NASA SUSPENDED LOAD OPERATION INTERIM ANALYSIS/APPROVAL

1. OPERATION
Installation of the ACTS Apogee Kick Motor

2. REQUESTOR	ORGN.	PHONE	DATE	REQUEST NO.
R. T. Gedney	NASA/LeRC	(216)433-3552	June 26, 1992	SLO-KSC-1992-001

3. CONTRACTOR	4. CONTRACT NO.	5. VEHICLE/GSE/EFFECTIVITY FACILITY	6. TIME PERIOD/DURATION
		Advanced Communications Technology Satellite	One-Time Only

7. DOCUMENT	8. TITLE	9. ITEM NO.
GE Procedure TP-AKI-2623352	AKM Installation	Section 6.2

10 REQUIREMENT

Code of Federal Regulations 29, Parts 1910.179(n)(3)(vi), 1910.180(h)(3)(vi), 1910.180(h)(4)(ii) -
...avoid carrying loads over people.

11. DESCRIPTION

The ACTS Apogee Kick Motor (AKM) is installed inside the center cylinder of the ACTS spacecraft by lowering the spacecraft over the AKM. The clearance between the AKM and the spacecraft is very tight requiring that the spacecraft to be unconstrained as it is lowered to prevent binding on the AKM. Personnel move under the spacecraft briefly during this operation to verify that clearance between the spacecraft and AKM is adequate and that it is therefore safe to continue lowering the spacecraft.

12. DETAILED RATIONALE

The ACTS design and AKM installation concept was finalized at the spacecraft Critical Design Review held in May of 1988. The operation has been designed such that the number of personnel exposed, and their time of exposure is minimized. The PHSF 50-ton bridge crane is used for this operation. The mass of the spacecraft with AKM installed will not exceed 5799 lbs. The crane operator maintains constant voice and visual contact with the personnel under the load and only allows personnel to move under the load when it is static. A detailed assessment was performed to attempt to design a secondary support fixture that would support the spacecraft in the event of a fall, thereby protecting the personnel beneath. After a through review of alternate concepts for this structure, it was concluded that the structure would block the egress path for personnel under the load and would therefore be an impediment to safety.

13. REMARKS

14. REQUIRED APPROVAL

CONTRACTOR		NASA	
☐ DESIGNS	☐ R&QA	☐ DESIGNS	☐ R&QA
☐ OPERATIONS	☐ SAFETY	☐ OPERATIONS	☐ SAFETY

15. TYPE OR PRINT NAME	SIGNATURE	ORGN.	DATE
R. T. Gedney /ACTS Project Manager	Richard T. Gedney	NASA/LeRC	6/26/92
W. R. Fletcher	W. R. Fletcher	CP-PSO	8/5/92

OPERATION - Installation of the Apogee Kick Motor (AKM) and AKM thermal baffle into the Advanced Communications Technology Satellite.

SUPPORTING DOCUMENTS - The associated operational procedures are as follows:

- GE Procedure TP-AKI-2623352, AKM Installation
- GE Plan PN-SAF-2623352, ACTS launch Site Safety Plan
- SAA01HS11-003 (Rev. B) West 50-Ton Bridge Crane - PHSF

GENERAL DESCRIPTION - The ACTS Apogee Kick Motor is installed inside the center cylinder of the ACTS spacecraft by lowering the spacecraft over the AKM. The clearance between the AKM and the spacecraft is very tight requiring that the spacecraft to be unconstrained as it is lowered to prevent binding on the AKM. Personnel move under the spacecraft briefly during this operation to verify that clearance between the spacecraft and AKM is adequate and that it is therefore safe to continue lowering the spacecraft.

