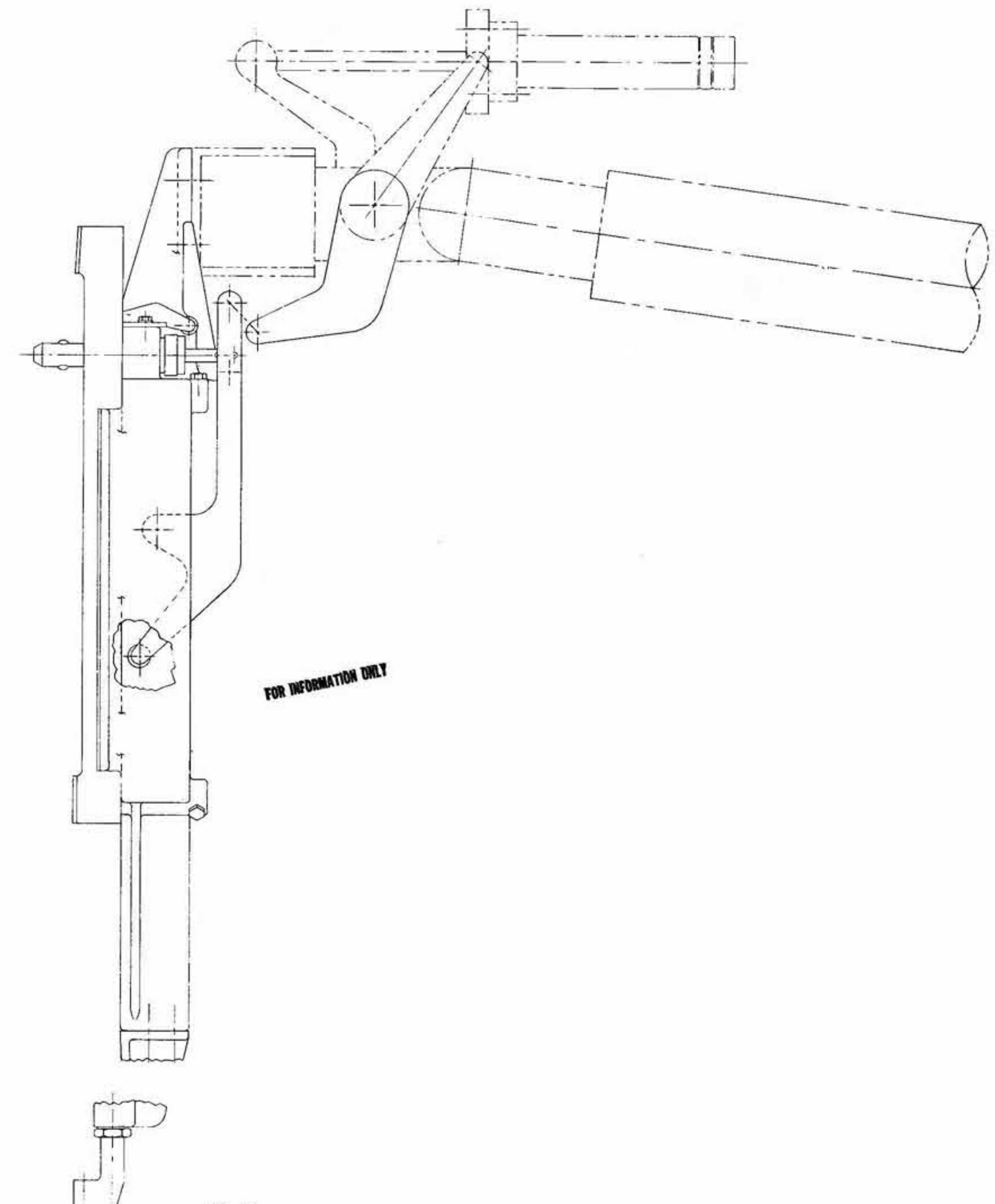
FOR INFORMATION
JUL 2 1963
WILL NOT BE REPLACED

NORTH AMERICAN AVIATION, INC. SPACE and INFORMATION SYSTEMS DIVISION 12214 LAKEWOOD BLVD., DOWNEY, CALIFORNIA		
CODE IDENT NO. 03953	SIZE J	SK33-0039
SCALE		SHEET 2 OF 2

