SATELLITE SERVICES SYSTEM ANALYSIS STUDY

volume 3A — service equipment requirements — Appendix

prepared for
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FOREWORD

This study was conducted for the Lyndon B. Johnson Space Center and directed by Contracting Officer's Representative (COR), Mssrs. Reuben Taylor and Gordon Rysavy. Grumman Aerospace Corporation's study manager was Mr. John Mockovciak Jr.

This final report is presented in seven volumes as follows:

Volume 1 - Executive Summary

Volume 2 - Satellite and Services User Model

Volume 2A - Satellite and Services User Model - Appendix

Volume 3 - Service Equipment Requirements

Volume 3A - Service Equipment Requirements - Appendix

Volume 4 - Service Equipment Concepts

Volume 5 - Programmatics

This Appendix to Volume 3 - Service Equipment Requirements contains the functional analyses of reference satellite missions (Appendix A), and level 1 on-orbit service mission scenarics (Appendix B). The data presented was used to identify the requirements and equipment needed for satellite services from the Orbiter.

Appendix A

Reference Satellite Missions - Functional Analysis

CONTENTS

CONTENTS (CONT'D)

APPENDIX A
REFERENCE SATELLITE MISSIONS – FUNCTIONAL ANALYSIS

1.0 INTRODUCTION

Servicing equipment is required for satellite deployment, examination, retrieval checkout, repair, maintenance, resupplying, reconfiguration, and earth return. Five satellite missions have been analyzed in depth to identify service functions, equipment, and related crew/satellite interfaces required to perform satellite servicing. The following missions were analyzed:

- X-Ray Timing Explorer (XTE)
- Upper Atmosphere Research Satellite (UARS)
- Advanced X-Ray Astrophysics Facility (..XAF)
- Earth Gravity Field Survey Mission (GRAVSAT)
- Orbiting Astronomical Observatory (OAO) Retrieval.

Satellite services equipment for the five missions have been grouped into common functions in a table at the end of this appendix.

2.0 REFERENCE SATELLITE: X-RAY TIMING EXPLORER (XTE)

2.1 SPACECRAFT DESCRIPTION AND MISSION SEQUENCES

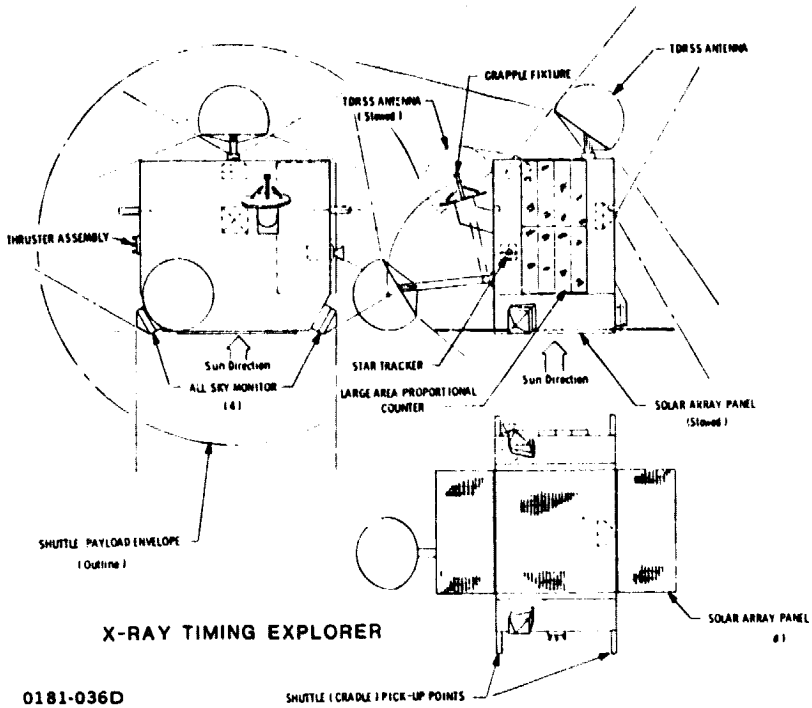
STATUS: Planned, two spacecraft

LAUNCH DATE: 1986

LIFETIME: 2 years

LAUNCH & TRANSFER VEHCILES: Orbiter launched & integrated propulsion

OPERATIONAL LOCATION: 400 km, 28.5° inclination



X-RAY TIMING EXPLORER

MASS AT OPERATIONAL LOCATION: 1000 kg

AVERAGE OPERATIONAL POWER: 600 W

OBJECTIVES:

To perform X-ray astronomy timing studies not addressed by experiments aboard the High Energy Astronomy Observatory (HEAO) and the Advanced X-Ray Astrophysics Facility (AXAF).

MISSION DESCRIPTION:

The spacecraft will be inserted into a 300 km circular orbit at 28.5° inclination by the Space Shuttle and raised to and maintained at 400 km by its on-board propulsion system. This orbit will minimize interference from the radiation belts, while permitting easy deployment and retrieval. Communications for this mission will be via the Tracking and Data Relay Satellite System (TDRSS) Multiple Access System.

INSTRUMENTS:

A Large Area Proportional Counter (LAPC) and All-Sky Monitor (ASM) or Wide Field Camera will be used.

SERVICE NEEDS:

DEPLOYMENT	EXAMINATION	RETRIEVAL	SUPPORT				EARTH RETURN
			C/O REPAIR	MAINTENANCE	RESUPPLY	RECONFIGURATION	
PLANNED	POTENTIAL	PLANNED	POTENTIAL	POTENTIAL	POTENTIAL	POTENTIAL	PLANNED

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REFERENCES:

- X-Ray Timing Explorer, GSFC, July 1980
- NASA Space Systems Technology Model, OAST, May 1980, A-10

XTE MISSION SEQUENCE

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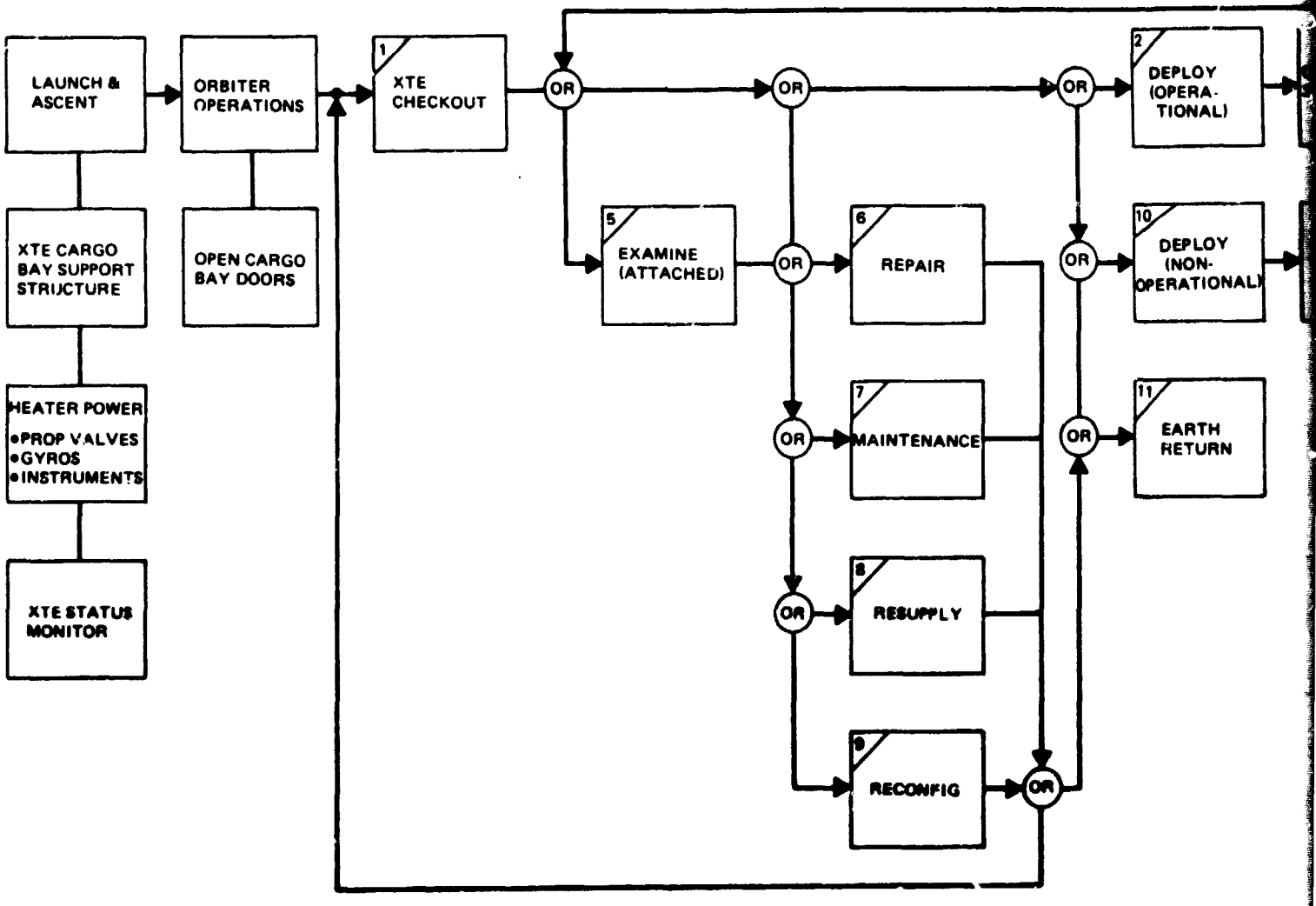
2.2 X-RAY TIMING EXPLORER MISSION OPERATIONS FUNCTIONAL ANALYSIS



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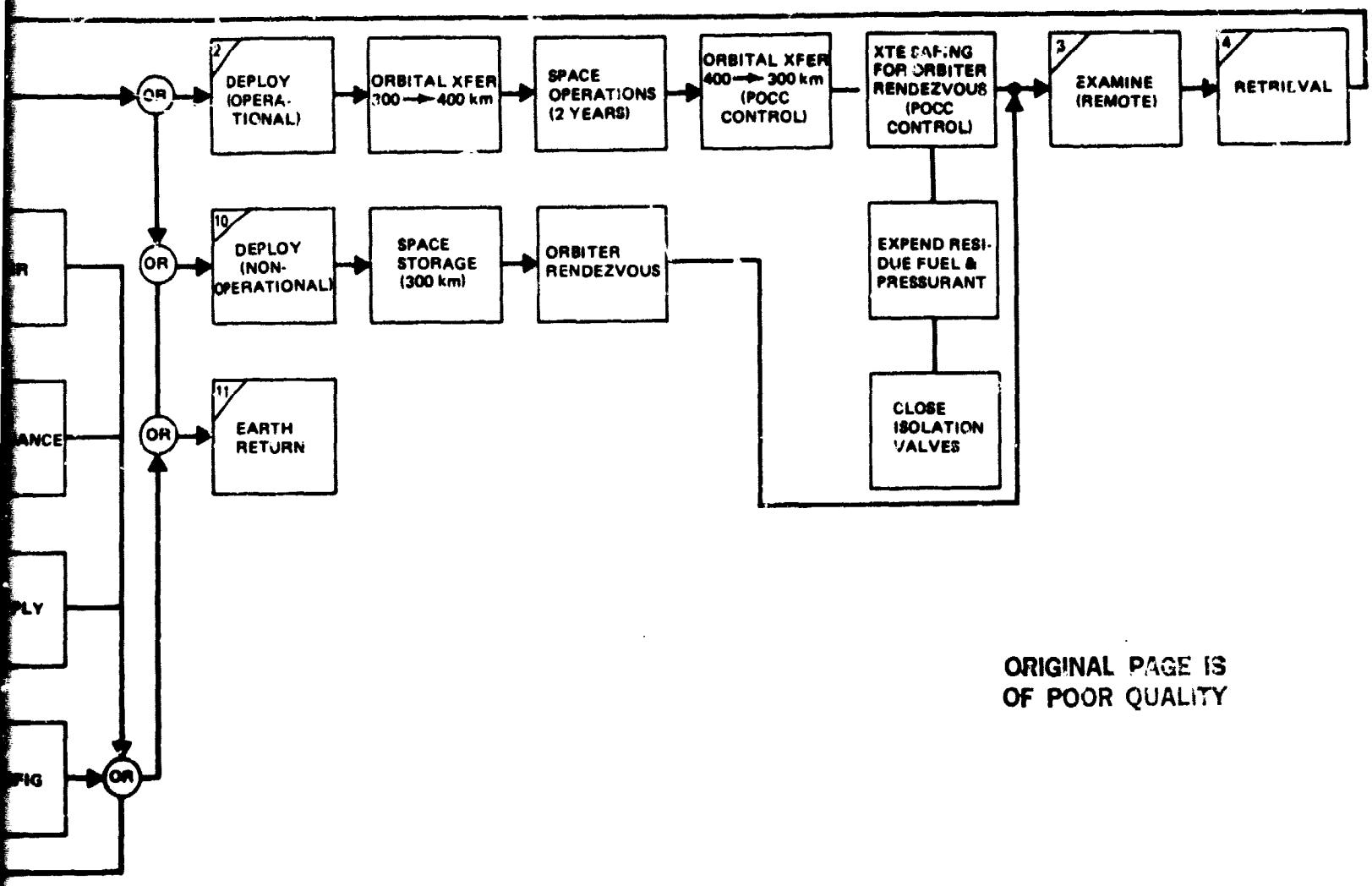

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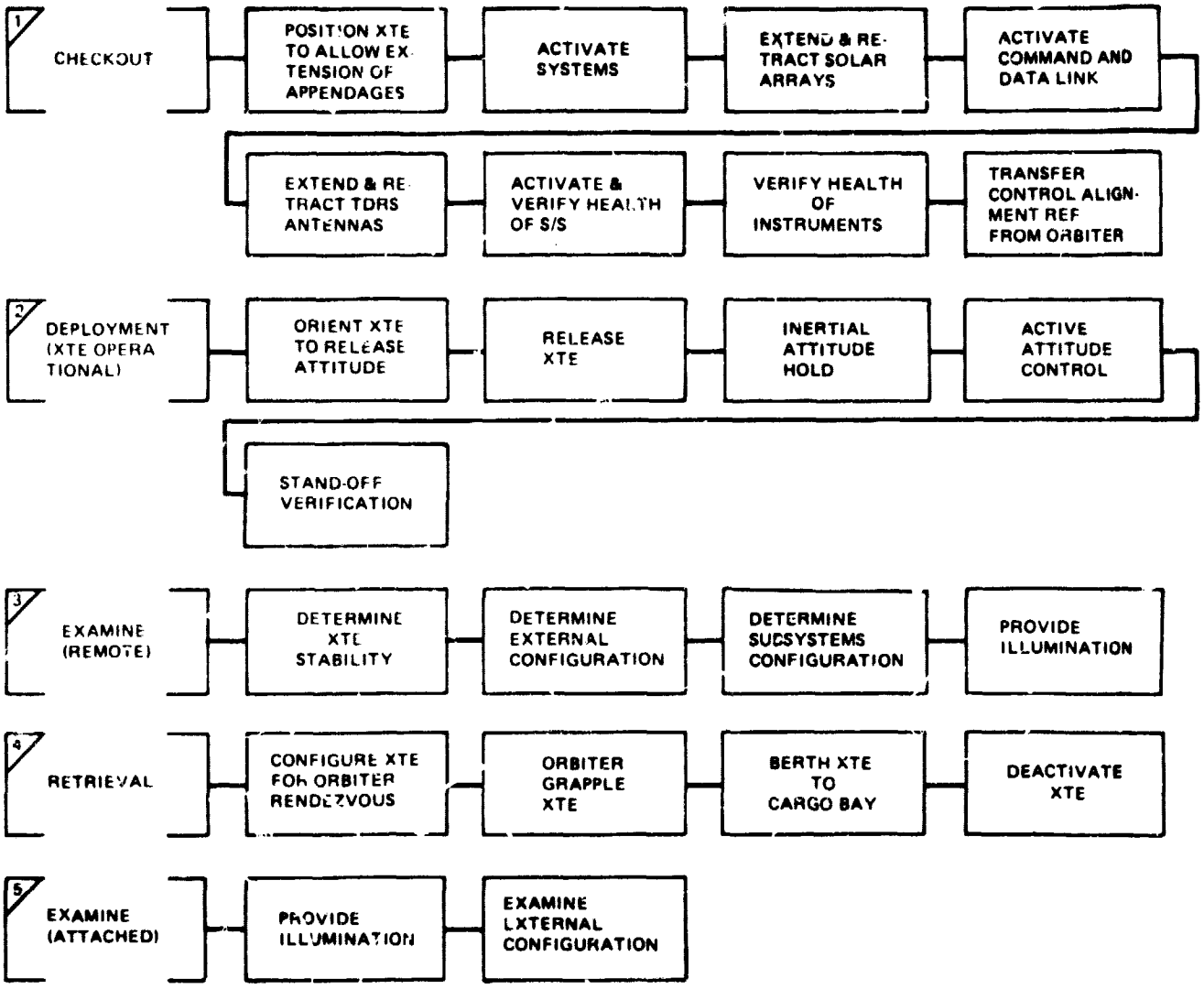
Fig. 2.2 X-Ray Timing Explorer Mission Operations Functional Analysis



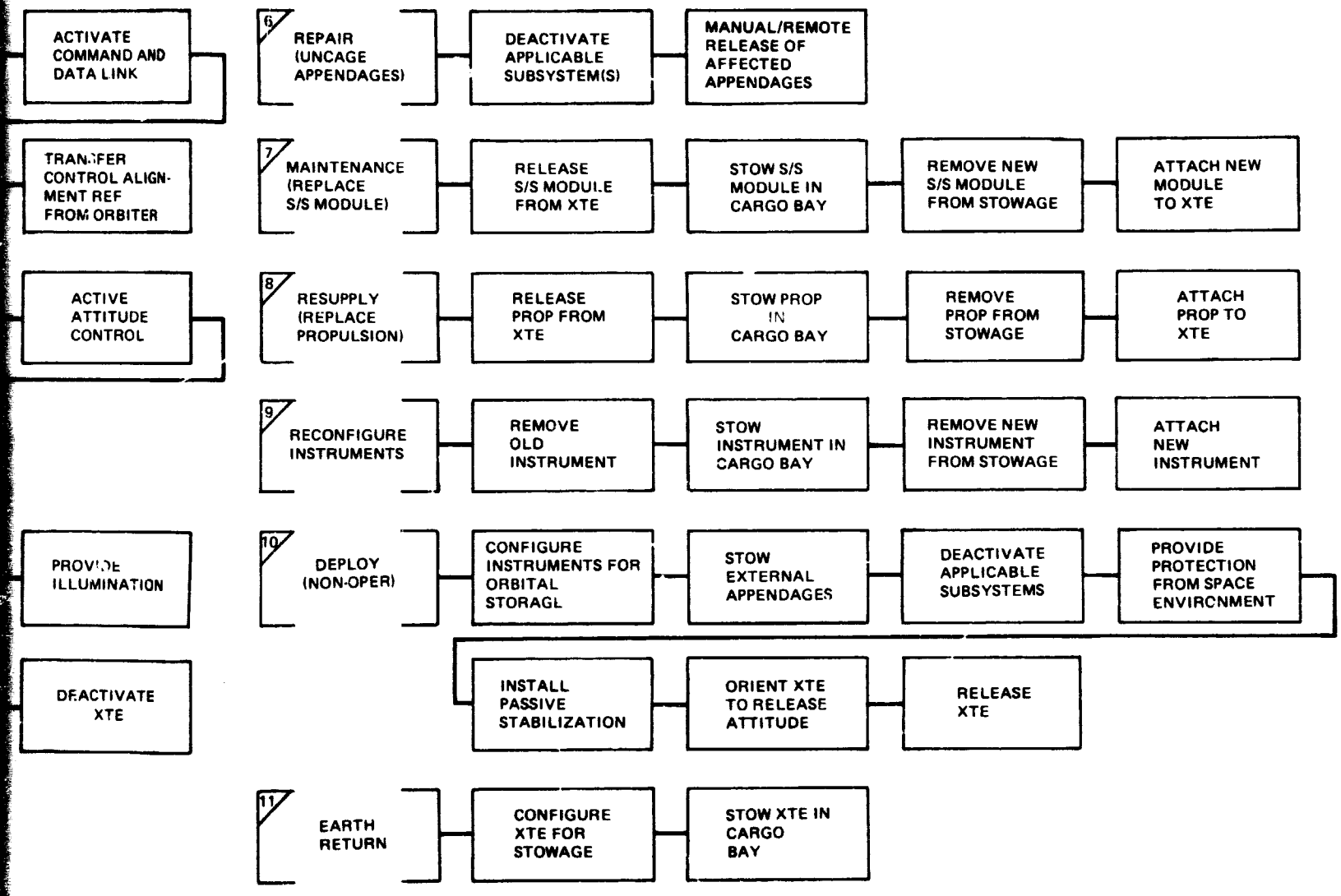


Fig. 2.3 XTE Servicing Operating Functional Analysis

2.4 IDENTIFICATION OF XTE SERVICING REQUIREMENTS

FUNCTION	CREW	XTE SPACECRAFT	ORBITER SERVICE EQUIPMENT
1/ CHECKOUT			
Position XTE to allow extension of appendages	---	Interface attachment to orbiter support fixture	Attachment to cargo bay and XTE
Activate Systems	Initiate power to XTE	Accept Orbiter power & provide electrical interface to support fixture	Electrical interface to XTE and Orbiter power. Control from AFD to support fixture
Extend & retract solar arrays and TDRS antennas	Initiate appendage extension/retraction	Provide interface to support fixture, accept commands & provide data verification	Electrical interface from AFD to XTE. Controls & displays required for signal generation and verification
Activate RF command and data link	Initiate activation of C&D link	Accept activation signal	Provide means of data transfer
Verify health of instruments	Initiate instrument activation, test & deactivation	Accept activation & test signals	Provide means of data transfer
Activate & verify health of subsystems	Initiate subsystem activation & test	Accept activation & test signals	Provide means of data transfer
Transfer control alignment reference from Orbiter	Initiate control reference data transfer	Accept orbiter reference data	Provide means of data transfer

2.4 IDENTIFICATION OF XTE SERVICING REQUIREMENTS (CONT'D)

FUNCTION	CREW	XTE SPACECRAFT	ORBITER SERVICE EQUIPMENT
2/ DEPLOYMENT (XTE OPERATIONAL)			
Orient XTE to release attitude	Orient Orbiter and XTE to release attitude	---	Orient XTE if RMS utilized
Release XTE	Initiate XTE release	Provide passive half of release mechanism	Provide release mechanism and accept activation signal
Inertial attitude hold	---	Maintain attitude hold during Orbiter separation	---
Active attitude control	Initiate active attitude control	Respond to RF and/ or internal control commands	AFD C&D means of RF control from orbiter or POCC as applicable
Stand-off verification	Verify XTE operational status	Respond to RF commands	POCC or Orbiter data link confirm transfer burn or next event
3/ EXAMINE (REMOTE NEAR ORBITER)			
Determine XTE stability	View XTE stability	---	Provide remotely controlled TV or EVA maneuvering system

2.4 IDENTIFICATION OF XTE SERVICING REQUIREMENTS (CONT'D)

FUNCTION	CREW	XTE SPACECRAFT	ORBITER SERVICE EQUIPMENT
Determine external configuration	View XTE external configuration remotely	---	Provide remotely controlled TV or EVA maneuvering system
Determine subsystem configuration	Verify configuration with POCC	Respond to RF commands	---
Provide illumination	Control illumination during dark side passes	---	Provide illumination for TV or EVA maneuvering system
4 RETRIEVAL			
Configure XTE for Orbiter rendezvous	Orbiter crew or POCC RF commands to reconfigure XTE	Implement reconfiguration	AFD command & display
Orbiter grapple XTE	Control remote grappling equipment	Provide stable fixture for grapple	Provide snare to grapple XTE
Berth XTE to cargo bay	Control remote equipment to berth XTE	Acquiescent during berthing maneuvers. Structural interface to berthing latches	Remotely controlled berthing equipment. Berthing structure & capture latches
Deactivate XTE	Initiate XTE deactivation	Electrical power, control and data connection to support equipment	Electrical power, control and data connection to XTE. Means of implementing control from AFD

2.4 IDENTIFICATION OF XTE SERVICING REQUIREMENTS (CONT'D)

FUNCTION	CREW	XTE SPACECRAFT	ORBITER SERVICE EQUIPMENT
5/ EXAMINE (ATTACHED)			
Provide illumination	Control illumination during dark side passes	---	Provide illumination for remote TV or EVA
Examine external	View XTE external configuration and mechanism	---	Provide remotely controlled camera or EVA maneuver aids
6/ REPAIR (UNCAGE APPENDAGES)			
Deactivate applicable subsystems	Initiate subsystems deactivation	Accept deactivation signal	AFD C&D means of transmitting signal & verifying operation
Manual/remote release of affected appendage(s)	Release appendage storage mechanism EVA or remotely	Provide mechanism compatible with external release	Provide compatible tool(s) if required
7/ MAINTENANCE (REPLACE S/S MODULE)			
Release S/S module from XTE	Control/operate removal equipment	Provide release mechanism & control interface disconnects	Interface equipment to activate module servicing mechanism. Means of mechanically holding module

2.4 IDENTIFICATION OF XTE SERVICING REQUIREMENTS (CONT'D)

FUNCTION	CREW	XTE SPACECRAFT	ORBITER SERVICE EQUIPMENT
Stow S/S module in cargo bay	Control/operate transport and stowage equipment	Interface for holding transport equipment	Transport of module to stowage. Stowage of module in cargo bay and means of retention
Remove new S/S module from stowage	Control/operate stowage release & transport equipment	Interface for holding transport equipment	Provide module stowage & release mechanism
8 RESUPPLY (REPLACE PROPULSION)			
Release prop from XTE	Control/operate removal equipment	Provide release mechanism & control interface disconnects. Interface for holding mechanism	Interface and actuation of prop to spacecraft servicing mechanism. Mechanical holding of propulsion
Prop cargo bay stowage	Control/operate transport and stowage equipment	Interface for holding & transport of prop module	Transport of prop to stowage. Stowage of prop in cargo bay & means of retention
Remove prop from stowage	Control/operate stowage release & transport equipment	Interface for holding & transport of prop module	Stowage of prop in cargo bay & retention means. Transport to XTE
Attach prop to XTE	Control/operate installation of equipment	Provide attachment mechanism & control interface	Interface with prop holding/ latching

FUNCTION	CREW	XTE SPACECRAFT	ORBITER SERVICE EQUIPMENT
9 RECONFIGURE (REPLACE INST MODULE)			
Remove old instrument	Control/operate removal equipment	Provide release mechanism & control interface disconnects. Interface for holding mechanism	Interface & actuation of instrument to spacecraft servicing mechanism. Mechanical holding of instruments
Stow instrument in cargo bay	Control/operate transport and stowage equipment	Interface for holding & transport of instrument	Transport of instrument to storage. Stowage of instrument in cargo bay & means of retention
Remove new instrument from stowage	Control/operate stowage release and transport equipment	Interface for holding & transport of instrument	Stowage of instrument in cargo bay & means of retention
Install new instrument	Control/operate installation of equipment	Provide attachment mechanism & control/power interfaces	Interface with instrument holding/latching
10 DEPLOYMENT (XTE NON-OPERATIONAL)			
Configure instruments for orbital storage	Initiate instrument deactivation and configure for orbital storage	Provide for orbital storage configuration	Provide protective covers/shields as required

2.4 IDENTIFICATION OF XTE SERVICING REQUIREMENTS (CONT'D)

FUNCTION	CREW	XTE SPACECRAFT	ORBITER SERVICE EQUIPMENT
Stow external appendages	Initiate folding/ retraction of appendages	Provide retraction mechanism	If remote means of retraction not available, provide equipment
Deactivate applicable S/S	Initiate subsystem deactivation	Accept deactivation signals	---
Provide protection from space environment	Install covers as required	Provide interface, if required, to accept covers	Shroud/covers that interface with the XTE
Install passive stabilization	Install stabilization equipment directly or by remote control	Accept stabilization equipment	Stabilization equipment
Orient XTE to release attitude	Orient orbiter and XTE to release attitude	---	Orient XTE if RMS utilized
11 EARTH RETURN			
Configure XTE for stowage	Retract appendage by EVA, remotely or automatically. De-activate subsystem & instruments	Provide mechanism to permit appendage stowage	Provide compatible tools if required
Stow XTE in cargo bay	Control stowage mechanism	---	Provide stowage mechanism. AFD C&D means of routing commands to stowage mechanism

2.5 DESCRIPTION OF SERVICE EQUIPMENT

2.5.1 XTE Crew Service Equipment/Usage

Aft flight deck controls and displays are required to perform the following:

- Reposition service equipment in cargo bay for checkout, deployment, retrieval, and servicing
- Orient XTE to release attitude and initiate release
- Initiate activation/deactivation of XTE power busses and subsystems*
- Deployment/folding of XTE appendages (solar arrays and TDRS antennas)*
- Initiate transfer of orbiter control alignment reference to XTE
- Initiate activation/deactivation of XTE command and data link*
- Initiate activation/deactivation and test of instruments*
- Initiate activation/deactivation and test of subsystems*
- Initiate XTE release signal
- Initiate active attitude control of XTE*
- Determine operational status after XTE deployment*
- TV display for MTV free flyer remote camera
- Install stabilization equipment for orbital storage (optional operation)
- Control MTV remote free flyer
- Control payload bay illumination.

Controls and displays requirements are dependent on resolution of:

- XTE operational verification, orbiter or POCC
- Use of remote free flyer (MTV) to perform inspection.

Control/display functions noted with an asterisk, (*), could be satellite-user controlled from the ground via appropriate communication links provided for those purposes, either through the Orbiter or through the satellite's communication system.

EMU usage is required during EVA for the following functions:

- Replacement of XTE subsystems and instruments
- Stowage of XTE subsystems and instruments
- Transport of subsystems and instruments
- Repair of deployable appendages.