RATIONALE/ANALYSIS - The suspended load tasks comply with the NASA Alternate Safety Standard as follows:

1a. *"A justification why the operation cannot be conducted without personnel beneath the load....."*

The ACTS Apogee Kick Motor (AKM) is installed inside the central cylinder of the spacecraft (refer to attachment #1). The spacecraft central cylinder has a mounting flange that mates with the mounting flange on the AKM and accepts 48 bolts. The AKM is installed by lowering the spacecraft over the AKM as it rests on an installation stand (refer to attachment #2). Because the clearance between the spacecraft flange and the AKM is very small (on the order of 35 mils), personnel are required to get under the load to take measurements verifying that the spacecraft is well centered over the AKM. Without these measurements, the spacecraft could damage the AKM during the installation process by contacting the AKM case, heat shields, or heaters. Additionally, there are four small diameter aluminum alignment rods that are installed to the spacecraft flange prior to hoisting the spacecraft off of its dolly. These rods mate with holes in the AKM flange and provide coarse alignment to help guide the spacecraft onto the AKM. Personnel are required under the load to initially thread these rods into the AKM flange.

When the two flanges are nearly mated a technician must go under the load to verify that the alignment of the AKM index pin is correct. This is required to ensure that the two bolt patterns are properly clocked. This task is not of concern because the spacecraft and AKM flanges are approximately one inch apart. If the load were dropped, it would come safely to rest on the AKM flange (which is in turn supported by the installation stand).

The final task involving exposure to the suspended load is installation of the AKM thermal baffle. This is done after the spacecraft, with AKM mated, is hoisted off the installation stand. The baffle attaches to the spacecraft adapter ring as shown in attachment #3 using 24 fasteners. Because of clearances required to install these fasteners, the baffle cannot be installed while mated to the Perigee Stage Adapter (PSA), dolly, or installation stand.

1b. *"Details of precautions taken to protect personnel should the load drop...."*

The measurement operations never take place while the load is moving. Personnel only move under the load when it is static and steady. A secondary support system has been thoroughly evaluated (refer to attachment #4). The secondary support consists of a movable platform with a flat ring to catch the spacecraft at the separation ring should it drop. This platform is moved using two hand-operated jack screws as the spacecraft is lowered. The spacecraft must remain unconstrained during the installation operation to prevent binding on the AKM. The platform is therefore lowered gradually with the spacecraft so that a small gap is always present. The gap is not allowed to exceed 2 inches to limit the dynamic force that the support structure would have to handle should the spacecraft fall.

However, examination of attachment #4 shows the limited access for ingress to, and egress from, the work area. On the East and West sides of the spacecraft, technicians would be forced to crawl through an 11-inch space between the support structure and the AKM installation stand to access the work area. On the North and South sides of the spacecraft, technicians would have to maneuver around the solar array and the platform support beam 27 inches off the floor. In the event of an emergency requiring a quick exit from the work area, the exit paths are extremely limited. Many alternative configurations for this structure were studied but none were able to provide adequate access for quick egress. This lack of quick egress is the principal reason for ruling out the use of a secondary support structure.

1c. *"...Steps shall be taken to limit the number of personnel under the load.."*

Four technicians are required under the load when the guide rods interface with the AKM flange to ensure that the rods are properly threaded into the AKM flange. Four technicians are required under the load to take simultaneous clearance measurements between the spacecraft and AKM. Two technicians are required under the load to install the AKM thermal baffle. The test director and GE safety inspector ensure that all other personnel remain a safe distance from the load.

1d. *"Steps shall be taken to ensure that personnel do not remain under the load any longer than necessary..."*

Guide rod threading takes approximately 2 minutes. Total exposure during clearance measurement will not exceed 10 minutes. Installation of the AKM thermal baffle will not exceed 10 minutes. The test director and GE safety inspector ensure that personnel under the load accomplish their task as quickly as possible and move out from under the load.

2. *"Each operation will be reviewed on a case-by-case basis."*

This Analysis/Approval is the vehicle to initiate the review for the ACTS one-time operation.

3. *"Only those suspended load operations approved by the center/facility NASA director of safety will be permitted,..."*

This operation will not be performed until proper approval has been given.

4. *"The operational procedures document...will...specify the necessary additional requirements identified by the hazard analysis..."*

The AKM installation procedure will be modified to identify specific measurement points and to include instructions for controlling personnel access to, and time under, the AKM installation stand. The working procedure is available at the work site for review and documentation purposes during the operation.