Sheet 1 of 2

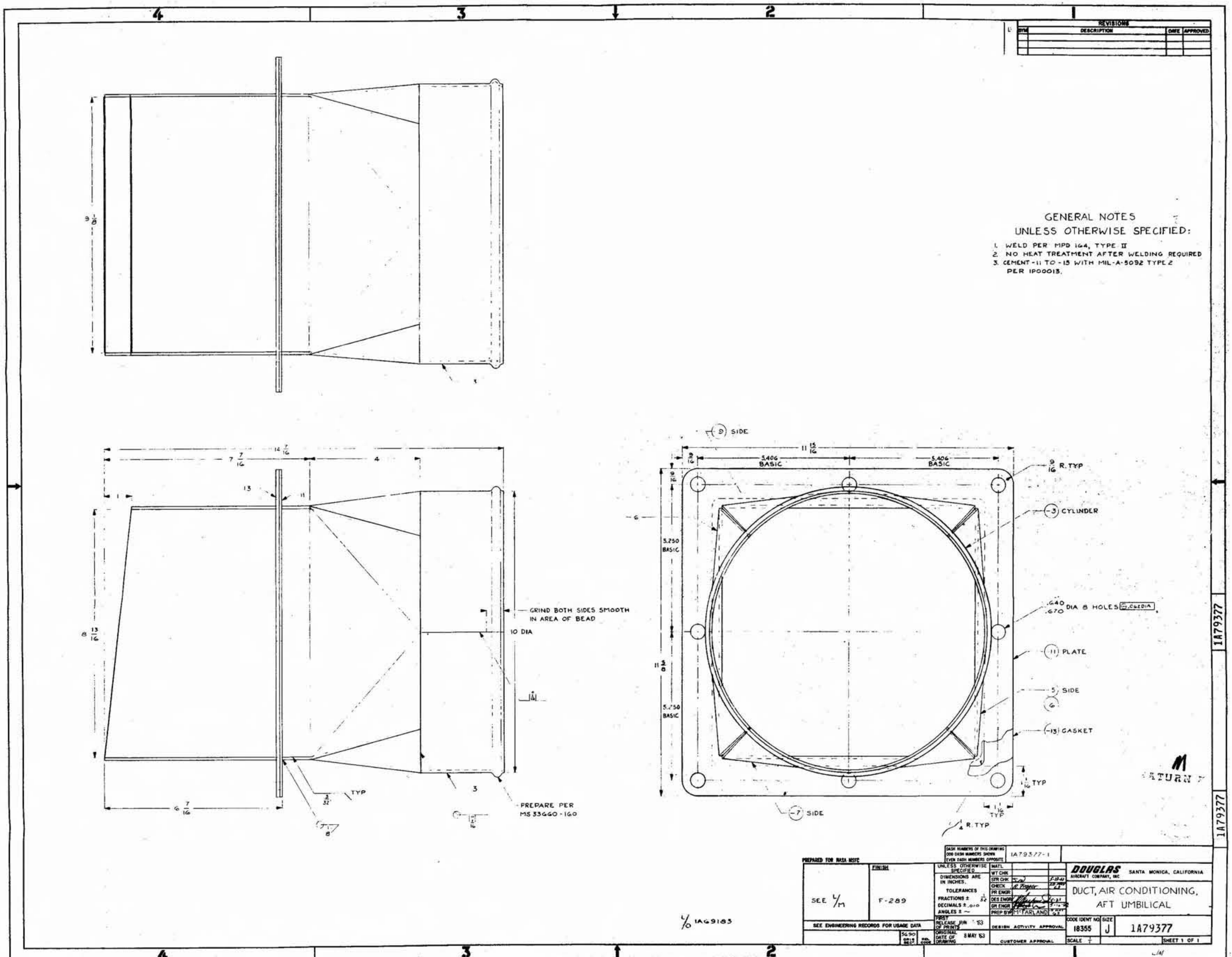


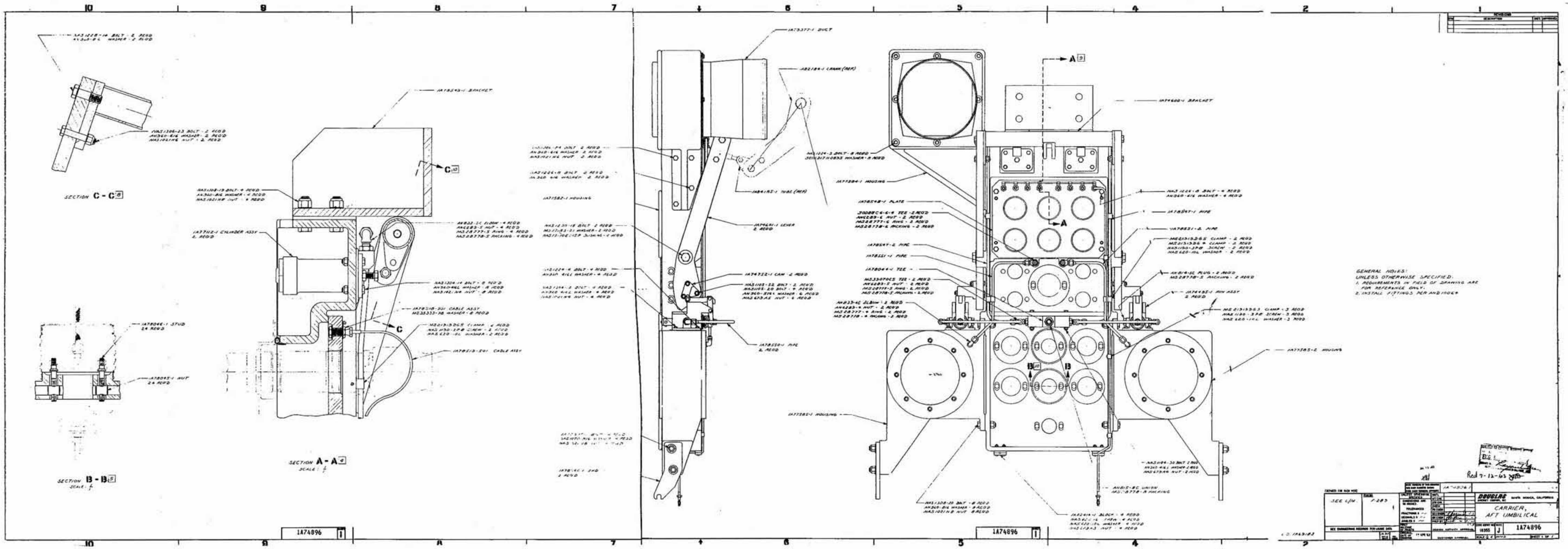
SECTION G-G
SCALE 1/2

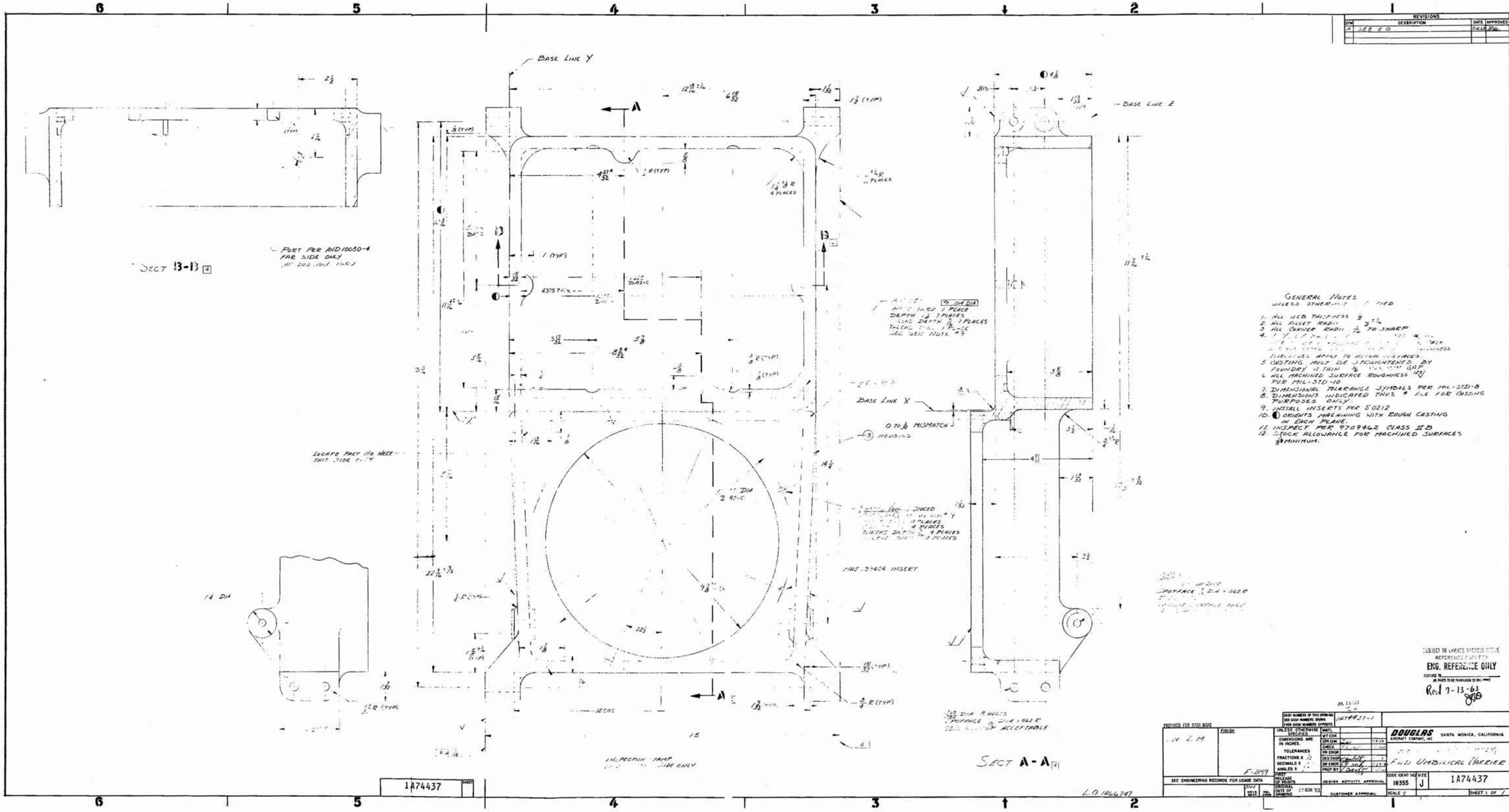


VIEW B-B
SCALE 1/2


SECTION C-C
SECTION B-B
SECTION F-F
SECTION E-E
VIEW D-D
SECTION A-A
GENERAL NOTES:
UNLESS OTHERWISE SPECIFIED:
1. CASTING IS CLASS IIB PER 3709462
2. DRAFT ANGLE 1° MAX
3. ALL WEB THICKNESS 1/2
4. ALL FILLET RADII 1/4
5. ALL EDGE RADII ... 1/8
6. CASTING MUST BE STRAIGHTENED BY FOUNDRY WITHIN 1/16 IN 12 INCHES
7. 1/16 STOCK ALLOWANCE FOR MACHINED SURFACES
8. X, Y, & Z BASE LINES ARE THEORETICAL & ARE ESTABLISHED BY THE NOMINAL CAST SURFACES NOTED, EXCLUSIVE OF DRAFT. STRAIGHTNESS TOLERANCES APPLY TO ACTUAL SURFACES.
9. TOLERANCE SYMBOLS PER MIL-STD-8
10. ALL MACHINED SURFACE ROUGHNESS 125 PER MIL-STD-10
11. ORIENTS MACHINING WITH ROUGH CASTING IN EACH PLANE
12. MACHINE FILLET RADII 1/8
13. INSTALL INSERTS PER SO212
14. INDICATES TOOLING POINTS
15. DECREASE 1/2 R AS REQUIRED IN AREA OF BOSS TO MAINTAIN BOSS HEIGHT & 1/16 R
SUBJECT TO CHANGE WITHOUT NOTICE
REFERENCE COPY FOR
ENG. REFERENCE ONLY
Rec'd 7-12-63
PREPARED FOR NASA ...
MATERIAL
FINISH
F-289
SEE ENGINEERING RECORDS FOR USAGE DATA
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES.
TOLERANCES
FRACTIONS ± 1/32
DECIMALS ± .010
ANGLES ± 1°