2.5.2 XTE - Integration Requirements for Servicing

XTE INTEGRATION REQUIREMENTS	ISSUES/RATIONALE
Structural interface attachment and release mechanism to orbiter support fixture	
Grapple fixture located accessible to RMS grapple and mounted on firm satellite structure	
Electrical power, control and data connection to orbiter support fixture	
Internal provisions to allow external control, test and status monitoring of appendages, subsystems and instruments	
Non-RCS attitude hold during Orbiter separation	
Provisions for safing propulsion and RCS system. This includes expending residue fuel and pressurants during revisits	
Provisions for (contingency) external means of folding appendages	If appendage design is not compatible with auto retraction, external release for folding is required.
Accept signals to permit transfer of Orbiter alignment reference to XTE	
Inhibit RCS operation during deployment and Orbiter separation. Provide other means of attitude hold	

2.5.2 XTE - Integration Requirements for Servicing (Cont'd)

XTE INTEGR/ :ION REQUIREMENTS	ISSUES/RATIONALE
Provisions for orbital storage - accept environment protection covers/ shrouds as applicable - attachment for passive stabilization Attachments for subsystem, propulsion and instrument modules that permit removal and reinstallation	

2.5.3 XTE - Service Equipment Requirements

SERVICE EQUIPMENT REQUIREMENTS	ISSUES/RATIONALE/REMARKS
Provide structural attachment of XTE to the Orbiter cargo bay. This support fixture shall provide latches that allow release and berthing of the XTE. It shall permit deployment of appendages and replacement of instruments, sub-systems modules and propulsion Provide electrical power, command and data signal interface, as required, to the XTE via the Orbiter support fixture Provide means of command and data transfer from the AFD to the support fixture Provide covers, as necessary, to protect the XTE from the space environment during orbital storage Provide passive stabilization equipment to be attached to the XTE for orbital storage Provide tools, if required, to permit manual deployment or storage of appendages Provide an RMS snare to grapple the XTE Provide means of holding & transporting subsystem, propulsion, and instrument modules from the XTE to storage location	

2.5.3 XTE - Service Equipment Requirements (Cont'd)

SERVICE EQUIPMENT REQUIREMENTS	ISSUES/RATIONALE/REMARKS
Make provisions for stowing the new & used modules in the cargo bay Make provisions for stowing special tools required for servicing XTE Provide cargo bay lighting to permit servicing operations during dark side passes. This requires illumination of the XTE external surfaces Provide a remotely controlled TV camera, space maneuverable and/or EVA maneuvering system for XTE remote examination. Also provide lighting for remote operations	

3.0 REFERENCE SATELLITE: UPPER ATMOSPHERIC RESEARCH SATELLITE (UARS)

3.1 SPACECRAFT DESCRIPTION & MISSION SEQUENCE

STATUS: Planned, two spacecraft

LAUNCH DATE: 1986

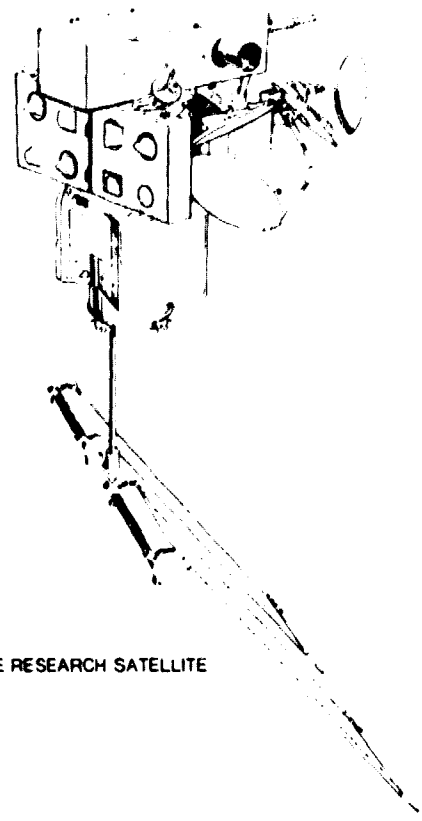
LIFETIME: 18 months

LAUNCH & TRANSFER VEHICLES: Orbiter launched and MMS propulsion

OPERATIONAL LOCATION: 500 km, 56° inclination

TOTAL MASS AT OPERATIONAL LOCATION: 3500 kg

AVERAGE OPERATIONAL POWER: 1000 W



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UPPER ATMOSPHERE RESEARCH SATELLITE

OBJECTIVES:

The initial mission of the Upper Atmospheric Research Satellite will be to study the radiation, chemistry, and dynamics of the upper atmosphere at low, mid, and moderately high altitudes and the coupling between these properties in order to determine the seasonal correlations. Interaction and coupling between atmospheric regions and process will be emphasized on this mission.

MISSION DESCRIPTION:

The satellite will be placed in a 56° inclination orbit at an altitude of about 500 km, providing adequate geographic coverage for many of the scientific requirements. Processed scientific data will be transmitted to earth via TDRSS. The retrieval, reuse, and possible on-orbit refurbishment of the satellite will be accomplished by the Shuttle in conjunction with the spacecraft's on-board propulsion system.

INSTRUMENTS:

UV spectrometer, Doppler interferometer, modulated gas cell radiometer, filter radiometer, Nadir emission radiometer, emission radiometer, occulation radiometer, UV airglow emission spectrometer, 1.27 micrometer-emmision spectrometer, far IR spectrometer, laser heterodyne radiometer, microwave limb sounder.

SERVICE NEEDS:

DEPLOYMENT	EXAMINATION	RETRIEVAL	SUPPORT				EARTH RETURN
			C/O REPAIR	MAINTENANCE	RESUPPLY	RECONFIGURATION	
PLANNED	POTENTIAL	PLANNED	POTENTIAL	POTENTIAL	POTENTIAL	POTENTIAL	PLANNED

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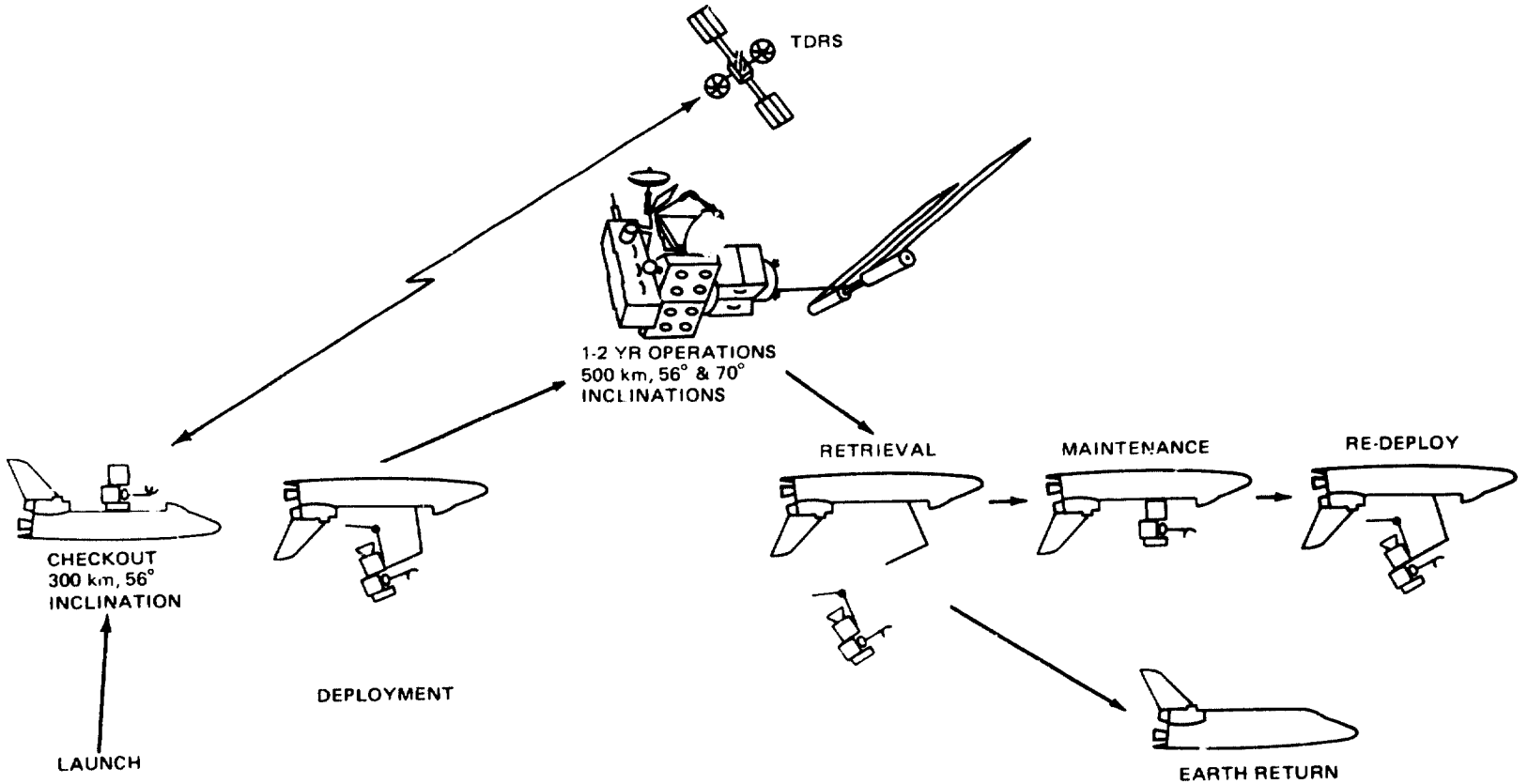
REFERENCES:

- Upper Atmosphere Research Satellite Technical Report, GSFC, August 1979
- NASA Space Systems Technology Model, OAST, May 1980, E-7.



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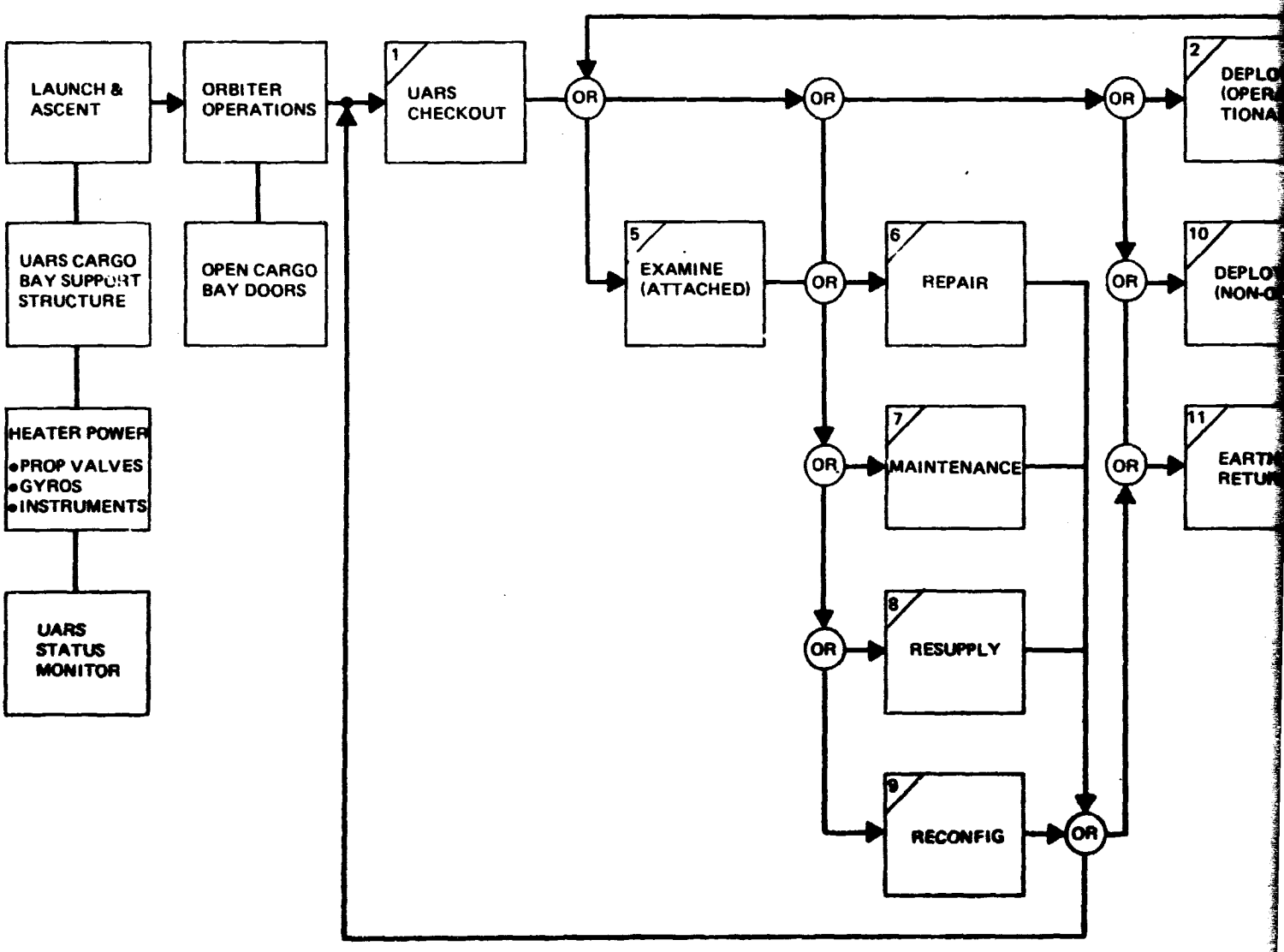
UARS MISSION SEQUENCE

3.2 UARS MISSION OPERATIONS FUNCTIONAL ANALYSIS



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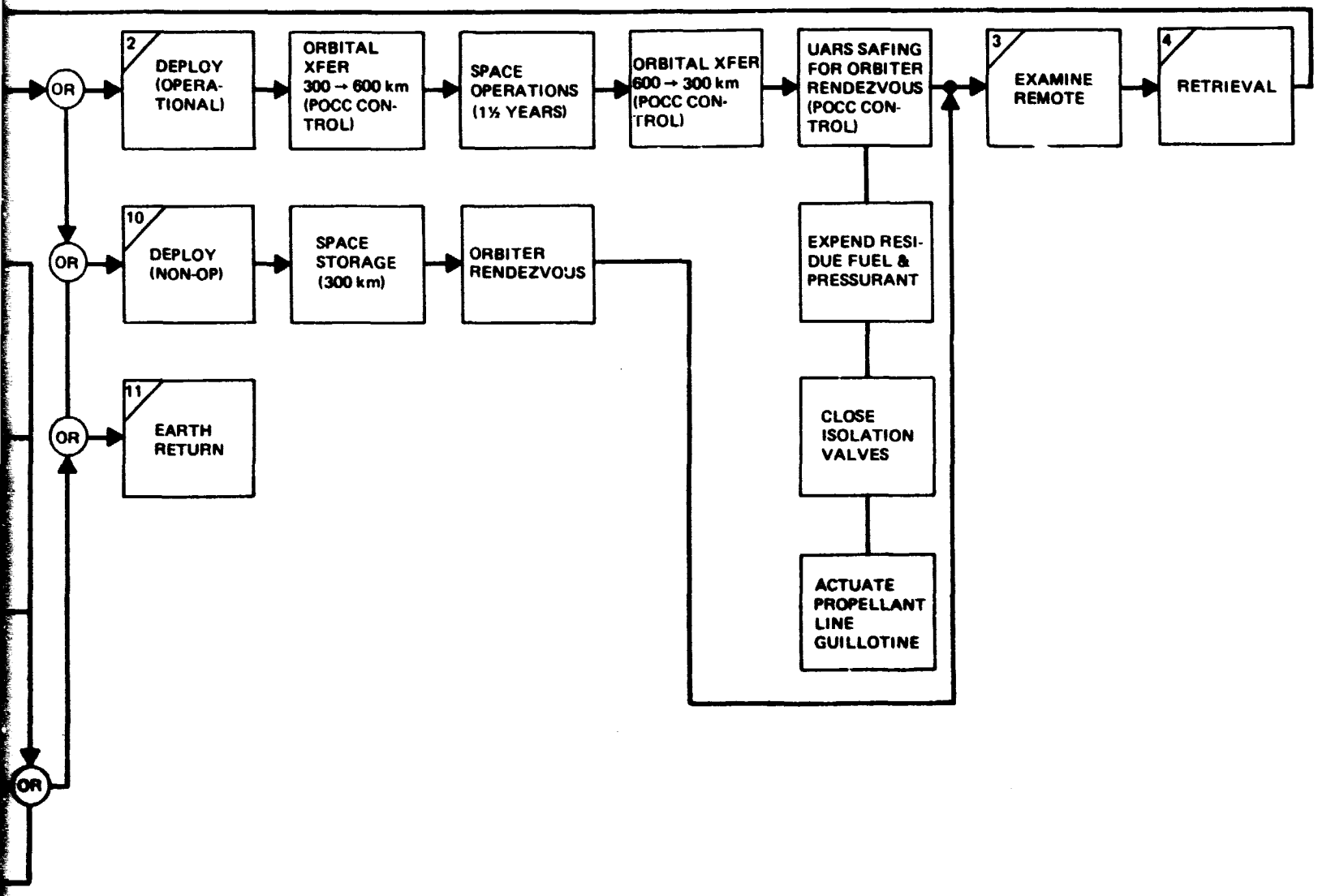

Fig. 3.2 UARS Mission Operations Functional Analysis

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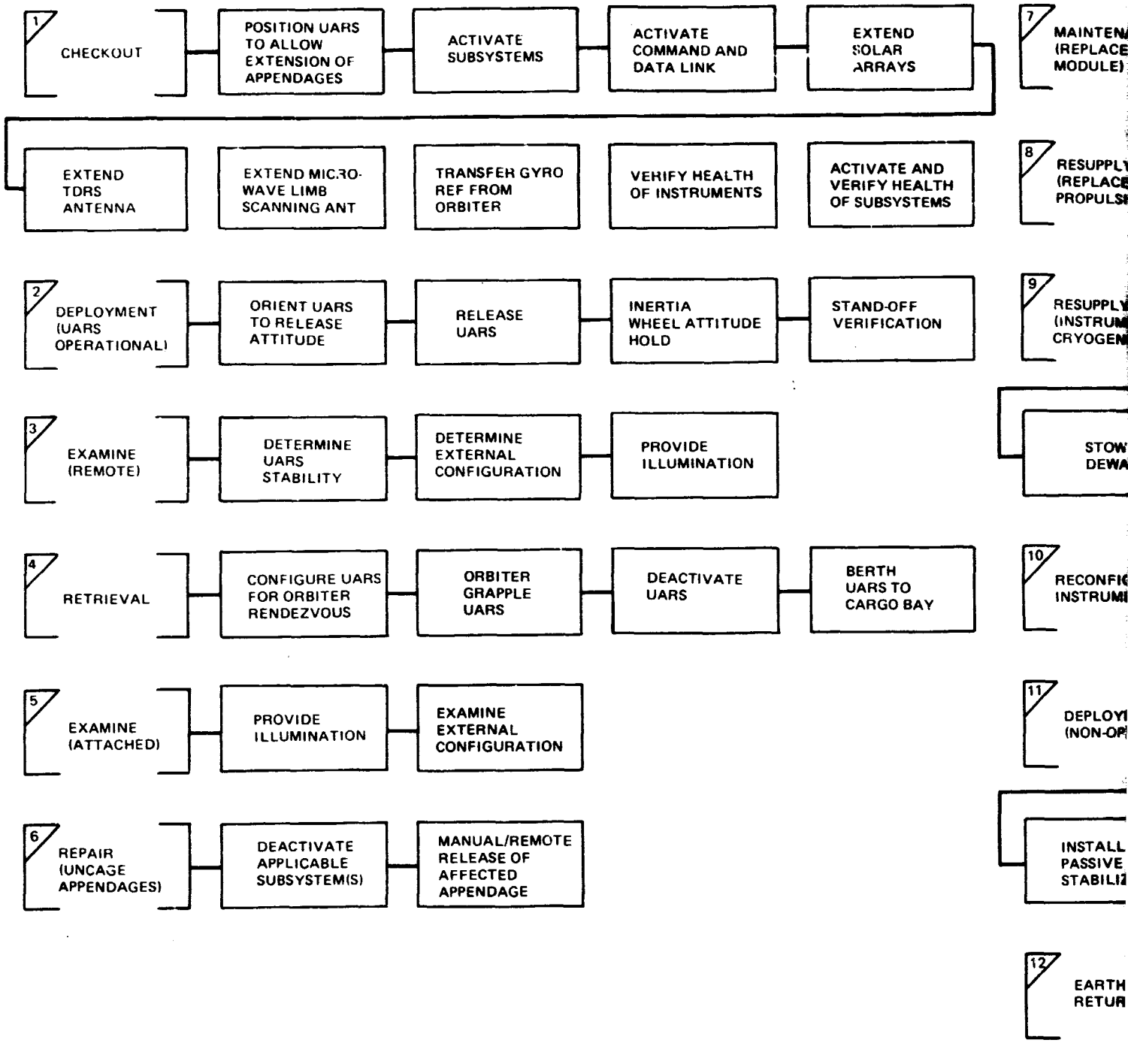

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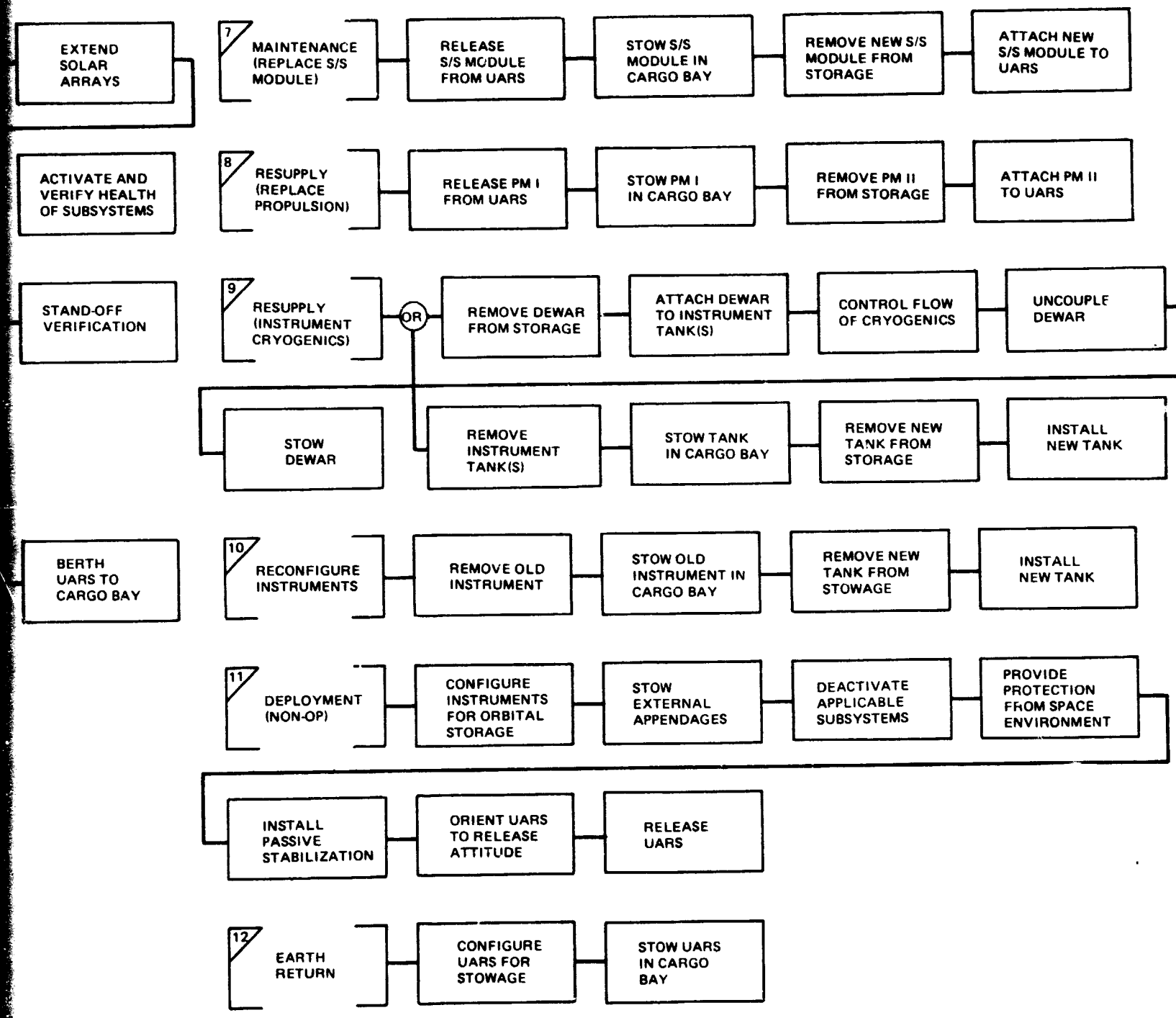

Fig. 3.3 UARS Servicing Operations Functional Analysis

3.4 IDENTIFICATION OF UARS SERVICING REQUIREMENTS

FUNCTION	CREW	UARS SPACECRAFT	ORBITER SERVICE EQUIPMENT
1 CHECKOUT UARS			
Position UARS to allow extension of appendages	Initiate repositioning	Interface attachment to Orbiter support fixture	Attachment cargo bay & UARS. Provide means for extension. Control from AFD to support fixture
Activate subsystems	Initiate power to UARS	Accept Orbiter power & provide electrical interface to support fixture	Electrical interface to UARS & Orbiter power. Control from AFD to support fixture
Activate C&D link	Initiate activation of C&D link	Accept activation signal	Provide means of data transfer
Extend solar arrays			
Extend TDRS antenna	Initiate appendage deployment	Power, command, signal & data interface to support equipment	Electrical interface from AFD to UARS. Controls & displays required for signal generation and verification
Extend microwave scan antennas			
Transfer gyro reference from Orbiter	Initiate gyro data transfer	Accept signals to gyro package	Provide means of data transfer

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3.4 IDENTIFICATION OF UARS SERVICING REQUIREMENTS (CONT'D)

FUNCTION	CREW	UARS SPACECRAFT	ORBITER SERVICE EQUIPMENT
Verify instrument health	Initiate instrument activation & test	Accept activation & test signals & transmit data to AFD	Provide means of data transfer
Activate & verify health of S/S	Initiate S/S activation & test	Accept activation & test signals	Provide means of data transfer
2 DEPLOY UARS (OPERATIONAL)			
Orbiter maneuvers to release attitude	Crew initiates release attitude	---	---
Orbiter release UARS	Crew initiates UARS release	Provide passive half of release mechanisms	Provide release mechanism & accept actuation signal
UARS inertia wheel attitude hold	---	Maintain attitude hold during Orbiter separation	---
Stand-off verification	Verify operational status	Respond to RF commands	POCC or Orbiter data link confirm transfer burn or next event
3 EXAMINE (REMOTE NEAR ORBITER)			
Determine UARS stability	View UARS stability condition	---	Provide remotely controlled TV or EVA maneuvering system

3.4 IDENTIFICATION OF UARS SERVICING REQUIREMENTS (CONT'D)

FUNCTION	CREW	UARS SPACECRAFT	ORBITER SERVICE EQUIPMENT
Determine UARS configuration	View UARS external configuration remotely	---	Provide remotely controlled TV or EVA maneuvering system
Provide illumination	Control illumination during dark passes	---	Provide illumination for TV or EVA maneuvering system
4/ RETRIEVAL			
Configure UARS for Orbiter rendezvous	Orbiter crew or POCC RF commands to reconfigure UARS	Implement reconfiguration	AFD command and display
Grapple UARS	Control remote grappling equipment	Provide stable fixture for grapple	Provide snare to grapple UARS
Berth UARS to support fixture	Control remote berthing equipment	Acquiescent during berthing maneuvers. Structural interface to berthing latches	Remotely controlled berthing equipment. Berthing structure & capture latches
Deactivate UARS	Initiate UARS deactivation	Electrical power, control & data connection to support equipment. Accept & implement instrument and subsystem shut-down signals	Electrical power, control and data connections to UARS Electrical interface from AFD to UARS

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3.4 IDENTIFICATION OF UARS SERVICING REQUIREMENTS (CONT'D)

FUNCTION	CREW	UARS SPACECRAFT	ORBITER SERVICE EQUIPMENT
5 EXAMINE (ATTACHED)			
Examine external configuration	View UARS external configuration and mechanism	---	Provide remotely controlled camera or EVA
Provide illumination	Control illumination during dark side passes	---	Provide illumination for remote TV or EVA
6 REPAIR (UNCAGE APPENDAGES)			
Deactivate applicable subsystems	Initiate subsystem deactivation	Accept deactivation signal	AFD C&D means of transmitting signal & verifying operation
Manual/remote release of affected appendage(s)	Release appendage stowage mechanism EVA or remotely	Provide mechanism compatible with external release	Provide compatible tools if required
7 MAINTENANCE (REPLACE S/S MODULE)			
Release S/S module from UARS	Control/operate removal equipment	Provide release mechanism & control interface disconnects. Interface for holding mechanism	Interface and actuation of S/S module to satellite servicing mechanism. Mechanical holding of S/S module

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3.4 IDENTIFICATION OF UARS SERVICING REQUIREMENTS (CONT'D)

FUNCTION	CREW	UARS SPACECRAFT	ORBITER SERVICE EQUIPMENT
Stow S/S module in cargo bay	Control/operate transport and stowage equipment	Interface for holding transport equipment	Transport of S/S module to stowage. Stowage of S/S module in cargo bay & means of retention
Remove S/S module from stowage	Control/operate stowage release and transport equipment	Interface for holding transport equipment	Stowage of S/S module in cargo bay and retention means. Transport of S/S module to UARS
Attach S/S module to UARS	Control/operate installation equipment	Provide attachment mechanism & control interfaces	Interface with S/S module holding/latching
8 RESUPPLY (INSTRUMENT CRYOGENICS)			
Remove dewar from stowage	Control/operate removal equipment	---	Provide stowage of dewar in cargo bay and means of retention
Attach dewar to UARS tank(s)	Control/operate installation equipment	Provide fill port	Provide means of holding & transport of dewar to UARS
Control flow of cryogenics	Control flow of cryogenics	---	Provide means of controlling cryogenics flow
Uncouple dewar	Control/operate uncoupling	---	Provide means of holding & releasing dewar
Stow dewar	Control/operate transport and stowage equipment	---	Provide transport to stowage. Stowage of dewar in cargo bay & means of retention

FUNCTION	CREW	UARS SPACECRAFT	ORBITER SERVICE EQUIPMENT
Remove tank(s)	Control/operate removal equipment	Tank attachment release mechanism. Cryogenic/instrument interface coupling. Holding interface	Means of mechanically holding tank
Tank stowage in cargo bay	Control/operate transport and stowage equipment	---	Provide transport to stowage. Stowage of tank & means of retention
Remove new tank from stowage	Control/operate removal equipment	---	Provide stowage of tank in cargo bay & means of retention/release. Means of holding tank
Install new tank	Control/operate installation equipment	Tank attachment mechanism. Cryogenic/instrument interface coupling	Provide transport of tank to UARS. Means of installing tank & operating retention mechanism
9/ RECONFIGURATION			
Release PM I from UARS	Control/operate removal equipment	Provide release mechanism & control interface disconnects. Interface of holding mechanism	Interface & actuation of PM I to satellite servicing mechanism. Mechanical holding of PM I
Stow PM I in cargo bay	Control/operate transport and stowage equipment	Interface for holding transport equipment	Transport of PM I to stowage. Stowage of PM I in cargo bay & means of retention
Remove PM II from stowage	Control/operate stowage release & transport equipment	Interface for holding transport equipment	Stowage of PM II in cargo bay & means of retention. Transport PM II to UARS

3.4 IDENTIFICATION OF UARS SERVICING REQUIREMENTS (CONT'D)

FUNCTION	CREW	UARS SPACECRAFT	ORBITER SERVICE EQUIPMENT
Attach PM II to UARS	Control/operate installation equipment	Provide attachment mechanism & control interfaces	Interface with PM II holding/latching
10 DEPLOY UARS (NON-OPERATIONAL)			
Configure instruments for orbital storage	Initiate instrument deactivation & configure for orbital storage	Provide for orbital storage configuration	Provide protective covers/shield as required
Stow external appendages	Initiate folding/retraction of appendages	Provide retraction mechanisms	Provide equipment if remote means of retraction not available
Deactivate applicable S/S	Initiate subsystem deactivation	Accept deactivation signals	---
Provide S/C protection from orbital environment	Install covers as required	Accept covers	Covers that interface with the UARS
Install passive stabilization	Install stabilization equipment directly or by remote control	Accept stabilization equipment	Stabilization equipment
Orient UARS to to release attitude	Orient Orbiter and UARS to release attitude	---	Orient UARS if RMS utilized

3.4 IDENTIFICATION OF UARS SERVICING REQUIREMENTS (CONT'D)

FUNCTION	CREW	UARS SPACECRAFT	ORBITER SERVICE EQUIPMENT
Release UARS	Initiate UARS release	Provide passive half of release mechanism	Provide release mechanism and accept activation signal. Means of implementing release signal
11 EARTH RETURN			
Configure UARS for stowage	Retract appendages EVA remotely or automatically. Deactivate subsystems & instruments	Provide mechanism, as required, to permit appendage retraction	Provide compatible tools, if required
Stow UARS in cargo bay	Initiate command to stowage mechanism	---	Provide stowage mechanism
8 RESUPPLY (REPLACE PROPULSION)			
Release PM I from UARS	Control/operate removal equipment	Provide release mechanism & control interface disconnect. Interface for holding mechanism	Interface and actuation of PM I to satellite servicing mechanism. Mechanical holding of PM I

3.4 IDENTIFICATION OF UARS SERVICING REQUIREMENTS (CONT'D)

FUNCTION	CREW	UARS SPACECRAFT	ORBITER SERVICE EQUIPMENT
Stow PM I in cargo bay	Control/operate transport and stowage equipment	Interface for holding/transport of equipment	Transport of PM I to stowage. Stowage of PM I in cargo bay & means of retention
Remove PM II from stowage	Control/operate stowage release and transport equipment	Interface for holding/ transport equipment	Stowage of PM II in cargo bay & retention means. Transport of PM II to UARS
Attach PM II to UARS	Control/operate installation equipment	Provide attachment mechanism and control interfaces	Interface with PM II holding/ latching

3.5 DESCRIPTION OF SERVICE EQUIPMENT

3.5.1 UARS Crew Service Equipment/Usage

Aft flight deck controls and displays are required to perform the following:

- Reposition service equipment in the cargo bay during checkout, deployment, retrieval and servicing
- Initiate activation/deactivation of UARS power busses and subsystems*
- Deployment/folding of UARS appendages (solar arrays, TDRS antenna, and microwave scanning antennas)*
- Initiate transfer of Orbiter alignment reference to UARS gyros
- Initiate activation/deactivation of UARS command and data link*
- Initiate activation/deactivation and test of instruments*
- Initiate UARS release signal
- Determination of operational status after UARS deployment*
- TV display for MTV free flyer remote camera
- Controls for MTV remote free flyer
- Controls and displays requirements are dependent on resolution of:
  - UARS release approach, RMS or flight support equipment
  - UARS operational verification, Orbiter or POCC
  - Use of remote free flyer (MTV) to perform inspection.