5. *"...if a new procedure not covered by the original analysis is deemed necessary...the NASA Center/facility Safety Office will be consulted and must approve..."*

The ACTS launch site safety plan, GE document PN-SAF-2623352, requires that any real-time alterations to hazardous procedures be coordinated with the Launch Site Safety Office prior to proceeding.

6. *"The crane/hoist shall be designed, tested.."*

Suspended load operations in the PHSF associated with the mating of the ACTS to its AKM involve the use of the West 50-ton bridge crane. The crane is designed, tested, inspected, maintained, and operated in accordance with NSS/GO-1740.9 - the NASA Safety Standard for Lifting Devices and Equipment. The 50-ton bridge crane is designed with a minimum safety factor of 5 (based on the ultimate material strength) for the hoist load bearing components. The 50-ton bridge crane undergoes a monthly, quarterly, semiannual, and annual schedule preventative maintenance program. The wire rope is inspected monthly for discrepancies. The crane hook undergoes an annual Non-Destructive Testing (NDT) inspection (i.e. magnu-fluxed to verify no distortion of the crane hook).

A load test is performed annually to 100 percent of the rated capacity of the crane and block. The crane is being used to lift 6,634 pounds (6.7% of capacity) during suspended load operations.

The lifting devices used in this operation meet the requirements of KHB 1700.7.

7. *The crane/hoist involved in suspended load operations shall undergo a FMEA.."*

A Systems Assurance Analysis (SAA) has been completed for the 50-ton bridge crane. SAA01HS11-003 for the 50-ton bridge crane includes a Failure Modes and Effects Analysis/Critical Items List (FMEA/CIL) and a Hazards Analysis. No single failure points (SFP's) were identified.

8. *...the crane/hoist will undergo a visual inspection..."*

The 50 ton bridge crane will undergo a visual inspection and pre-operational check-out prior to each use per NSS/GO 1740.9.

9. *"A trained and licensed operator shall remain at the crane/hoist controls..."*

The crane operator, supplied by GE, will have completed the KSC-provided crane operators course and will be certified by KSC for crane operations as specified in section 6.5.2 of the ACTS Launch Site Support Plan, K-PSM-11.131.

10. *"Safety controlled areas shall be established..."*

The AKM installation procedure, GE document TP-AKI-2623352, requires that all non-essential personnel be cleared from the PHSF high bay during the operation. This procedure specifies the personnel required for this operation in Section 5.3.1. Only the minimum number of people will be permitted under the suspended load. Appropriate safety clear areas are established before beginning the procedure.

11. *"Prior to the suspended load operation, a meeting with the crane/hoist operator(s), signal person(s)...shall be held..."*

The ACTS Launch Site Safety Plan, GE document PN-SAF-2623352, requires a pre-task briefing for all hazardous operations (refer to Section 5.1, item 7). This briefing will cover all aspects of the hazardous operation including personnel required, communication, task responsibility, test safety precautions, and emergency procedures.

12. *"Communications between the operator(s), signal person(s)...shall be maintained..."*

Communications (by voice and visual) are maintained with all personnel under a suspended load. Emergency porcedures and training contain instructions to discontinue operations if communications are lost. The hardware is safed and the area is cleared if additional hazards warrent clearing the controlled area. All personnel are cleared from under a suspended load during loss of communications.

13. *...Personnel working under the load shall remain in continuous sight of the operator(s)..."*

All personnel remain within sight of the Lift Coordinator and the Emergency Stop operator.