DASH NUMBERS OF THIS DRAWING ODD DASH NUMBERS SHOWN EVEN DASH NUMBERS OPPOSITE
PART OR IDENTIFYING NO.
1A74430-1
DESIGN ACTIVITY APPROVAL
CUSTOMER APPROVAL
DOUGLAS AIRCRAFT COMPANY, INC SANTA MONICA, CALIFORNIA
HOUSING, UMBILICAL CARRIER, AFT
CODE IDENT NO 18355
SIZE J
1A74430
SHEET 1 OF 1


REVISIONS
SYM
DESCRIPTION
DATE
APPROVED
GENERAL NOTES
UNLESS OTHERWISE SPECIFIED:
1. WELD PER MPD 164, TYPE II
2. NO HEAT TREATMENT AFTER WELDING REQUIRED
3. CEMENT -11 TO -13 WITH MIL-A-5092 TYPE 2
PER 1P00013.
GRIND BOTH SIDES SMOOTH
IN AREA OF BEAD
10 DIA
PREPARE PER
MS 33660-160
TYP
(-9) SIDE
BASIC
R. TYP
(-3) CYLINDER
DIA 8 HOLES
(11) PLATE
(-5) SIDE
(-13) GASKET
TYP
(-7) SIDE
R. TYP
1/0 1A69183
DASH NUMBERS OF THIS DRAWING
ODD DASH NUMBERS SHOWN
EVEN DASH NUMBERS OPPOSITE
1A79377-1
PREPARED FOR NASA MSFC
FINISH
SEE L/M
F-289
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES.
TOLERANCES
FRACTIONS ± 1/32
DECIMALS ± .010
ANGLES ± ~
MATL
WT CHK
STR CHK
CHECK
PR ENGR
DES ENGR
GR ENGR
PREP BY MCFARLAND
DOUGLAS
AIRCRAFT COMPANY, INC
SANTA MONICA, CALIFORNIA
DUCT, AIR CONDITIONING,
AFT UMBILICAL
SEE ENGINEERING RECORDS FOR USAGE DATA
FIRST RELEASE OF PRINTS JUN '63
ORIGINAL DATE OF DRAWING 8 MAY '63
DESIGN ACTIVITY APPROVAL
CUSTOMER APPROVAL
CODE IDENT NO 18355
SIZE J
1A79377
SCALE 1/2
SHEET 1 OF 1