Control/display functions noted with an asterisk, (*), could be satellite-user controlled from the ground via appropriate communication links provided for those purposes, either through the Orbiter or through the satellite's communication system.

EMU usage is required during EVA for the following functions:

- Replacement of UARS subsystems and instruments
- Stowage of UARS subsystems and instruments
- Transport of subsystems and instruments
- Repair of deployable appendages.

3.5.2 UARS - Integration Requirements for Servicing

UARS INTEGRATION REQUIREMENTS	ISSUES/RATIONALE
Structural interface attachment to Orbiter support fixture	
Grapple fixture located accessible to grapple and mounted on firm satellite structure	
Electrical power, control and data connection to support fixture	
Internal provisions to allow external control and status monitoring of appendages subsystems and instruments	
Provisions for safing propulsion and RCS system. This includes expending residue fuel and pressurant during revisits	
Provisions for (contingency) external means of folding appendages	If appendage design is not compatible with auto retraction, external release for folding is required.
Accept signals to permit transfer of Orbiter alignment reference to UARS gyros	
Inhibit RCS operation during deployment and Orbiter separation. Provide other means of attitude hold	
Provisions for orbital storage - accept environmental protection - covers/shrouds as applicable - attachment for passive stabilization	
Attachments for subsystem, propulsion and instrument modules that permit removal and reinstallation	

3.5.3 UARS Service Equipment Requirements

SUPPORT EQUIPMENT REQUIREMENTS	ISSUES/RATIONALE/REMARKS
Provide structural attachment of UARS to the Orbiter cargo bay. This support fixture shall provide latches that allow release and berthing of the UARS. It shall permit deployment of appendages and replacement of instruments, subsystems, modules and propulsion. Equipment replacement may require the capability to rotate the UARS about its longitudinal axis	Reference documentation describes deployment of appendage while attached to the RMS and maneuvered clear of the cargo bay. Requirements for module exchange are not satisfied, therefore, a holding fixture is specified.
Provide electrical power, command and data signal interface as required to the UARS via the Orbiter support fixture	
Provide means of command & data transfer from the AFD to the Orbiter support fixture	
Provide covers, as necessary, to protect the UARS from the space environment during orbital storage	
Provide passive stabilization equipment to be attached to the UARS for orbital storage	
Provide remotely controlled camera or EVA maneuver aids	
Provide tools, if required, to permit manual deployment or stowage of appendages	
Provide an RMS snare to grapple the UARS	
Provide means of holding & transporting subsystem, propulsion and instrument modules from the UARS to stowage location	
Make provisions for stowing the new & used modules in the cargo bay	
Make provisions for stowing special tools required for servicing UARS	
Provide for stowage of (instrument) cryogenic dewar & transport to UARS	Depending on selection of approach to replenish instrument cryogenics, one requirement can be deleted.
Provide for stowage of replacement cryogenic tanks & transport to UARS	

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4.0 REFERENCE SATELLITE: ADVANCED X-RAY ASTROPHYSICS FACILITY (AXAF)

4.1 SPACECRAFT DESCRIPTION & MISSION SEQUENCE

STATUS: Planned, one spacecraft

LAUNCH DATE: 1987

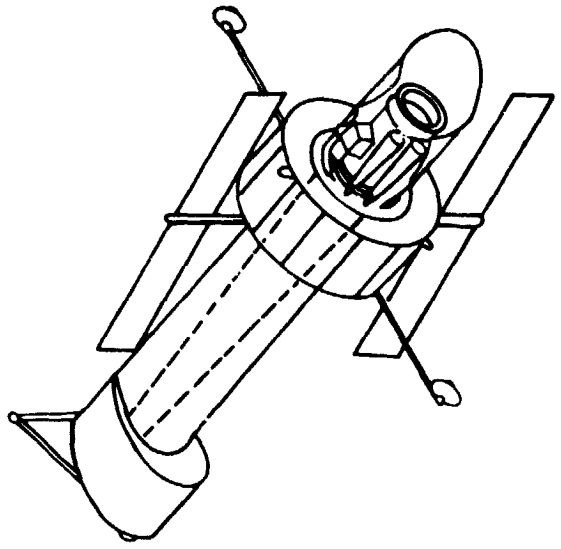
LIFETIME: 10-15 years

LAUNCH AND TRANSFER VEHICLES: Shuttle plus one OMS kit

OPERATIONAL LOCATION: 460 km orbit, inclination 28.5°

TOTAL MASS AT OPERATIONAL LOCATION: 10,000 kg

AVERAGE OPERATIONAL POWER: 900 W



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OBJECTIVES:

The Advanced X-Ray Astrophysics Facility (AXAF) will serve as an x-ray astrophysics facility to complement visual and radio observations made from the ground and from space observatories such as the Space Telescope. The basic objectives are to determine the positions of x-ray sources, their physical properties (ie: composition and structure) and the processes involved in x-ray photon production.

MISSION DESCRIPTION:

AXAF is a free-flying, Shuttle-launched spacecraft designed to view celestial x-ray sources. The facility has a 1.2 meter diameter Wolter type I mirror assembly which has a 0.5 arc sec resolution goal. Instruments using this mirror assembly are mounted in a rotating carousel at the focal plane. AXAF is being designed for on-orbit repair and instrument changeouts. Recovery for ground refurbishment and avionics redundance are planned to achieve a 10 to 15 year lifetime.

INSTRUMENTS:

High and low resolution x-ray imagers; high, medium, and low resolution dispersive spectrometers; x-ray polarimeter.

SERVICE NEEDS:

DEPLOYMENT	EXAMINATION	RETRIEVAL	SUPPORT				EARTH
			C/O REPAIR	MAINTENANCE	RESUPPLY	RECONFIGURATION	RETURN
PLANNED	POTENTIAL	PLANNED	POTENTIAL	POTENTIAL	POTENTIAL	POTENTIAL	PLANNED

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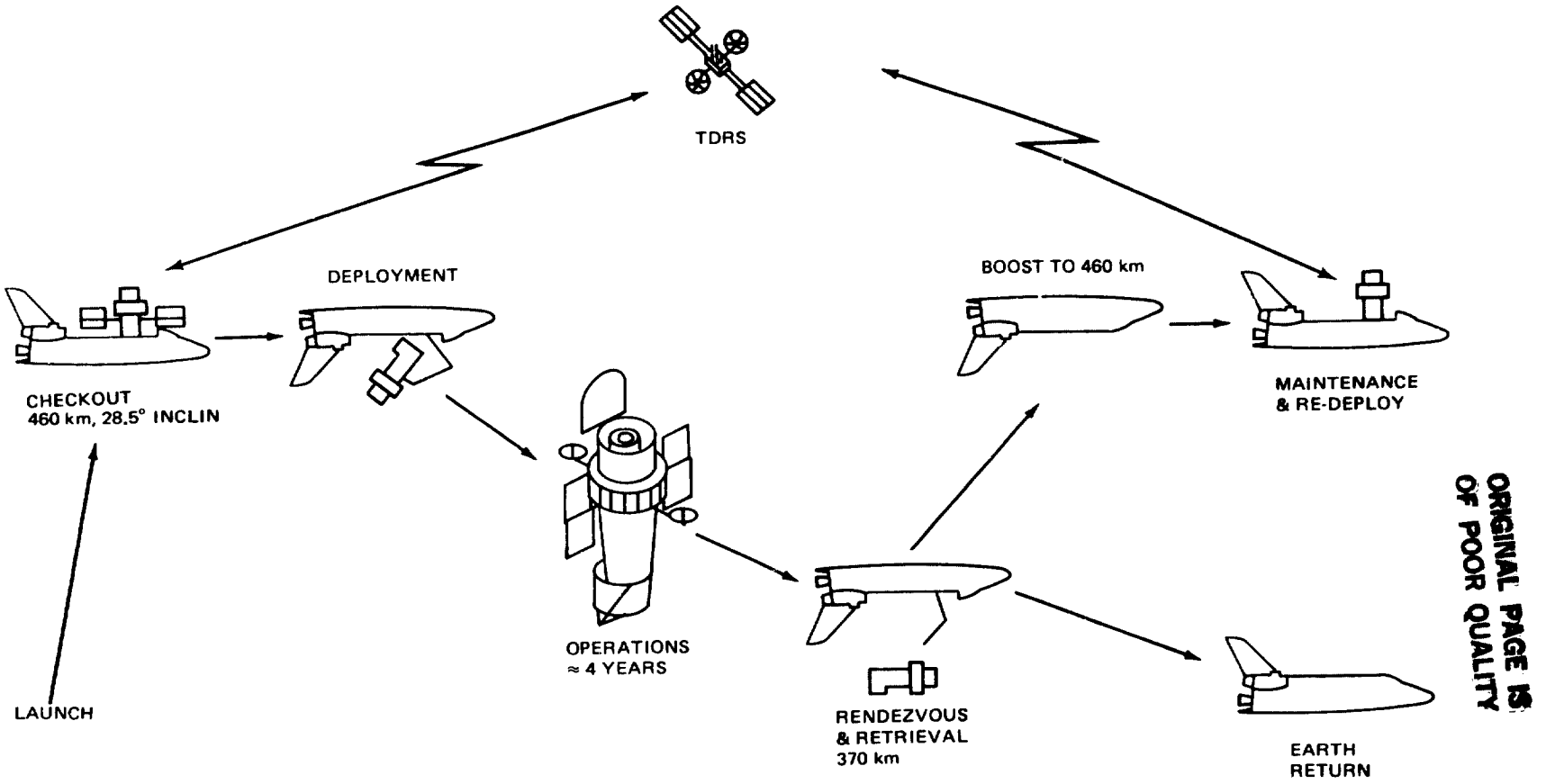
REFERENCES:

- Advanced X-Ray Astrophysics Facility, MSFC, May 1978
- NASA Space Systems Technology Model, OAST, May 1980, A-9.



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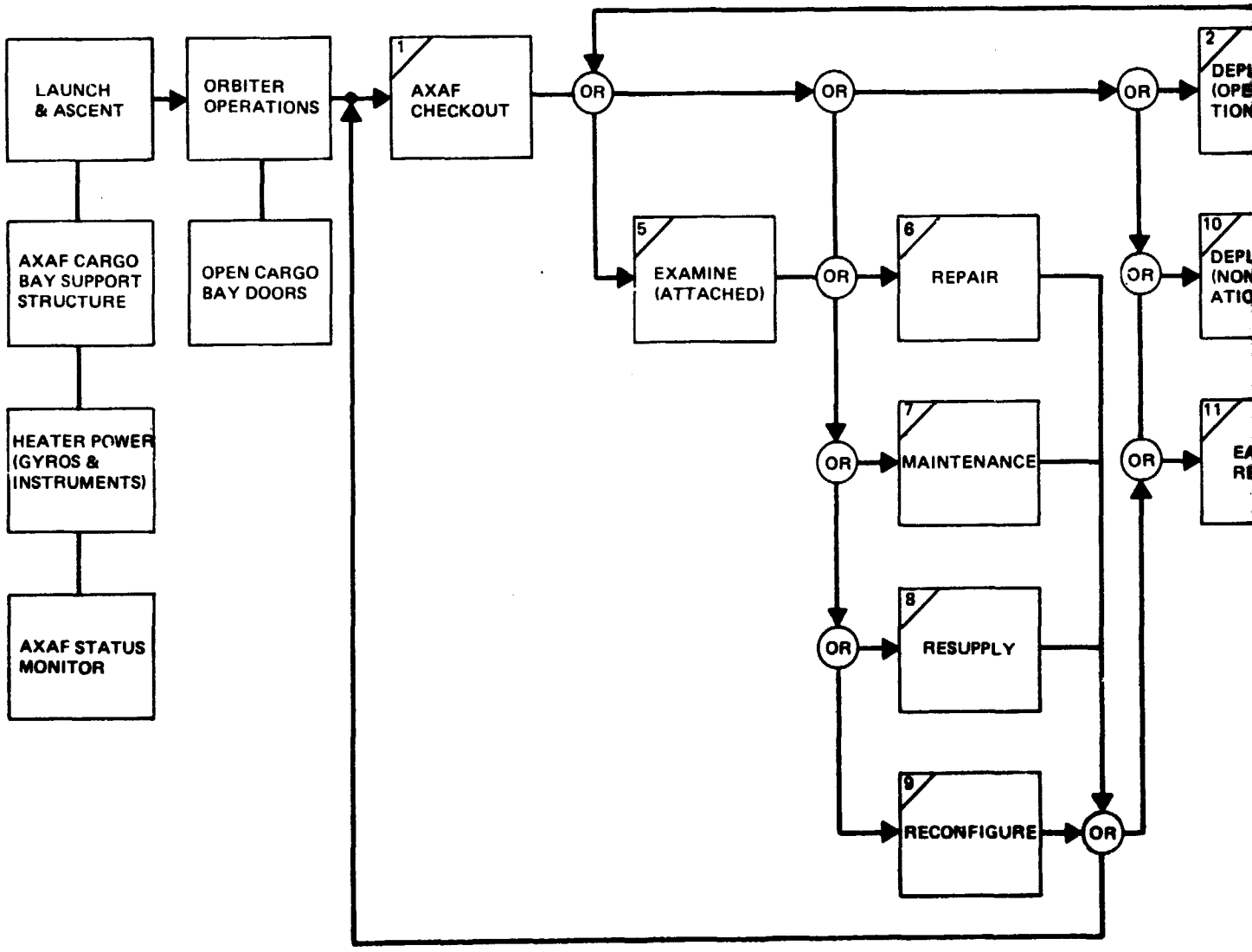
AXAF MISSION SEQUENCE

4.2 ADVANCED X-RAY ASTROPHYSICS FACILITY MISSION OPERATIONS FUNCTIONAL ANALYSIS



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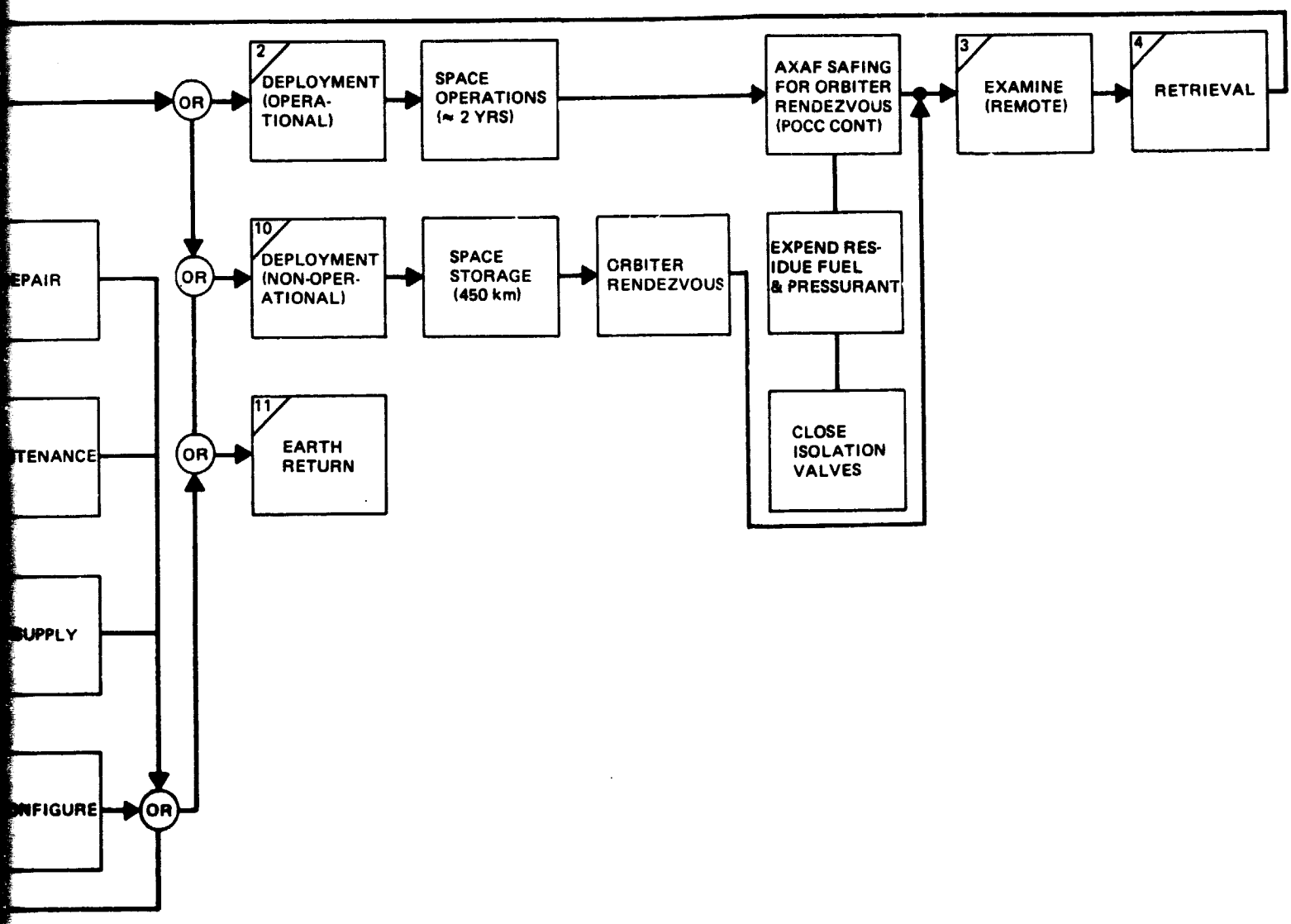

Fig. 4.2 Advanced X-Ray Astrophysics Facility Mission Operations Functional Analysis

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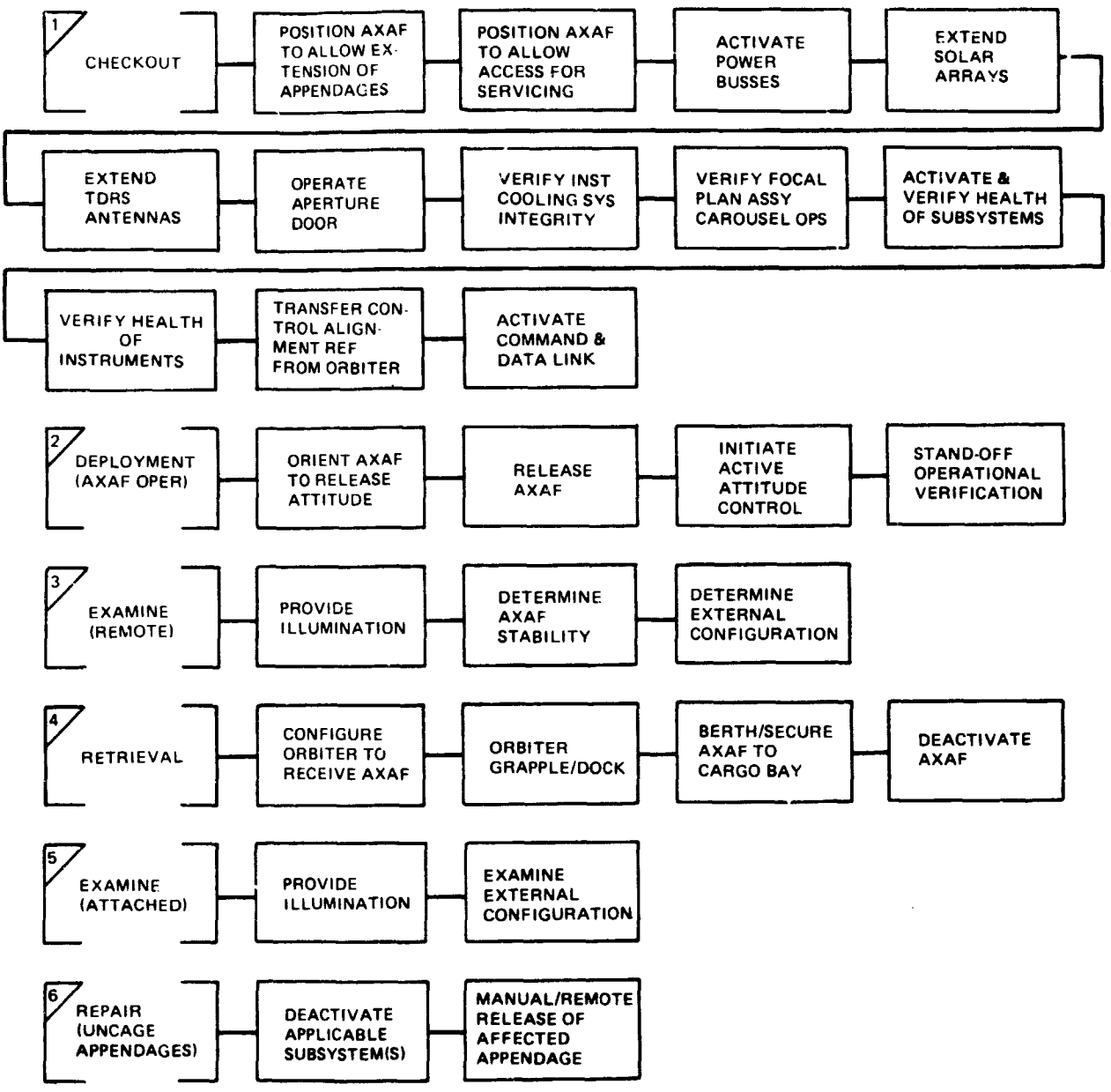

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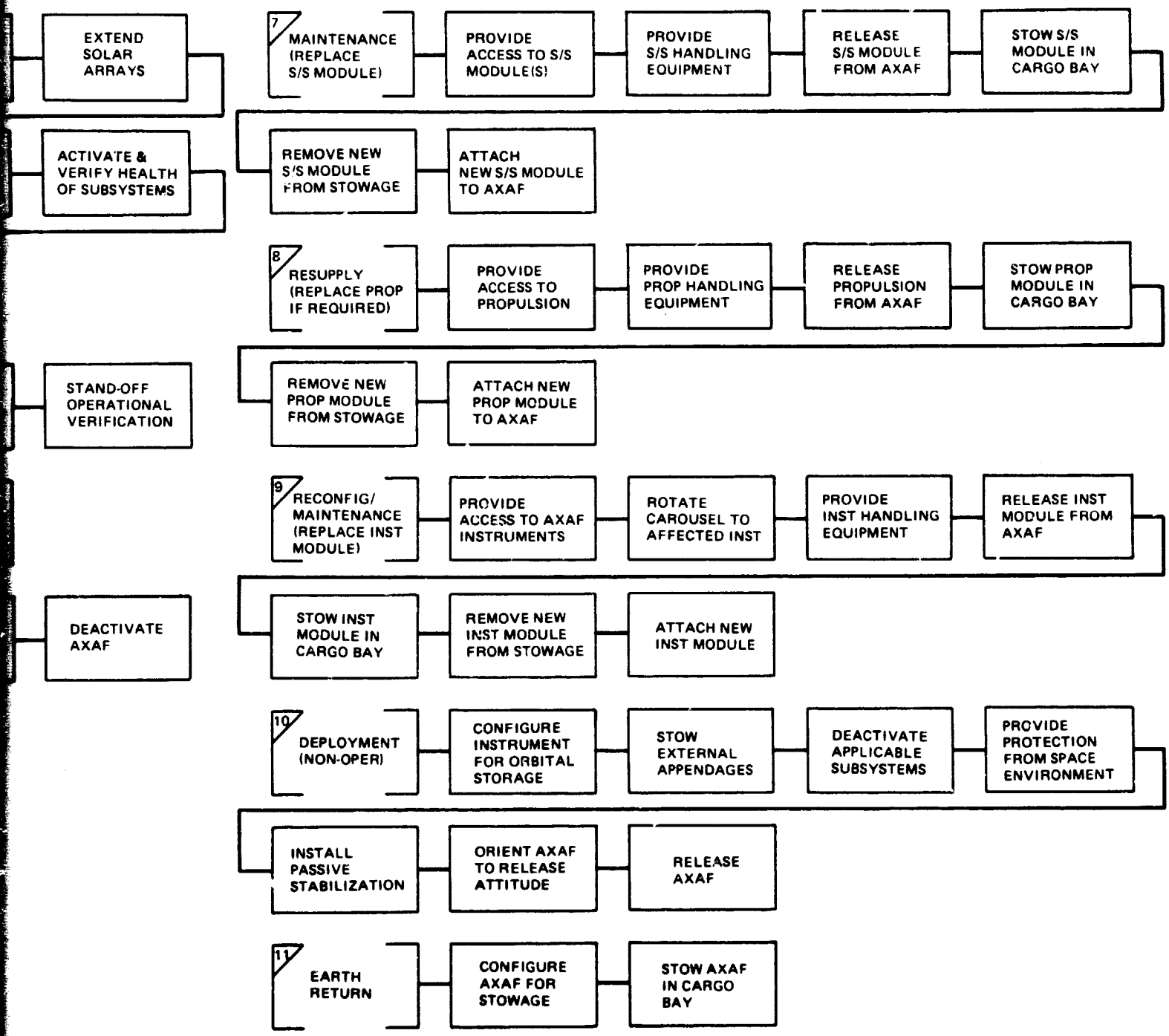

Fig. 4.3 Advanced X-Ray Astrophysics Facility (AXAF) Servicing Functional Analysis

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4.4 IDENTIFICATION OF AXAF SERVICING REQUIREMENTS

FUNCTION	CREW	AXAF SPACECRAFT	ORBITER SERVICE EQUIPMENT
1 CHECKOUT AXAF			
Position AXAF to allow extension of appendages & access for servicing	Initiate repositioning	Interface attachment to Orbiter service equipment	Structural attachment to cargo bay, to AXAF & means for repositioning. AFD control & display & transmission to repositioning mechanism
Activate power busses	Initiate power to AXAF	Electrical interface to support equipment	Electrical power interface to Orbiter and control equipment. AFD controls & displays and transmission to control equipment
Extend solar arrays, TDRS antennas and operate aperture door	Initiate extension of appendages	Accept command signals & generate data verification. Provide interface for external function equipment	AFD controls & displays and transmission to AXAF/support equipment interface
Verify cooling system integrity	Install & activate parasitic heat load	Accept heat input at standard instrument module attachment	Provide heat source & structural attachment at modular instrument location AFD controls & displays and transmission to AXAF/support equipment
Verify focal plane assembly carousel operations	Initiate carousel rotation	Accept command signals & generate data verification Interface to support equipment	AFD controls & displays and transmission to AXAF support equipment interface to AXAF

4.4 IDENTIFICATION OF AXAF SERVICING REQUIREMENTS (CONT'D)

FUNCTION	CREW	AXAF SPACECRAFT	ORBITER SERVICE EQUIPMENT
Activate command & data link	Initiate command & data link	Accept activation command	AFD controls & displays & transmission to AXAF/support equipment
Verify health of instruments	Initiate instrument activation & test	Accept activation & test signals. Transmit data	Provide means of command & data transfer
Transfer control reference from Orbiter	Initiate data transfer	Accept signals to control package	Provide means of data transfer
2 DEPLOYMENT (AXAF OPERATIONAL)			
Orient AXAF to release attitude	Initiate release attitude (Orbiter/ support equipment)	---	Orient AXAF as required
Release AXAF	Initiate AXAF release	Provides passive half of release mechanism	Provide release mechanism and accept acctuation signal
Initiate active attitude control	Initiate active attitude control safe separation	Accept & process RF command	AFD C&D means of RF control or POCC as applicable
Stand-off operational verification	Verify operational status	Accept & process RF command	Orbiter or OCC data link confirm operational status

4.4 IDENTIFICATION OF AXAF SERVICING REQUIREMENTS (CONT'D)

FUNCTION	CREW	AXAF SPACECRAFT	ORBITER SUPPORT EQUIPMENT
3 EXAMINE (REMOTE NEAR ORBITER)			
Provide illumination	Activate remotely controlled illumination	---	Provide illumination to AXAF. AFD C&D means of transmitting signal
Determine AXAF stability	View AXAF condition remotely	---	Provide remotely controlled TV or EVA stability system
Determine external configuration	View AXAF configuration remotely	---	Provide remotely controlled TV or EVA stability system to view external configuration
4 RETRIEVAL			
Configure orbiter to receive AXAF	Initiate support equipment configuration to receive AXAF	---	Provide non-contamination attitude control system. Accept command from AFD to configure fixture to receive AXAF. AFD C&D means of transmitting reconfiguration commands
Orbiter grapple/ dock AXAF	Control remote grappling equipment/orbiter	Provide stable fixture for grapple/docking	Provide snare to grapple AXAF or docking interface

