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THE SPACE SHUTTLE ORBITER REMOTE MANIPULATOR POSITIONING MECHANISM

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INTRODUCTION

The Space Shuttle Orbiter provides the Manipulator Positioning Mechanism (MPM). Manipulators may be mounted on either left or right sides of the Payload Bay or both sides if two are flown. This Manipulator Positioning Mechanism is provided on purpose of securing the remote arm in stowed position during lift-off, boost and landing, it also provides the deploy, latch and unlatch capabilities of the Remote Manipulator System Arm (RMS ARM). (See Figure 1 and 2).

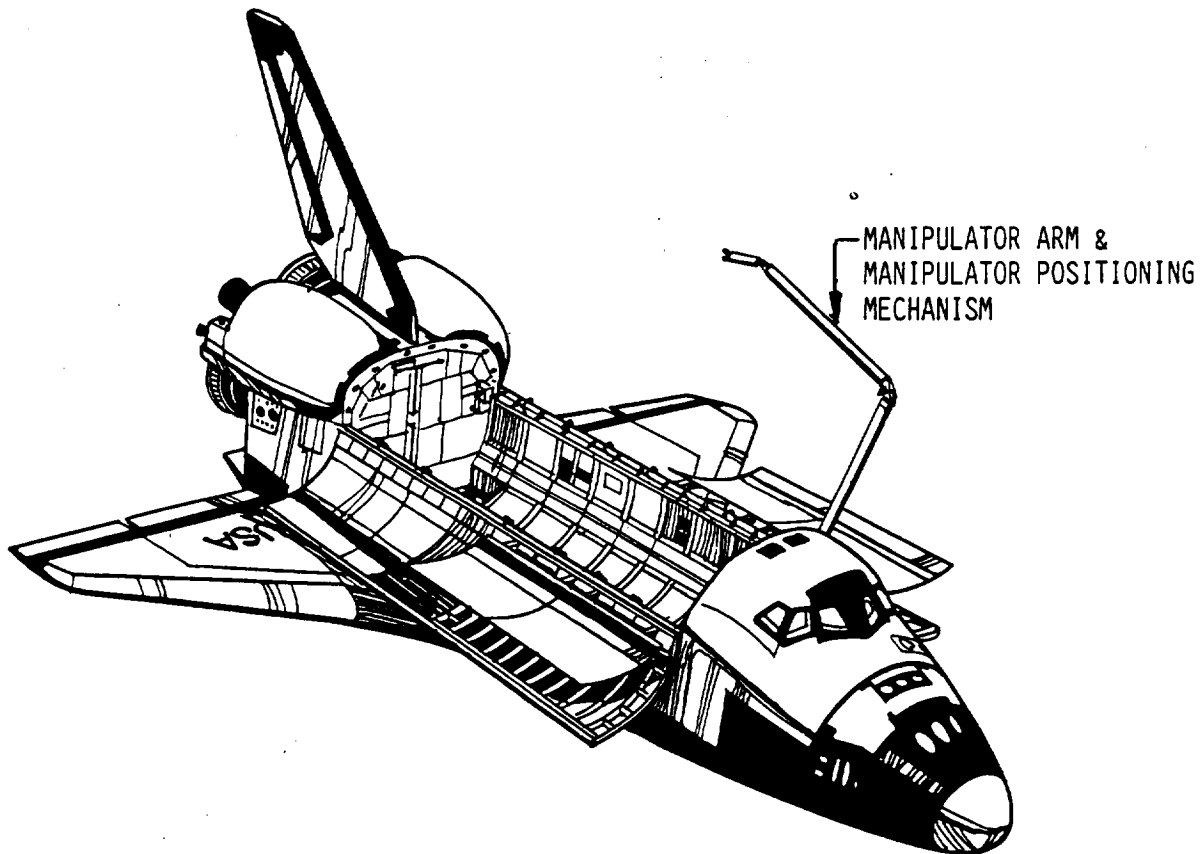


Figure 1. RMS ARM On Its On-Orbit Use Position

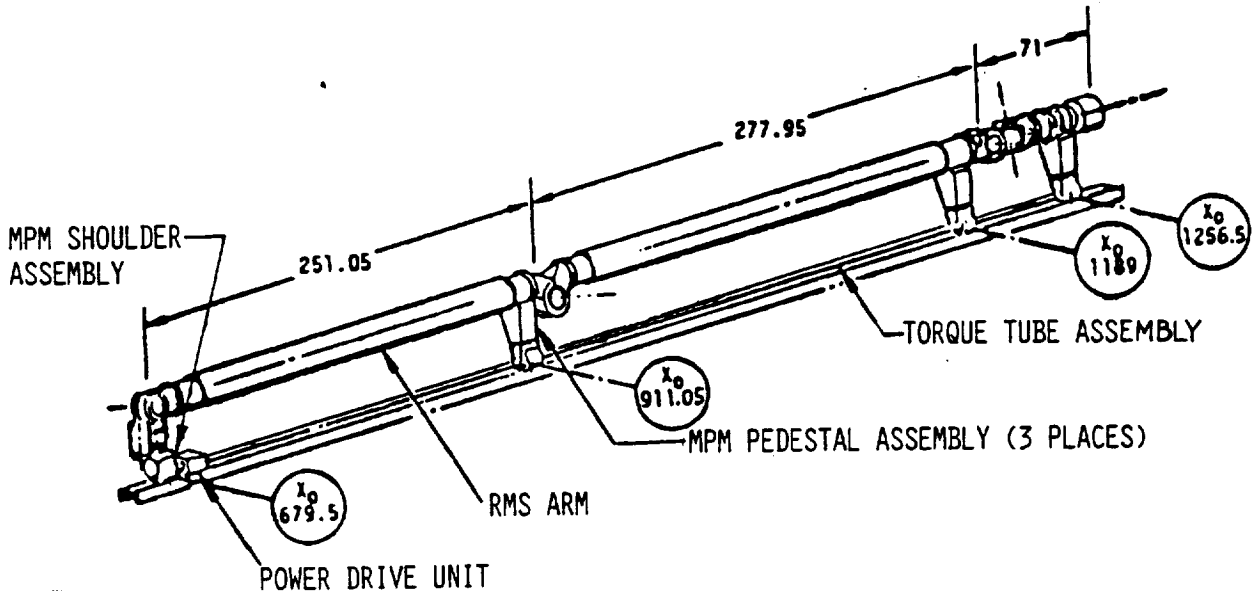


Figure 2. Manipulator Positioning Mechanism - General Arrangement  
DESIGN MANIPULATOR POSITIONING MECHANISM (MPM)

The MPM is comprised of the following major assemblies:

- A. Shoulder Assembly - Support of all loads experienced as a result of in flight operation of the arm (See Figure 3).
  1. Electromechanical actuator - gear box, and redundant motor, power drive unit (PDU).
  2. Rotary actuator - planetary gear box.
  3. Base assembly - structural mount to bridge fitting.
  4. Fitting assembly - supporting fitting for RMS.
  5. Drive linkage - mechanical drive from gear box to fitting assembly.
  6. Hook assembly - securing device for deployed position.
  7. Switch Module - deploy and stow indicators.
  8. Retractor - device providing separation capability.
  
- B. Three Pedestal Assemblies - support of the arm in stowed position and provide latch and unlatch capabilities. (See Figure 4).
  1. Rotary actuator - planetary gear box.
  2. Base assembly - structural mount to bridge fitting.
  3. Fitting assembly - supporting fitting for RMS.
  4. Drive linkage - mechanical drive from gear box to fitting assembly.
  5. Switch modules - ready-to-latch and latch, deploy and stow indicators.
  6. Retractor - device providing separation capability.
  7. Retention latch hook - device providing latch and unlatch capabilities.
  
- C. Torque Tube Assembly - Drive shaft system providing capability of simultaneous drive on all four assemblies ( Shoulder Assembly and Three Pedestal Assemblies).
  
- D. Thermal Blankets and Covers- Solar Shields.