SECTION C - C
SECTION B - B
SECTION A - A
GENERAL NOTES:
UNLESS OTHERWISE SPECIFIED:
1. REQUIREMENTS IN FIELD OF DRAWING ARE FOR REFERENCE ONLY.
2. INSTALL FITTINGS PER AND 10064
Red 7-12-63
SEE L/M.
F-283
SEE ENGINEERING RECORDS FOR USAGE DATA
DOUGLAS
SANTA MONICA, CALIFORNIA
CARRIER,
AFT UMBILICAL
18355
J
1A74896


REVISIONS
A SEE E.O.
BASE LINE Y
BASE LINE Z
BASE LINE X
SECT B-B
PORT PER AND10050-4 FAR SIDE ONLY
O TO 1/32 MISMATCH
MS 33404 INSERT
SECT A-A
LOCATE PART NO HERE THIS SIDE ONLY
INSPECTION STAMP
GENERAL NOTES
1. ALL WEB THICKNESS
2. ALL FILLET RADII
3. ALL CORNER RADII 1/16 TO SHARP
5. CASTING MUST BE STRAIGHTENED BY FOUNDRY WITHIN
6. ALL MACHINED SURFACE ROUGHNESS 125 PER MIL-STD-10
7. DIMENSIONAL TOLERANCE SYMBOLS PER MIL-STD-8
8. DIMENSIONS INDICATED THUS * ARE FOR CASTING PURPOSES ONLY.
9. INSTALL INSERTS PER S0212
10. ORIENTS MACHINING WITH ROUGH CASTING IN EACH PLANE.
11. INSPECT PER 9709462 CLASS IIB
12. STOCK ALLOWANCE FOR MACHINED SURFACES MINIMUM.
ENG. REFERENCE ONLY
Rcd 7-13-63
1A74437-1
PREPARED FOR NASA MSFC
SEE ENGINEERING RECORDS FOR USAGE DATA
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES.
TOLERANCES
FRACTIONS ±
DECIMALS ±
ANGLES ±
F-289
DOUGLAS AIRCRAFT COMPANY, INC
SANTA MONICA, CALIFORNIA
FWD UMBILICAL CARRIER
CODE IDENT NO 18355
SIZE J
1A74437
SHEET 1 OF 1
L.O. 1A66747

DRAWING LIST OF MATERIAL DRAFT

SEQ. NO. 000 SHEET 1 OF 1

DRAWING NO. C 1A74810 REV A

NOMENCLATURE END ASSEMBLY, SUPPORT, FWD UMBILICAL

SEQ NO.	1 REQ	2 REQ	3 REQ	4 REQ (1A74810-1)	5 ACTION CODE	6 REV	7 PART OR IDENTIFYING NO.	8 NOMENCLATURE OR DESCRIPTION	9 VENDOR	10 STOCK SIZE	11 MATERIAL DESCRIPTION	12 MATERIAL SPECIFICATION	13 FIND NO.	14 ZONE	15 NOTES
01				1			-3	END		5/8 x 4 x 8 GR LGWISE	PLATE 2024-T351				
02				1			NAS561C14-24	PIN							
03															
04															
05															
06				SPEC			MIL-STD-10								
07				SPEC			F-289								
08															
09															
10															
11															
12															
13															
14															

ENGINEERING ORDER DOUGLAS AIRCRAFT CO., INC. SANTA MONICA, CALIF. CODE 18355 — NEW — 12JUN63 — SHEET 1 OF 1 — SIZE C DWG NO 1A74810

TITLE: END ASSEMBLY

DISPOSITIONS:
1. FABRICATION EFFECTIVITY MUST CONFORM. ASSY/INSTAL USAGE OF CHANGED OR PRIOR PARTS ACCEPTABLE
2. PARTS MUST CONFORM AT NOTED EFFECTIVITY
3. REWORK AS NOTED
4. SCRAP
5. NOTED

1 DRAWING CHANGED A
2 ADVANCE E.O.
3 SERIAL E.O.
4 NEW/REVISED RELEASE

EXTRA DWG: (1) HILTZ (1) APPLEBY } K522 — ENGRG TIME CHG 5770-1301 — CWO 26011 — DESIGN SECTION K522

E.O. MADE BY THOMPSON 6-13-63 — DWG MADE OR CHKD BY BURNETT 6-13-63

MODEL	SECTION	RELEASE S.O.	SHIP NO	EFFECTIVITY FIRST	EFFECTIVITY LAST	START OF CHG	TABULATION	NEXT ASSEMBLY DRAWING NUMBER	FINAL ASSEMBLY REQMT			SEQ NO.
DSV-4B-316	3700	5772-X316	2	1	1		1A74810-1	1A77953	2		D	1
DSV-4B-316	3700	5773-X316	2	2	3		1A74810-1	1A77953	2		D	2