4.4 IDENTIFICATION OF AXAF SERVICING REQUIREMENTS (CONT'D)

FUNCTION	CREW	AXAF SPACECRAFT	ORBITER SUPPORT EQUIPMENT
Berth/secure AXAF to cargo bay	Control remote equipment to berth AXAF	Acquiesent during berthing/docking. Structural interface to berthing/docking latches	Berthing/docking structure & capture latches
Deactivate AXAF	Initiate AXAF deactivation	Electrical power, control & data connection to support equipment. Accept and implement subsystem shutdown signals	Electrical power, control and data connections to AXAF. AFD C&D to AXAF means of transmitting signals/data
5 EXAMINE (ATTACHED)			
Provide illumination	Activate cargo bay & AXAF illumination	---	Provide auxiliary cargo bay lighting for AXAF servicing operations
Examine external configuration	View AXAF external configuration and mechanism directly or remotely	---	Provide remotely controlled TV or EVA maneuvering system

FUNCTION	CREW	AXAF SPACECRAFT	ORBITER SUPPORT EQUIPMENT
6 REPAIR (UNCAGE APPENDAGES)			
Deactivate applicable subsystems	Initiate subsystem deactivation	Accept deactivation signal	AFD C&D means of transmitting signal and verifying operations
Manual/remote release of affected appendage(s)	Release appendage stowage mechanism EVA or remotely	Provide mechanism compatible with external release	Provide compatible tool(s), if required
7 MAINTENANCE (REPLACE S/S MODULE)			
Provide access to S/S module	Initiate AXAF orientation	Design equipment clearance adequate for module replacement	Provide positioning equipment for AXAF
Provide S/S handling equipment	---	Design equipment with handling pads/points as applicable	Means of attaching/holding S/S module
Release S/S modules from AXAF	Perform hands on/remote control of module release	Attachments designed for easy space removal	Means of releasing module attachments

4.4 IDENTIFICATION OF AXAF SERVICING REQUIREMENTS (CONT'D)

FUNCTION	CREW	AXAF SPACECRAFT	ORBITER SUPPORT EQUIPMENT
Stow S/S module in cargo bay	Control/operate transport & stowage equipment	---	Transport of module to stowage. Stowage of module in cargo bay & means of retention
Remove new S/S module from stowage	Control/operate stowage release & transport of equipment	Interface for holding transport of equipment	Stowage of new S/S module in cargo bay & means of retention. Transport of S/S module to AXAF
Attach new S/S module to AXAF	Control/operate installation equipment	Provide attachment mechanism & control interfaces	Interface with module holding and latching
9 RECONFIGURATION (REPLACE INST MODULE)			
Provide access to axial instruments	Initiate AXAF orientation. Control/operate access doors	Design access doors for space operation	Interface with access door latches, if required
Rotate carousel to affected instrument	Initiate & control carousel operation	Provide external access to control and operate carousel	Interface with carousel control and power. AFD C&D means of transmitting signals and verifying operations
Provide instrument handling equip	---	Design equipment with handling pads/ points as applicable	Means of attaching/holding holding instrument modules

4.4 IDENTIFICATION OF AXAF SERVICING REQUIREMENTS (CONT'D)

FUNCTION	CREW	AXAF SPACECRAFT	ORBITER SUPPORT EQUIPMENT
Release instrument modules from AXAF	Perform hands on/remote control of module release	Attachments designed for easy space removal	Means of releasing module attachments
Stow instrument module in cargo bay	Control/operate transport & stowage equipment	--- ---	Transport of module to stowage. Stowage of module in cargo bay & means of retention
Remove new instrument from stowage	Control/operate release & transport of equipment	Interface for holding/transport of equipment	Stowage of new S/S module in cargo bay & means of retention. Transport of S/S module to AXAF
Attach new instrument module to AXAF	Control/operate installation equipment	Provide attachment mechanism & control interfaces	Interface with module holding and latching
10 DEPLOYMENT (NON-OPERATIONAL)			
Configure instrument for orbital storage	Initiate deactivation & configure instruments	Provide for orbital storage configuration	Covers/shields, as required
Stow external appendages	Initiate folding/retraction of appendages	Provide retraction mechanism	Provide equipment if remote means of retraction not available
Deactivate applicable subsystem	Initiate subsystem deactivation	Accept deactivation signals	AFD C&D means of data transfer

4.4 IDENTIFICATION OF AXAF SERVICING REQUIREMENTS (CONT'D)

FUNCTION	CREW	AXAF SPACECRAFT	ORBITER SUPPORT EQUIPMENT
Provide protection from space environment	Initiate/install covers as required	Provide integral protection/accept covers	Covers/protection equipment that interface with AXAF
Install passive stabilization	Install stabilization equipment directly or by remote control	Accept stabilization equipment	Stabilization equipment
Orient AXAF to release attitude	Initiate release attitude (Orbiter/support equipment	---	Orient AXAF as required
Release AXAF	Initiate AXAF release	Provides passive half of release mechanism	Provide release mechanism and accept actuation signal
11/ EARTH RETURN			
Configure AXAF for stowage	Retract appendages remotely or automatically. Deactivate subsystems & instruments	Provide mechanism to permit retraction of appendages	Provide compatible tools, if required
Stow AXAF in cargo bay	Control stowage mechanism	---	Provide stowage mechanism. AFD C&D means of routing command to stowage mechanism

4.5 DESCRIPTION OF SERVICE EQUIPMENT

4.5.1 AXAF Crew Service Requirements/Usage

Aft flight deck controls and displays are required to perform the following functions:

- Reposition service equipment in the cargo bay for checkout, deployment, retrieval and servicing
- Initiate activation/deactivation of AXAF power busses, subsystems and instruments*
- Deploy/fold AXAF appendages, i.e., solar arrays, TDRS antenna and aperture door (if not constrained by contamination requirements)*
- Control rotation of axial instruments carousel*
- Control and monitor parasitic heat load*
- Initiate transfer of orbiter alignment reference to AXAF
- Initiate activation/deactivation of AXAF command and data link*
- Initiate verification tests of instruments and subsystems*
- Initiate AXAF release signal
- Determine operational status after AXAF deployment*
- Initiate RCS attitude control at safe separation distance (200 feet)*
- Initiate deployment, activation, deactivation and retraction of non-contaminating ACG system
- Initiate Orbiter support fixture for AXAF retrieval
- Activate supplementary cargo bay illumination
- Control maneuvering of MTV remote free flyer
- TV display for MTV free flyer remote camera.

Control and display requirements are dependant on resolution of:

- AXAF release approach; RMS or flight support fixture
- AXAF operational verification; orbiter or POCC
- Use of remote free flyer for inspection
- Need for orbiter non-contaminating ALS to minimize AXAF contamination of optical surfaces.

Control/display functions noted with an asterisk, (*) could be satellite-user controlled from the ground via appropriate communication links provided for those purposes, either through the Orbiter or through the satellite's communication system.

EMU usage is required during EVA for the following functions:

- Replacement of AXAF subsystems and instruments
- Stowage of AXAF subsystems and instruments
- Transportation of AXAF subsystems and instruments
- Repair of deployable appendages.

4.5.2 AXAF Integration Requirements for Servicing

AXAF INTEGRATION REQUIREMENTS	ISSUES/RATIONALE/REMARKS
Structural and electrical attachment to Orbiter support fixture	
Electrical power, control and data connection to support fixture interface	
Internal provisions to allow external control and status monitoring of appendages, subsystems and instruments	
Provisions for (contingency) external means of folding appendages	If appendage design is not compatible with auto retraction, external release for deployment/folding is required.
Accept test signals and provide data to permit analysis of instrument operation	
Accept external input for carousel rotation	
Accept Orbiter alignment reference	
Grapple fixture located accessible to RMS grapple and mounted on firm satellite structure	
Provide means of non-RCS attitude hold during Orbiter separation. Accept and process RCS operational activation signal	
Accept and process RF operational verification commands and provide operational data	
Provisions for safing RCS/propulsion as applicable (expend residue fuel and pressurant) during revisits	
Equipment modules access for replacement	Doors, if required.

4.5.2 AXAF Integration Requirements for Servicing (Con't'd)

AXAF INTEGRATION REQUIREMENTS	ISSUES/RATIONALE/REMARKS
Attachments for subsystem and instrument modules that permit removal and reinstallation Provisions for attaching orbital storage equipment - accept environmental covers/shrouds - attachment for passive stabilization	

4.5.3 AXAF Service Equipment Requirements

SERVICE EQUIPMENT REQUIREMENTS	ISSUES/RATIONALE/REMARKS
Provide structural attachment of the AXAF to the Orbiter cargo bay. This support fixture shall provide latches that allow release and berthing of the AXAF. It shall permit deployment of appendages and replacement of instruments and subsystem modules. Equipment replacement may require the capability to rotate the AXAF about its longitudinal axis and tilt to be within crew/RMS reach Provide electrical power, command and data signal interface as required to the AXAF via the Orbiter support fixture Provide means of command and data transfer from the AFD to the Orbiter support fixture Provide control panel/displays in the AFD to allow crew control of the support equipment and AXAF while attached to the Orbiter Provide cargo bay lighting to permit servicing operations during dark side passes. This requires illumination of the AXAF external surfaces and inside the AXAF instrument and subsystem access areas Provide a non-contamination attitude control system for Orbiter use when contamination sensitive instruments are serviced Provide covers/shields as necessary to protect the AXAF from the space environment during orbital storage Provide passive stabilization equipment to be attached to the AXAF for Orbital storage Provide a remotely controlled TV camera and/or EVA maneuvering aids for AXAF examination while attached to the cargo bay	

4.5.3 AXAF Service Equipment Requirements (Cont'd)

SERVICE EQUIPMENT REQUIREMENTS	ISSUES/RATIONALE/REMARKS
Provide tools, if required, to permit manual deployment or stowage of appendages Provide an RMS snare to grapple the AXAF Provide a remotely controlled TV camera (MTV), space maneuverable and/or EVA maneuvering system for AXAF examination remotely from the Orbiter. Also, provide lighting for remote operations Provide means of holding and transporting subsystem and instrument modules from the AXAF to storage Make provisions for stowing new and used modules in the cargo bay Make provisions for stowing special tools required for servicing AXAF	

5.0 REFERENCE SATELLITE: Earth Gravity Field Survey Mission (GRAVSAT)

5.1 SPACECRAFT DESCRIPTION AND MISSION SEQUENCE

STATUS: Planned, 2 spacecraft

LAUNCH DATE: 1985

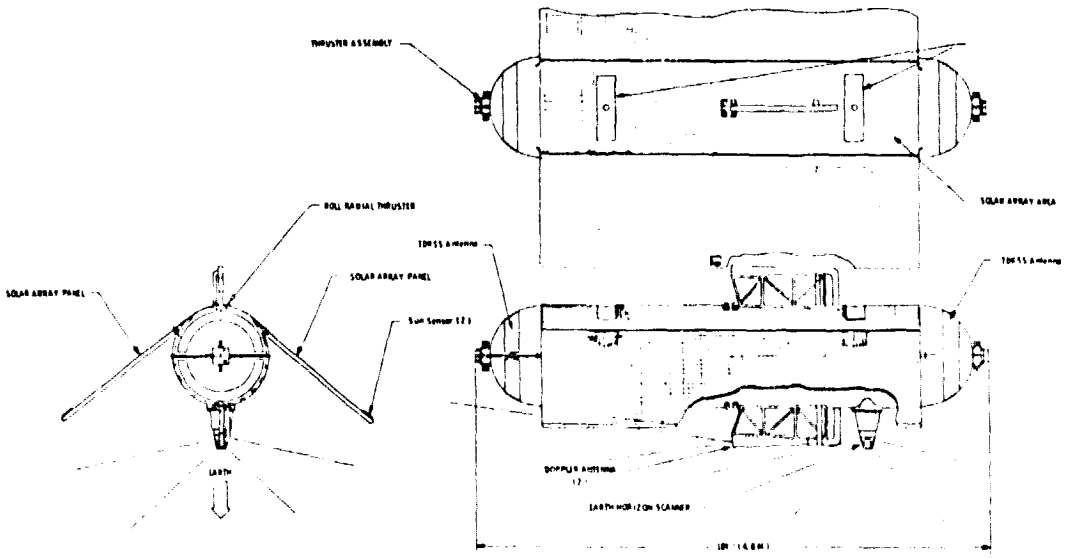
LIFETIME: 7 months

LAUNCH AND TRANSFER VEHICLES: Orbiter and integral prop

OPERATIONAL LOCATION: 160 km, 90° inclination

MASS AT OPERATIONAL LOCATION: 1600 kg

AVERAGE OPERATIONAL POWER: 210 W



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GRAVSAT ORBIT CONFIGURATION

OBJECTIVES:

A dedicated Earth Gravity Field Survey Mission (GRAVSAT) will sense the gravity field fine structure and thus provide knowledge and understanding of (1) the origin and structure of geological features on the Earth's surface, (2) the mechanical properties of the Earth's lithospheric plates and the forces which drive their motion, and (3) the large-scale circulation of the oceans and major current systems by the determination of an improved ocean geoid.

MISSION DESCRIPTION:

The mission plan is to release two free flying satellites from the Orbiter in a 300 km polar orbit. They will transfer to the same low altitude (approximately 160 km) circular, for a 6-month period. The tracking of one satellite following another in this low orbit about the Earth yields Doppler data which, after analysis, provides information about the Earth's gravitational field.

INSTRUMENTS:

GRAVSAT is unusual in that the spacecraft is the instrument itself; as such, there is no separate instrument module. The spacecraft reacts to normal orbital body forces (gravity) and the surface forces associated with a low altitude spacecraft (drag and solar pressure). Within the spacecraft, at the center of its mass, is a sensing system which includes a free-floating ball that reacts only to body forces. The system senses motion between the ball and the rest of the spacecraft and provides a signal to a propulsion system that accelerates the spacecraft in a manner so that the spacecraft closely approximates a zero surface force orbit.

SERVICE NEEDS:

DEPLOYMENT	EXAMINATION	RETRIEVAL	SUPPORT				EARTH
			C/O REPAIR	MAINTENANCE	RESUPPLY	RECONFIGURATION	RETURN
PLANNED	POTENTIAL	POTENTIAL	POTENTIAL		POTENTIAL		POTENTIAL

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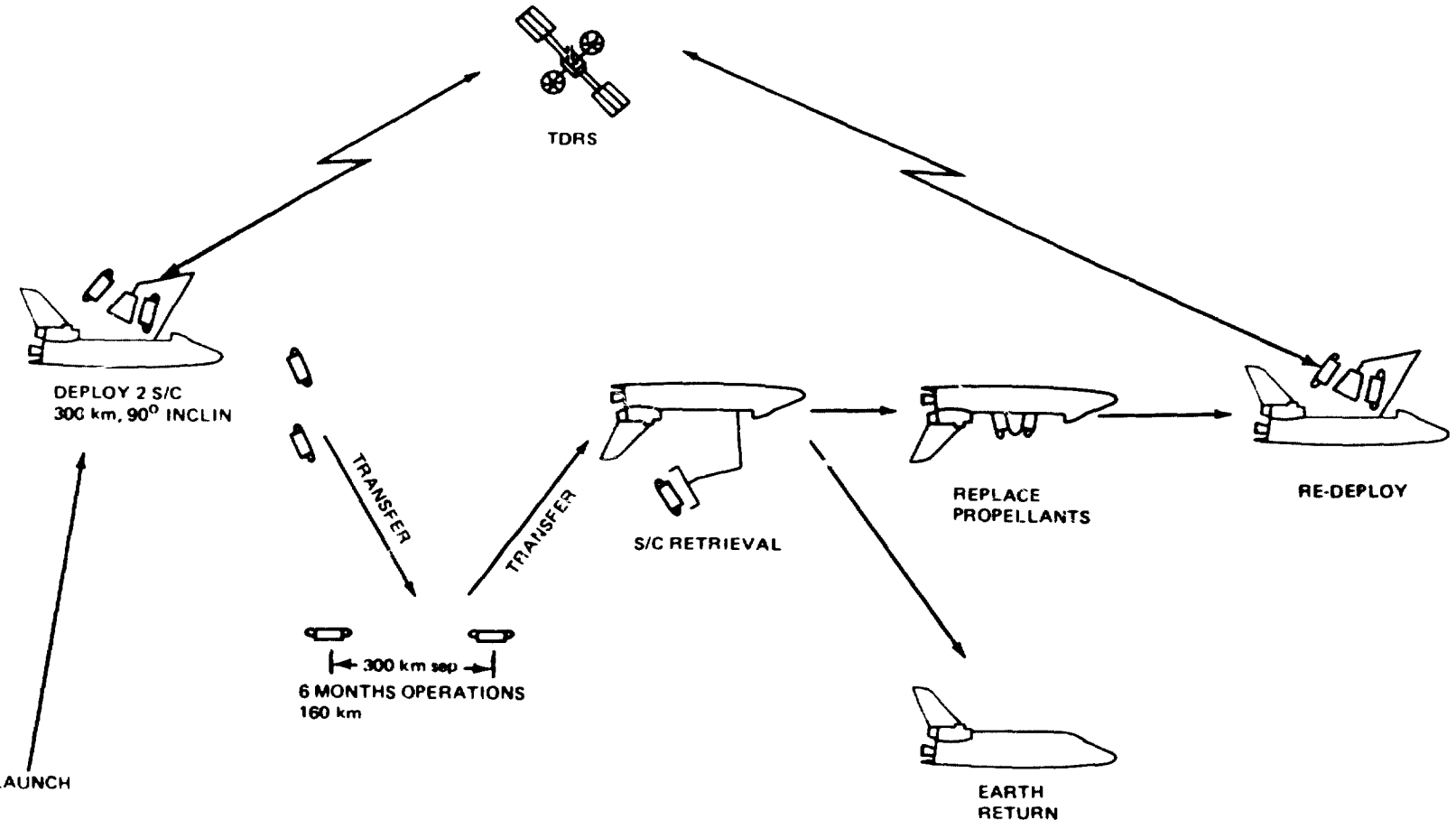
REFERENCES:

- Preliminary Execution Phase Project Plan for Gravity Satellite, GSFC, November 1980
- NASA Space Systems Technology Model, OAST, May 1980, R-4.



GRAVSAT MISSION SEQUENCE

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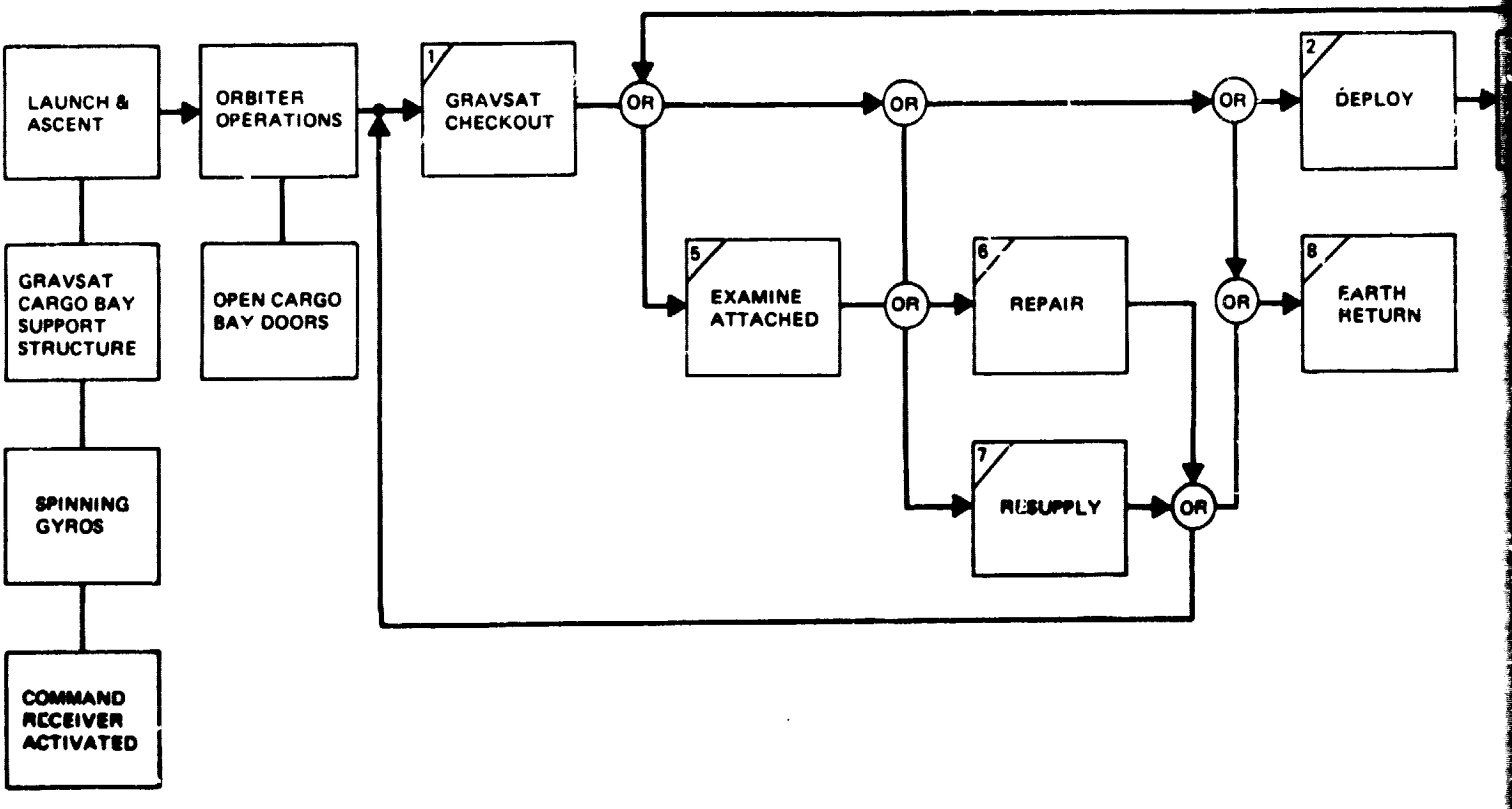
5.2 GRAVSAT MISSION OPERATIONS FUNCTIONAL ANALYSIS



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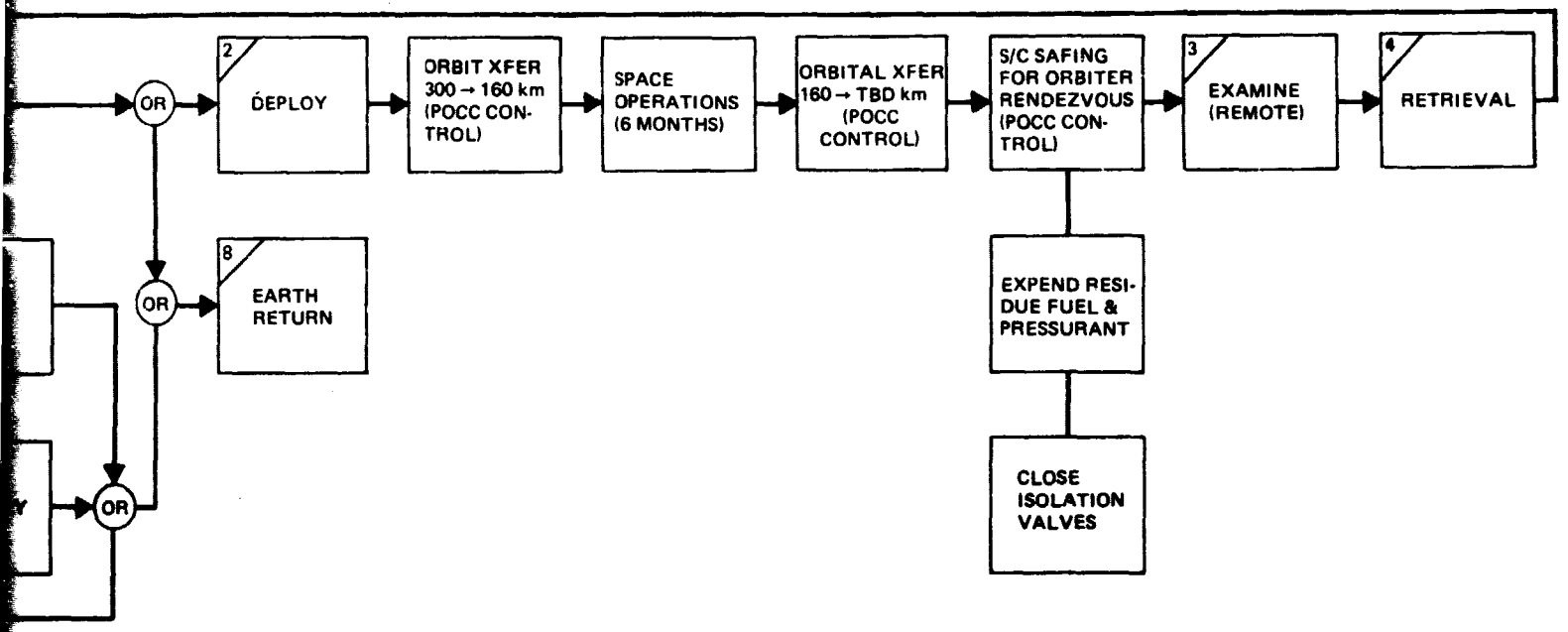

Fig. 5.2 GRAVSAT Mission Operations Functional Analysis

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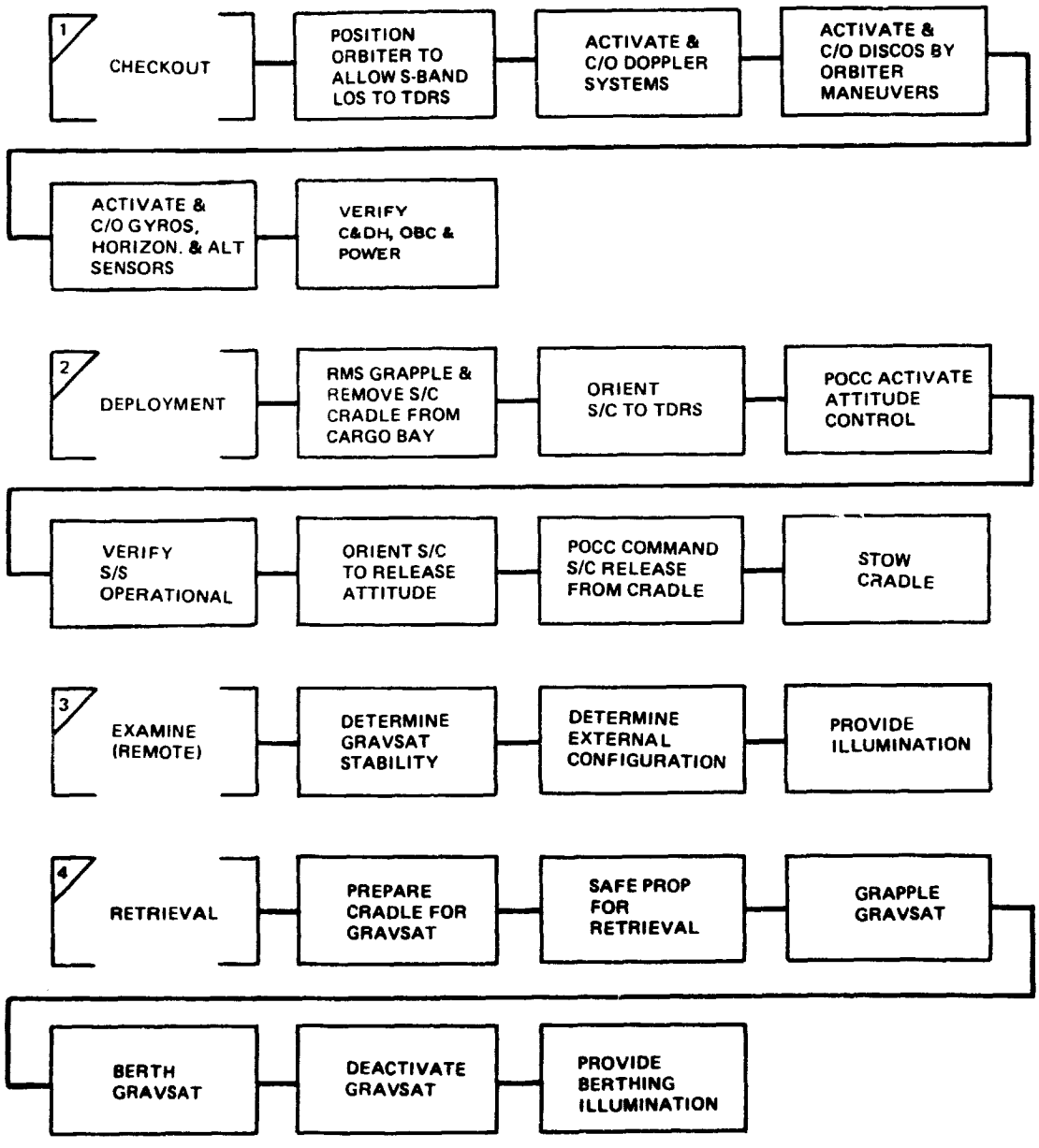