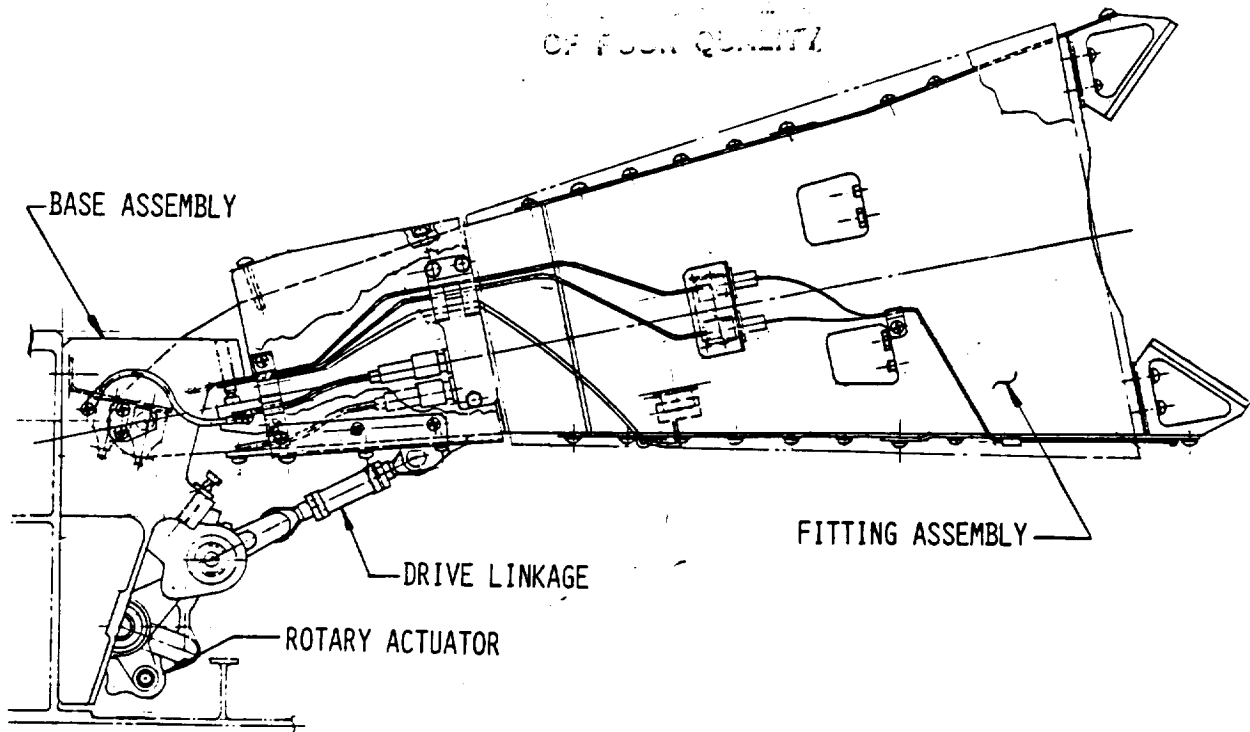


Figure 3. Manipulator Positioning Mechanism Pedestal Assembly  
( 3 Places)

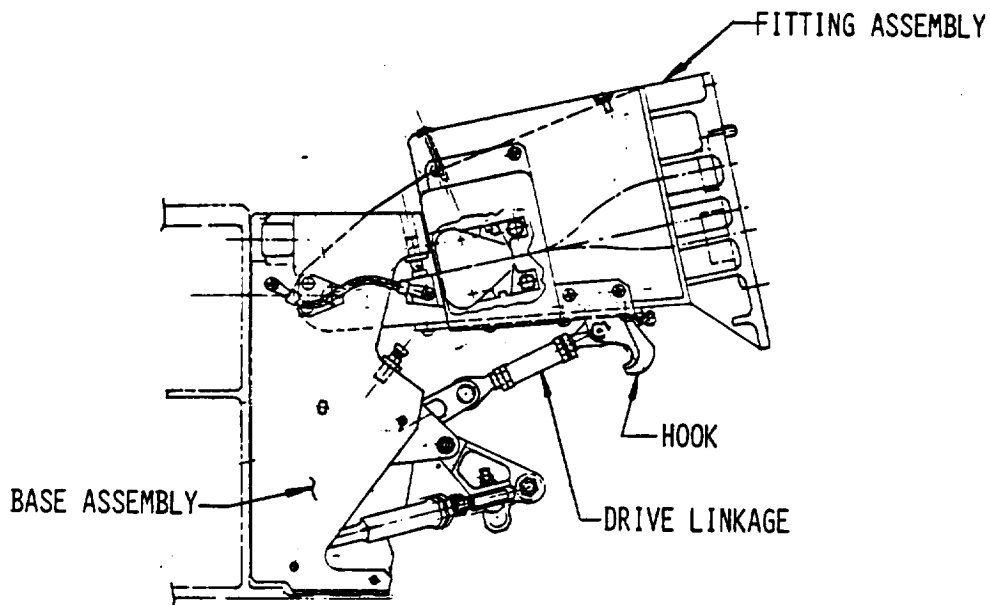


Figure 4. Manipulator Positioning Mechanism Shoulder Assembly

### FUNCTIONAL DESCRIPTION

In stowed position, the drive linkage incorporates an overcenter lock to preclude backdrive of the actuation train (See Figures 5 and 6).

The MPM utilizes a single electromechanical actuator which drives through a torque tube to four gear boxes at the manipulator retention locations. Operation of these four gear boxes causes the arm to pivot outward to its on-orbit use position.

Once positioned outboard, the three pedestal assemblies release latches holding the manipulator arm, enabling the arm to articulate and perform its mission function (See Figure 7). On completion of its mission function, the arm articulates to its extended configuration and is rotated back to the locations of the three aft retention systems where they capture and latch the manipulator arm.