COMPLETELY REVISED & REDRAWN

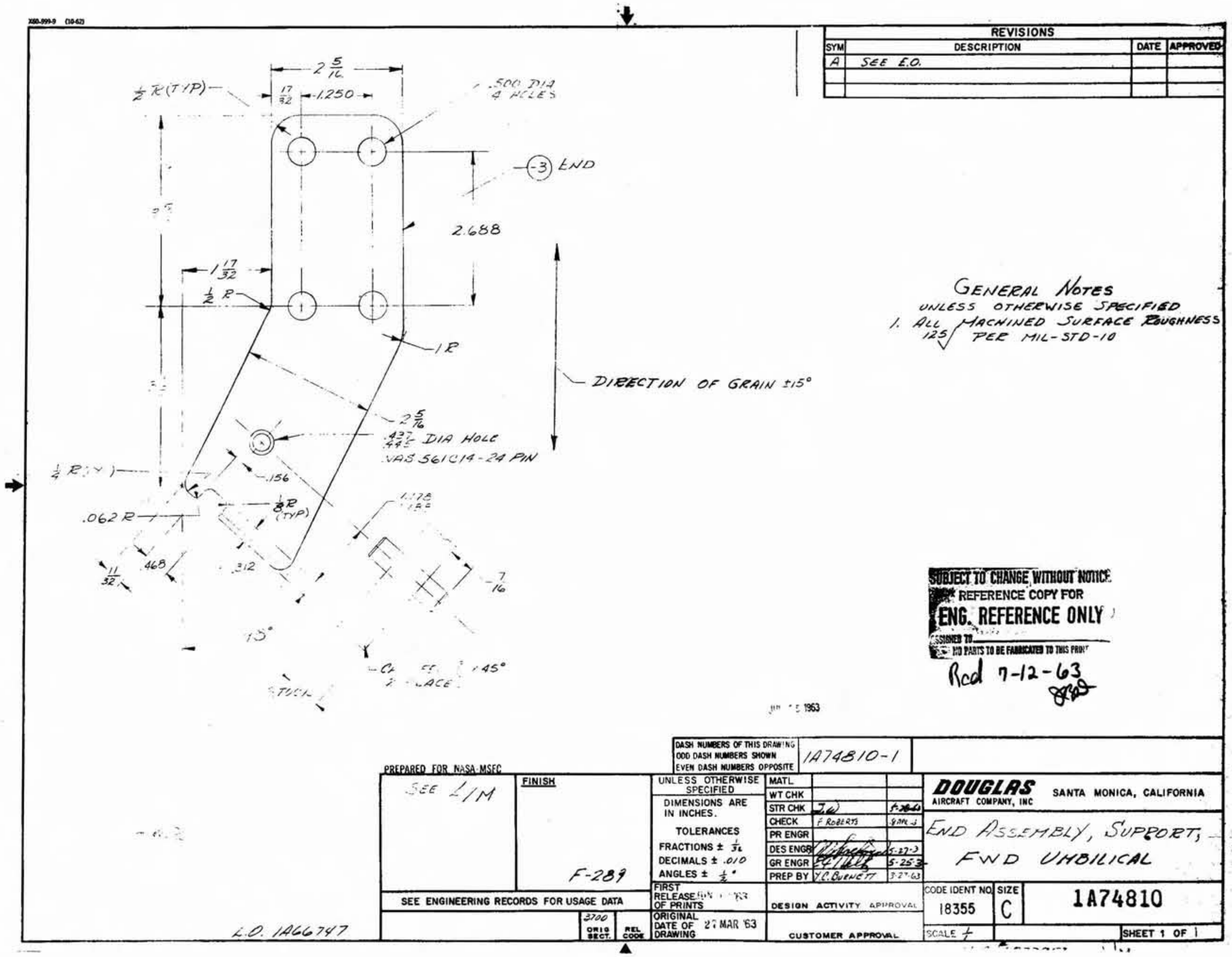
L/M FOR -1

1 REQ'D NAS561C14-24 PIN WAS 1 REQ'D NAS561C10-26 PIN

FOR -3

5/8 x 4 x 8 GR LGWISE STOCK SIZE WAS 5/8 x 4 x 7 3/4 GR LGWISE

1A74810 DWG NO.



[illegible]

DRAWING LIST OF MATERIAL DRAFT
Drawing No. 1A74896 — Rev NEW — Sheet 6 of 7
Nomenclature: CARRIER, AFT UMBILICAL

Qty (-1)	Part or Identifying No.	Nomenclature or Description	Zone	Notes
6	NAS679A5	NUT	6	
4	NAS1021N6	NUT	7	J
2	AN320-12	NUT	10	
2	AN6289-4	NUT	5	
2	AN6289-6	NUT	5	
6	AN6289-5	NUT	5	A
8	MS28778-5	PACKING	4	F
2	MS28778-4	PACKING	5	
2	MS28778-6	PACKING	5	
1	MS28778-8	PACKING	4	
6	AN960-516L	WASHER	6	
8	MS35333-78	WASHER	8	
4	NAS623-16	SCREW	4	

DRAWING LIST OF MATERIAL DRAFT
Drawing No. 1A74896 — Rev NEW — Sheet 4 of 7
Nomenclature: CARRIER, AFT UMBILICAL

Qty (-1)	Part or Identifying No.	Nomenclature or Description	Zone	Notes
6	NAS1226-8	BOLT	4	B
2	NAS1306-23	BOLT	10	
7	NAS1190-3P8	SCREW	3	G
3	MS21919D63	CLAMP	3	
4	NAS1105-20	BOLT	6	
2	NAS1104-30	BOLT	4	
2	NAS1105-52	BOLT	6	
8	NAS1224-3	BOLT	6	
8	NAS1308-20	BOLT	5	
4	NAS1308-19	BOLT	9	
2	NAS1306-24	BOLT	7	
2	NAS1230-45	BOLT	7	
4	NAS1224-4	BOLT	7	

DRAWING LIST OF MATERIAL DRAFT
Drawing No. 1A74896 — Rev NEW — Sheet 2 of 7
Nomenclature: CARRIER, AFT UMBILICAL

Qty (-1)	Part or Identifying No.	Nomenclature or Description	Zone	Notes
1	1A79377-1	DUCT	6	
1	1A78548-1	PLATE	5	
2	1A74752-1	CAM	6	
2	1A78550-1	PIPE	5	
1	1A78547-1	PIPE	4	
1	1A78547-2	PIPE	5	
1	1A78551-1	PIPE	5	
1	1A78551-2	PIPE	4	
2	1A74495-1	PIN ASSY	4	
1	1A78519-501	CABLE ASSY	8	
4	1A82419-1	BLOCK	4	

DRAWING LIST OF MATERIAL DRAFT
Drawing No. 1A74896 — Rev NEW — Sheet 7 of 7
Nomenclature: CARRIER, AFT UMBILICAL

Qty (-1)	Part or Identifying No.	Nomenclature or Description	Vendor	Zone	Notes
22	52LH2335-048	NUT	ELASTIC STOPNUT CORP. UNION NEW JERSEY	10	
		F-289			
		AND10064			

NOTE A: ALSO USED IN ZONE 8
NOTE B: ALSO USED IN ZONE 7
NOTE C: ALSO USED IN ZONE 7 & 8
NOTE D: ALSO USED IN ZONE 7 & 10
NOTE E: ALSO USED IN ZONE 7 & 9
NOTE F: ALSO USED IN ZONE 5 & 8
NOTE G: ALSO USED IN ZONE 4 & 8
NOTE H: ALSO USED IN ZONE 7 & 10
NOTE J: ALSO USED IN ZONE 10