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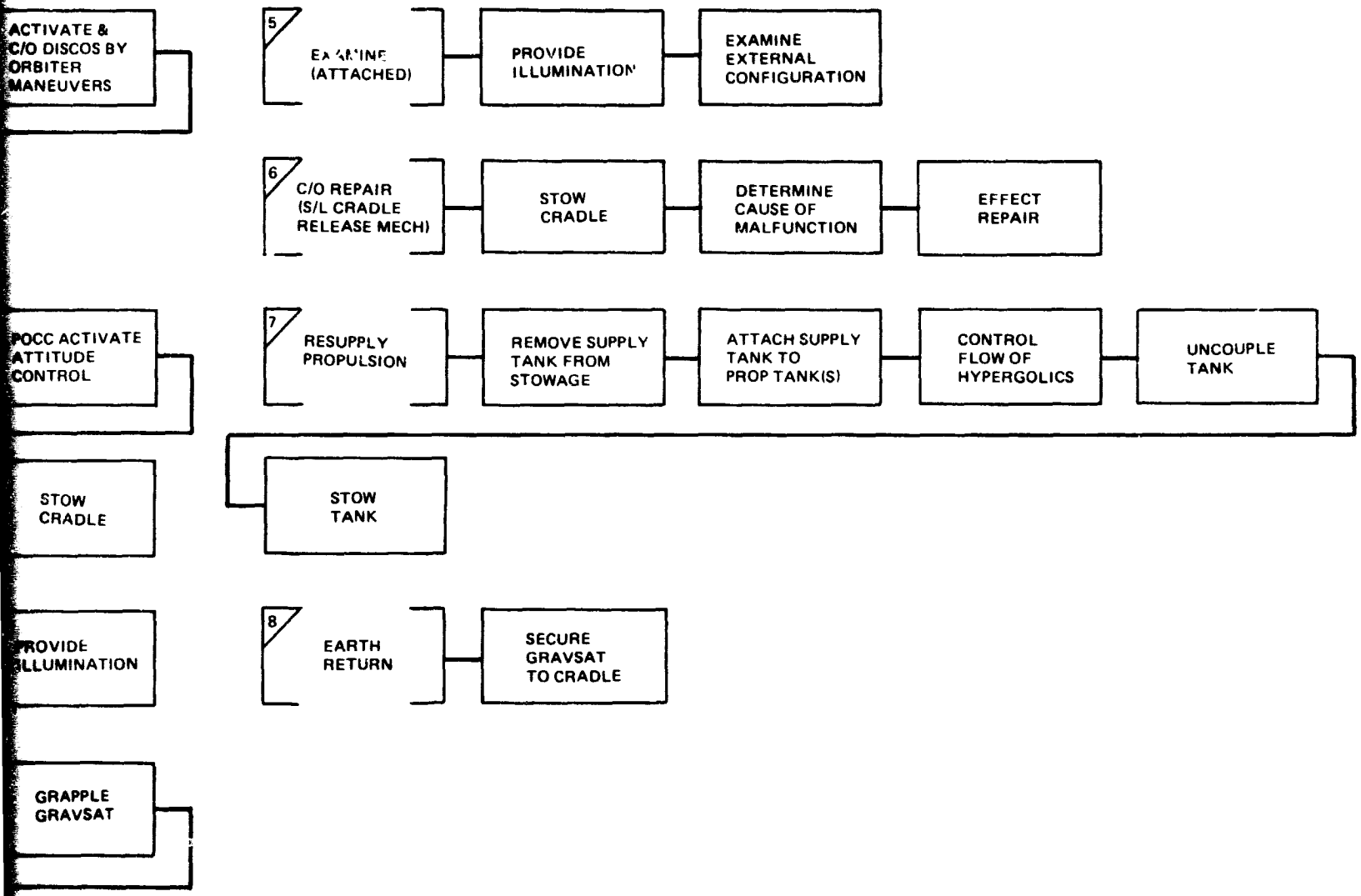

Fig. 5.3 GRAVSAT Servicing Operations Functional Analysis

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5.4 IDENTIFICATION OF GRAVSAT SERVICING REQUIREMENTS

FUNCTION	CREW	GRAVSAT SPACECRAFT	ORBITER SERVICE EQUIPMENT
1 CHECKOUT (C/O)			
Position Orbiter to allow S-Band LOS to TDRSS	Maneuver Orbiter	---	---
Activate & C/O Doppler systems	Verify POCC test operations		
Activate & C/O Discos by Orbiter maneuver	Maneuver Orbiter as required by POCC test sequences	---	---
Activate & C/O gyros, horizon & alt sensors	Verify POCC test operations	---	---
Verify C&DH OBC & power	Verify POCC test operations		
2 DEPLOYMENT			
RMS grapple and removal of S/C cradle from cargo bay	Operate RMS, grapple S/C cradle & remove from cargo bay	---	Provide support cradle for two S/C interfaces with cargo bay & mounting for grapple fixture

5.4 IDENTIFICATION OF GRAVSAT SERVICING REQUIREMENTS (CONT'D)

FUNCTION	CREW	GRAVSAT SPACECRAFT	ORBITER SERVICE EQUIPMENT
Orient S/C to TDRSS	Maneuver Orbiter & RMS for LOS to TDRS	---	---
POCC activate attitude control	Verify POCC test operations	---	---
Verify S/S operational	Verify POCC test operations	---	---
Orient S/C to release attitude	Maneuver S/C via RMS per intruc-tions from POCC	---	---
POCC command S/C release from cradle	Confirm S/C release	---	Provide cradle release mechanism to interface with S/C
Stow cradle	Maneuver cradle with RMS to cargo bay stowage & operate latching	---	Cradle interface alignment & mating pins to longeron cap-ture latches
3 EXAMINE (REMOTE)			
Provide illumination	Control illumination remotely during dark side passes	---	Provide illumination for TV or EVA maneuvering system

5.4 IDENTIFICATION OF GRAVSAT SERVICING REQUIREMENTS (CONT'D)

FUNCTION	CREW	GRAVSAT SPACECRAFT	ORBITER SERVICE EQUIPMENT
Determine GRAVSAT stability	View GRAVSAT stability condition or receive information from POCC	---	Provide remotely controlled TV or EVA maneuvering system
Determine GRAVSAT external configuration	View GRAVSAT stability condition	---	Provide remotely controlled TV or EVA maneuvering system
4/RETRIEVAL			
Prepare cradle for GRAVSAT	Remotely or via EVA open or verify cradle latches open	Attachment compatible with cradle retention	Latches/retention mechanism provided to accept GRAVSAT
Safe S/C for retrieval	Verify POCC safing	Provide remotely controlled prop vents	---
Grapple GRAVSAT	Control remote grappling equipment	Provide stable fixture for grapple	Provide snare to grapple GRAVSAT
Berth GRAVSAT	Control remote equipment to berth GRAVSAT	Acquiescent during berthing maneuvers. Structural interface to berthing latches	Remotely controlled berthing equipment. Berthing structure & capture latches
Deactivate GRAVSAT	Maneuver Orbiter S/C LOS to TDRS. Verify POCC S/C deactivation	---	---

5.4 IDENTIFICATION OF GRAVSAT SERVICING REQUIREMENTS (CONT'D)

FUNCTION	CREW	GRAVSAT SPACECRAFT	ORBITER SERVICE EQUIPMENT
5 EXAMINE (ATTACHED)			
Provide illumination	Control illumination during dark side passes	---	Provide illumination for remote TV or EVA
Examine external configuration	View GRAVSAT external configuration & attachment mechanism	---	Provide remotely controlled camera or EVA maneuver aids
6 C/O REPAIR (S/C CRADLE RELEASE MECH)			
Stow cradle	Maneuver cradle to cargo bay stowage & confirm latching	---	Cradle interface alignment & mating pins to Longeron capture latches
Determine cause of malfunction	Conduct mechanical functioning and/or circuit test remotely or EVA	Interfaces to permit inspection & test	Provide tools and/or test equipment
Effect repair	Perform EVA repair procedures	Provisions for EVA repair	Provide tools

5.4 IDENTIFICATION OF GRAVSAT SERVICING REQUIREMENTS (CONT'D)

FUNCTION	CREW	GRAVSAT SPACECRAFT	ORBITER SERVICE EQUIPMENT
7 RESUPPLY PROPULSION			
Remove supply tank from stowage	Control/operate removal equipment	---	Provide stowage of tank in cargo bay & means of retention
Attach tank to propulsion tank(s)	Control/operate installation equip	Provide fill port	Provide means of holding & transporting dewar to GRAVSAT
Control flow to hypergolics	Control flow of hypergolics	---	Provide means of controlling hypergolic
Uncouple tank	Control/operate uncoupling	---	Provide means of holding & releasing tank coupling
Stow tank	Control/operate transportation and stowage equipment	---	Provide transportation to stowage. Stowage of dewar in cargo bay & means of retention
8 EARTH RETURN			
Secure GRAVSAT to cradle	Install hold down clamps/ fittings	Accept clamps/ fittings	Provide clamps/fittings

5.5 DESCRIPTION OF SERVICE EQUIPMENT

5.5.1 GRAVSAT Crew Service Requirements/Usage

Aft flight deck controls and displays are required to perform the following:

- Cargo bay cradle latching/release
- Control cargo bay auxiliary lighting for berthing and examining GRAVSAT and stowing cradle
- TV display for MTV free flyer remote camera
- Controls for remote free flyer.

EMU interfaces are required for the following:

- Test equipment and tools required for repair activities.

5.5.2 GRAVSAT Integration Requirements for Servicing

GRAVSAT INTEGRATION REQUIREMENTS	ISSUES/RATIONALE/REMARKS
Structural interface attachments to cradle fixture	
Interfaces to permit inspection/repair	
Fill port to replenish propellant	
Provisions for safing propulsion/RCS system. This includes expending residual fuel and pressurant during a revisit	
Grapple fixture accessible to RMS grapple and mounted on firm satellite structure	

5.5.3 GRAVSAT - Service Equipment Requirements

SERVICE EQUIPMENT REQUIREMENTS	ISSUES/RATIONALE/REMARKS
Provide structural attachment of GRAVSAT cradle to the Orbiter cargo bay. This cradle shall be provided with interfaces to cargo bay latches to permit removal and reinstallation during orbital operations. It shall also provide a grapple fixture for RMS attachment. Attachment and interfaces for 2 GRAVSAT satellites shall be provided. Mechanisms shall be provided for reinstallation of the GRAVSATS	
Provide cargo bay illumination for cradle stowage, S/C berthing, examination and repair operations	
Provide an RMS end effector to grapple the GRAVSAT	
Provide signal interfaces between support equipment and AFD	
Provide a remotely controlled camera (MTV) or EVA maneuver aids for cargo bay examination operations	
Provide tools, as required, for servicing operations	
Provide a remotely controlled free flyer (MTV) with a TV camera and lights for remote examination	
Provide stowage of propellant supply tank in cargo bay	Propellant resupply is dependent on Orbiter retrieval operations at low altitude (160 km) or the GRAVSAT transferring to a higher orbit acceptable to Orbiter operations.
Provide transport for the supply tank from storage to the spacecraft	
Provide controls for transfer of propellant and attachment of supply to the GRAVSAT	

6.0 REFERENCE SATELLITE: ORBITING ASTRONOMICAL OBSERVATORY (OAO)

6.1 SPACECRAFT DESCRIPTION AND MISSION SEQUENCE

STATUS: Uncooperative spacecraft
NORAD catalogue satellite Number 2142

LAUNCH DATE: 1966

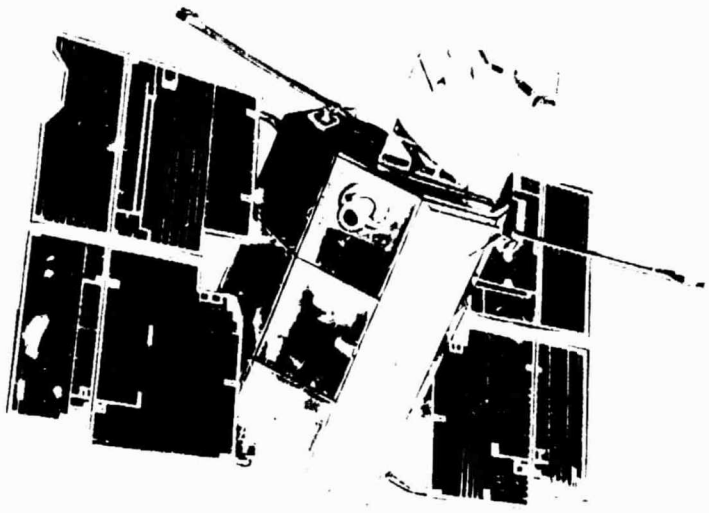
LIFETIME: Undetermined

LAUNCH & TRANSFER VEHICLE:
Atlas Centaur

OPERATIONAL LOCATION: 800 km
35° inclination

MASS AT OPERATIONAL LOCATION:
1900 kg

AVERAGE OPERATIONAL POWER:
Not applicable



OBJECTIVES: Not applicable

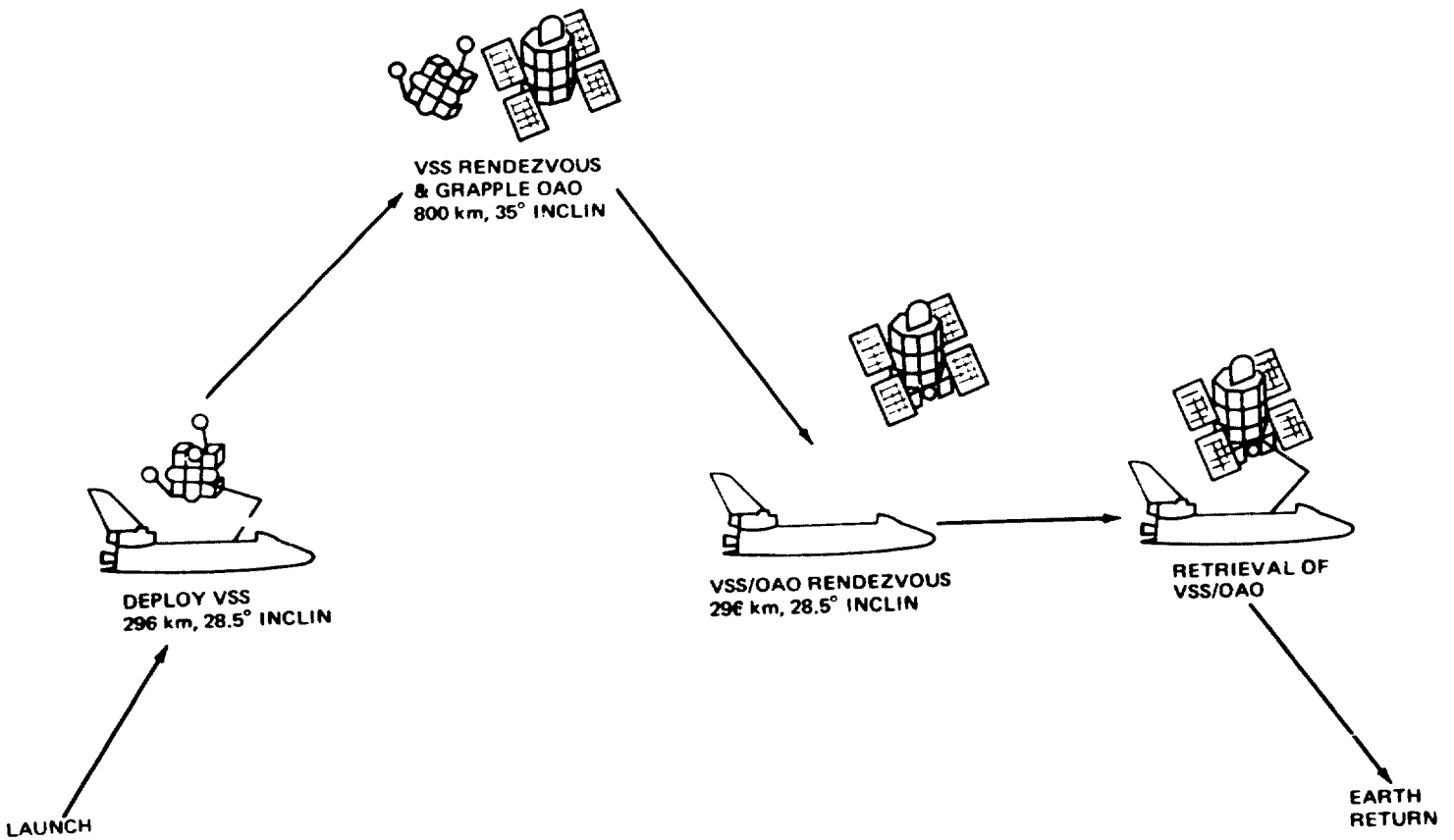
MISSION DESCRIPTION: Not applicable

INSTRUMENTS: Not applicable

SERVICE NEEDS: Retrieval and earth return

REFERENCES:

- Systems Design Manual OAO Spacecraft 4, GAC, October 1971



OAO RETRIEVAL MISSION SEQUENCE

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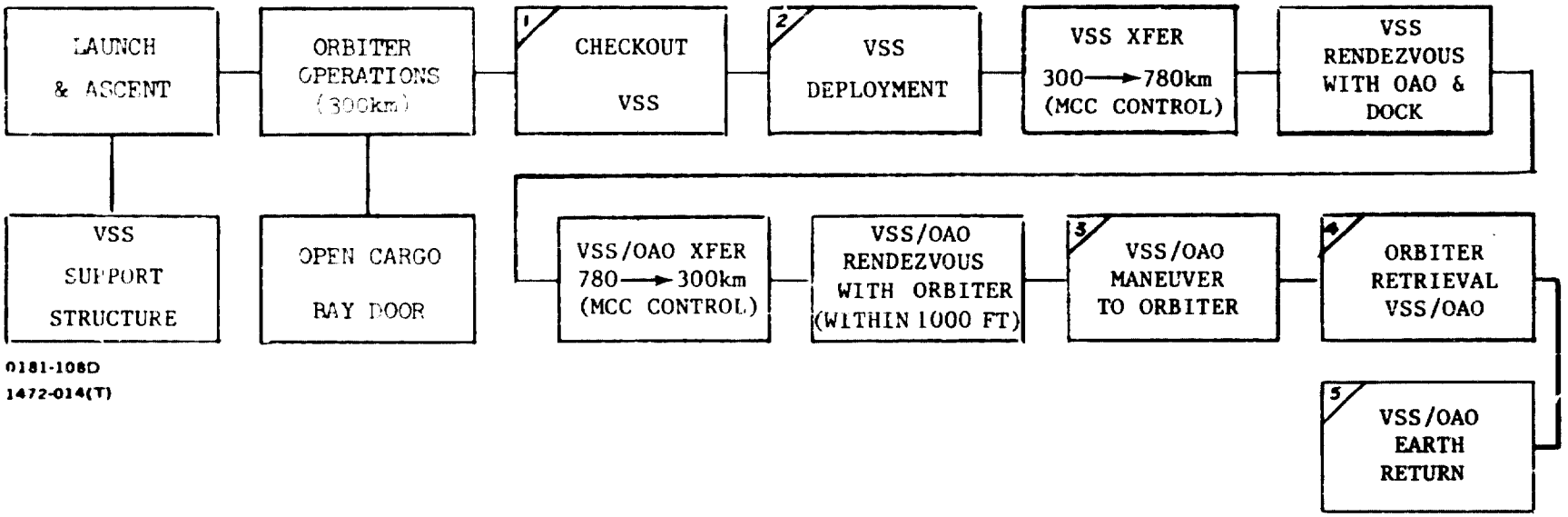
1472-013(T)

6.2 ORBITING ASTRONOMICAL OBSERVATORY-RETRIEVAL MISSION OPERATIONS FUNCTIONAL ANALYSIS



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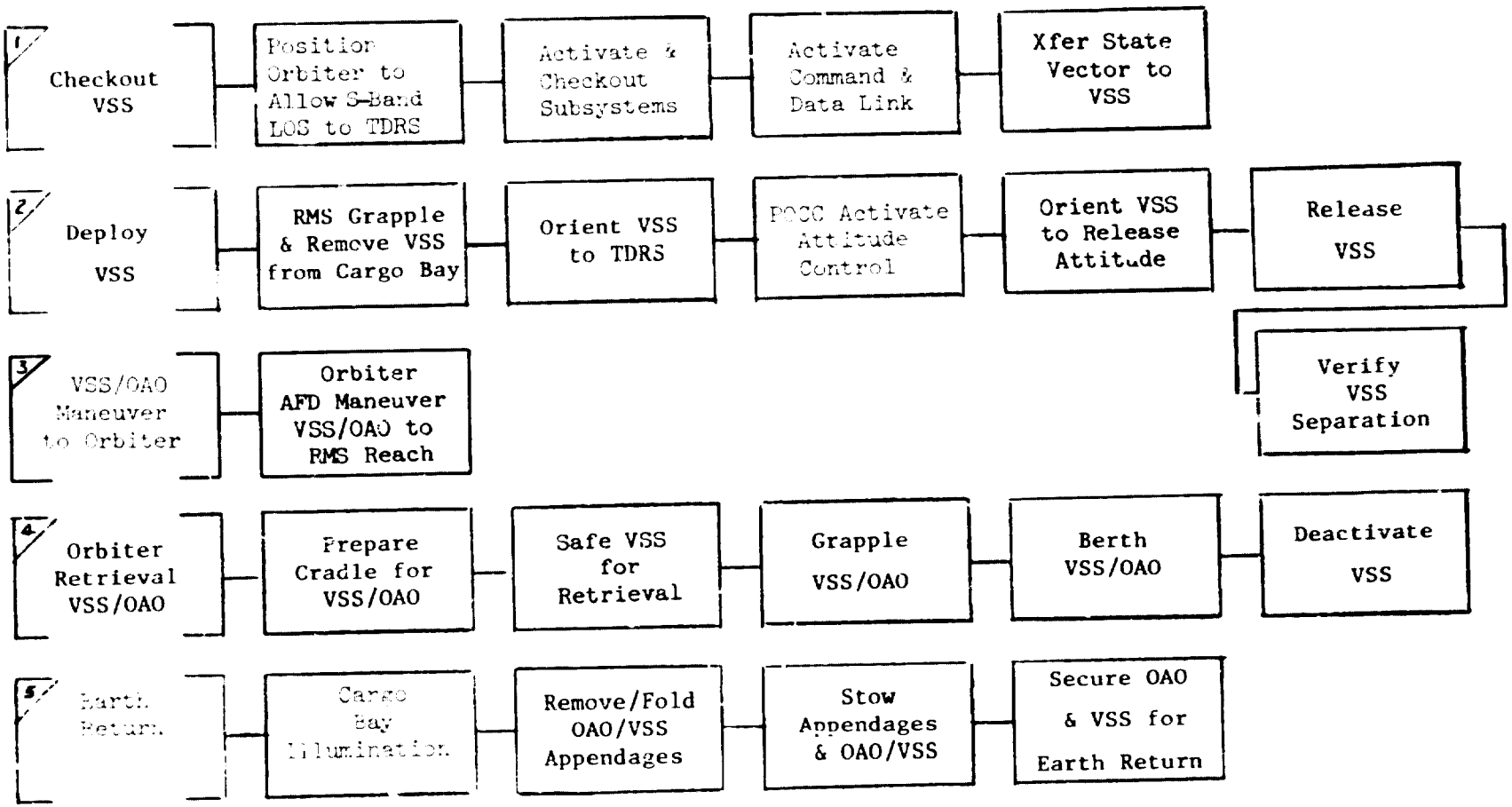
6.3 SERVICING OPERATIONS FUNCTIONAL ANALYSIS



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6.4 IDENTIFICATION OF ACA - RETRIEVAL SERVICING REQUIREMENTS

FUNCTION	CREW	VSS SPACECRAFT	ORBITER SUPPORT EQUIPMENT
1/ CHECKOUT VSS			
Position Orbiter to allow S-Band LOS to TDRS	Maneuver Orbiter	---	---
Activate & C/O subsystems	Initiate power to S/S and verify	Accept remote activation	Provide power to TMS and interface between VSS and AFD
Activate Command & Data link	Initiate C&D activation	Accept activation signal	Provide interface between Orbiter & VSS
Transfer state vector to VSS	Initiate state vector transfer	Accept state vector data	Provide interface between Orbiter & VSS
2/ DEPLOY VSS			
RMS grapple and remove VSS from cargo bay	Operate RMS, grapple VSS & remove from cargo bay	Provide grapple fixture	Provide support fixture for VSS interface with cargo bay
Orient VSS to TDRS	Maneuver Orbiter & RMS for VSS to TDRS	---	---
POCC activate attitude control	Verify POCC test operations	---	---

6.4 IDENTIFICATION OF OAO - RETRIEVAL SERVICING REQUIREMENTS (CONT'D)

FUNCTION	CREW	VSS SPACECRAFT	ORBITER SUPPORT EQUIPMENT
Orient VSS to release attitude	Maneuver S/C via RMS to release attitude	---	---
Release VSS	Initiate release via RMS	---	---
Verify VSS separation	Observe separation operations	---	---
3 VSS/OAO MANEUVER TO ORBITER			
Orbiter AFD maneuver VSS/OAO to RMS reach distance	Operate VSS close proximity controls	VSS accep[illegible]ntrol signals fro[illegible] Orbiter	Provide AFD controls & displays for close proximity flight control of VSS
4 ORBITER RETRIEVAL VSS/OAO			
Prepare cradle for VSS/OAO	Remotely or EVA open or verify structure latches open	Attachment compatible with support structure	Latches/retention mechanism provided to accept VSS
Safe VSS for retrieval	Verify POCC safing	Provide remotely controlled prop vents	---

6.4 IDENTIFICATION OF OAO - RETRIEVAL SERVICING REQUIREMENTS (CONT'D)

FUNCTION	CREW	VSS SPACECRAFT	ORBITER SUPPORT EQUIPMENT
Grapple VSS/OAO	Control remote grappling equipment	Provide stable fixture for grapple	Provide snare to grapple VSS
Berth VSS/OAO	Control remote equipment to berth VSS/OAO	VSS acquiescent during berthing maneuvers. Structural interface to berthing latches	Provide latching structure and latches. Remotely controlled berthing equipment
Deactivate VSS	Maneuver Orbiter for S/C LOS to TDRS. Verify POCC S/C deactivation	---	---
5 EARTH RETURN			
Cargo bay illumination	Activate cargo bay lighting	---	Provide auxiliary cargo bay lighting for OAO operations
Remove/fold VSS/OAO appendages	EVA appendage removal/folding (sun shades, booms, solar arrays)	---	Tools to release appendage for folding and cutters. Holding & transportation equipment for appendages
Stow appendages & OAO/VSS	Control of transportation equipment & stowage operations	---	Stowage equipment for appendages & OAO
Secure VSS/OAO for earth return	Control remotely or operate EVA	---	Provide equipment to secure OAO for earth return & landing

6.5 DESCRIPTION OF SERVICE EQUIPMENT

6.5.1 Crew Service Requirements/Usage

Aft flight deck controls and displays are required to perform the following functions:

- Close proximity flight operations controls for VSS
- Controls for cargo bay holding fixture if operation is not performed EVA
- Controls for cargo bay stowage equipment if operation is not performed EVA
- Remote controls for grapple equipment
- Remote controls for berthing equipment
- Controls for cargo bay auxiliary lighting.

EMU interfaces are required for the following functions:

- Positioning and operation of holding fixture/clamping mechanism
- Preparation and operation of OAO stowage
- Folding/removal operations of appendages
- Securing/stowage of appendages
- Transport of equipment.

6.5.2 Service Equipment Requirements

SERVICE EQUIPMENT REQUIREMENTS	ISSUES/RATIONALE/REMARKS
Provide Versatile Service Stage (VSS) with a capability to retrieve the OAO and transport it to Orbiter	
Grapple fixture mounted on VSS and located accessible to grappler	
Electrical power control, and data connection on VSS to interface with support fixture	
Internal provisions to allow VSS retraction of TDRS antenna and control of subsystems	
VSS accept signal to permit transfer Orbiter state vector/alignment	
VSS rendezvous capability with an uncooperative satellite	
Means of VSS grappling on unstable OAO and holding it securely for transportation to Orbiter	Sticky pads could attach to polished aluminum outer skin panels.
Provision for safing VSS propulsion (i.e., venting)	
VSS attached structure compatible with cargo bay support structure	
VSS acquiescent during deployment and berthing operations	
Provide support fixture to hold the VSS in the cargo bay during launch, on orbit and earth return	During retrieval, the OAO is attached to the VSS; a means of holding the combined VSS/OAO is therefore required. The OAO could subsequently be removed and stowed in another fixture.
Provide mechanical latching mechanism, guides, etc., to permit release and berthing of the VSS	
Provide electrical interfaces on the support fixture for power, signal and data transfer	

6.5.2 Service Equipment Requirements (Cont'd)

SERVICE EQUIPMENT REQUIREMENTS	ISSUES/RATIONALE/REMARKS
Provide a snare (RMS) to grapple the VSS and remotely controlled berthing equipment	
Provide auxiliary cargo bay lighting as required for berthing and stowing operations	
Provide means of dumping OAO pneumatic system nitrogen	
Provide retention of the OAO during Earth return and landing	If OAO structural attachment points not available, may require containment inside a "casket".
Provide stowage for appendages and tools	
Provide tools for releasing appendage deployment mechanism or cutters as required	
Provide for transportation of appendages to stowage	

7.0 REFERENCE SATELLITE MISSIONS-SERVICE EQUIPMENT GROUPS

The following table identifies the service functions/equipment surfaced for the five reference satellite missions, in terms of equipment groupings.