All four assemblies (Shoulder Assembly and Three Pedestal Assemblies) then rotate simultaneously to return the arm to its stowed position to allow closure of the Payload Bay Doors for entry.

In case of failures result in inability to stow or latch the arm for entry, a pyrotechnic separation system is provided at each manipulator retention location to allow jettison of the failed components and a safe orbiter configuration for entry (See Figure 8). One possibility to save the system is to stow it manually, this is called Extra Vehicular Activity (EVA).

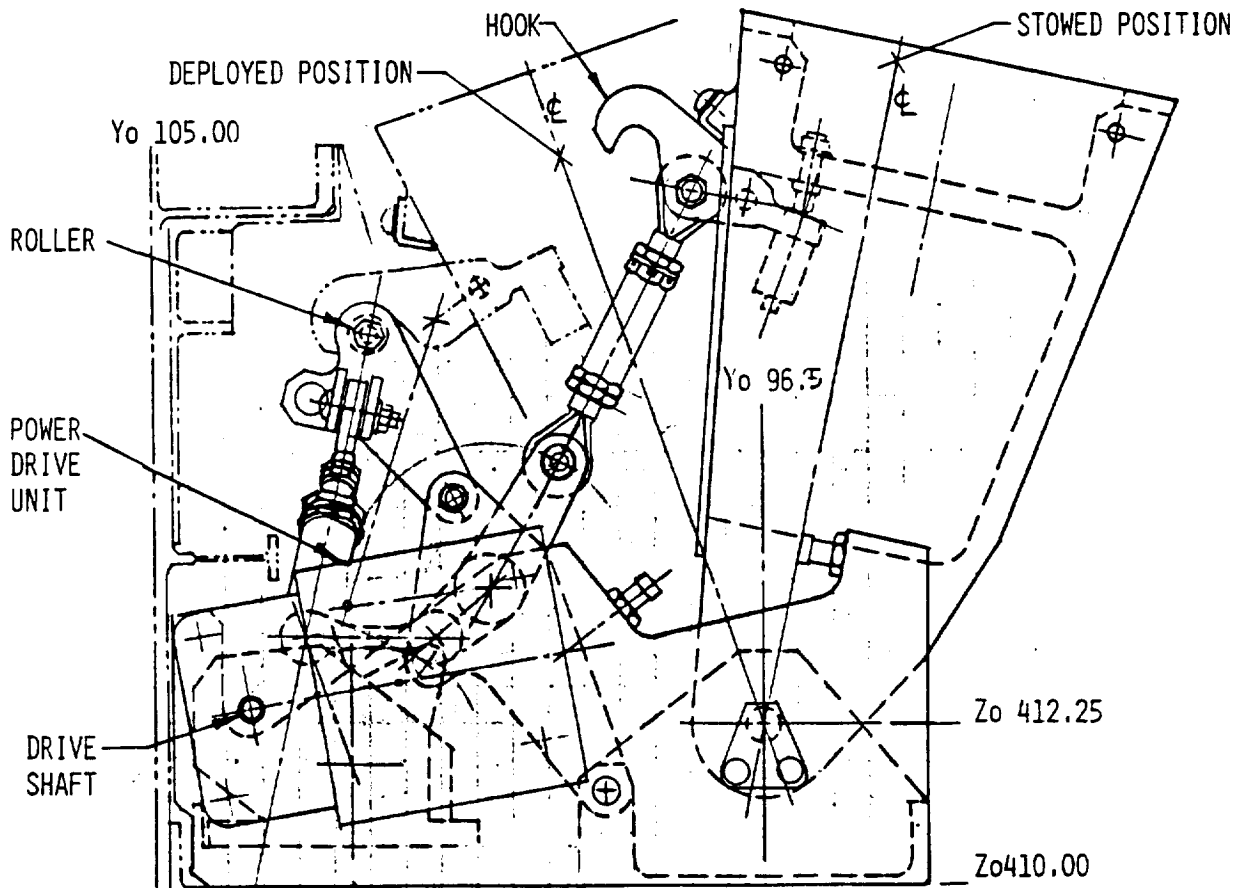