DRAWING LIST OF MATERIAL DRAFT
Drawing No. 1A74896 — Rev NEW — Sheet 5 of 7
Nomenclature: CARRIER, AFT UMBILICAL

Qty (-1)	Part or Identifying No.	Nomenclature or Description	Zone	Notes
4	NAS1304-12	BOLT	7	
8	NAS1304-14	BOLT	8	
2	MS27183-21	WASHER	7	
10	AN960-616	WASHER	4	H
2	AN960-1416L	WASHER	10	
11	NAS620-10L	WASHER	3	G
4	NAS1070-816	WASHER	7	
18	AN960-416L	WASHER	4	C
14	AN960-816	WASHER	5	D
4	NAS679A3	NUT	4	
2	NAS679A4	NUT	4	
12	NAS1021N4	NUT	7	A
16	NAS1021N8	NUT	5	E

DRAWING LIST OF MATERIAL DRAFT
Drawing No. 1A74896 — Rev NEW — Sheet 3 of 7
Nomenclature: CARRIER, AFT UMBILICAL

Qty (-1)	Part or Identifying No.	Nomenclature or Description	Zone	Notes
2	AN914-5C	PLUG	4	
1	AN815-8C	UNION	4	
2	J30088 CC-6-4	TEE	5	
2	MS39070C5	TEE	5	
2	AN833-4C	ELBOW	5	
4	AN833-5C	ELBOW	8	
4	MS21919D65	CLAMP	4	A
2	NAS1228-14	BOLT	10	
2	MS21919D64	CLAMP	4	
2	NAS73-10E015P	BUSHING	7	
2	MS28777-4	RING	5	
2	MS28777-6	RING	5	
6	MS28777-5	RING	5	A
8	50111 217H0835	WASHER	6	

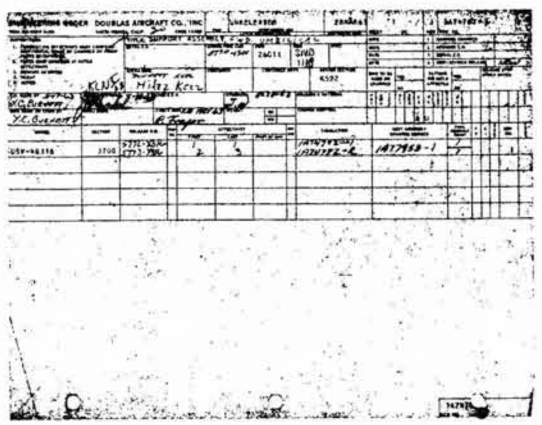
DRAWING LIST OF MATERIAL DRAFT
Drawing No. 1A74896 — Rev NEW — Sheet 1 of 7
Nomenclature: CARRIER, AFT UMBILICAL

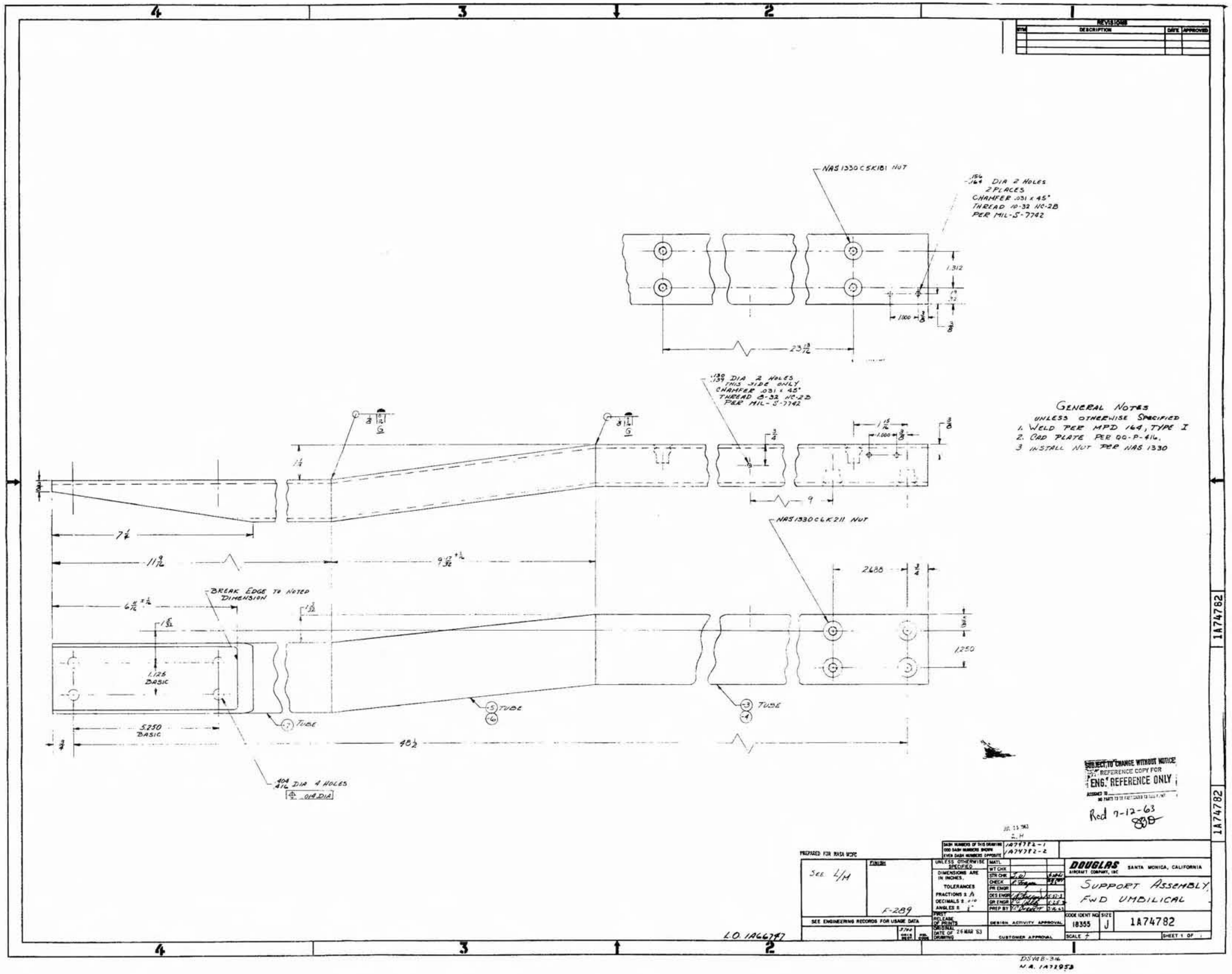
Qty (-1)	Part or Identifying No.	Nomenclature or Description	Zone	Notes
1	1A77582-1	HOUSING	7	
1	1A77584-1	HOUSING	5	
1	1A77585-1	HOUSING	6	
1	1A77585-2	HOUSING	3	
2	1A78546-1	END	7	
4	1A77935-1	BOLT	7	
2	1A79601-1	LEVER	6	
1	1A74600-1	BRACKET	4	
1	1A78044-1	TEE	5	
24	1A78045-1	NUT	10	
24	1A78046-1	STUD	10	
1	1A78549-1	BRACKET	8	
2	1A77112-1	CYLINDER ASSY	9	
1	1A78518-501	CABLE ASSY	8	

