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SOLAR MAXIMUM OBSERVATORY REPAIR MISSION

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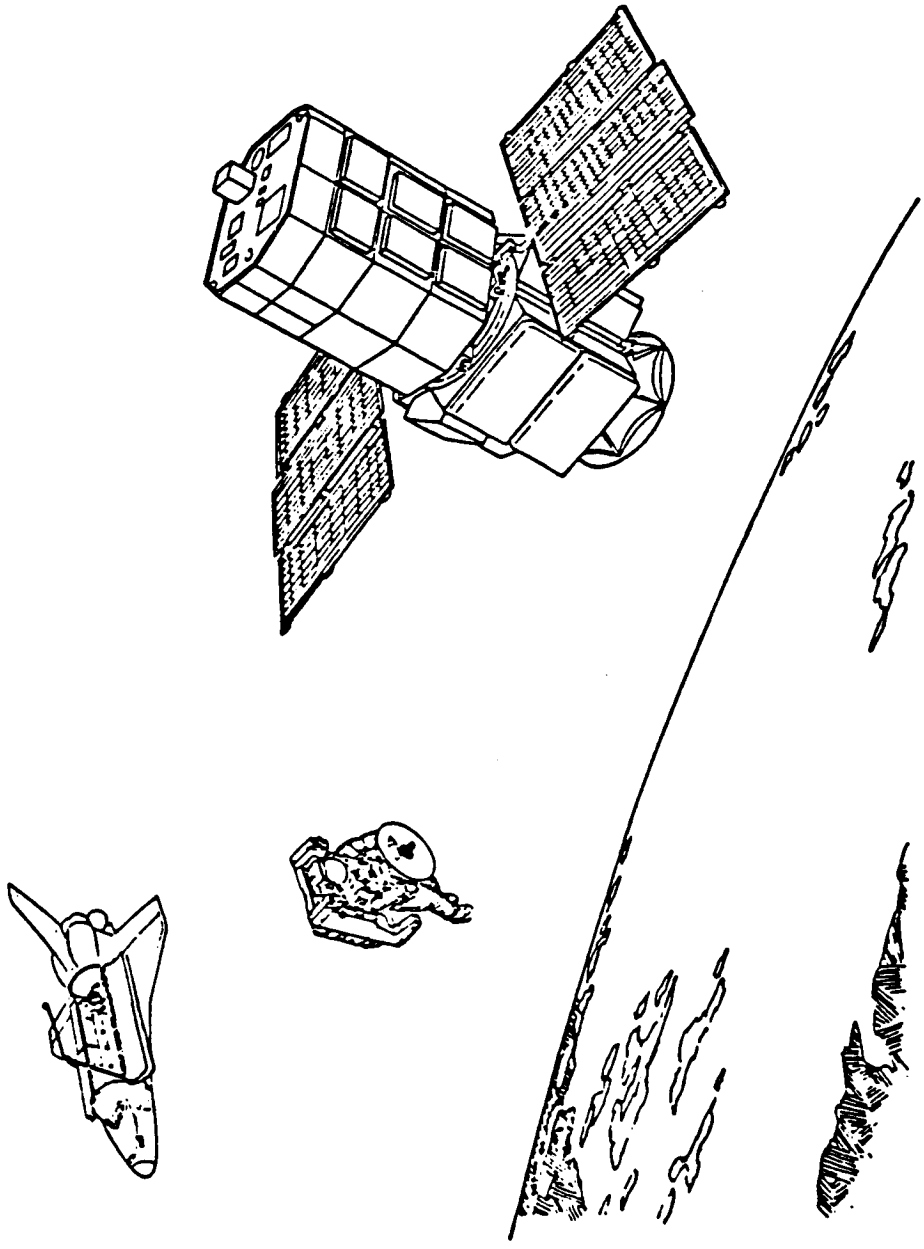
Johnson Space Center
June 22, 1982

SOLAR MAXIMUM OBSERVATORY
REPAIR MISSION



SOLAR MAXIMUM REPAIR MISSION
RATIONALE

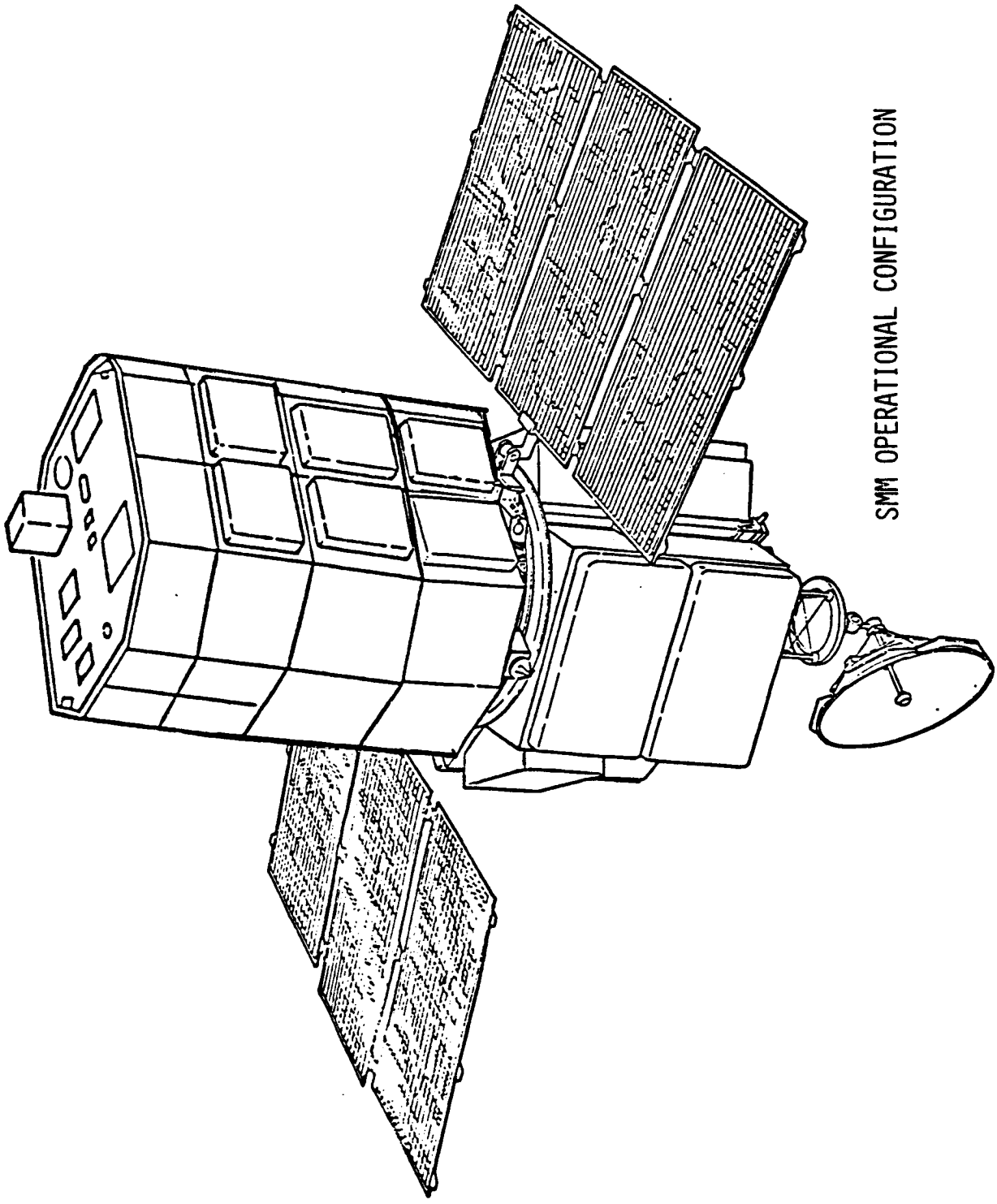
- THE SOLAR MAXIMUM SPACECRAFT IS THIS NATION'S ONLY ORBITING SOLAR OBSERVATORY.
  - SPACECRAFT PARTIALLY DISABLED -- 3 OF 7 SCIENTIFIC INSTRUMENTS CURRENTLY OPERATING.
  - IMPORTANT NEW SOLAR SCIENCE CAN BE DONE WITH SPACECRAFT REPAIR.
  - SHUTTLE MANIFESTING OPPORTUNITIES OCCUR IN LATE 1983 TO EARLY 1984.
  - SPACECRAFT AND SCIENCE REPAIR KITS CAN BE MADE AVAILABLE BY LATE 1983.

- ON-ORBIT SERVICING/RETRIEVAL IS A PLANNED AND IMPORTANT CAPABILITY UNIQUE TO THE SHUTTLE.
- SEVERAL IMPORTANT NASA PROGRAMS INCLUDE THIS CAPABILITY:
  (E.G., LANDSAT, LONG DURATION EXPOSURE FACILITY, SPACE TELESCOPE, SOLAR MAXIMUM MISSION).
- TIMELY DEMONSTRATION IS NEEDED TO ENCOURAGE OTHER USERS TO INCORPORATE FUTURE SPACE REPAIR/RETRIEVAL COMPATIBILITY IN THEIR DESIGN SPECIFICATIONS.
- WOULD DRAMATICALLY DEMONSTRATE TO THE INTERNATIONAL COMMUNITY THE BENEFITS OF SHUTTLE OVER COMPETING LAUNCH SYSTEMS.
- MISSION HAS HIGH PUBLIC AND INDUSTRY APPEAL
  - NECESSARY FOR EFFECTIVE SPACE INDUSTRIALIZATION AND FUTURE MISSION PLANNING.