SERVICE EQUIPMENT GROUPS	XTE	UARS	AXAF	GRAVSAT	OAO
STRUCTURAL SUPPORT					
• Deployment Fixture	●	●	●	●	
• Spin Table	—	—	—	—	
• Berthing Fixture	●	●	●	●	●
• Docking Module	—	—	—	—	—
• Debris Stowage					●
• Replacement Module Stowage	●	●	●		
• Tool Stowage	●	●	●	●	●
• End Effectors Stowage				●	●
REMOTE CONTROL FREE FLYER					
• Inspection	●	●	●	●	●
• Satellite Stabilization					●
• Retrieval	—	—	—	—	
• Earth Entry	—	—	—	—	
• Instrumentation Platform	—	—	—	—	
MANNED FREE FLYER					
• Inspection	●	●	●	●	●
• Repair	—	—	—	—	
• Equipment Transport	—	—	—	—	
• Assembly	—	—	—	—	

SERVICE EQUIPMENT GROUPS (CONT'D)	XTE	UARS	AXAF	GRAVSAT	OAO
RMS END EFFECTORS					
• Equipment Transport	•	•	•		•
• Equipment Exchange	•	•	•		
• Personnel Transport	•	•	•		
• Satellite Retrieval/Deployment	•	•	•	•	•
• RMS Extender	—	—	—	—	—
• Dexterous Manipulator	—	—	—	—	—
CONTROL AND DIAGNOSTIC EQUIPMENT					
• Aft Flight Deck	•	•	•	•	•
• Payload Bay	—	—	—	—	—
EVA SUPPORT					
• Work Site Restraints	•	•	•	•	•
• Traverse Aids	•	•	•	•	•
FLUID/GASES REPLACEMENT/TRANSFER					
• Solid Cryogenic Methane and Ammonia		•			
Solid Cryogenic Neon, Nitrogen and Liquid Helium		•			
Solid Cryogenic Neon/Ammonia		•			
Solid Cryogenic Hydrogen		•			
Solid Cryogenic Ammonia/Carbon Dioxide		•			
• Fluids Xenon, Propane, Carbon Dioxide and Argon			•		
• Hypergolic Propellant				•	
ORBITAL STORAGE					
• Passive Stabilization	•	•	•		
• Thermal Protection	•	•			

APPENDIX B
LEVEL 1 ON-ORBIT OPERATIONS SCENARIOS

CONTENTS

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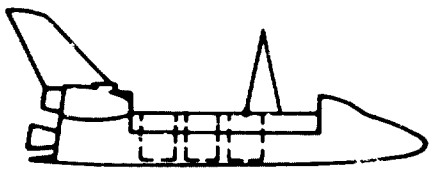
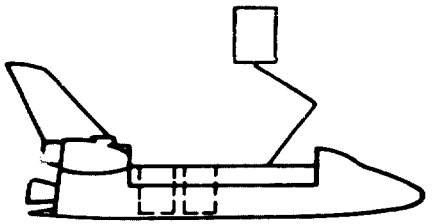
FOLDOUT FRAME

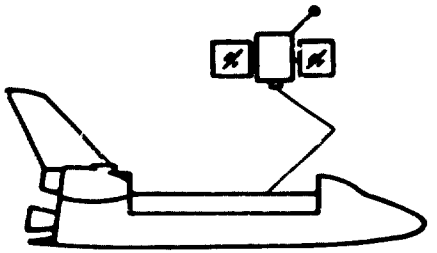
PAYLOAD DEPLOYMENT



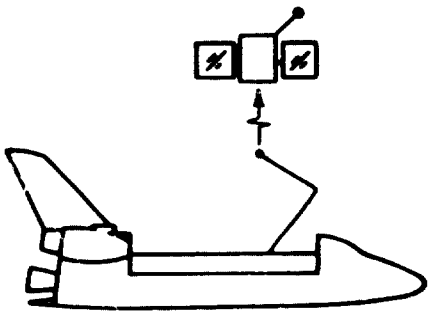
- Satellites stowed in retention structures
- Status/health checks via umbilical in retention structure (comm via orbiter S-Band)
- RMS attaches to satellite
- State vector transfer
- Transfer payload to internal power



- Retention system latches/umbilical released
- RMS elevates payload within view of AFD/payload bay TV cameras
- Activation of selected satellite subsystems via ground link (comm via satellite)

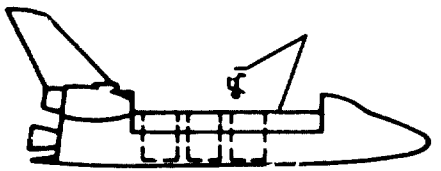


- Satellite appendages deployed by ground command and verified by orbiter crew
- Final status/health check prior to deployment (comm via satellite)



- RMS releases satellite in preferred attitude at ~ 1 ft/sec velocity
- Satellite activation of RCS at > 200 ft

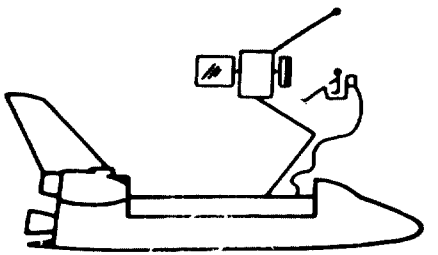
BACKUP FOR RETENTION LATCH HANGUP



- MFR/RMS deployed for manual release

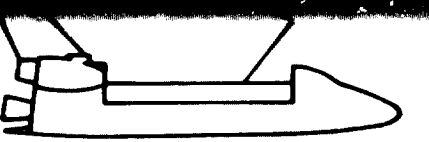
or

BACKUP FOR APPENDAGE HANGUP



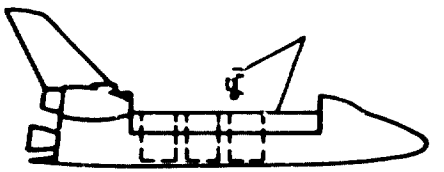
- MMU/WRU with stabilizer deployed for manual assist

- Satellite appendages deployed by ground command and verified by orbiter crew
- Final status/health check prior to deployment (comm via satellite)



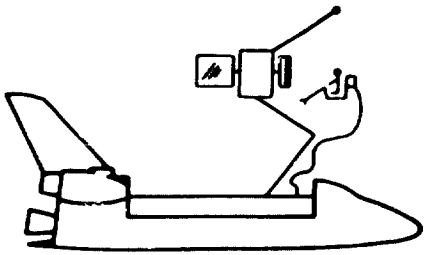
- RMS releases satellite in preferred attitude at ~ 1 ft/sec velocity
- Satellite activation of RCS at > 200 ft

BACKUP FOR RETENTION LATCH HANGUP



- MFR/RMS deployed for manual release
  or
  EVA via handrails employed
- Retention latches in closed position (unlocked) to enable RMS attachment

BACKUP FOR APPENDAGE HANGUP



- MMU/WRU with stabilizer deployed for manual assist

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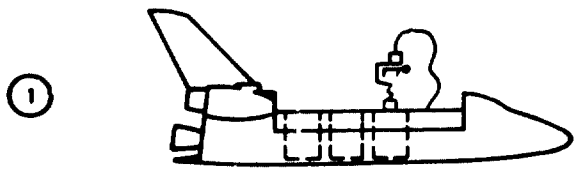
IRAD

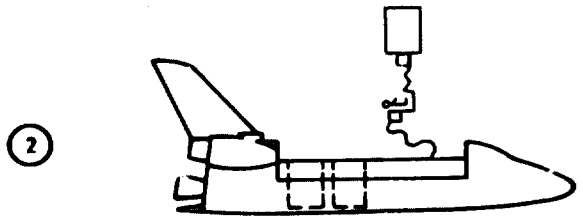
D1 Nominal Deployment Sequence – Direct Delivery Payload Class – Multiple Payloads -- RMS Usage

GRUMMAN

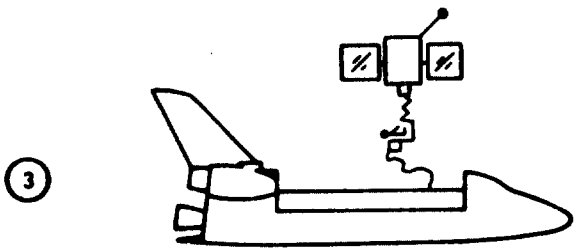
PAYLOAD DEPLOYMENT



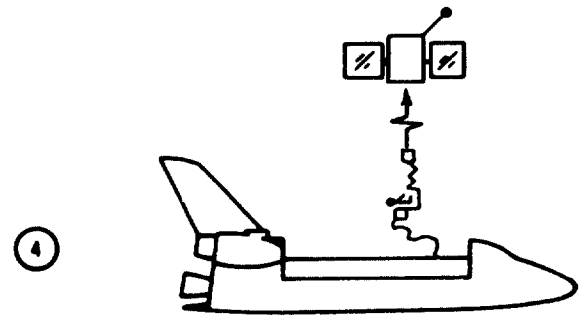
- Satellites stowed in retention structures
- Status/health checks via umbilical in retention structure (comm via orbiter S-Band)
- State vector transfer
- Transfer payload to internal power
- MMU/WRU with RMS end-effector attaches to satellite



- Retention system latches/umbilical released
- MMU/WRU translates satellite above payload bay within view of AFD/payload bay TV cameras
- Activation of satellite ACS/selected subsystems via ground link (comm via satellite)

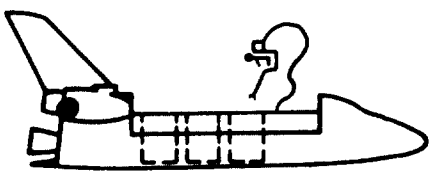


- MMU/WRU maintains stability/position of satellite
- Satellite appendages deployed by ground command and verified by orbiter crew
- Final status/health check prior to deployment (comm via satellite)



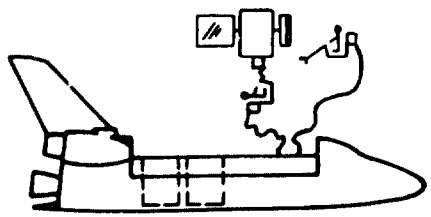
- MMU/WRU releases satellite in nominally-preferred attitude at ~ 1 ft/sec velocity
- Satellite activation of RCS at > 200 ft

BACKUP FOR RETENTION LATCH HANGUP



- MMU/WRU with stabilizer deployed for manual release
  or
  EVA via handrails employed

BACKUP FOR APPENDAGE HANGUP

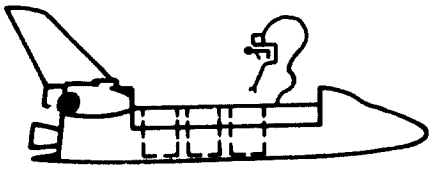


- First MMU/WRU maintains stability/position of satellite
- Second MMU/WRU with stabilizer deployed for manual assist

- MMU/WRU maintains stability/position of satellite
- Satellite appendages deployed by ground command and verified by orbiter crew
- Final status/health check prior to deployment (comm via satellite)

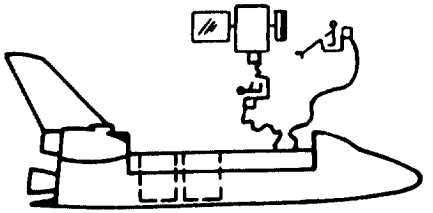
- MMU/WRU releases satellite in nominally-preferred attitude at ~ 1 ft/sec velocity
- Satellite activation of RCS at > 200 ft

BACKUP FOR RETENTION LATCH HANGUP



- MMU/WRU with stabilizer deployed for manual release
  or
  EVA via handrails employed

BACKUP FOR APPENDAGE HANGUP



- First MMU/WRU maintains stability/position of satellite
- Second MMU/WRU with stabilizer deployed for manual assist

FOLDOUT FRAME 2

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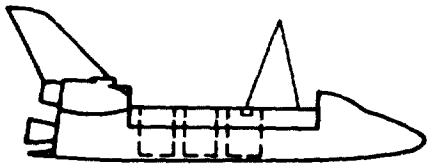
R81-0181-129(T)

IRAD

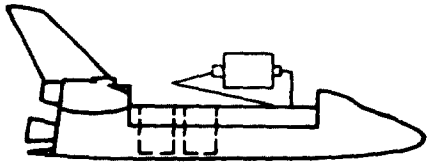
D2 RMS Inoperative Deployment Sequence – Direct Delivery Payload Class – Multiple Payloads

GRUMMAN

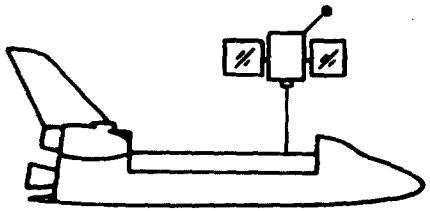
PAYLOAD DEPLOYMENT

① 

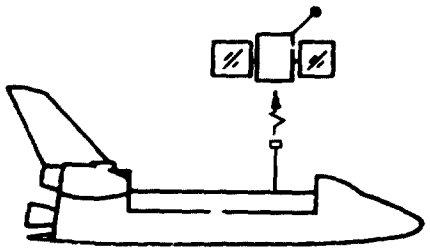
- Satellites stowed in retention structures
- Status/heaith checks via umbilical in retention structure (comm via orbiter S-Band)
- RMS attaches to satellite

② 

- Retention system latches/umbilical released
- RMS translates satellite and berths to HPA
- Activation of selected satellite subsystems via ground link (comm via satellite)

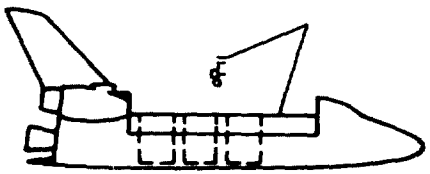
③ 

- Satellite appendages deployed by ground command and verified by orbiter crew
- State vector transfer
- Transfer payload to internal power
- Final status/health check prior to deployment (comm via satellite)

④ 

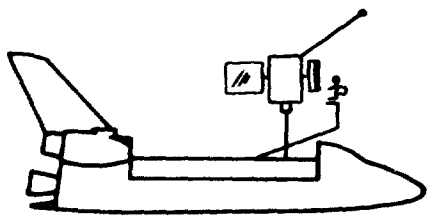
- HPA releases satellite in preferred attitude at ~ 1 ft/sec velocity
- Satellite activation of RCS at > 200 ft

BACKUP FOR RETENTION LATCH HANGUP



- MFR/RMS deployed for manual release
  or
  EVA via handrails employed
- Retention latches in closed position (unlocked) to enable RMS attachment

BACKUP FOR APPENDAGE HANGUP

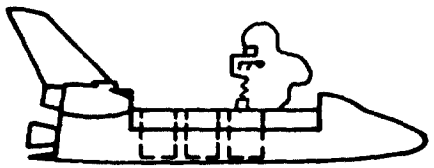


- MFR/RMS deployed for manual assist
  or
  Work station on HPA is utilized

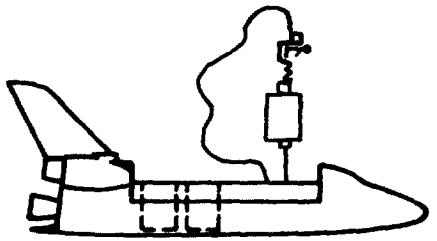
R81-0181-130(T)

D3 Alternate Deployment Sequence — Direct Delivery Payload Class — Multiple Payloads — RMS/HPA Usage

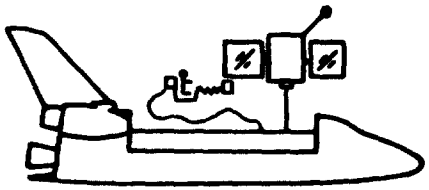
PAYLOAD DEPLOYMENT

① 

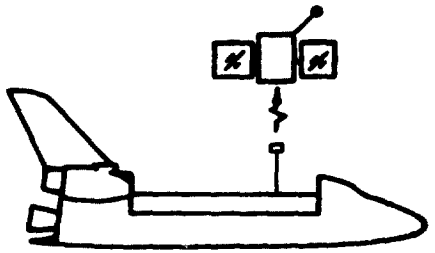
- Satellites stowed in retention structures
- Status/health checks via umbilical in retention structure (comm via orbiter S-Band)
- MMU/WRU with RMS end-effector attaches to satellite

② 

- Retention system latches/umbilical released
- MMU/WRU translates satellite and berths to HPA
- Activation of selected satellite subsystems via ground link (comm via satellite)

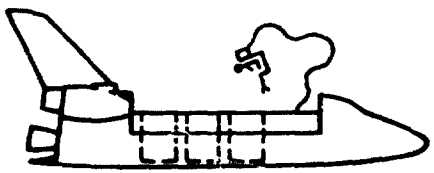
③ 

- Satellite appendages deployed by ground command and verified by orbiter crew
- State vector transfer
- Transfer payload to internal power
- Final status/health check prior to deployment (comm via satellite)

④ 

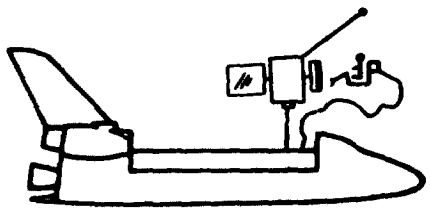
- HPA releases satellite in preferred attitude at ~ 1 ft/sec velocity
- Satellite activation of RCS at > 200 ft

BACKUP FOR RETENTION LATCH HANGUP



- MMU/WRU with stabilizer deployed for manual release
  or
  EVA via handrails employed

BACKUP FOR APPENDAGE HANGUP



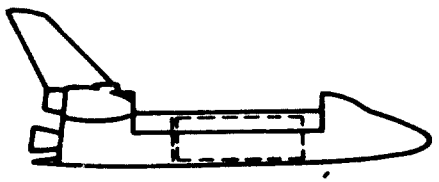
- MMU/WRU with stabilizer deployed for manual assist
  or
  Work station on HPA is utilized

R81-0181-131(T)
0181-020D

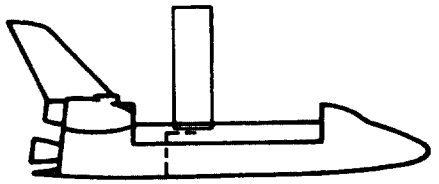
D4 RMS Inoperative Deployment Sequence — Direct Delivery Payload Class — Multiple Payloads — HPA Usage

IRAD

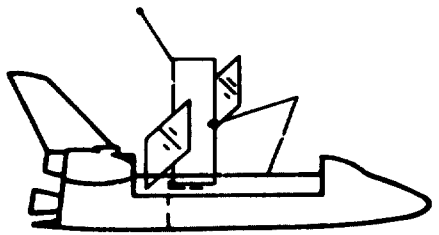
PAYLOAD DEPLOYMENT

① 

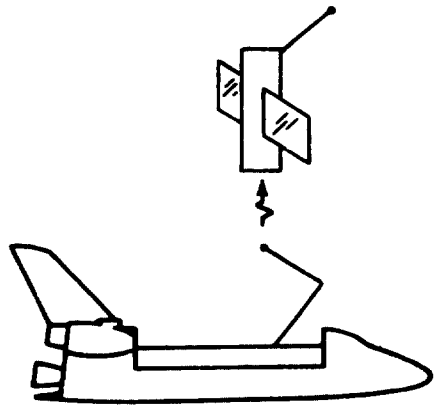
- Satellite stowed in cargo bay
- Status/health checks via umbilical in tilt table (comm via orbiter S-Band)

② 

- Retention latches released
- Satellite rotated out of payload bay via tilt table
- Activation of selected satellite subsystems via ground link (comm via satellite)

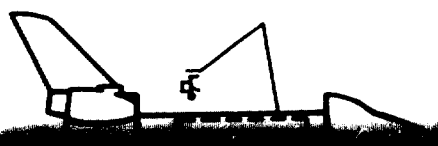
③ 

- Satellite appendages deployed by ground command and verified by orbiter crew
- State vector transfer
- Transfer payload to internal power
- Final status/health check prior to deployment (comm via satellite)
- RMS attaches to satellite
- Satellite released from tilt table/umbilical

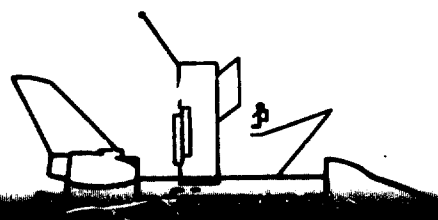
④ 

- RMS releases satellite in preferred attitude at ~ 1 ft/sec velocity
- Satellite activation of RCS at > 200 ft

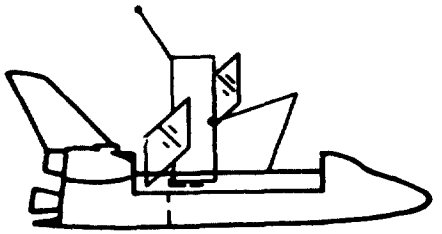
BACKUP FOR RETENTION LATCH HANGUP



BACKUP FOR APPENDAGE HANGUP

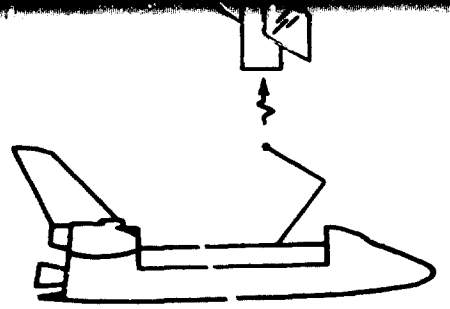


③



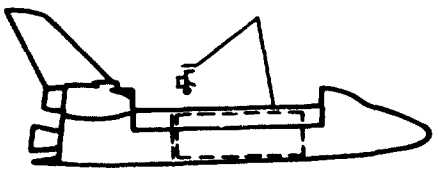
- Satellite appendages deployed by ground command and verified by orbiter crew
- State vector transfer
- Transfer payload to internal power
- Final status/health check prior to deployment (comm via satellite)
- RMS attaches to satellite
- Satellite released from tilt table/umbilical

④



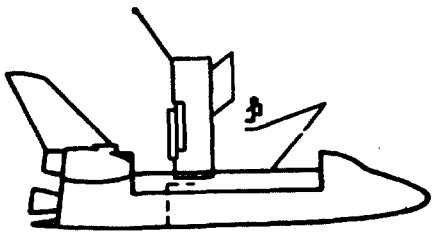
- RMS releases satellite in preferred attitude at ~ 1 ft/sec velocity
- Satellite activation of RCS at > 200 ft

BACKUP FOR RETENTION LATCH HANGUP



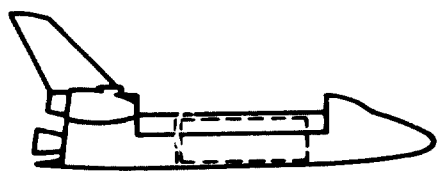
- MFR/RMS deployed for manual release
  or
  EVA via handrails employed

BACKUP FOR APPENDAGE HANGUP

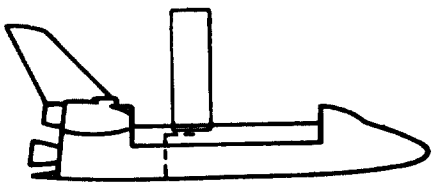


- MFR/RMS deployed for manual assist
  or
  Work Station on tilt table is utilized

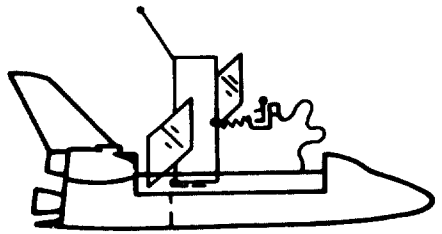
PAYLOAD DEPLOYMENT



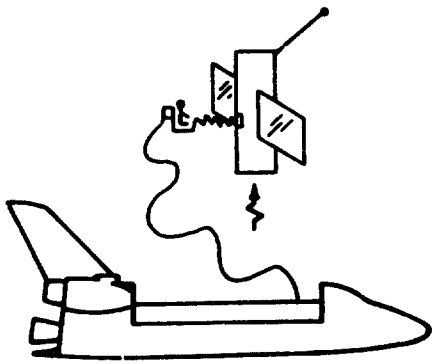
- Satellite stowed in cargo bay
- Status/health checks via umbilical in tilt table (comm via orbiter S-Band)



- Retention latches released
- Satellite rotated out of payload bay via tilt table
- Activation of selected satellite subsystems via ground link (comm via satellite)

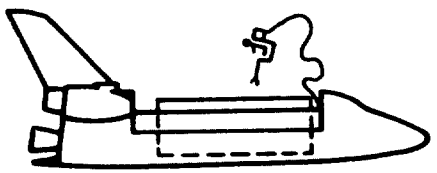


- Satellite appendages deployed by ground command and verified by orbiter crew
- State vector transfer
- Transfer payload to internal power
- Final status/health check prior to deployment (comm via satellite)
- MMU/WRU with RMS end effector attaches to satellite
- Satellite released from tilt table/umbilical

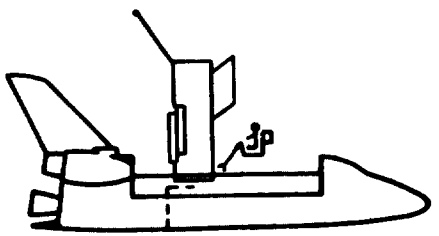


- MMU/WRU releases satellite in preferred attitude at ~ 1 ft/sec velocity
- Satellite activation of RCS at > 200 ft

BACKUP FOR RETENTION LATCH HANGUP



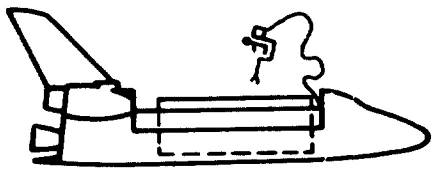
BACKUP FOR APPENDAGE HANGUP



- Satellite appendages deployed by ground command and verified by orbiter crew
- State vector transfer
- Transfer payload to internal power
- Final status/health check prior to deployment (comm via satellite)
- MMU/WRU with RMS end effector attaches to satellite
- Satellite released from tilt table/umbilical

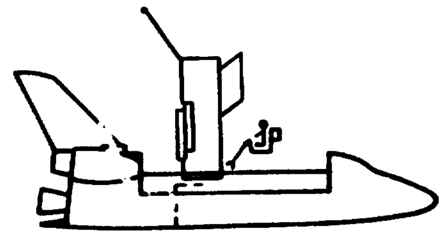
- MMU/WRU releases satellite in preferred attitude at ~ 1 ft/sec velocity
- Satellite activation of RCS at > 200 ft

BACKUP FOR RETENTION LATCH HANGUP



- MMU/WRU with stabilizer deployed for manual release
  or
  EVA via handrails employed

BACKUP FOR APPENDAGE HANGUP



- MMU/WRU with stabilizer deployed for manual release
  or
  Work Station on tilt table is utilized

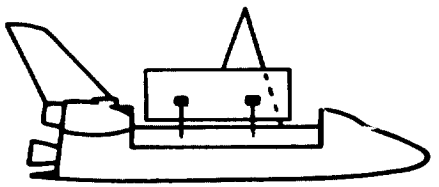
0181-022D
R81-0181-133(T)

IRAD

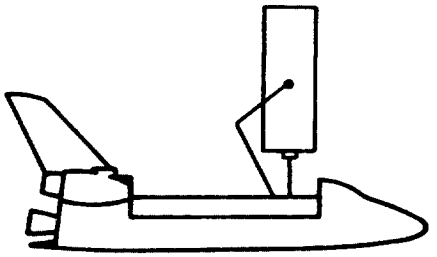
D6 RMS Inoperative Deployment Sequence – Direct Delivery Payload Class – Large Payloads – Tilt Table Usage

GRUMMAN

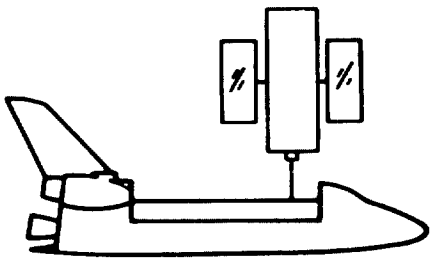
PAYLOAD DEPLOYMENT

① 

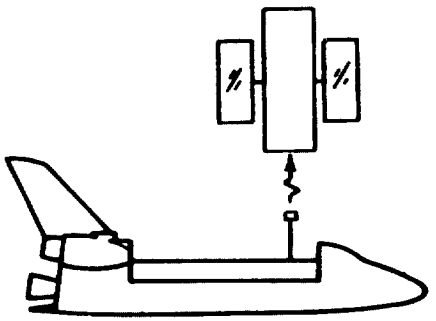
- Satellite stowed in retention structure
- Status/health checks via umbilical in retention structure (comm via orbiter S-Band)
- Retention system latches/umbilical released
- PIDA elevates satellite above payload bay
- RMS attaches to satellite

② 

- PIDA releases satellite
- RMS translates satellite & berths to HPA
- Activation of selected satellite subsystem via ground link (comm via satellite)

③ 

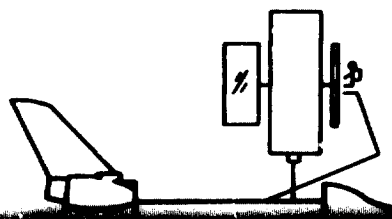
- Satellite appendages deployed by ground command & verified by orbiter crew
- State vector transfer
- Transfer payload to internal power
- Final status/health check prior to deployment (comm via satellite)

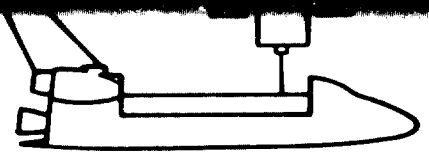
④ 

- HPA releases satellite in preferred attitude at ~ 1 ft/sec velocity
- Satellite activation of RCS at > 200 ft

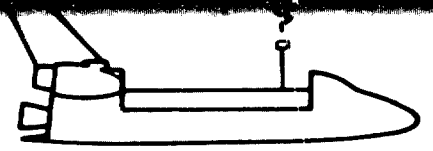
BACKUP FOR RETENTION LATCH HANGUP

BACKUP FOR APPENDAGE HANGUP



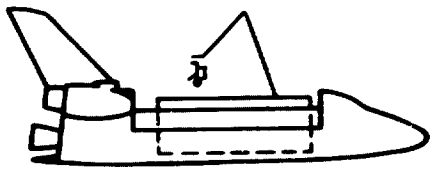


- Satellite appendages deployed by ground command & verified by orbiter crew
- State vector transfer
- Transfer payload to internal power
- Final status/health check prior to deployment (comm via satellite)



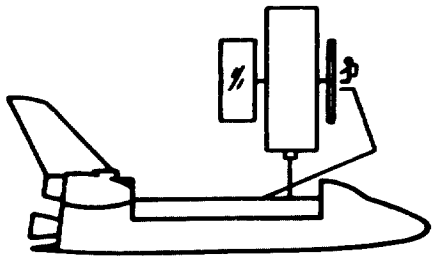
- HPA releases satellite in preferred attitude at ~ 1 ft/sec velocity
- Satellite activation of RCS at > 200 ft

BACKUP FOR RETENTION LATCH HANGUP



- MFR/RMS deployed for manual release
  or
  EVA via handrails employed
- Retention latches in closed position but unlocked to retain satellite

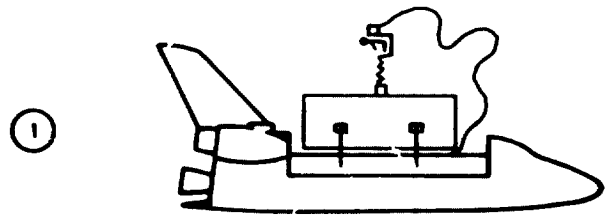
BACKUP FOR APPENDAGE HANGUP



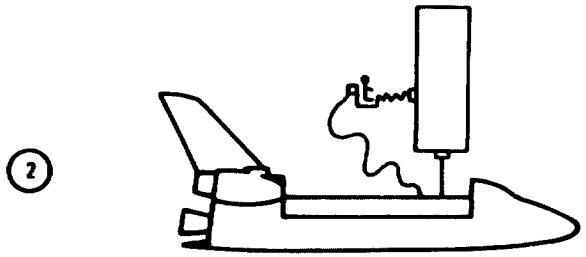
- MFR/RMS deployed for manual assist
  or
  Work station on HFA is utilized

D7 Alternate Deployment Sequence – Direct Delivery Payload Class – Large Payloads –RMS/HPA Usage

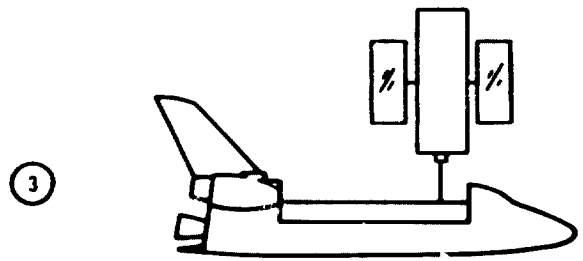
PAYLOAD DEPLOYMENT



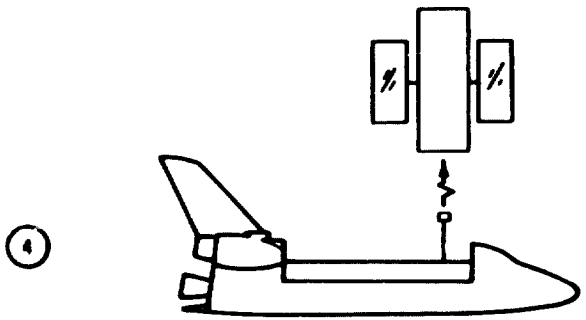
- Satellite stowed in retention structure
- Status/health check via umbilical in retention structure (comm via orbiter S-Band)
- Retention system latches/umbilical released
- PIDA elevates satellite above payload bay
- MMU/WRU with RMS end effector attaches to satellite



- PIDA releases satellite
- MMU/WRU translates satellite and berths to HPA
- Activation of selected satellite subsystems via ground link (comm via satellite)