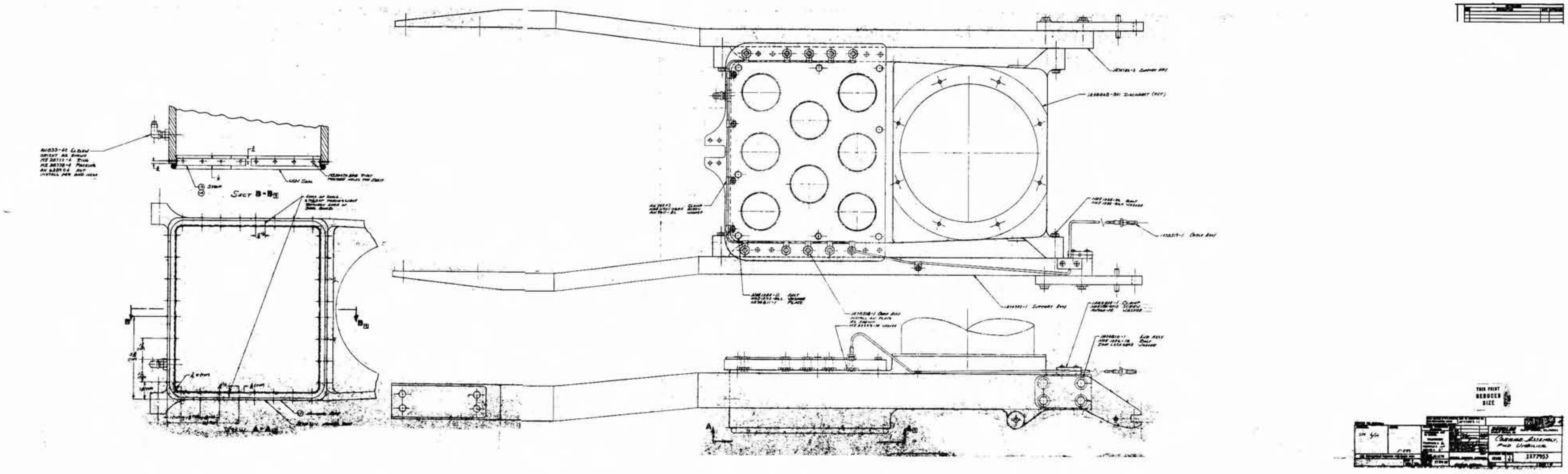
DRAWING LIST OF MATERIAL DRAFT

SEQ NO. — SHEET 1 OF 1
DRAWING NO. 1A74782 — REV NEW
NOMENCLATURE SUPPORT ASSY

Qty -2	Qty 1A74782-1	Action Code	Rev	Part or Identifying No.	Nomenclature or Description	Vendor	Stock Size	Material Description	Material Specification	Find No.	Zone	Notes
	1			-3	TUBE		1½ x 2½ RECT x .120 x 29	L.C. STL TUBE W	QQ-T-830 COMP MT 1015 COND W		2	
1				-4	TUBE		1½ x 2½ RECT x .120 x 29	↑	↑		2	
	1			-5	TUBE		1½ x 2½ RECT x .120 x 10				3	
1				-6	TUBE		1½ x 2½ RECT x .120 x 10	↓	↓		3	
1	1			-7	TUBE		1½ x 2½ RECT x .120 x 11⅜	L.C. STL TUBE W	QQ-T-830 COMP MT1015 COND W		4	
4	4			NAS1330C5K181	NUT						2	
4	4			NAS1330C6K211	NUT						2	
SPEC	SPEC			F-289								
SPEC	SPEC			MPD 164 TYPE I								
SPEC	SPEC			QQ-P-416								
REF	REF			NAS 1330	METHOD							







ENGINEERING ORDER DOUGLAS AIRCRAFT CO., INC. SANTA MONICA, CALIF. CODE 18355

UNRELEASED — 23APR63 — SHEET 1 OF / — SIZE J — DWG NO 1A77953

TITLE: CARRIER ASSEMBLY

Field	Entry
CHARGE THIS CHG	5770-1301
EWO	26011
MDL	SIVB-1119
DESIGN SECTION	K522
DATE	JUN 12 '63
NEW/REVISED RELEASE	NEW
DWG TO BE MADE OR CHANGED	YES / NO
PATTERN DIE MOLD AFFECTED	YES / NO
MADE BY	4-24-63 Y.C. BURNETT
GROUP APPROVAL	5-10-63
CHECK DWG	23 MAY 63 R. Frazer
STRENGTH	5-28-63
RELEASE & MATERIAL	Feldstein 6/11/63
CHANGE CONTROL	6-63
ISSUE BASE OR CHKD BY	Y.C. BURNETT

DISPOSITIONS: FABRICATION EFFECTIVITY MUST CONFORM. ASSY/INSTAL USAGE OF CHANGED OR PRIOR PARTS ACCEPTABLE. PARTS MUST CONFORM AT NOTED EFFECTIVITY. REWORK AS NOTED. SCRAP. NOTED. KLN 5/78

MODEL	SECTION	RELEASE S.O.	EFFECTIVITY FIRST	EFFECTIVITY LAST	TABULATION	NEXT ASSEMBLY DRAWING NUMBER	FINAL ASSEMBLY REQ'T		SEQ NO.	
2SV-4B-316	3700	5772-X316	1	1	1A77953-1	1A57785	1	D	1	3
2SV-4B-316	3700	5773-X316	2	3	1A77953-1	1A5[illegible]	1	D	2	2

B Walk[illegible]

1A82414 UNREL'D

1A7[illegible] UNREL'D

A141

1A77953

LIST OF MATERIAL — DOUGLAS AIRCRAFT COMPANY, INC. SANTA MONICA, CALIF.