SOLAR MAXIMUM OBSERVATORY

DESCRIPTION

- THREE-AXIS STABILIZED SOLAR-POINTING OBSERVATORY NO PROPULSION
- SEVEN SCIENTIFIC INSTRUMENTS TO INVESTIGATE SOLAR FLARES AND ENERGY OUTPUT
- SPACECRAFT DESIGNED TO BE CAPTURED AND SERVICED IN ORBIT OR RETRIEVED BY THE SHUTTLE



SMM OPERATIONAL CONFIGURATION

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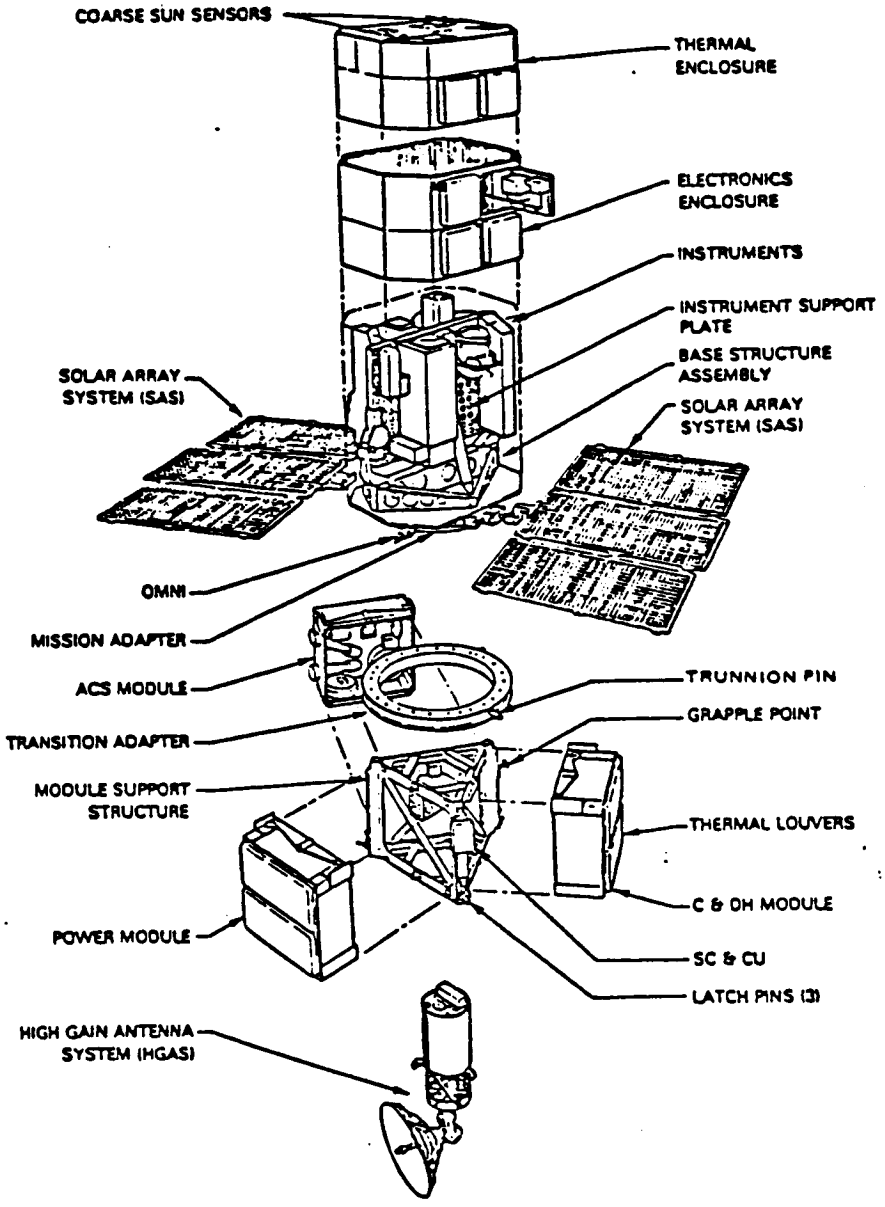

SMM OBSERVATORY EXPLODED VIEW

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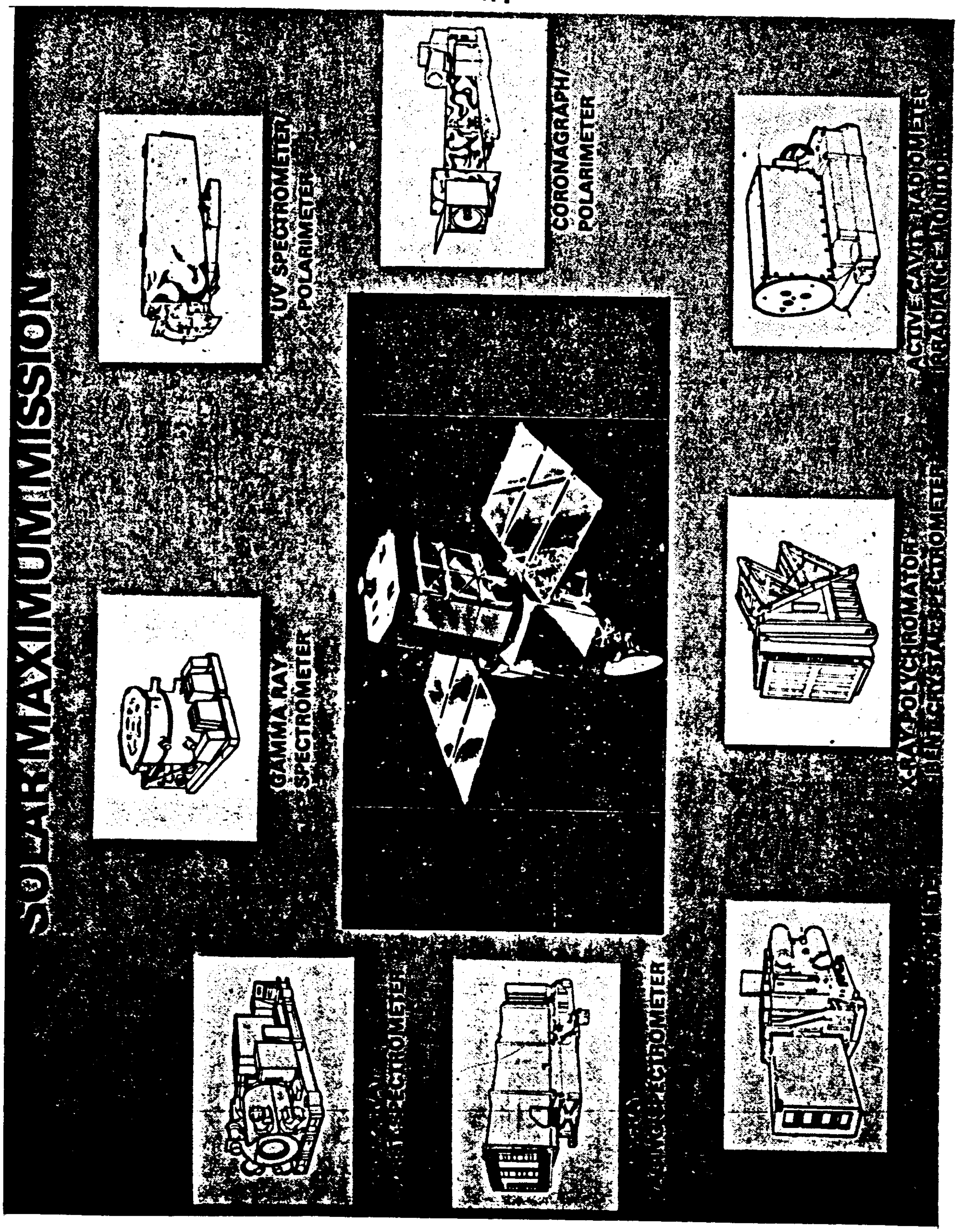


MAJOR SMM RESULTS TO DATE

- FIRST IMAGES EVER MADE OF HARD X-RAYS FROM A SOLAR FLARE
- DISCOVERY OF SOURCE OF HIGH-ENERGY EMISSIONS FROM FLARES
- DETECTION OF SHORT-TERM AND LONG-TERM VARIATIONS IN TOTAL SOLAR ENERGY OUTPUT
- DISCOVERY OF RAPID ACCELERATION OF PROTONS IN FLARES
- DISCOVERY OF MANY NEW NUCLEAR REACTIONS IN FLARES, SHOWING UNUSUAL ELEMENT ABUNDANCES
- DETECTION OF VIOLENT MOTIONS IN HIGH-TEMPERATURE FLARE PLASMA
- FIRST DETECTION OF NEUTRONS FROM A FLARE