- Satellite appendages deployed by ground command & verified by orbiter crew
- State vector transfer
- Transfer payload to internal power
- Final health/status check prior to deployment (comm via satellite)



- HPA releases satellite in preferred attitude at ~ 1 ft/sec velocity
- Satellite activation of RCS at > 200 ft

BACKUP FOR RETENTION LATCH HANGUP

BACKUP FOR APPENDAGE HANGUP

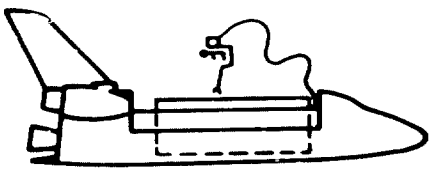
③

- Satellite appendages deployed by ground command & verified by orbiter crew
- State vector transfer
- Transfer payload to internal power
- Final health/status check prior to deployment (comm via satellite)

④

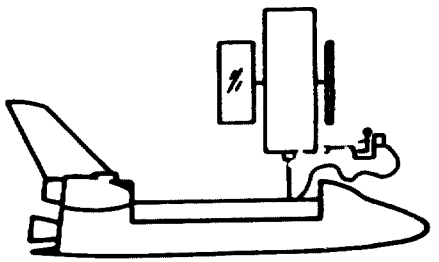
- HPA releases satellite in preferred attitude at ~ 1 ft/sec velocity
- Satellite activation of RCS at > 200 ft

BACKUP FOR RETENTION LATCH HANGUP



- MMU/WRU with stabilizer deployed for manual release
  or
  EVA via handrails employed

BACKUP FOR APPENDAGE HANGUP



- MMU/WRU with stabilizer deployed for manual assist
  or
  Work station on HPA is utilized

FOLDOUT FRAME 2

0181-024D
R81-0181-135(T)

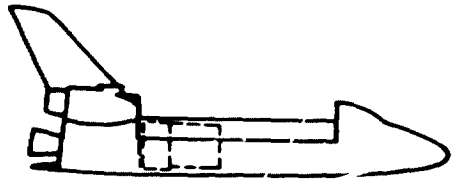
IRAD

D8 RMS Inoperative Deployment Sequence – Direct Delivery Payload Class – Large Payloads – HPA Usage

GRUMMAN

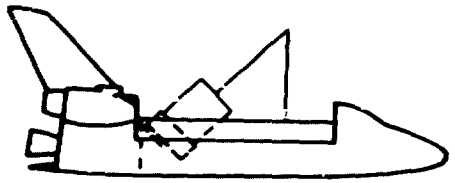
PAYLOAD DEPLOYMENT

1



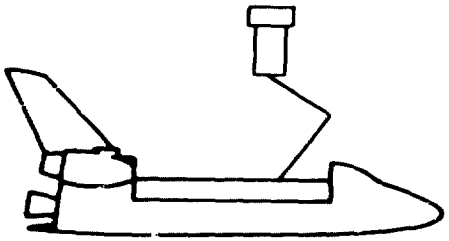
- Satellite/VSS stowed in retention structure
- Status/health checks via umbilical in retention structure (comm via orbiter S-Band)

2



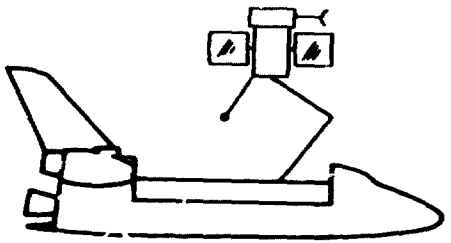
- Retention system latches released
- Payload rotated via tilt table
- RMS attaches to payload
- State vector transfer

3



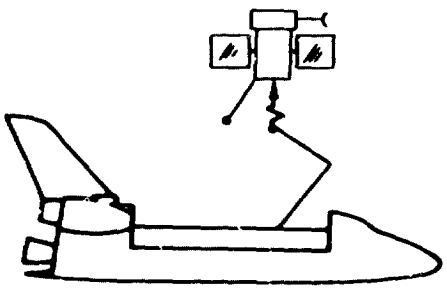
- Transfer payload to internal power
- Payload released from tilt table/umbilical
- Satellite/VSS elevated within view of AFD/payload by TV cameras
- Activation of selected subsystems of satellite/VSS via ground link (comm via satellite/propulsion stage)

4



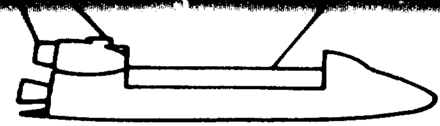
- Satellite/VSS appendages deployed by ground command and verified by orbiter crew
- Final status/health check prior to deployment (comm via satellite/VSS)

5



- RMS releases payload at ~ 1 ft/sec velocity

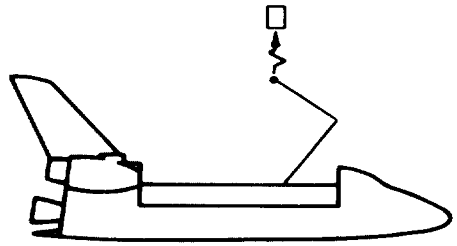
5



- RMS releases payload at ~ 1 ft/sec velocity
- VSS activation of RCS at > 200 ft separation

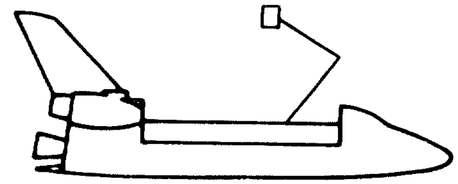
MTV DEPLOYMENT

6



- MTV deployed to view VSS firing
- VSS activates propulsion system at > 2700 ft separation

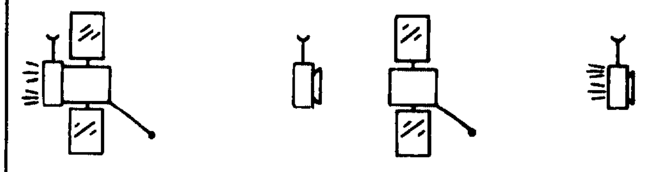
7



- Orbiter/MTV rendezvous
- MTV retrieved by RMS and stowed in payload bay

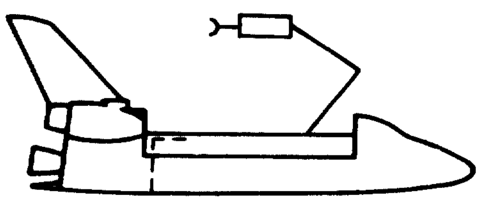
8

VSS delivers satellite to operational orbit
and
Returns to orbiter



VSS RETRIEVAL

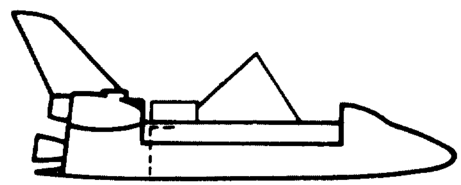
9



- Orbiter/VSS rendezvous (VSS active)
- VSS ACS active (RCS disabled, propellent vented)
- RMS attaches to VSS

BACKUP FOR RETENTION LATCH HANGUP

10

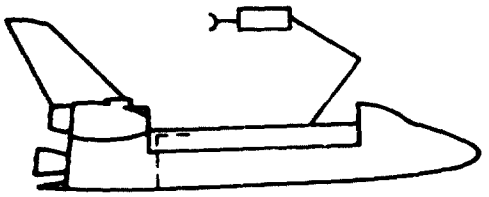


- VSS berthed to tilt table
- VSS inactivated
- VSS rotated to stowed position
- Retention latches locked

BACKUP FOR APPENDAGE HANGUP

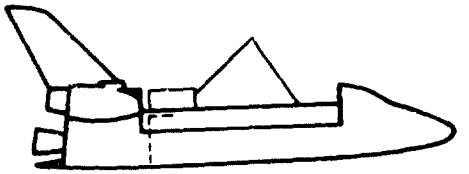
FOLDOUT FRAME 2

(9)



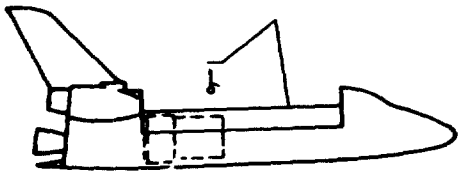
- Orbiter/VSS rendezvous (VSS active)
- VSS ACS active (RCS disabled, propellent vented)
- RMS attaches to VSS

(10)



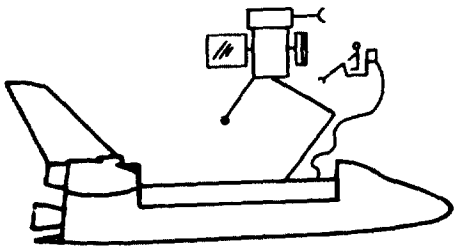
- VSS berthed to tilt table
- VSS inactivated
- VSS rotated to stowed position
- Retention latches locked

BACKUP FOR RETENTION LATCH HANGUP



- MFR/RMS deployed for manual release
  or
  EVA via handrails employed
- Retention latches in closed position (unlocked) to enable RMS attachment

BACKUP FOR APPENDAGE HANGUP



- MMU/WRU with stabilizer deployed for manual assist

0181-025D
1472-016(T)

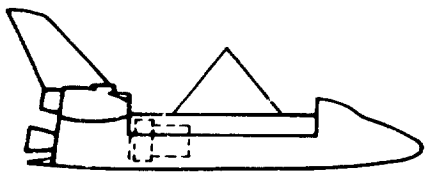
IRAD

D9 Nominal Deployment Sequence — LEO/Propulsion Payload Class — Versatile Service Stage — RMS/Tilt Table Usage — Stage/Satellite Mated on Ground

GRUMMAN

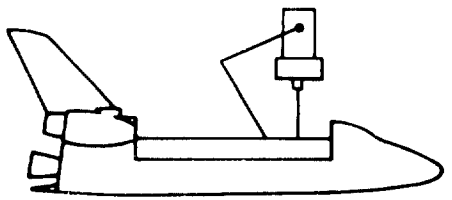
PAYLOAD DEPLOYMENT

1



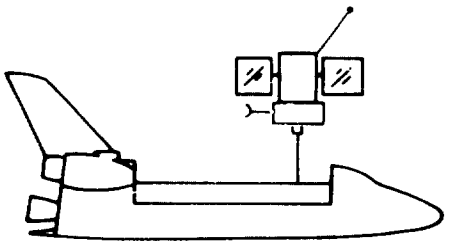
- Satellite/VSS stowed in retention structure
- Status/health checks via umbilical in retention structure (comm via orbiter S-Band)
- RMS attaches to payload

2



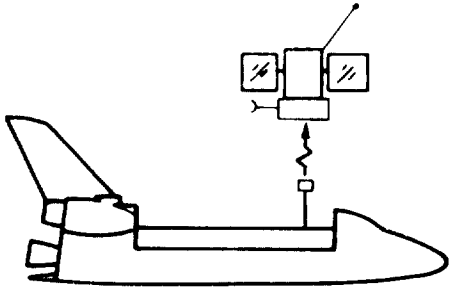
- Retention latches/umbilical released
- RMS translates payload and berths to HPA/umbilicals
- Activation of selected subsystems via ground link (comm via satellite/VSS)

3



- Satellite/VSS appendages deployed by ground command, and verified by orbiter crew
- State vector transfer
- Transfer payload to internal power
- Final status/health check prior to deployment (comm via satellite/VSS)

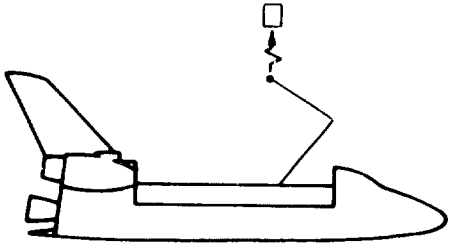
4



- HPA releases payload at ~ 1 ft/sec velocity
- VSS activation of RCS at > 200 ft separation

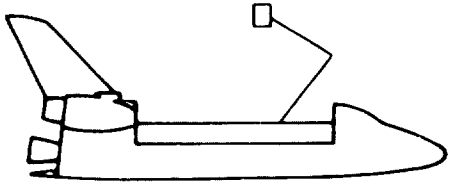
MTV DEPLOYMENT

5

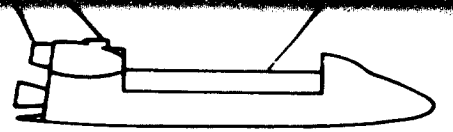


- MTV deployed to view VSS firing
- VSS activates propulsion system at > 2700 ft separation

6



- Orbiter/MTV rendezvous
- MTV retrieved by RMS and stowed in



- MTV deployed to view VSS firing
- VSS activates propulsion system at > 2700 ft separation

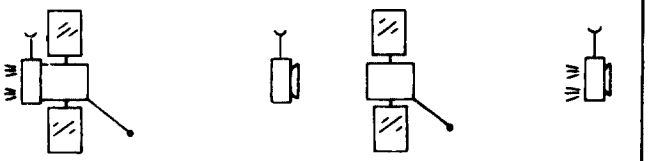
6

- Orbiter/MTV rendezvous
- MTV retrieved by RMS and stowed in payload bay

FOLDOUT FRAME 2

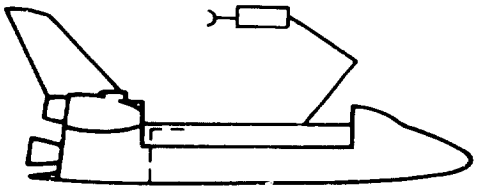
7

VSS delivers satellite to operational orbit
and
Returns to orbiter



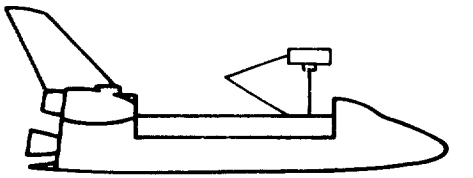
VSS RETRIEVAL

8



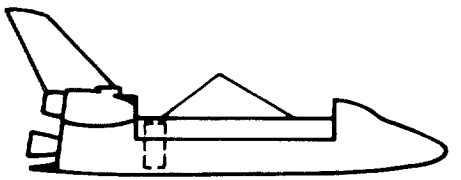
- Orbiter/VSS rendezvous (VSS active)
- VSS ACS active (RCS disabled, propellant vented)
- RMS attaches to VSS

9



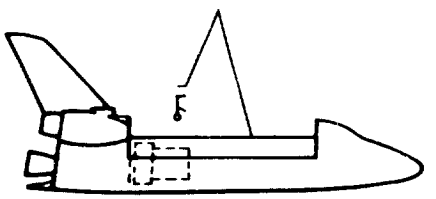
- VSS berthed to HPA
- VSS inactivated/checked out for return

10

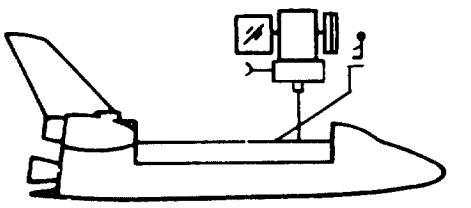


- RMS transfers VSS to retention structure
- Retention latches locked

BACKUP FOR RETENTION LATCH HANGUP



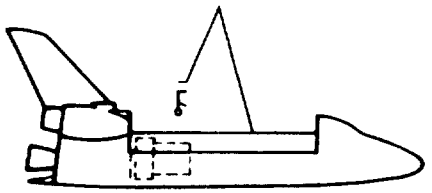
BACKUP FOR APPENDAGE HANGUP



ORIGINAL PAGE IS
OF POOR QUALITY

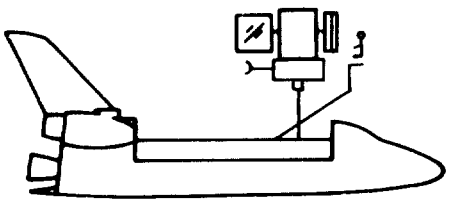
- RMS transfers VSS to retention structure
- Retention latches locked

BACKUP FOR RETENTION LATCH HANGUP



- MFR/RMS deployed for manual release
  or
  EVA via handrails employed
- Retention latches in closed position (unlocked) to enable RMS attachment

BACKUP FOR APPENDAGE HANGUP



- MFR/RMS deployed for manual assist
  or
  Work station on HPA is utilized

0818-026D
R81-0181-137(T)

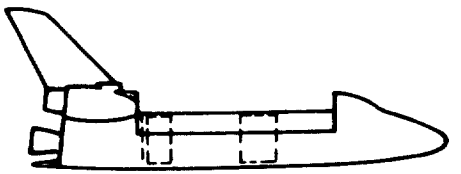
IRAD

D10 Alternate Deployment Sequence – LEO/Propulsion Payload Class – Versatile Service Stage – RMS/HPA Usage – Stage/Satellite Mated on Ground

GRUMMAN

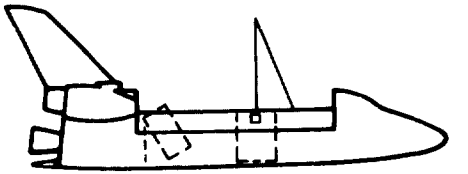
PAYLOAD DEPLOYMENT

1



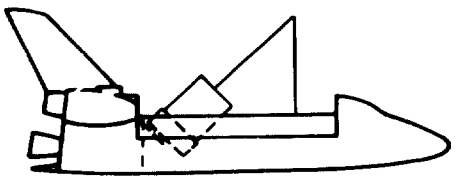
- Satellite and VSS stowed in retention structure
- Status/health checks via umbilical in retention structures (comm via orbiter S-Band)

2



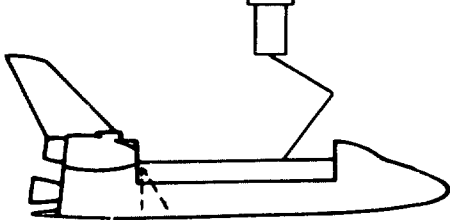
- VSS retention latches released
- VSS rotated to satellite mating position via tilt table
- RMS attaches to satellite
- Satellite retention latches/umbilical released

3



- Satellite mated to VSS
- Satellite status/health check via mating VSS umbilical
- State vector transfer
- Transfer payload to internal power

4

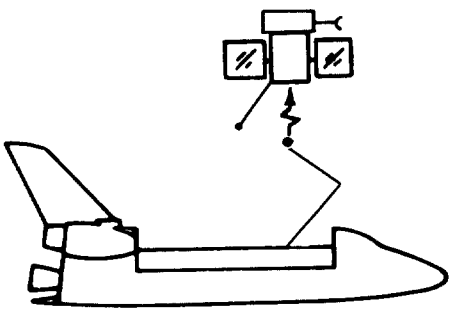


- VSS released from tilt table/umbilical
- Satellite/VSS elevated within view of AFD/payload bay TV cameras
- Activation of selected subsystems of satellite/VSS via ground link (comm via satellite/VSS)

5

- Satellite/VSS appendages deployed by ground command and verified by orbiter crew
- Final status/health check prior to deployment (comm via satellite/stage)

6



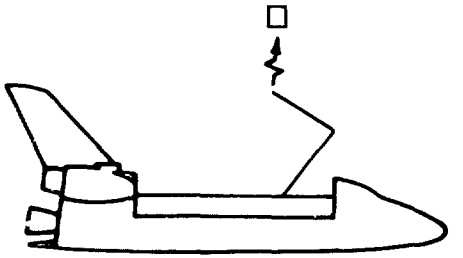
- RMS releases payload at ~ 1 ft/sec velocity
- VSS activation of RCS at > 200 ft separation

- Satellite/VSS appendages deployed by ground command and verified by orbiter crew
- Final status/health check prior to deployment (comm via satellite/stage)

- RMS releases payload at ~ 1 ft/sec velocity
- VSS activation of RCS at > 200 ft separation

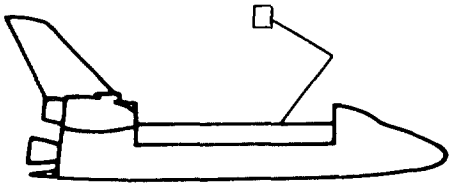
MTV DEPLOYMENT

(7)



- MTV deployed to view stage firing
- VSS activates propulsion system at > 2700 ft separation

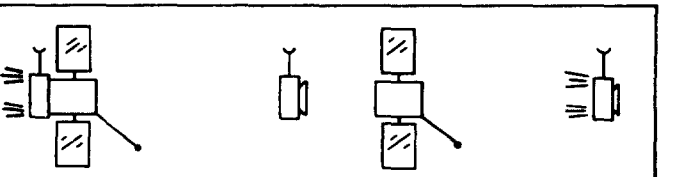
(8)



- Orbiter/MTV rendezvous
- MTV retrieved by RMS and stowed in payload bay

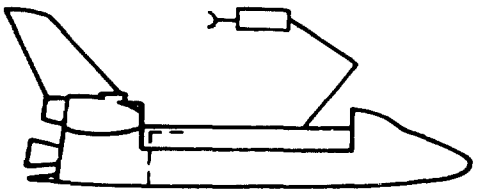
(9)

VSS delivers satellite to operational orbit
and
Returns to orbiter



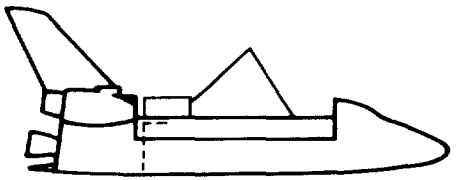
VSS RETRIEVAL

(10)



- Orbiter/VSS rendezvous (VSS active)
- VSS ACS active (RCS disabled, propellents vented)
- RMS attaches to VSS

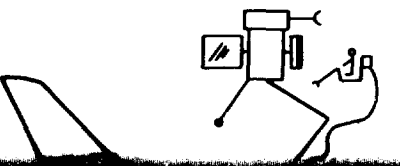
(11)



- VSS berthed to tilt table
- VSS inactivated/checked out for return
- VSS rotated to stowed position
- Retention latches locked

BACKUP FOR RETENTION LATCH HANGUP

BACKUP FOR APPENDAGE HANGUP



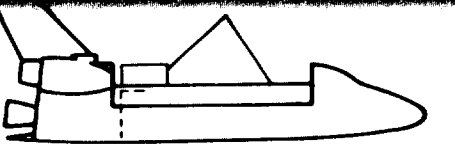
FOLDOUT FRAME 2

ORIGINAL PAGE IS
OF POOR QUALITY

(10)

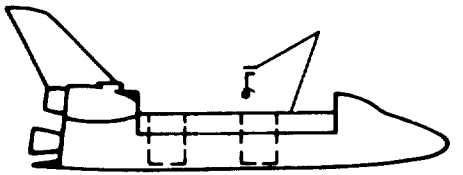
- Orbiter/VSS rendezvous (VSS active)
- VSS ACS active (RCS disabled, propellents vented)
- RMS attaches to VSS

(11)



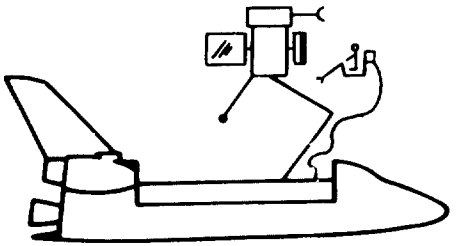
- VSS berthed to tilt table
- VSS inactivated/checked out for return
- VSS rotated to stowed position
- Retention latches locked

BACKUP FOR RETENTION LATCH HANGUP



- MFR/RMS deployed for manual release
  or
  EVA via handrails employed
- Retention latches in closed position (unlocked) to enable RMS attachment

BACKUP FOR APPENDAGE HANGUP

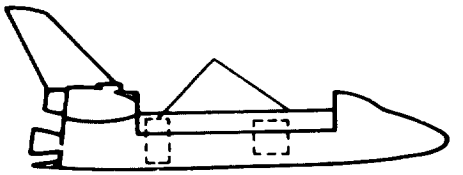


- MMU/WRU with stabilizer deployed for manual assist

D11 Nominal Deployment Sequence – LEO/Propulsion Payload Class – Versatile Service Stage – RMS/Tilt Table Usage – Stage/Satellite Mated On-Orbit

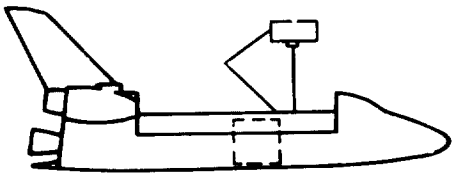
PAYLOAD DEPLOYMENT

1



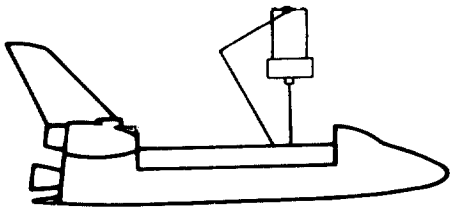
- Satellite and VSS stowed in retention structures
- Status/health checks via umbilical in retention structure (comm via orbiter S-Band)
- RMS attaches to VSS

2



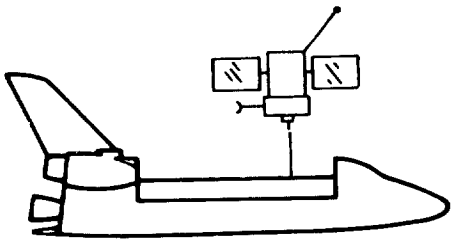
- VSS retention latches/umbilical released
- RMS translates VSS and berths to HPA/umbilicals, umbilical connections verified

3



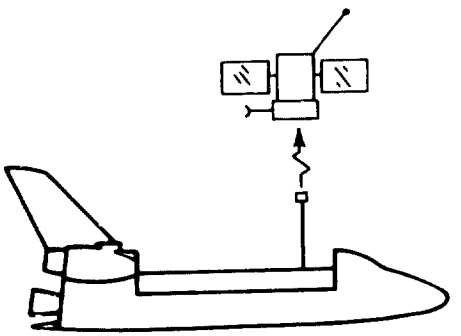
- RMS attaches to satellite
- Satellite retention latches/umbilical released
- RMS translates satellite and mates to VSS
- Activation of selected subsystems of satellite/VSS via ground link (comm via satellite/VSS)

4



- Satellite/VSS appendages deployed by ground command and verified by orbiter crew
- State vector transfer
- Transfer payload to internal power
- Final status/health check prior to deployment (comm via satellite/VSS)

5

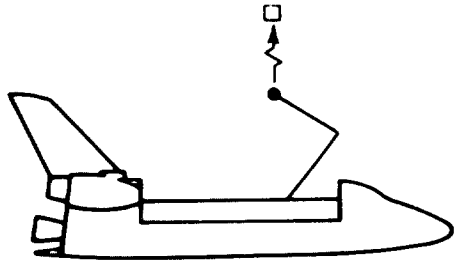


- HPA releases payload at ~ 1 ft/sec velocity
- VSS activation of RCS at > 200 ft separation

- HPA releases payload at ~ 1 ft/sec velocity
- VSS activation of RCS at > 200 ft separation

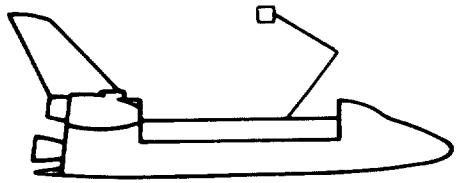
MTV DEPLOYMENT

6



- MTV deployed to view stage firing
- VSS activates propulsion system at > 2700 ft separation

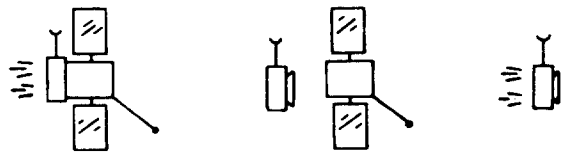
7



- Orbiter/MTV rendezvous
- MTV retrieved by RMS and stowed in payload bay

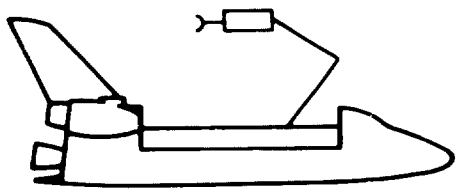
8

VSS delivers satellite to operational orbit
and
Returns to orbiter



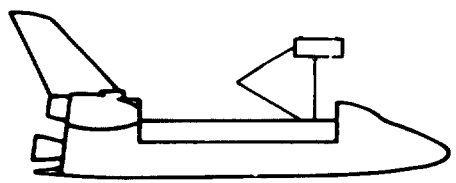
VSS RETRIEVAL

9



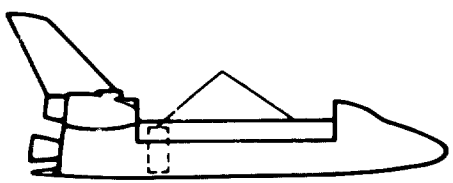
- Orbiter/VSS rendezvous (VSS active)
- VSS ACS active (RCS disabled, propellents vented)
- RMS attaches to VSS

10



- VSS berthed to HPA
- VSS inactivated/checked out for return

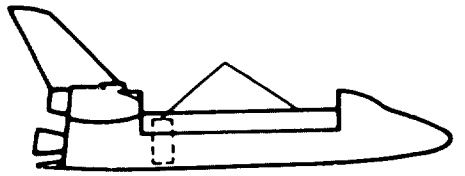
11



- RMS transfers VSS to retention structure
- Retention latches locked

- Orbiter/VSS rendezvous (VSS active)
- VSS ACS active (RCS disabled, propellents vented)
- RMS attaches to VSS

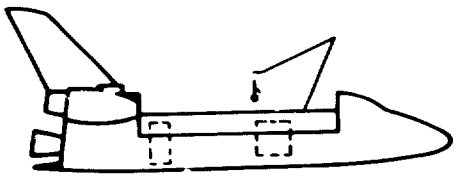
(11)



- RMS transfers VSS to retention structure
- Retention latches locked

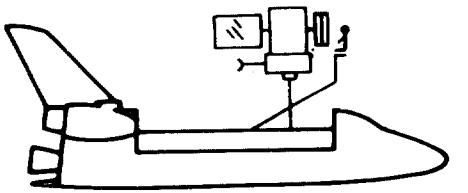
- VSS berthed to HPA
- VSS inactivated/checked out for return

BACKUP FOR RETENTION LATCH HANGUP



- MFR/RMS deployed for manual release
  or
  EVA via handrails employed
- Retention latches in closed position (unlocked) to enable RMS attachment

BACKUP FOR APPENDAGE HANGUP



- MFR/RMS deployed for manual assist
  and/or
  Work station on HPA is utilized

0181-028D
1472-018(T)

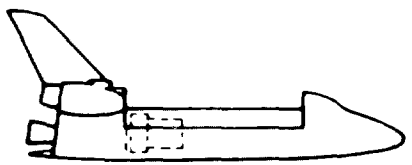
D12 Alternate Deployment Sequence – LEO/Propulsion Payload Class – Versatile Service Stage – RMS/HPA Usage – Stage/Satellite Mated On-Orbit