CARRIER ASSEMBLY, FWD UMBILICAL — DRAWING NO LM J1A77953 — REV NEW — DATE OF ISSUE 11JUN63 — CODE IDENT NO 18355 — SHEET 1 OF 2

1A77953-7	1A77953-1	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	CODE IDENT NO	STOCK SIZE	MATERIAL DESCRIPTION	MATERIAL SPECIFICATION	FIND NO	ZONE	NOTES
	REF	AND10064	METHOD							
	1	AN6289C4	NUT						10	
	5	AN742F3	CLAMP						7	
	1	AN333-4C	ELBOW						10	
	4	AN960-10	WASHER						4	
	5	AN960-8L	WASHER						7	
	32	MS20470A3-12	RIVET						9	
	1	MS28777-4	RING						10	
	1	MS28778-4	PACKING						10	
	10	MS35333-78	WASHER						5	
	4	NAS1190-3P12	SCREW						4	
	5	NAS1190C08P5	SCREW						7	
	8	NAS1224-12	BOLT						6	
	8	NAS1225-?6	BOLT						4	
	8	NAS1226-12	BOLT						4	
	8	NAS1252-416L	WASHER						6	
	8	NAS1252-516H	WASHER						4	

CARRIER ASSEMBLY, FWD UMBILICAL — DRAWING NO LM J1A77953 — REV NEW — DATE OF ISSUE 11JUN63 — CODE IDENT NO 18355 — SHEET 2 OF 2

1A77953-7	1A77953-1	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	CODE IDENT NO	STOCK SIZE	MATERIAL DESCRIPTION	MATERIAL SPECIFICATION	FIND NO	ZONE	NOTES
	8	S0111C25K0895	WASHER						4	
REF		S0217	METHOD							
1		1A74437-1	HOUSING ASSY						9	
	1	1A74782-1	SUPPORT ASSY						4	
	1	1A74782-2	SUPPORT ASSY						4	
	2	1A74810-1	END						4	
	1	1A74811-1	PLATE						6	
2		1A77953-3	STRIP		.032 X 1 X 11	AL SHEET CLAD 2024-T3	QQ-A-362 TEMP T3		9	
2		1A77953-4	STRIP		.032 X 1 X 11	AL SHEET CLAD 2024-T3	QQ-A-362 TEMP T3		9	
	1	1A77953-7	HOUSING ASSY						9	
	1	1A78518-1	CABLE ASSY						5	
	1	1A78519-1	CABLE ASSY						3	
	4	1A82414-1	CLAMP						4	
AR		BULK MATL	SEAL			6152-1 SEAL	CONNECTICUT HARD RUBBER CO. NEW HAVEN CONN.		9	
SPEC	SPEC	F289								

REFERENCES

Reference 1: Memo # M-P&VE-VA-120, dated August 28, 1963, entitled C-5 GROUND RULES.

Reference 2: Memo # M-P&VE-SL-24-63, dated February 5, 1963, entitled C-5 VEHICLE DEFLECTION ON THE LAUNCHER/ UMBILICAL TOWER.

Reference 3: Memo # M-P&VE-SL-29-63, dated February 14, 1963, entitled WIND-INDUCED OSCILLATIONS OF THE SATURN V (C-5) VEHICLE ON THE LAUNCHER/UMBILICAL TOWER.

Reference 4: Memo # M-P&VE-SS-225, dated December 19, 1962, entitled LATERAL AND VERTICAL DEFLECTIONS OF THE C-5 VEHICLE.

Reference 5: Memo # M-P&VE-ST-34-63, dated January 30, 1963, entitled THE PRELIMINARY SHOCK AND VIBRATION SPECIFICATIONS FOR THE PROPELLANT COUPLINGS AND ELECTRICAL UMBILICAL CONNECTORS OF THE UPPER STAGES, S-II, S-IVB, and INSTRUMENT UNIT, C-5 CONFIGURATION.

Reference 6: LAUNCHER-UMBILICAL TOWER, LAUNCH COMPLEX 39, DESIGN CRITERIA, sheets A-4 through A-7 by Reynolds, Smith and Hills.

Reference 7: DWG. NO. D75M02959L, SHT 53, dated August 14, 1962, entitled INFORMATION DRIFT CURVE C-5 LOR..

Reference 8: LAUNCHER-UMBILICAL TOWER, LAUNCH COMPLEX 39, DESIGN CRITERIA, sheets A-19 and A-20, Reynolds, Smith and Hills.

Reference 9: Memo # M-P&VE-PH-36-62, dated July 19, 1963, entitled PREDICTED TEMPERATURES AND PRESSURES FOR C-5 UMBILICAL TOWER.

TR-4-4-2-D
July 10, 1963

APPROVAL

SATURN V SERVICE ARMS
PRELIMINARY ENGINEERING REPORT
COMPLEX 39

VOLUME I

Keith Jenkins
for Mr. Frank D. Griffin
Chief, Electrical Section
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J. B. Downs
Mr. J. B. Downs, Jr.
Chief, Umbilical Arms Section
LO-DE 4

Curt P. Herold
Mr. Curt P. Herold
Deputy Chief, Launch Equipment Branch
LO-DE

Robert T. Moore Jr.
Mr. R. T. Moore, Jr.
Chief, Launch Equipment Branch
LO-DE

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North American Aviation Co.
12214 Lakewood, Blvd.
Downey, California

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The Boeing Co.
Recoverable Booster
Saturn Study Proj.
Seattle, Washington
Attn: Mr. Carl Blakely

NASA-MLO
Mr. Gus Donofrio
Mr. John Wilhelm
(801 19th Street, N.W.
Washington, D.C.)

NASA S-IV Resident Mgr.
Mr. Gorden Stoops
c/o Douglas Aircraft Co., Inc.
3000 Ocean Park Blvd.
Santa Monica, Calif.

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Dr. Debus

LO-BS
Mr. Whisenant

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Colonel Bidgood
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