WHAT SCIENCE CAN BE DONE WITH A REPAIRED SOLAR MAXIMUM MISSION

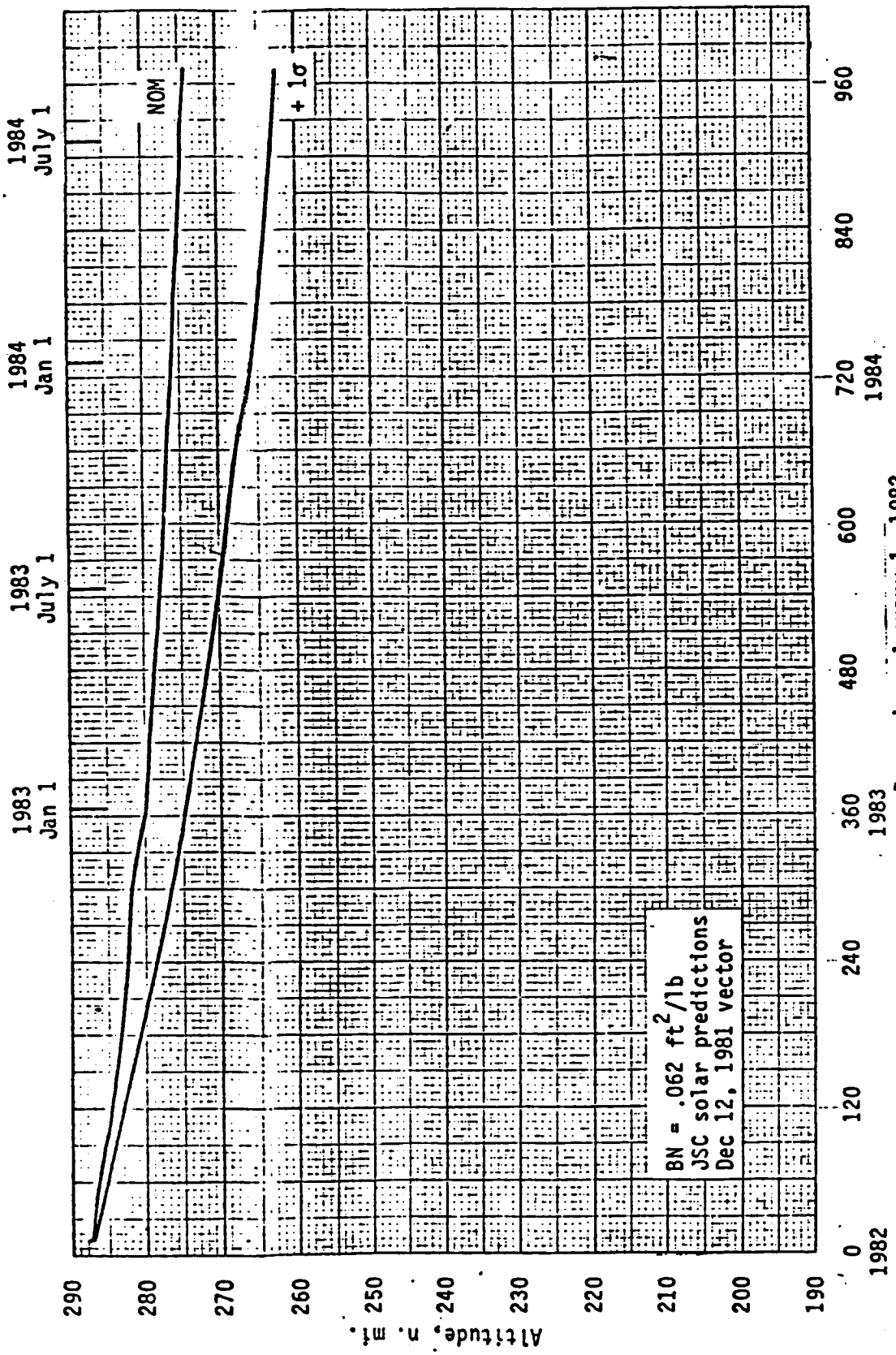
MAJOR SCIENCE OBJECTIVES

1. SOLAR FLARE STUDIES WITH SIX COORDINATED INSTRUMENTS
2. MEASUREMENTS OF CHANGES IN TOTAL SOLAR ENERGY OUTPUT
3. STUDIES OF OSCILLATIONS OF THE SUN
4. EVOLUTION OF THE SOLAR CORONA
5. STUDIES OF THE QUIET SUN AND EARTH

SOLAR MAXIMUM OBSERVATORY

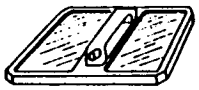
STATUS

- FUSE FAILURES IN ATTITUDE CONTROL SYSTEM MODULE WHEEL DRIVE CIRCUITS NEGATED THE OBSERVATORY'S FINE POINTING CAPABILITY (ARC SEC) DECEMBER, 1980
- SPACECRAFT UNDER COARSE-POINTING CONTROL MODE IS GATHERING SCIENTIFIC DATA (THREE OF SEVEN INSTRUMENTS). FOUR INSTRUMENTS REQUIRE FINE POINTING.
- SPACECRAFT REMAINS UNDER CONTROL THROUGH USE OF MAGNETIC TORQUER BARS AND SLOW ROLL; ROTATION IS ABOUT THE ROLL AXIS AT APPROXIMATELY 0.9^{0}/SEC.
- ORBIT ALTITUDE AS OF 4/14/82 IS 285.0 N. MI. PREDICTED (8/30/81) TO BE 285 N. MI.
- ATTITUDE CONTROL SYSTEM MODULE AND SCIENTIFIC INSTRUMENTS REPAIRABLE VIA MANNED EVA.
- MINOR OPERATIONAL ANOMALIES ON TWO SCIENTIFIC INSTRUMENTS. ANOTHER INSTRUMENT HAS MALFUNCTION OF ITS ELECTRONICS MODULE.
- ALL OTHER SPACECRAFT SYSTEMS OPERATING SUCCESSFULLY AND WITH FULL REDUNDANCY.

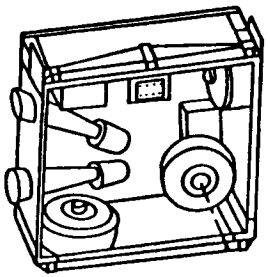


SMM DECAY PREDICTIONS

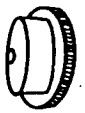
HARDWARE ELEMENTS



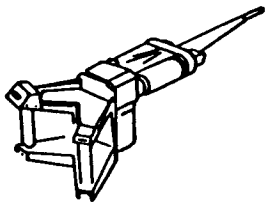
HXIS THERMAL CLOSURE



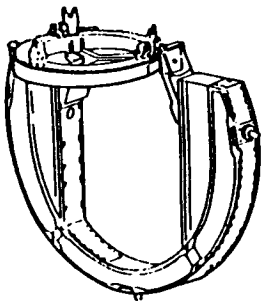
ATTITUDE CONTROL MODULE



XRP BAFFLE



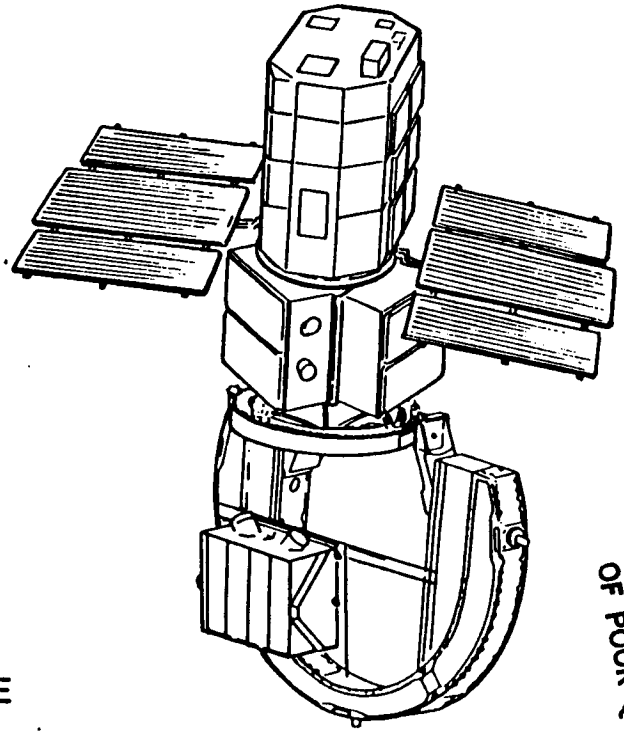
MODULE SERVICE TOOL



FSS CRADLE A'