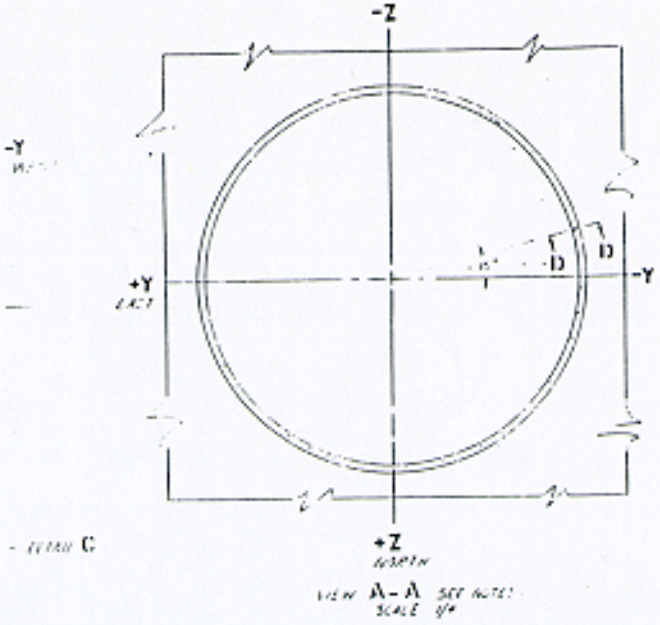
APPROVAL: DATE:

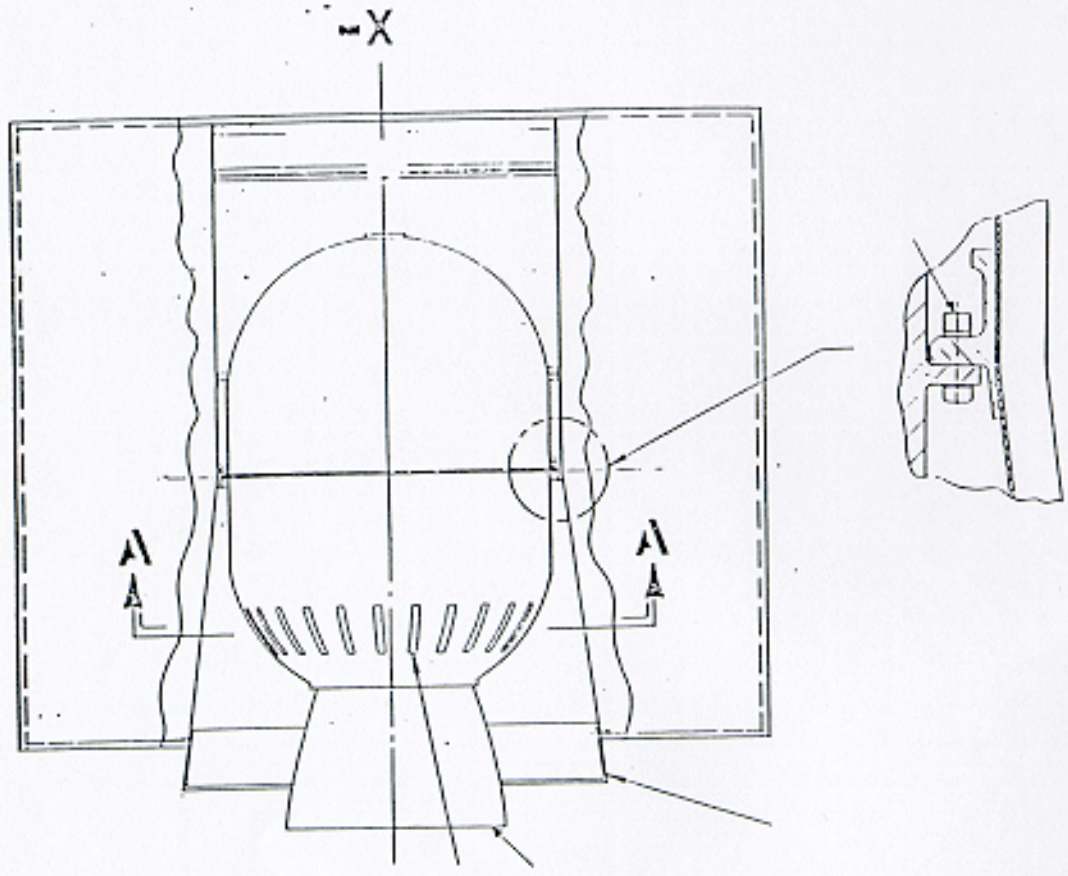
/s/ Joel R. Reynolds 8/14/92

Jackie E. Smith
Director, Safety and Reliability,
Kennedy Space Center

ACTS Launch Site Hoisting & Handling
AKM Installation

Spacecraft Interface

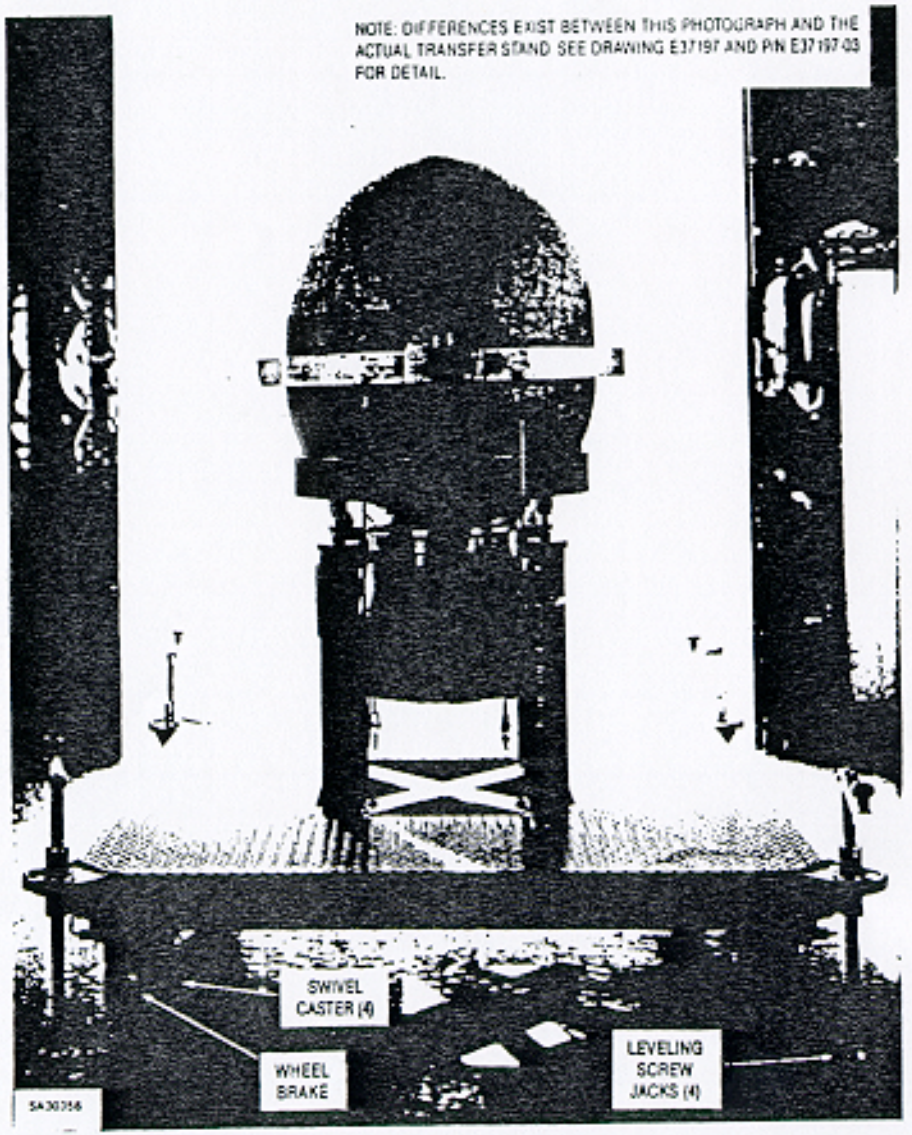




ATTACHMENT # 1

ACTS Launch Site Hoisting & Handling
AKM Installation

Transfer Stand