Figure 5. Shoulder Support - Stowed and Deployed Positions

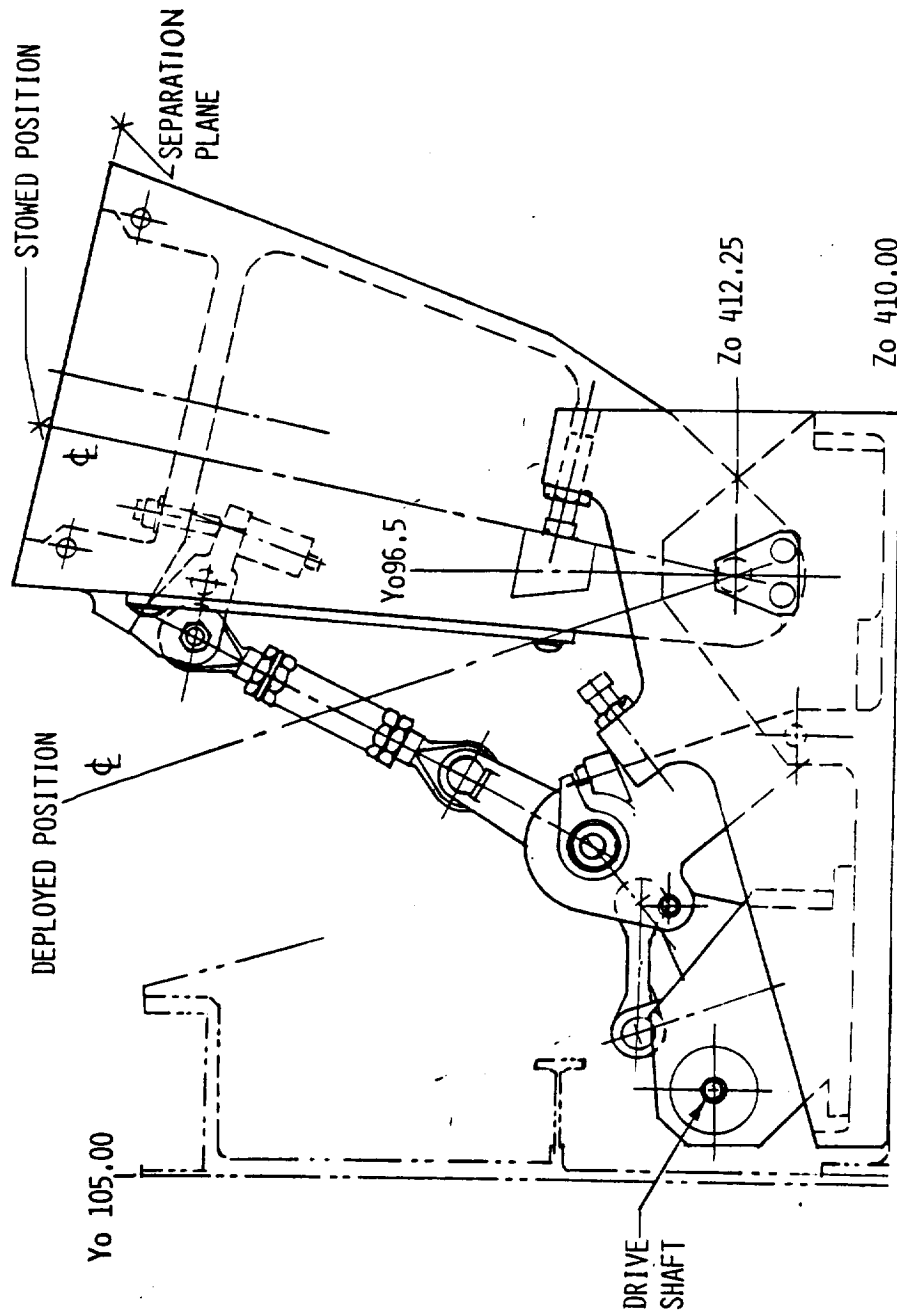


Figure 6. Retention Support - Stowed and Deployed Positions

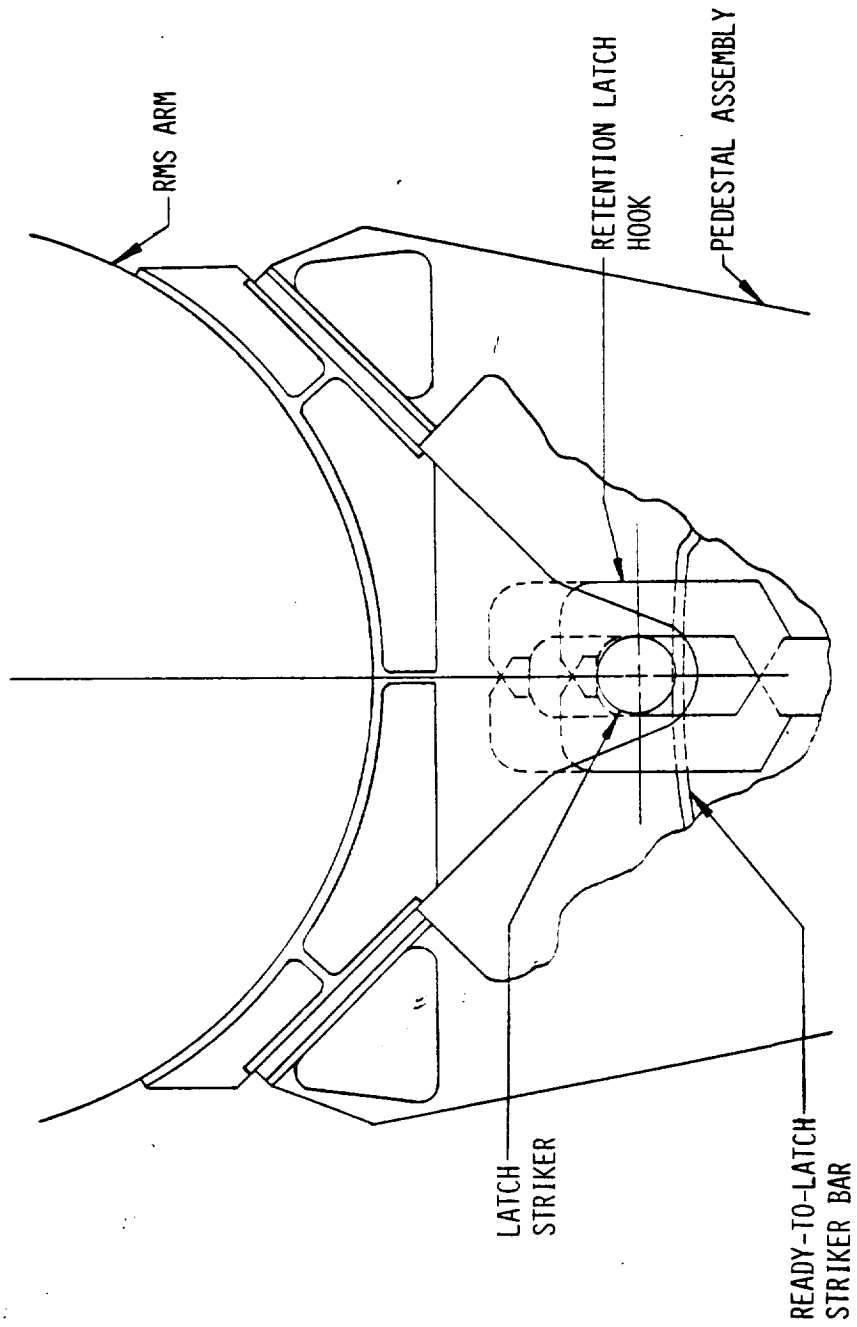


Figure 7. Manipulator Positioning Mechanism Latch and Unlatch Capabilities of RMS ARM