C/P ELECTRONICS

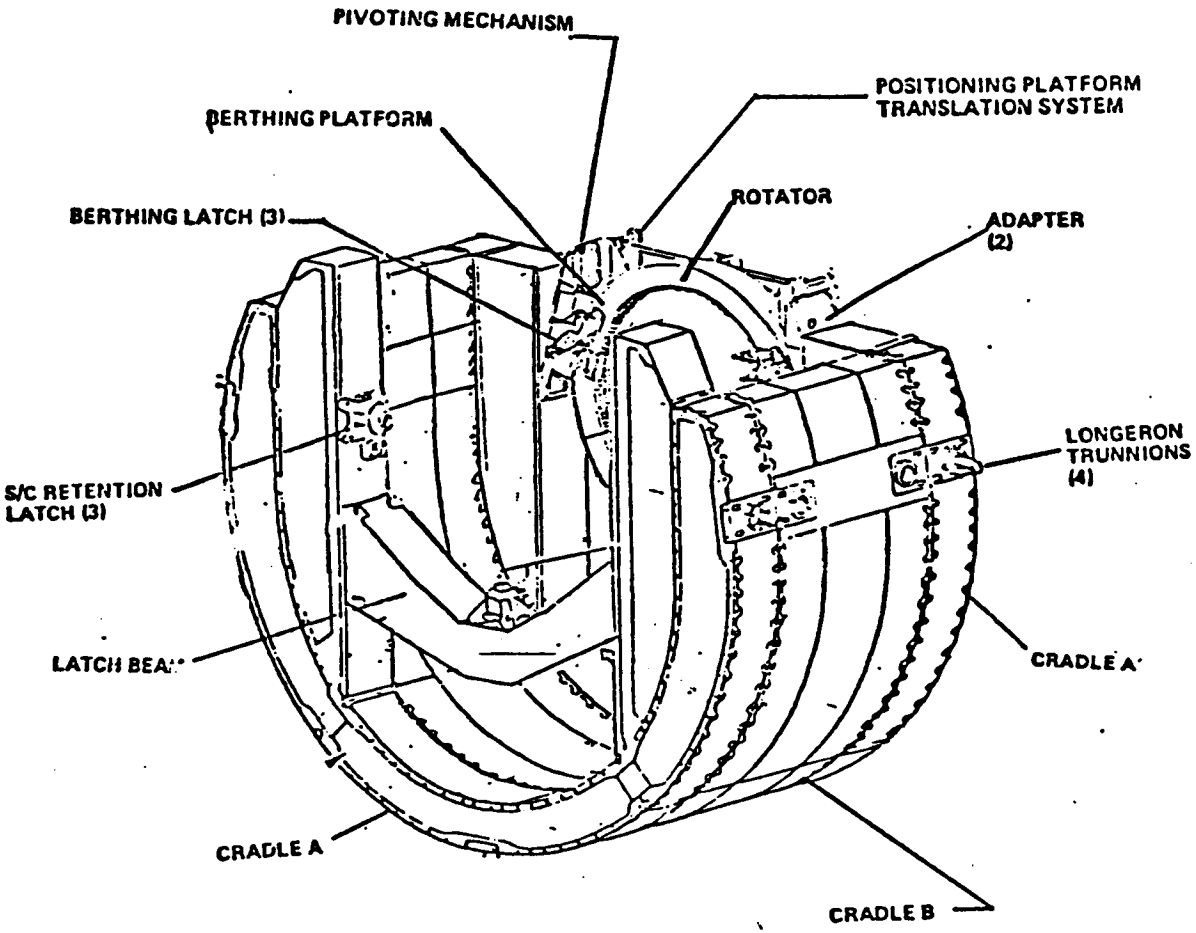
SYSTEM CONFIGURATION



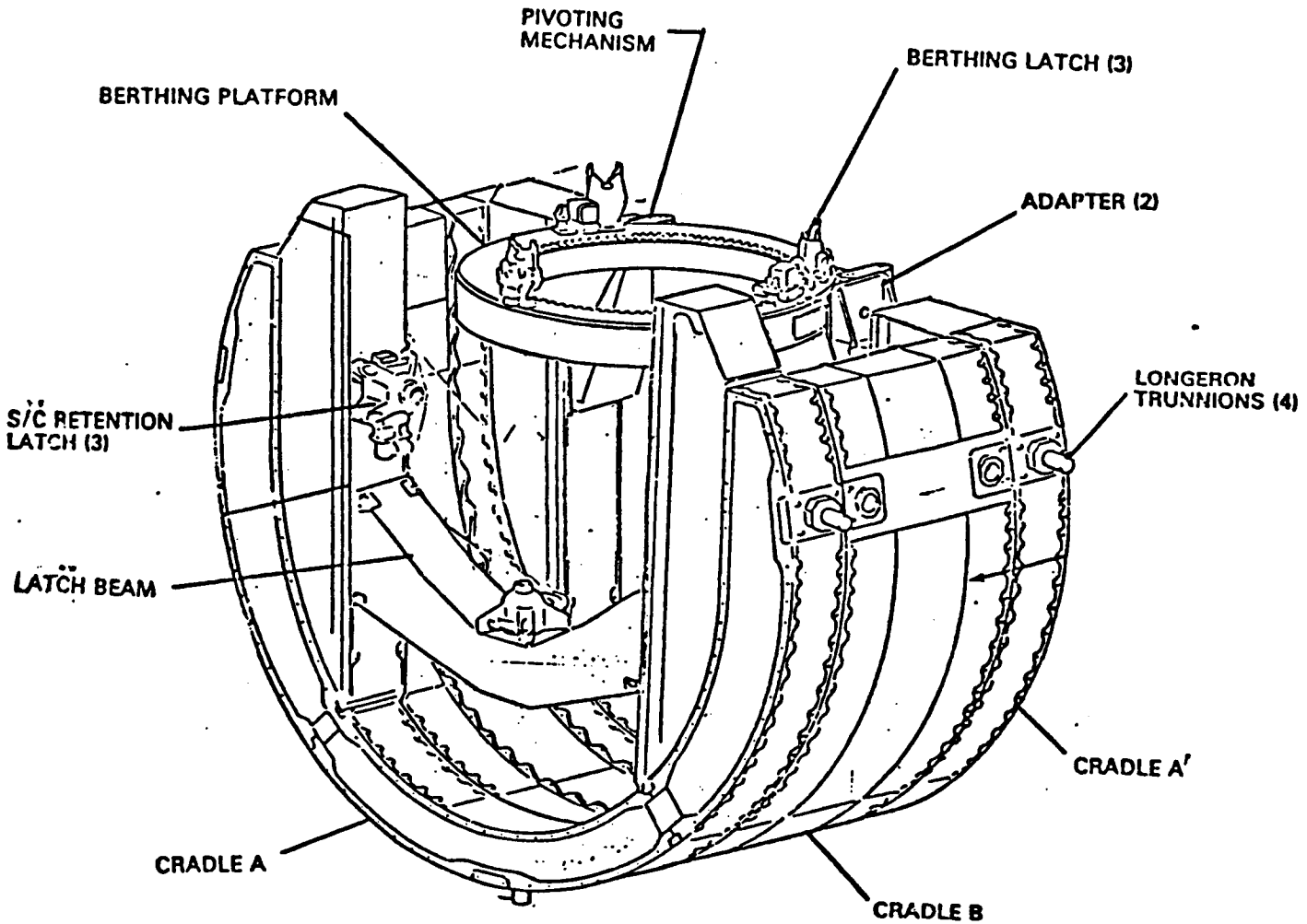
SOLAR MAXIMUM MISSION

SOLAR MAXIMUM OBSERVATORY REPAIR MISSION CHARACTERISTICS

- SHUTTLE LAUNCH - 3/84
- SHUTTLE CONFIGURATION INCLUDES:
  - REMOTE MANIPULATOR SYSTEM (RMS)
  - FLIGHT SUPPORT SYSTEM (FSS)
  - MANNED MANEUVERING UNIT (MMU)
- SPACECRAFT REPAIR KIT - SPARE LANDSAT ACS MODULE
- SCIENTIFIC INSTRUMENT REPAIR KITS - CORONAGRAPH ELECTRONICS, X-RAY POLYCHROMATOR BAFFLE AND HARD X-RAY IMAGING SPECTROMETER THERMAL CLOSURE
- REPAIR ACCOMPLISHED BY:
  - CAPTURE AND CONTROL OF OBSERVATORY IN FREE-FLIGHT BY ASTRONAUT IN THE MANNED MANEUVERING UNIT
  - OBSERVATORY BERTHED TO THE ORBITER WITH THE SHUTTLE REMOTE MANIPULATOR SYSTEM
  - THE SMM SPACECRAFT ATTITUDE CONTROL SYSTEM IS REPLACED USING EVA
  - THE SCIENTIFIC INSTRUMENTS ARE REPAIRED USING EVA
- REPAIR MISSION WILL RESTORE FINE POINTING AND ALL SCIENTIFIC INSTRUMENTS TO FULL PERFORMANCE.