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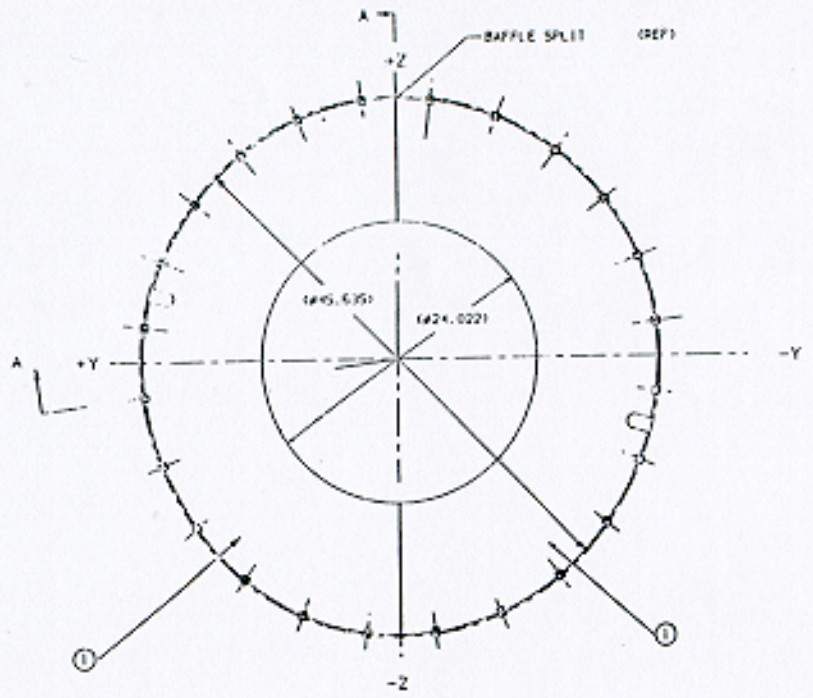

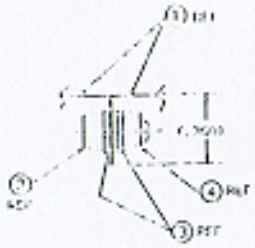

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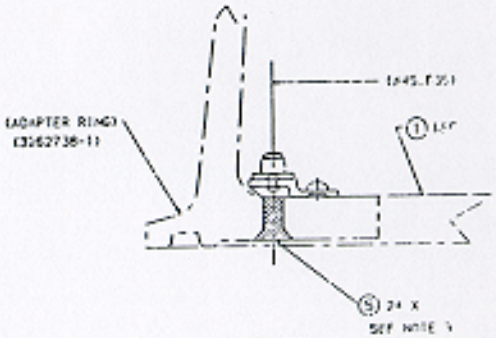

DETAIL B
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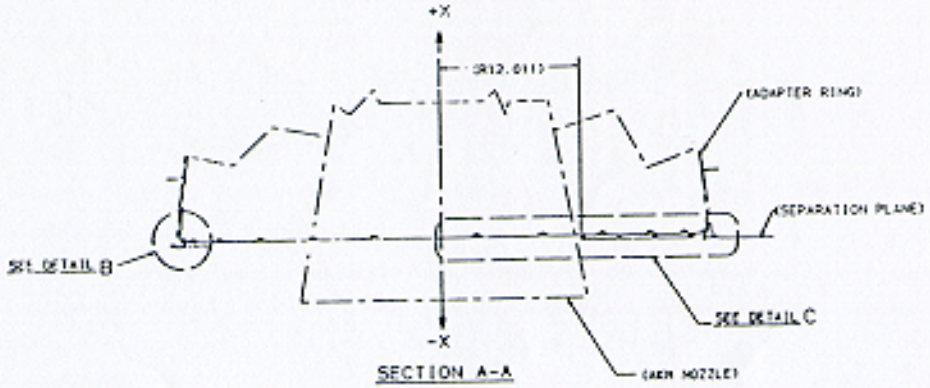
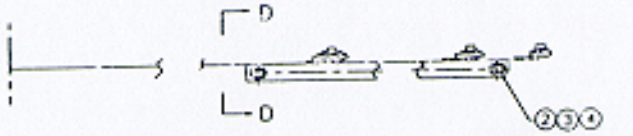