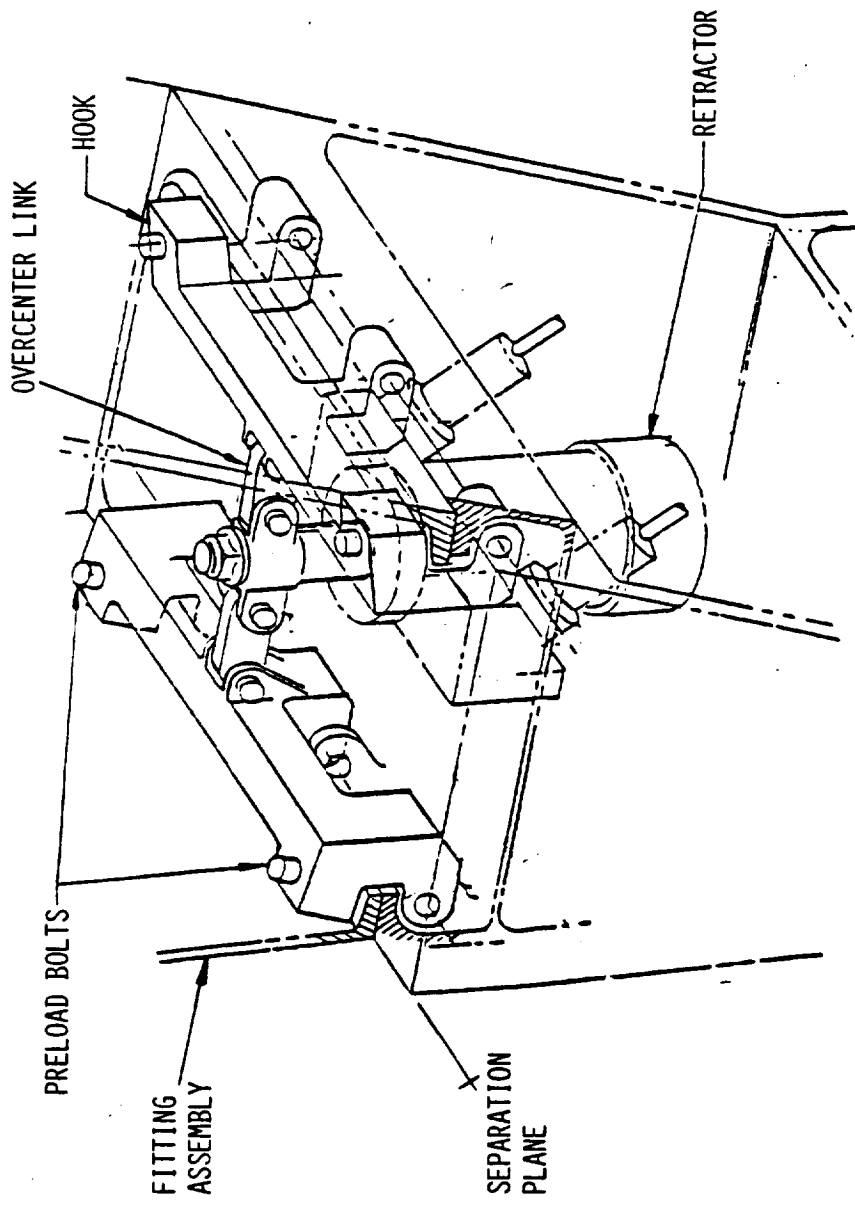


Figure 8. Manipulator Positioning Mechanism Separation System.

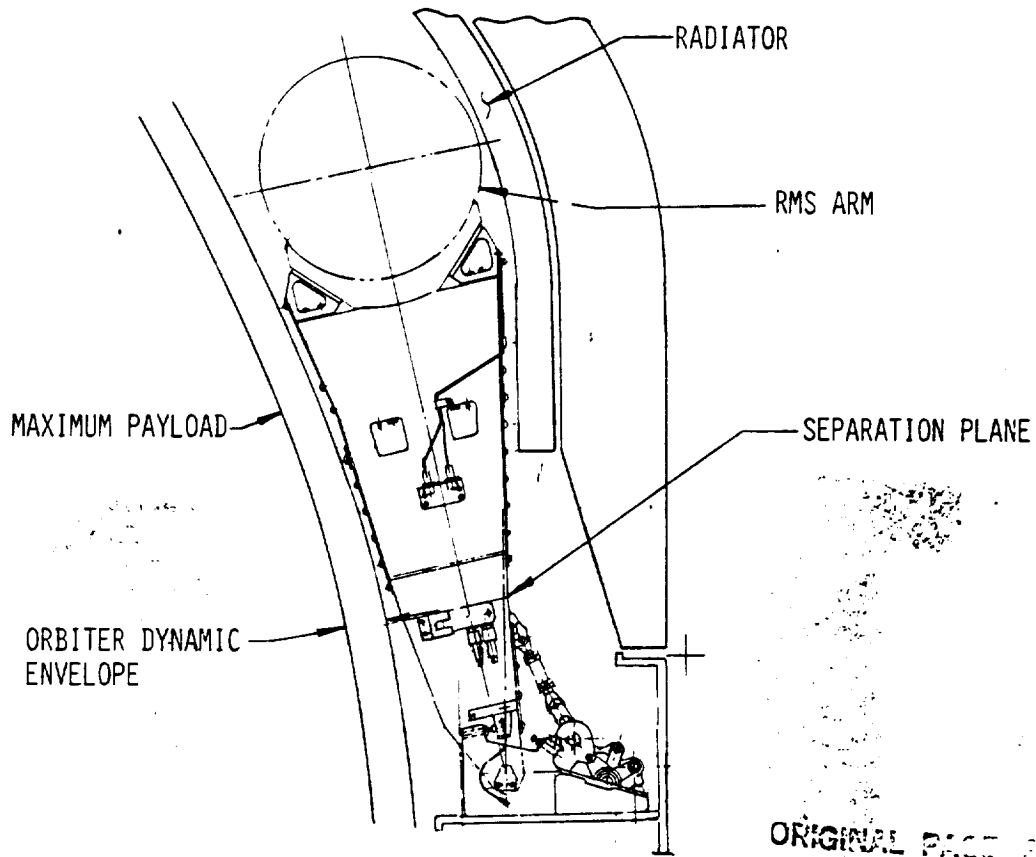


Figure 9. RMS/MPM Envelope

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DESIGN - RETENTION LATCH HOOK

**Requirements**

- o Secure Manipulator Arm in stowed position.
- o Lift-Off, boost and landing.
- o Latch & Stow capability of RMS Arm after usage.