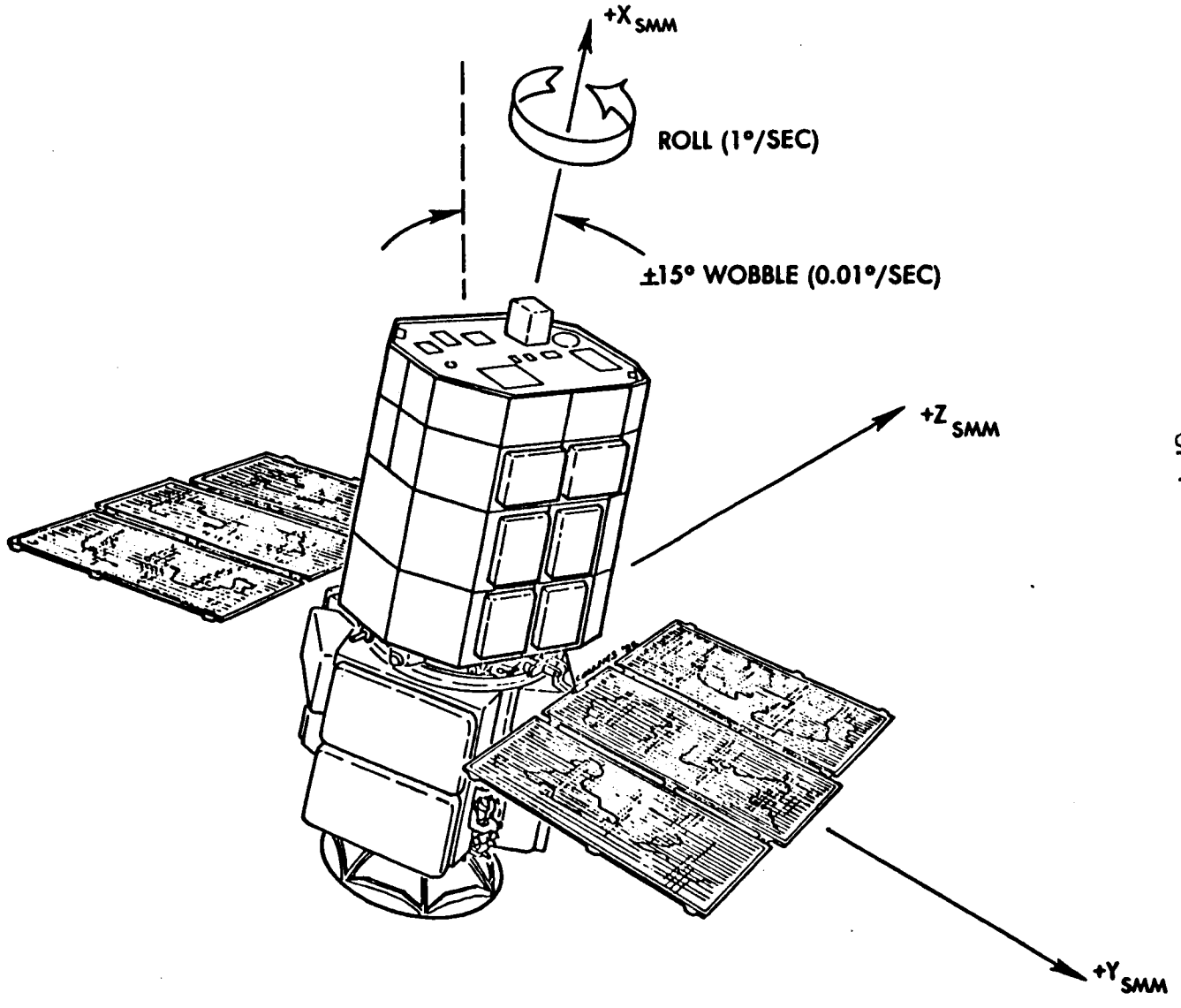


FSS STOWED CONFIGURATION FOR SMM RETRIEVAL



FSS OPERATIONAL CONFIGURATION FOR SMM RETRIEVAL

SMM SPACECRAFT TUMBLE RATES



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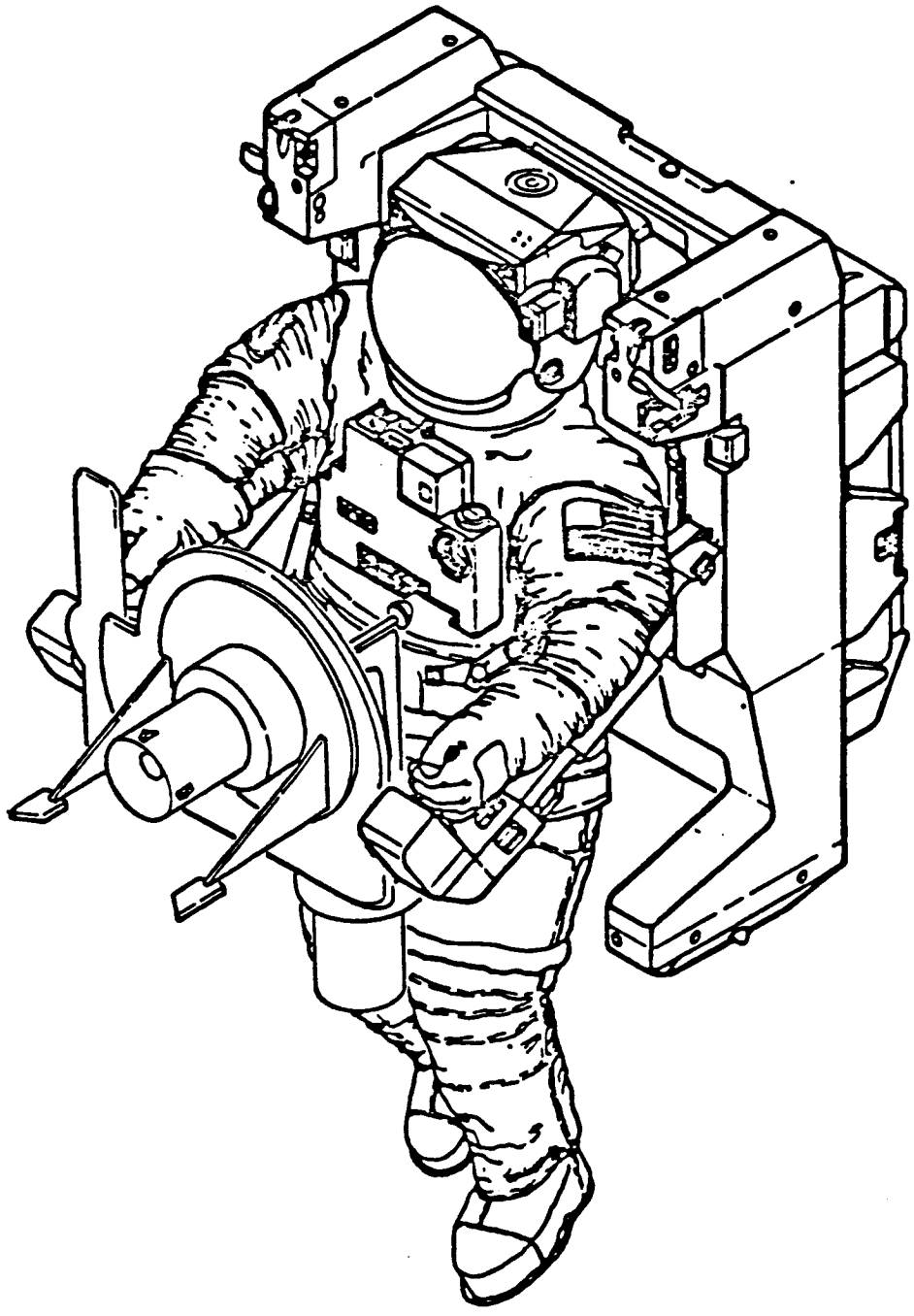
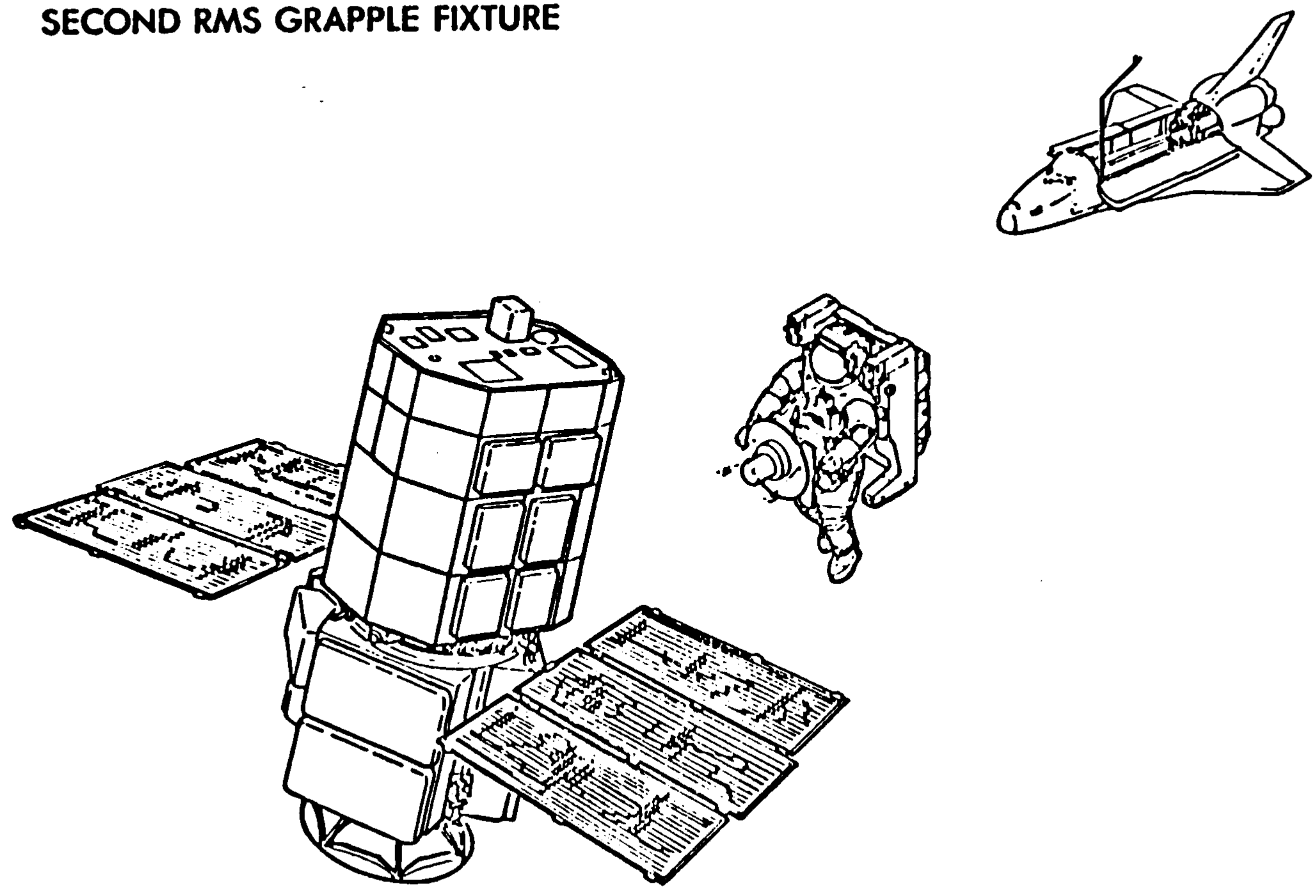
MANNED MANEUVERING UNIT WITH TRUNNION PIN ATTACHMENT DEVICE