SECTION A-A

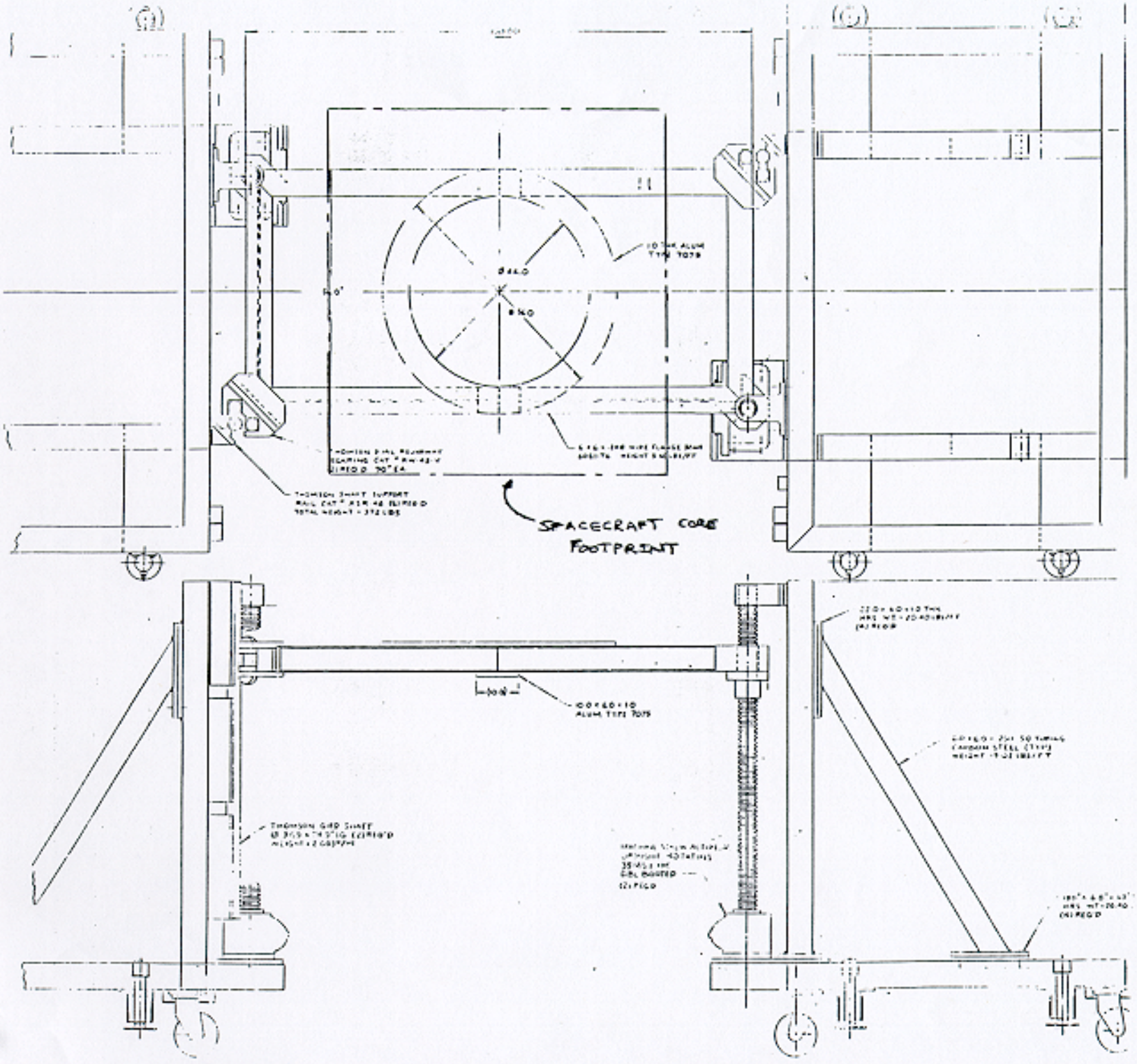


DETAIL C
SCALE-NONE

NOTES:
1. WEAR WRISTSHIP PER BSS0035 (ITEM 5).
2. TORQUE SCREWS, ITEM 2, TO 4.0 ±.5 IN-LBS ABOVE NUT RUN-IN TORQUE.
3. TORQUE SCREWS, ITEM 5, TO 8.0 ±.5 IN-LBS ABOVE NUT RUN-IN TORQUE.

FOR PARTS LIST SEE [illegible]

ATTACHMENT #3



ATTACHMENT #4