Latch Design mechanically compatible with RMS Arm design & operation.

- o Latch Envelope - 0.875 - In. "Z" &  $\pm$  1.50 - In. "Y" Axis.
- o Final travel of hook motion to be straight be straight line.
- o Z-Axis loading - approximately 2000 Lb.
- o Y-Axis Loading on hooks during latchup -150 Lb.
- o Operational time -7.5 sec, dual motors; 18 sec, single motor.

**Reliability**

- o Latch driven by redundant motors.
- o Dual rotating surfaces.



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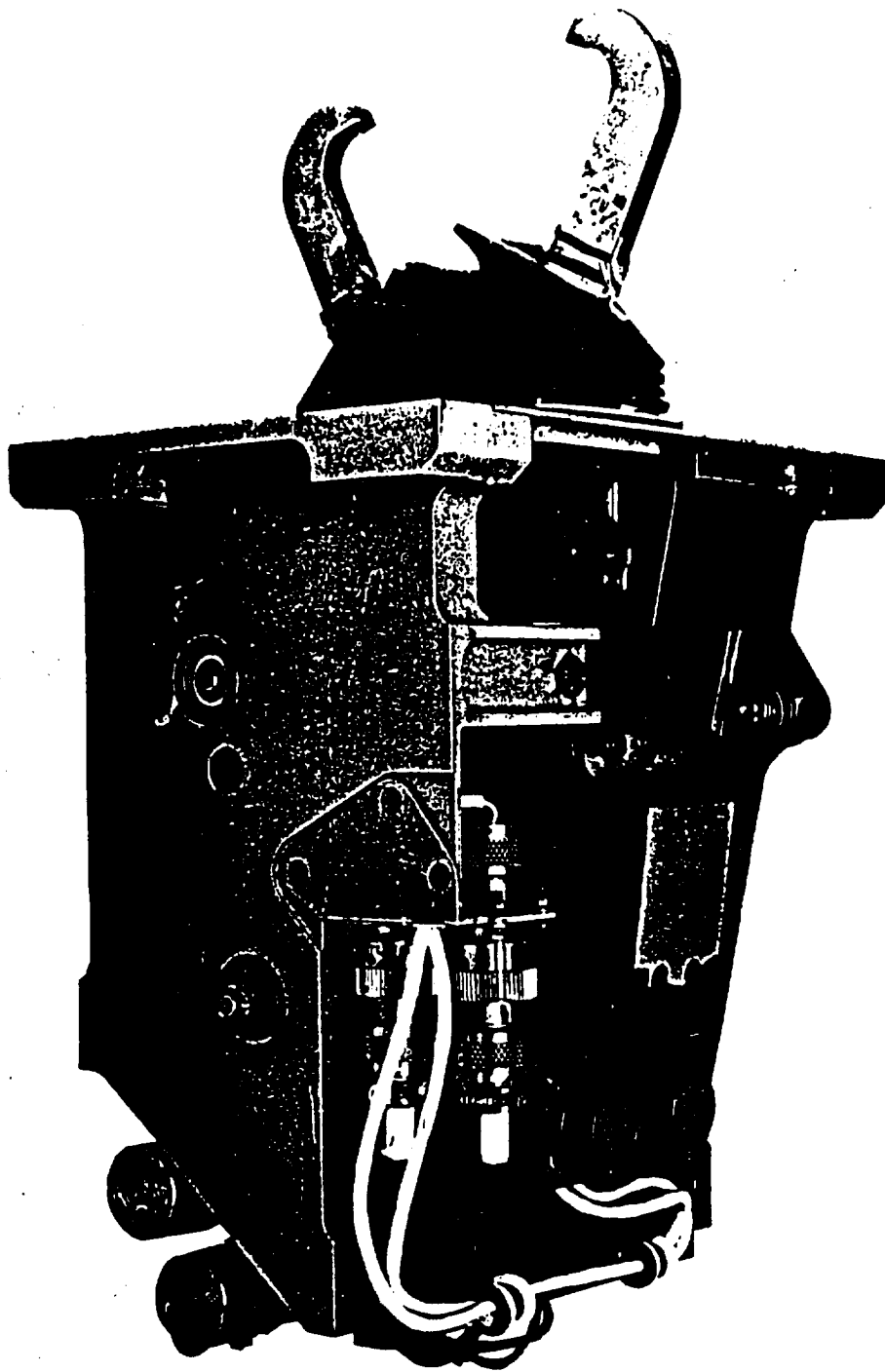


Figure 10. Manipulator Retention Latch