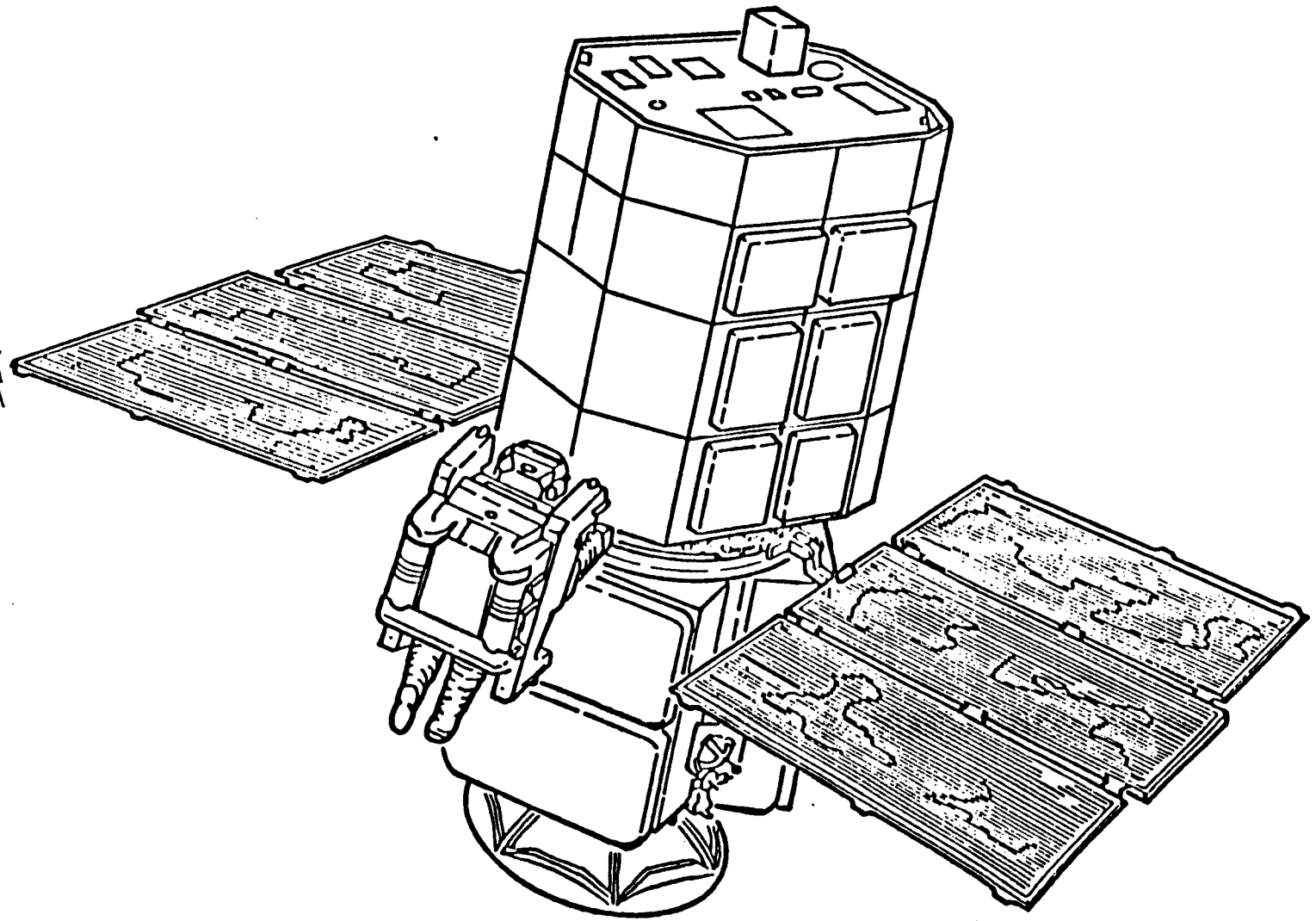


MMU CAPTURE OF SMM

- SHUTTLE STATIONKEEPS AT APPROXIMATELY 200 FEET
- EVA CREWMEMBER FLIES MMU OVER TO SMM SPACECRAFT CARRYING SECOND RMS GRAPPLE FIXTURE

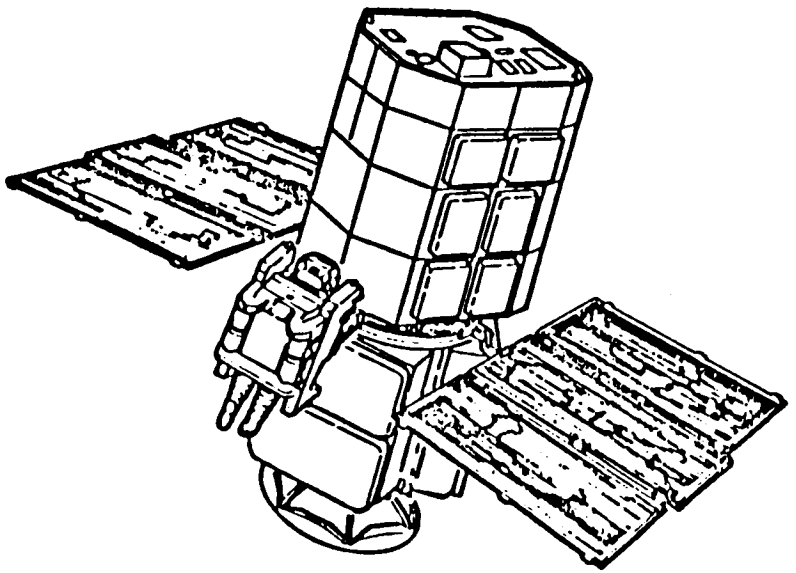


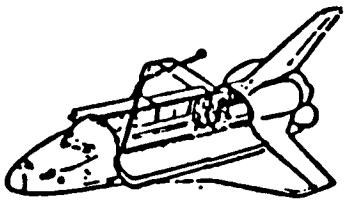
MMU ATTACHING SECOND RMS GRAPPLE FIXTURE AND STABILIZING SMM



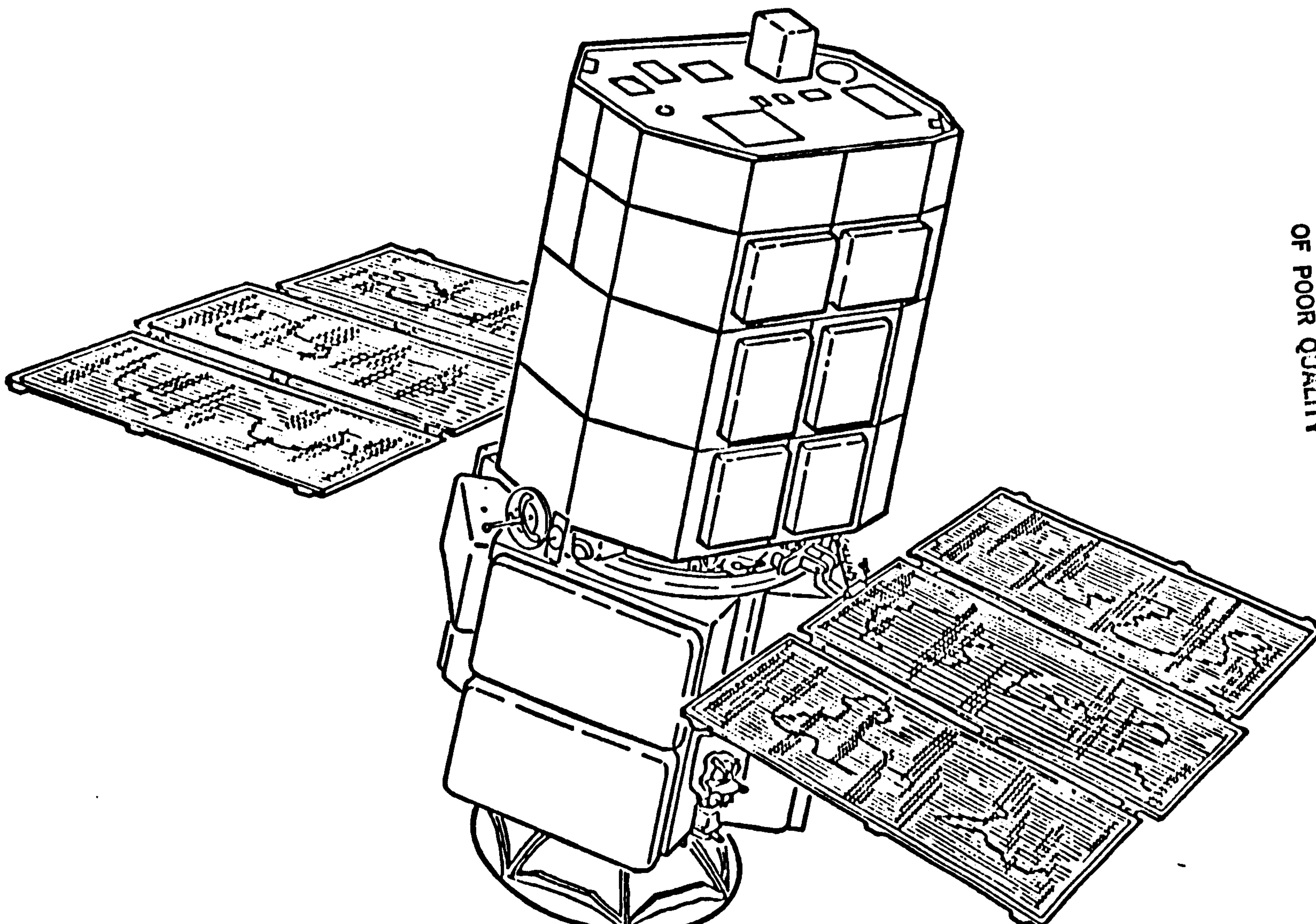
MMU CAPTURE OF SMM (CONT'D)

- EVA CREWMEMBER WITH MMU:
  - -UNDOCKS FROM SMM LEAVING SECOND RMS GRAPPLE FIXTURE ON SMM TRUNNION PIN
  - -FLIES TO BACKSIDE OF SMM AND DOCKS TO OPPOSITE SMM TRUNNION PIN
  - -USES MMU THRUSTERS TO MAINTAIN SMM ATTITUDE DURING SHUTTLE APPROACH AND RMS GRAPPLING

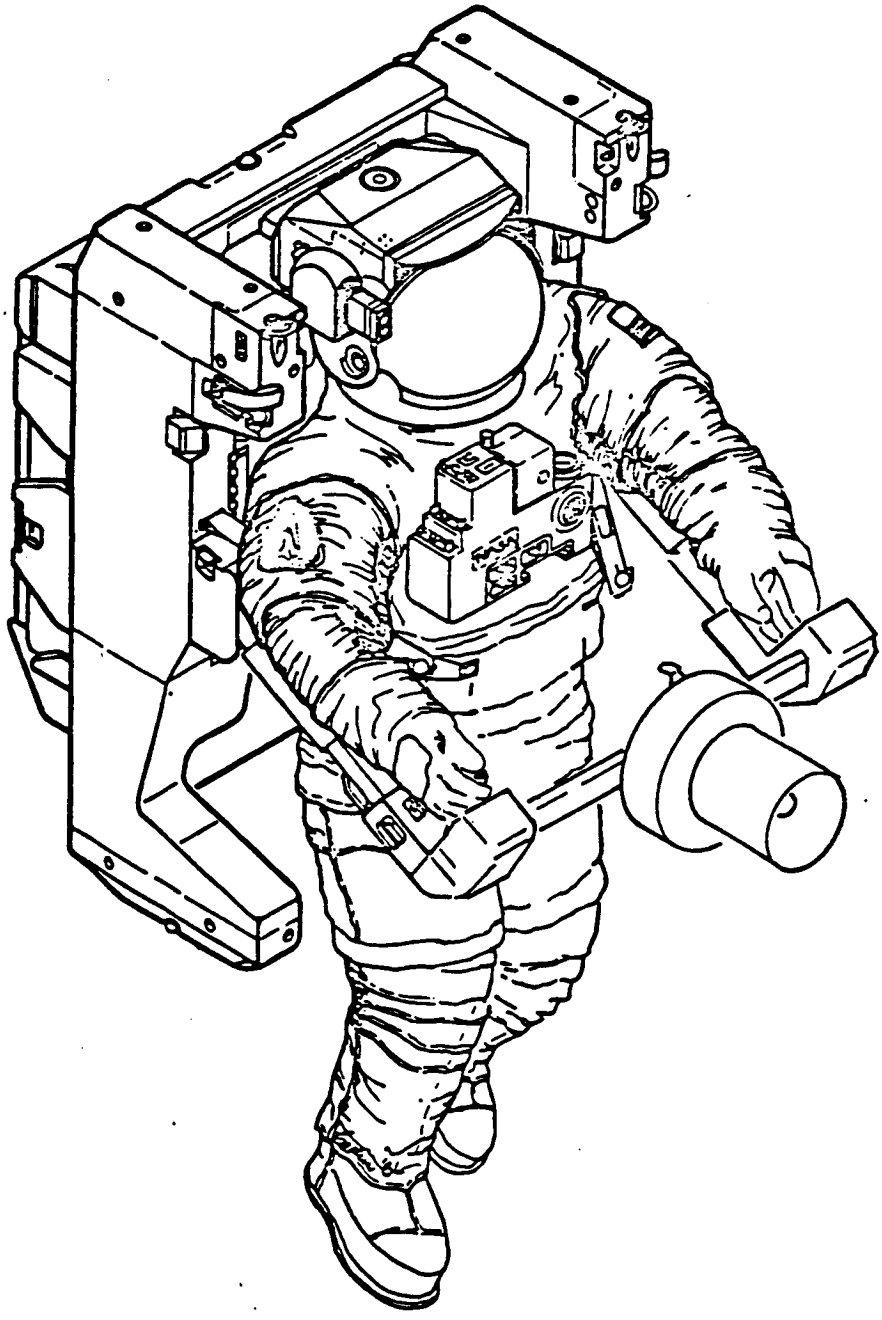




SOLAR MAXIMUM MISSION SPACECRAFT READY FOR RMS GRAPPLING

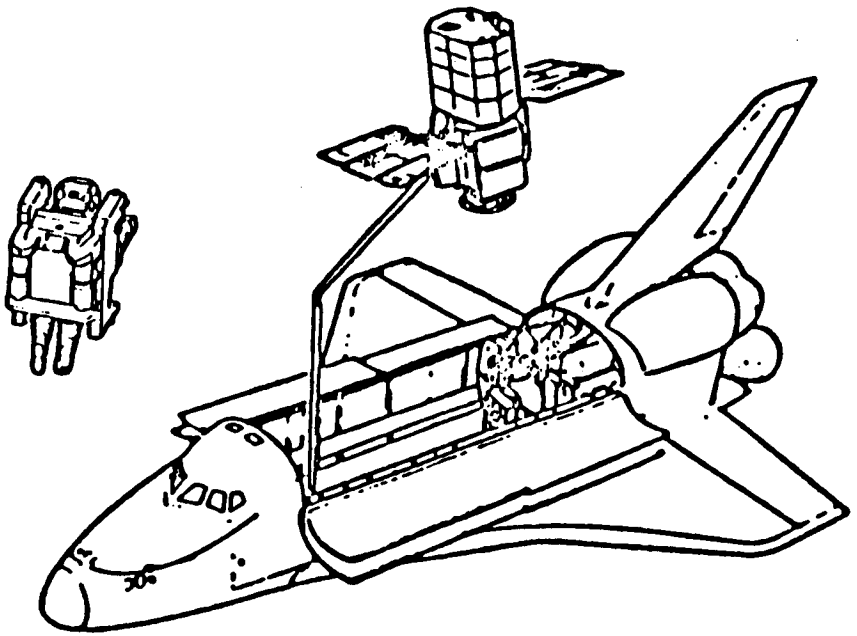


MANNED MANEUVERING UNIT WITH SMM ATTACHMENT DEVICE



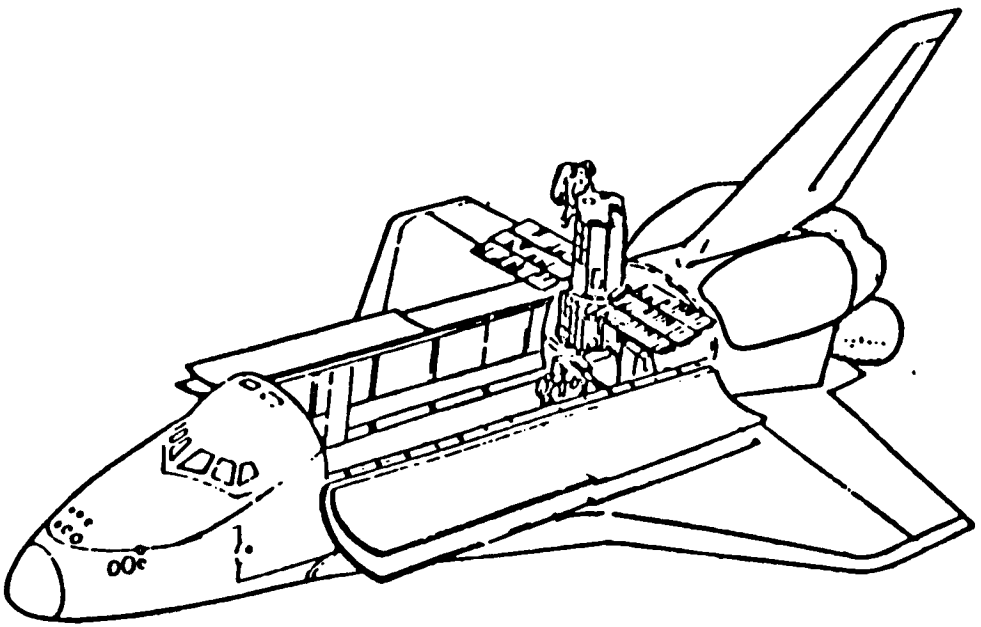
MMU CAPTURE OF SMM (CONT'D)

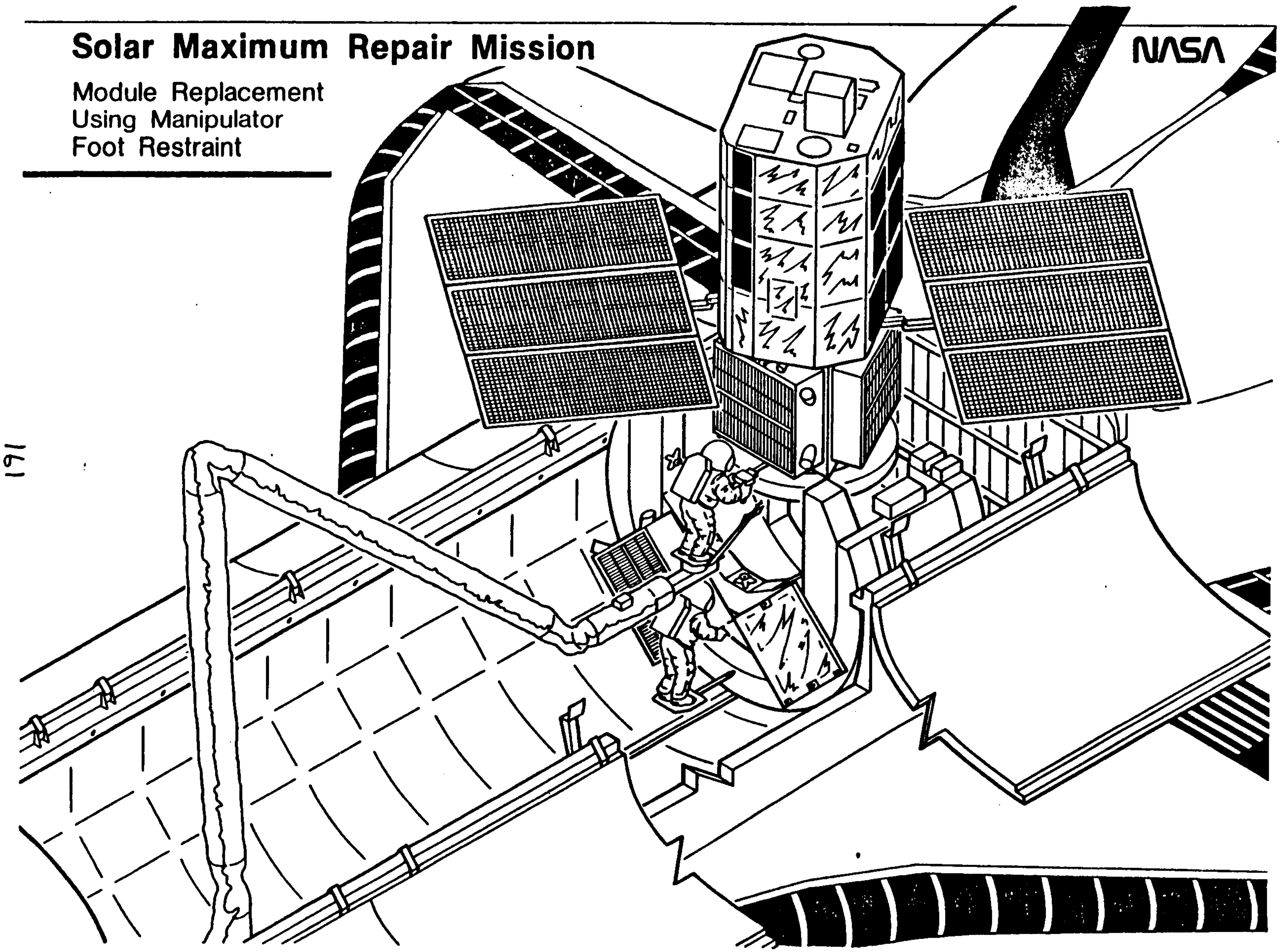
- RMS GRAPPLES SMM
- EVA CREWMEMBER WITH MMU:
  - -UNDOCKS FROM SMM
  - -COLLECTS CONTAMINATION SAMPLES
  - -PHOTOGRAPHS SMM AND BERTHING OPERATIONS
  - -RETURNS TO PAYLOAD BAY AND DOFFS MMU
- RMS BERTHS SMM TO CRADDLE



MMU CAPTURE OF SMM (CONT'D)

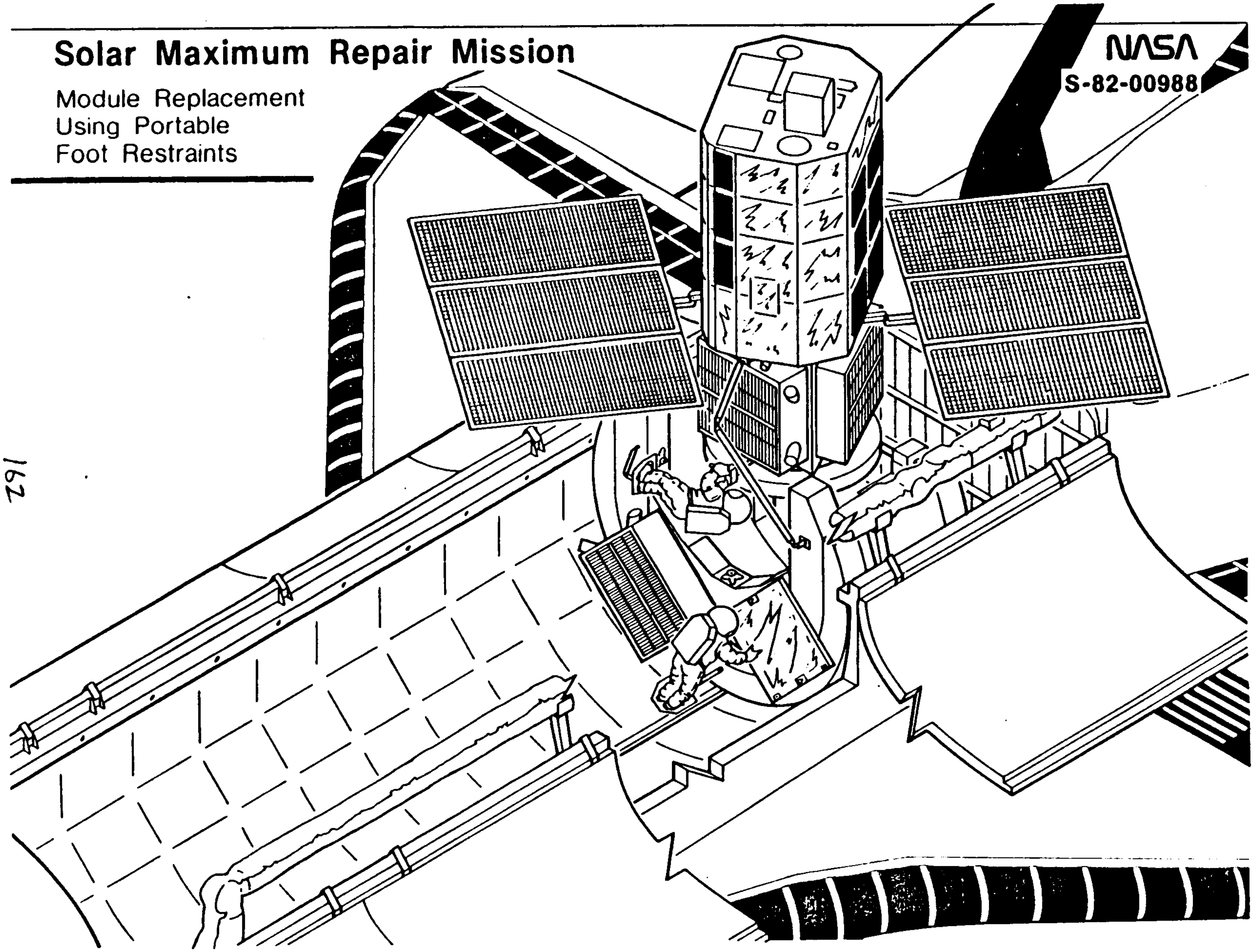
- EVA CREWMEMBERS CHANGE OUT SMM ATTITUDE CONTROL MODULE AND REPAIR MAIN ELECTRONICS BOX
- RMS DEPLOYS SMM
- CONTINGENCY MMU SUPPORT:
  - -INSTALL THERMAL BARRIER OVER HARD X-RAY SPECTROMETER WINDOW
  - -INSTALL PLASMA SHIELD OVER X-RAY POLYCHROMETER VENT
  - -RESTABILIZE SMM AFTER DEPLOYMENT





Solar Maximum Repair Mission

Module Replacement
Using Portable
Foot Restraints



SOLAR MAXIMUM REPAIR MISSION

BENEFITS TO THE STS

- VALIDATES THE OPERATION OF:
  - ON-BOARD RENDEZVOUS RADAR; FLIGHT AND GROUND BASED RENDEZVOUS SOFTWARE.
  - SHUTTLE-SPACECRAFT PROXIMITY OPERATIONS.
  - GRAPPLE AND BERTHING OF PARTIALLY DISABLED SPACECRAFT WITH THE RMS.
  - ASTRONAUT RESTRAINT SYSTEMS AS WORK STATIONS DURING EVA.
- ESTABLISHES FOR FUTURE USE:
  - MANNED MANEUVERING UNIT (MMU) FOR ASTRONAUT MOBILITY.
  - MMU AS A SURROGATE STABILIZATION CONTROL SYSTEM FOR GYRATING SPACECRAFT.
  - "DIRECT INSERTION" SHUTTLE LAUNCH TECHNIQUES FOR HIGH ALTITUDE MISSIONS.
  - FLIGHT QUALIFIED FLIGHT SUPPORT SYSTEM (FSS) TO SUPPORT SUBSEQUENT MISSIONS.
- PROVIDES OPPORTUNITIES FOR:
  - OBSERVING EXTERNAL TANK ENTRY, BREAKUP AND IMPACT DYNAMICS (HAWAII TRACKING).
  - ASSESSING THE EFFECTS OF PROLONGED SPACE EXPOSURE ON SPACECRAFT MATERIALS.
  - EVALUATING TECHNIQUES TO BE USED ON SPACE TELESCOPE AND OTHER OBSERVATORY-CLASS PAYLOADS.
  - EXPANDING THE SCOPE OF ACTIVITIES DURING EVA OPERATIONS APPLICABLE TO FUTURE MISSIONS.

REPAIR MISSION COST
vs.
INITIAL INVESTMENT

EXPRESSED IN CURRENT YEAR DOLLARS, THE SOLAR MAXIMUM MISSION SPACECRAFT & INSTRUMENTS COST APPROXIMATELY $ 200 MILLION TO DESIGN AND DEVELOP

THE ESTIMATE FOR THE REPAIR MISSION IS $ 45-55 MILLION FOR MISSION DIRECT COSTS, MISSION OPERATIONS CAPABILITY COSTS, AND RELATED COSTS. ON THE MANIFESTED MISSION WITH THE LDEF, LAUNCH COSTS ASSIGNABLE TO THE PROVISIONS FOR THE REPAIR MISSION ARE ESTIMATED AT APPROXIMATELY $ 10 MILLION.

THE ADDITIONAL INVESTMENT YIELDS ANOTHER TWO-TO-THREE YEARS OF SOLAR OBSERVATIONS AT A COST WHICH IS ABOUT A FOURTH OF THE CURRENT VALUE OF THE INITIAL INVESTMENT.

SOLAR MAXIMUM MISSION

SUMMARY

A REPAIRED SMM CAN BE USED TO CARRY OUT A RENEWED SCIENTIFIC PROGRAM OF IMPORTANT SOLAR STUDIES FOR TWO-THREE ADDITIONAL YEARS.