IRAD

GRUMMAN

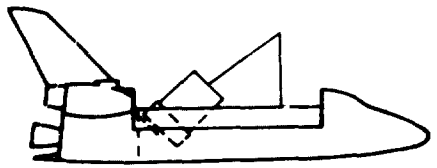
PAYLOAD DEPLOYMENT

1



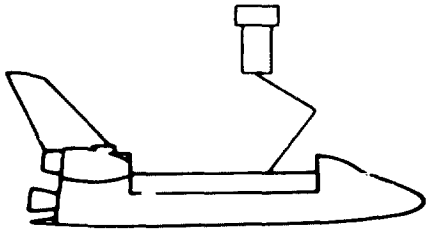
- Satellite/propulsion stage stowed in retention structure
- Status/health checks via umbilical in retention structure (comm via orbiter S-Band)

2



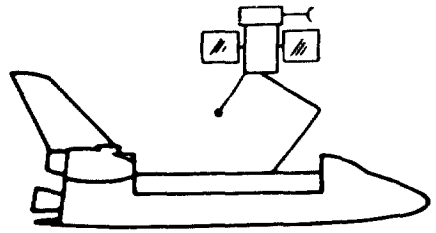
- Retention system latches released
- Payload rotated via tilt table
- RMS attaches to payload
- State vector transfer

3



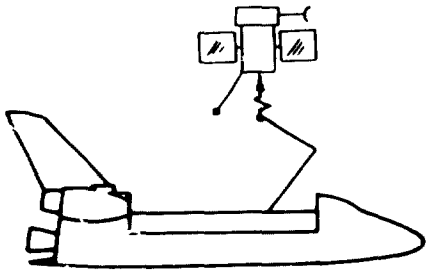
- Transfer payload to internal power
- Payload released from tilt table/umbilical
- Satellite/propulsion stage elevated within view of AFD/payload bay TV cameras
- Activation of selected subsystems of satellite/ propulsion stage via ground link (comm via satellite/propulsion stage)

4



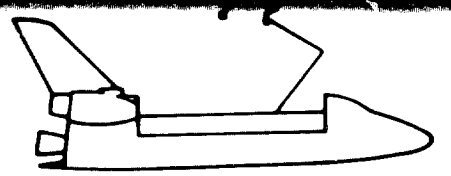
- Satellite/stage appendages deployed by ground command and verified by orbiter crew
- Final status/health check prior to deployment (comm via satellite/stage)

5



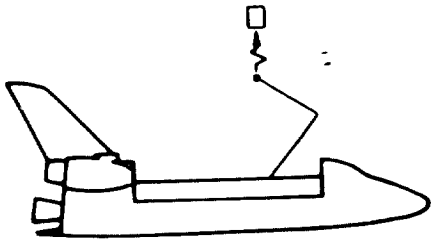
- RMS releases payload at ~ 1 ft/sec velocity
- Stage activation of RCS at > 200 ft separation

MTV DEPLOYMENT

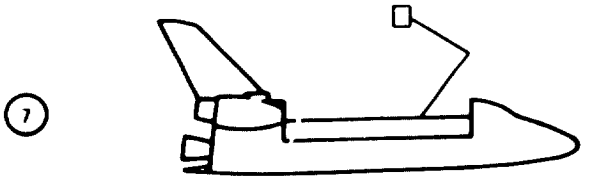


- RMS releases payload at ~ 1 ft/sec velocity
- Stage activation of RCS at > 200 ft separation

MTV DEPLOYMENT

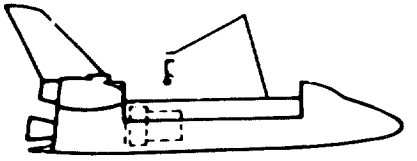


- MTV deployed to view stage firing
- Propulsion stage activates propulsion system at > 2700 ft separation



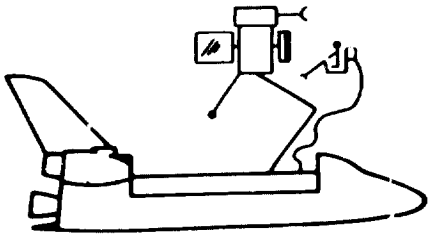
- Orbiter/MTV rendezvous
- MTV retrieved by RMS and stowed in payload bay

BACKUP FOR RETENTION LATCH HANGUP



- MFR/RMS deployed for manual release
  or
  EVA via handrails employed
- Retention latches in closed position (unlocked) to enable RMS attachment

BACKUP FOR APPENDAGE HANGUP



- MMU/WRU with stabilizer deployed for manual assist

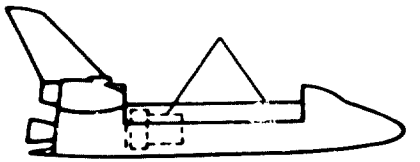
R81-0181-140(T)
0181-029D

D13 Nominal Deployment Sequence – LEO/Propulsion Payload Class – Integral Propulsion – RMS/Tilt Table Usage

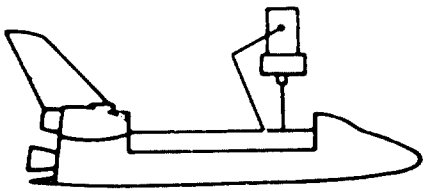
IRAD

GRUMMAN

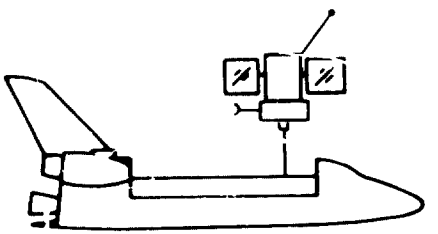
PAYLOAD DEPLOYMENT



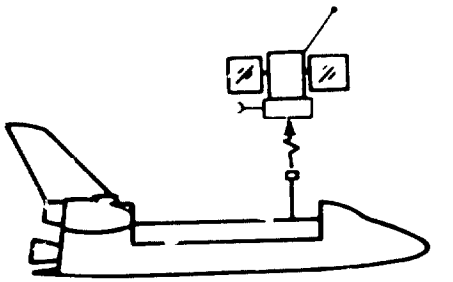
- Satellite/propulsion stage stowed in retention structure
- Status/health checks via umbilical in retention structure (comm via orbiter S-Band)
- RMS attaches to payload



- Retention latches/umbilical released
- RMS translates payload and berths to HPA/ umbilicals
- Activation of selected subsystems via ground link (comm via satellite/propulsion stage)

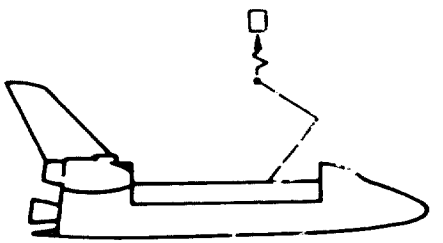


- Satellite/stage appendages deployed by ground command, and verified by orbiter crew
- State vector transfer
- Transfer payload to internal power
- Final status/health check prior to deployment (comm via satellite/stage)

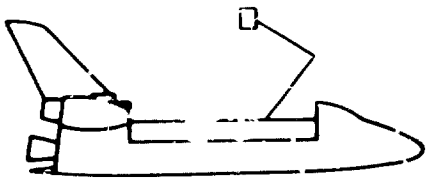


- HPA releases payload at ~ 1 ft/sec velocity
- Stage activation of RCS at > 200 ft separation

MTV DEPLOYMENT



- MTV deployed to view stage firing
- Propulsion stage activates propulsion system at > 2700



- Orbiter/MTV rendezvous
- MTV retrieved by RMS and stowed in payload bay

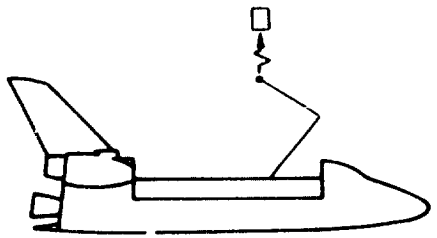
command, and verified by orbiter crew

- State vector transfer
- Transfer payload to internal power
- Final status/health check prior to deployment (comm via satellite/stage)

- Stage activation of RCS at > 200 ft separation

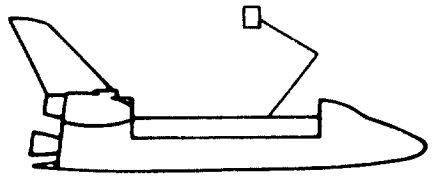
MTV DEPLOYMENT

(5)



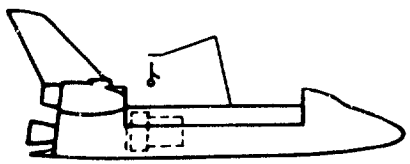
- MTV deployed to view stage firing
- Propulsion stage activates propulsion system at > 2700 ft separation

(6)



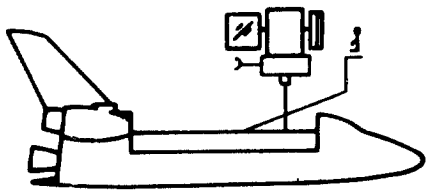
- Orbiter/MTV rendezvous
- MTV retrieved by RMS and stowed in payload bay

BACKUP FOR RETENTION LATCH HANGUP



- MFR/RMS deployed for manual release
  or
  EVA via handrails employed
- Retention latches in closed position (unlocked) to enable RMS attachment

BACKUP FOR APPENDAGE HANGUP



- MFR/RMS deployed for manual assist
  and/or
  Work station on HPA is utilized

FOLDOUT FRAME 2

0181-030D
1472-019(T)

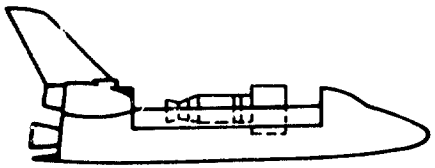
D14 Alternate Deployment Sequence — LEO/Propulsion Payload Class — Integral Propulsion — RMS/HPA Usage

IRAD

GRUMMAN

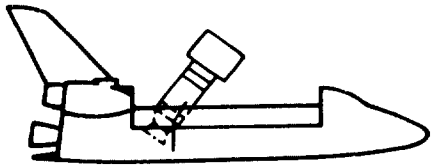
PAYLOAD DEPLOYMENT

1



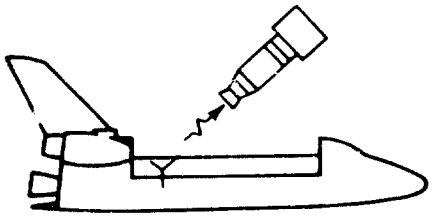
- Payload stowed in tilt table/retention structure
- Status/health checks via umbilical in tilt table/ retention structure (comm via orbiter S-Band)
- State vector transfer

2



- Tilt table elevates payload to deployment attitude
- Transfer payload to internal power
- Retention latches/umbilical released
- Activation of selected payload subsystems via ground link (comm via satellite/prop stage)

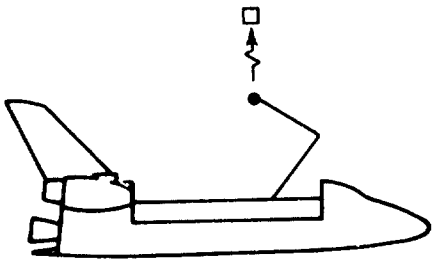
3



- Final status/health check prior to deployment (comm via payload)
- Tilt table/spring separation mechanism releases satellite ~ 2 ft/sec velocity
- IUS RCS activation at > 200 ft

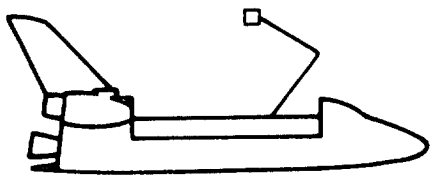
MTV DEPLOYMENT & ORBITER SEPARATION BURN

4



- MTV deployed to view IUS stage firing
- OMS separation burn to assure orbiter exit of hazard envelope. At ~ 80 nmi separation, orbiter assumes damage limit attitude

5

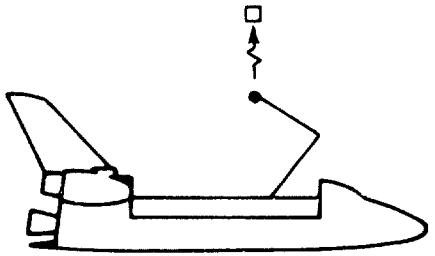


- Orbiter/MTV rendezvous
- MTV retrieved by RMS and stowed in payload bay

- Final status/health check prior to deployment (comm via payload)
- Tilt table/spring separation mechanism releases satellite ~ 2 ft/sec velocity
- IUS RCS activation at > 200 ft

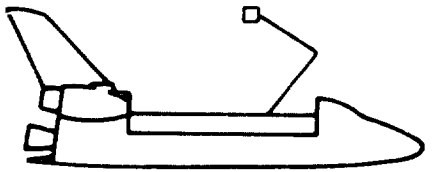
MTV DEPLOYMENT & ORBITER SEPARATION BURN

④



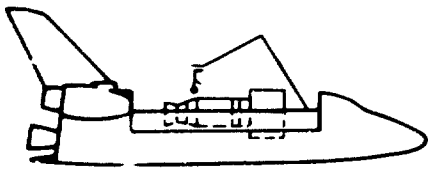
- MTV deployed to view IUS stage firing
- OMS separation burn to assure orbiter exit of hazard envelope. At ~ 80 nmi separation, orbiter assumes damage limit attitude
- IUS propulsion stage activated ~ 45 min after payload deployment

⑤



- Orbiter/MTV rendezvous
- MTV retrieved by RMS and stowed in payload bay

BACKUP FOR TILT TABLE HANGUP



- MFR/RMS deployed for manual release
  or
  EVA via handrails employed

0181-031D
1472-020(T)

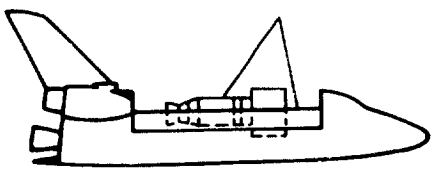
D15 Nominal Deployment Sequence – GEO/Propulsion Payload Class – IUS SRM – RMS/Tilt Table Usage

IRAD

GRUMMAN

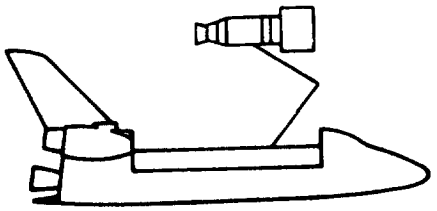
PAYLOAD DEPLOYMENT

(1)



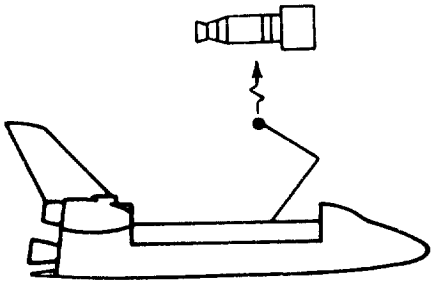
- Payload stowed in retention structure
- Status/health checks via umbilicals in retention structure (comm via orbiter S-Band)
- RMS attaches to payload
- State vector transfer

(2)



- Transfer payload to internal power
- Retention latches/umbilical released
- RMS elevates payload within view of AFD/payload bay TV cameras
- Activation of selected payload subsystems by ground link (comm via payload)

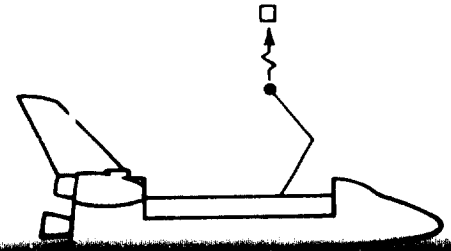
(3)



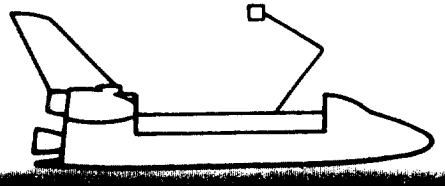
- Final status/health check prior to deployment (comm via payload)
- RMS releases satellite in preferred attitude at ~ 1 ft/sec velocity
- IUS RCS activation at > 200 ft

MTV DEPLOYMENT & ORBITER SEPARATION BURN

(4)



(5)

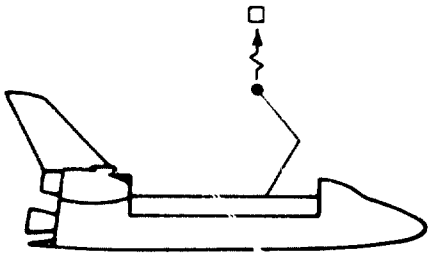


FOLDOUT FRAME

- Final status/health check prior to deployment (comm via payload)
- RMS releases satellite in preferred attitude at ~ 1 ft/sec velocity
- IUS RCS activation at > 200 ft

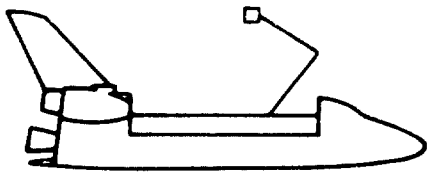
MTV DEPLOYMENT & ORBITER SEPARATION BURN

④



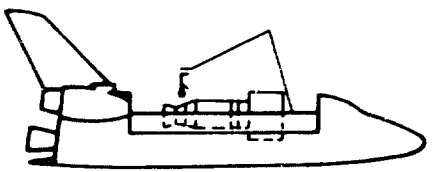
- MTV deployed to view IUS stage firing
- OMS separation burn to assure orbiter exit of hazard envelope. At ~ 80 nmi separation, orbiter assumes damage limit attitude
- IUS propulsion stage activated ~ 45 min after payload deployment

⑤



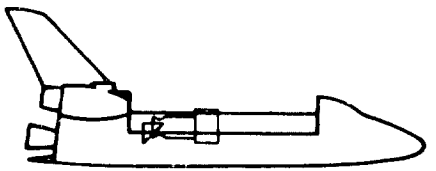
- Orbiter/MTV rendezvous
- MTV retrieved by RMS and stowed in payload bay

BACKUP FOR RETENTION LATCH HANGUP

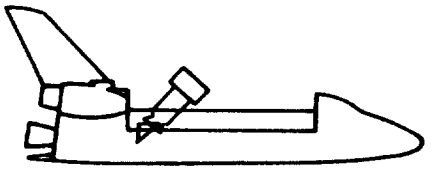


- MFR/RMS deployed for manual release
  or
  EVA via handrails employed
- Retention latches in closed position (unlocked) to enable RMS attachment

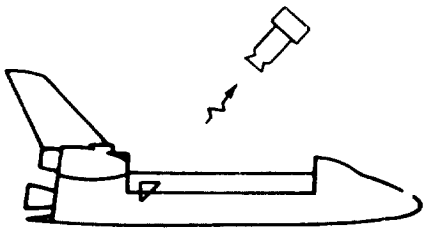
PAYLOAD DEPLOYMENT



- Payload stowed in tilt table/retention structure
- Status/health checks via umbilical in tilt table/ retention structure (comm via orbiter S-Band)
- State vector transfer

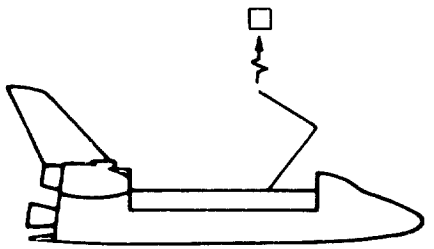


- Orbiter maneuvers to deployment attitude (Pitch = 135°)
- Tilt table elevates payload to deployment attitude
- Transfer payload to internal power
- Retention latches/umbilical released
- Activation of selected subsystems via ground link (comm via satellite/prop stage)

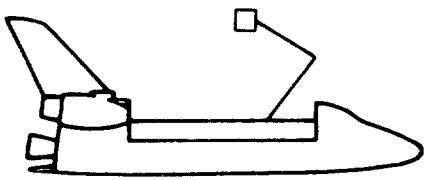


- Final status/health check prior to deployment (comm via payload)
- Payload spun-up on tilt table
- Spring separation mechanism releases payload ~ 2 ft/sec velocity
- PAM-A RCS activation at > 200 ft

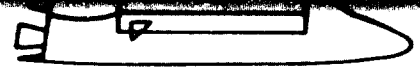
MTV DEPLOYMENT & ORBITER SEPARATION BURN



- MTV deployed to view PAM-A stage firing
- OMS separation burn to assure orbiter exit of hazard envelope. At ~ 25 nmi separation, orbiter assumes damage limit attitude
- PAM-A propulsion stage activated ~ 45 min after



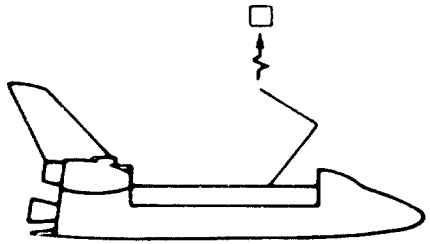
- Orbiter/MTV rendezvous
- MTV retrieved by RMS and stowed in payload bay



- Final status/health check prior to deployment (comm via payload)
- Payload spun-up on tilt table
- Spring separation mechanism releases payload ~ 2 ft/sec velocity
- PAM-A RCS activation at > 200 ft

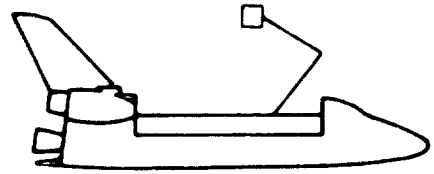
MTV DEPLOYMENT & ORBITER SEPARATION BURN

④



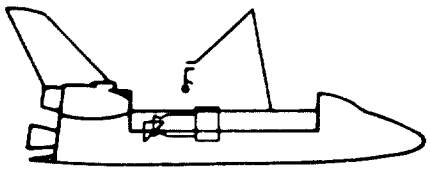
- MTV deployed to view PAM-A stage firing
- OMS separation burn to assure orbiter exit of hazard envelope. At ~ 25 nmi separation, orbiter assumes damage limit attitude
- PAM-A propulsion stage activated ~ 45 min after deployment

⑤



- Orbiter/MTV rendezvous
- MTV retrieved by RMS and stowed in payload bay

BACKUP FOR TILT TABLE HANGUP



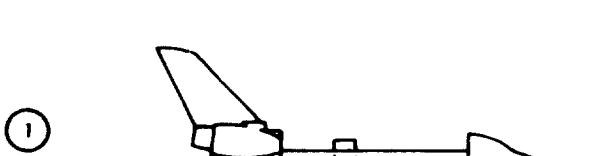
- MFR/RMS deployed for manual release
  or
  EVA via handrails employed

0181-033D
1472-022(T)
IRAD

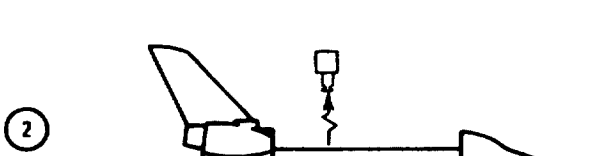
D17 Nominal Deployment Sequence – GEO/Propulsion Payload Class – PAM-A SRM – RMS/Tilt Table/Spin Table Usage

GRUMMAN

PAYLOAD DEPLOYMENT

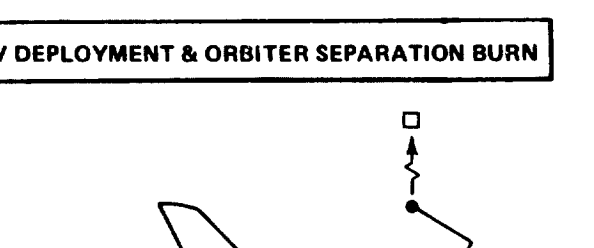


- Payload stowed in retention structure
- Status/health checks via umbilicals in retention structure (comm via orbiter S-Band)
- Sun shield opens to provide ground comm status check; sun shields closed
- State vector transfer



- Orbiter maneuvers to deployment attitude (Pitch = 90°)
- Sun shield opens, final status/health check prior to deployment (comm via orbiter S-Band)
- Transfer payload to internal power
- Payload spun-up, spring mechanism releases payload ~ 6 ft/sec velocity
- PAM-D RCS activation at > 200 ft

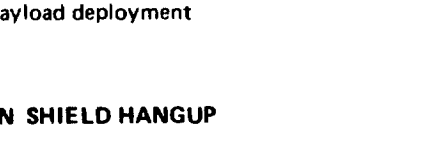
MTV DEPLOYMENT & ORBITER SEPARATION BURN

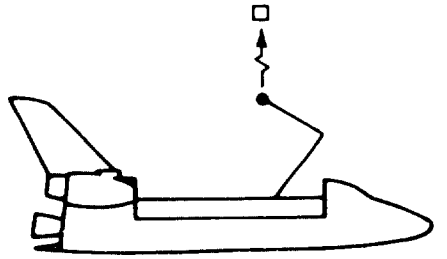


- MTV deployed to view PAM-D stage firing
- OMS separation burn to assure orbiter exit of hazard envelope. At ~ 25 nmi separation, orbiter assumes damage limit attitude
- PAM-D propulsion stage activated ~ 45 min after payload deployment

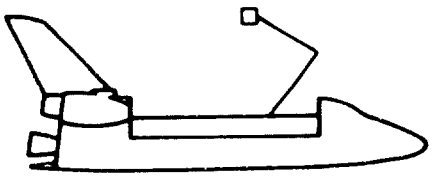
- Orbiter/MTV rendezvous
- MTV retrieved by RMS and stowed in payload bay

BACKUP FOR SUN SHIELD HANGUP



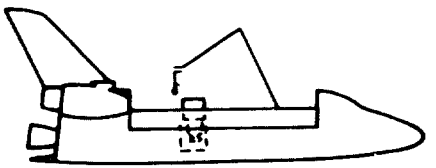


- MTV deployed to view PAM-D stage firing
- OMS separation burn to assure orbiter exit of hazard envelope. At ~ 25 nmi separation, orbiter assumes damage limit attitude
- PAM-D propulsion stage activated ~ 45 min after payload deployment



- Orbiter/MTV rendezvous
- MTV retrieved by RMS and stowed in payload bay

BACKUP FOR SUN SHIELD HANGUP



- MFR/RMS deployed for manual release
  or
  EVA via handrails employed

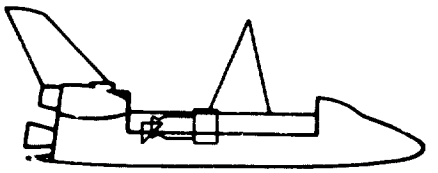
1472-023(T)
0181-034D

RAO

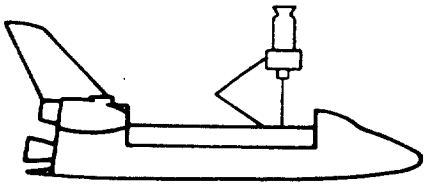
D18 Nominal Deployment Sequence – GEO/Propulsion Payload Class – PAM-D SRM – RMS/Spin Table Usage

GRUMMAN

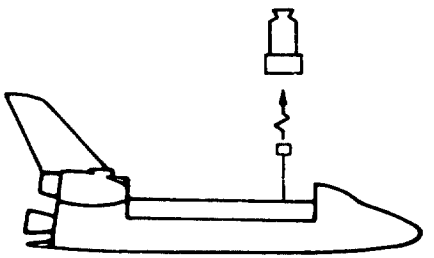
PAYLOAD DEPLOYMENT

① 

- Payload stowed in retention structure
- Status/health checks via umbilical in retention structure (comm via orbiter S-Band)
- RMS attaches to payload

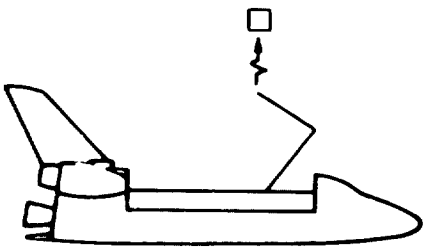
② 

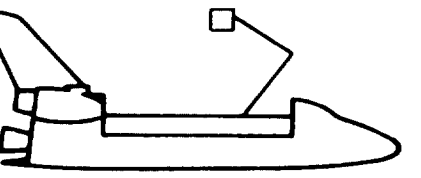
- Retention latches/umbilical released
- RMS translates payload and berths to HPA. Umbilical connections verified
- Orbiter maneuvers to deployment attitude
- Activation of selected subsystems via ground link (comm via satellite/prop stage)
- Transfer payload to internal power
- State vector transfer

③ 

- Final status/health check prior to deployment (comm via payload)
- Payload spun-up on HPA
- Spring separation mechanism releases payload ~ 2 to 6 ft/sec velocity
- SRM RCS activation at > 200 ft

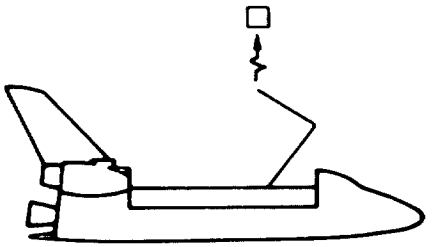
MTV DEPLOYMENT & ORBITER SEPARATION BURN

④ 

⑤ 

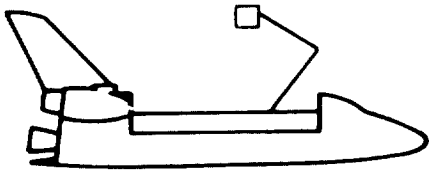
MTV DEPLOYMENT & ORBITER SEPARATION BURN

④



- MTV deployed to view SRM stage firing
- OMS separation burn to assure orbiter exit of hazard envelope. At ~ 25 nmi separation, orbiter assumes damage limit attitude
- SRM propulsion stage activated ~ 45 min after payload deployment

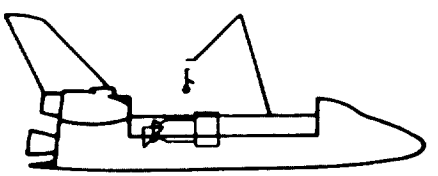
⑤



- Orbiter/MTV rendezvous
- MTV retrieved by RMS and stowed in payload bay

BACKUP FOR RETENTION LATCH HANGUP

⑥



- MFR/RMS deployed for manual release
  or
  EVA via handrails employed
- Retention latches in closed position (unlocked) to enable RMS attachment

0181-035D
1472-024(T)

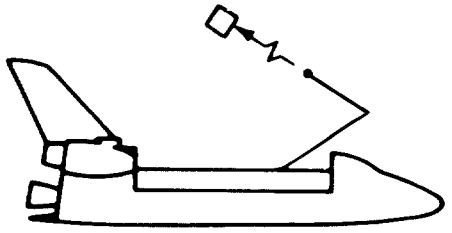
IRAD

D19 Alternat. Deployment Sequence – GEO/Propulsion Payload Class – SRM Spinner – RMS/HPA Usage

GRUMMAN

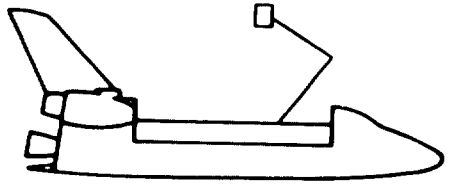
MTV DEPLOYMENT/PAYLOAD EXAMINATION

1



- Orbiter rendezvous with satellite to within ~ 1000 ft separation distance
- MTV is deployed to examine satellite

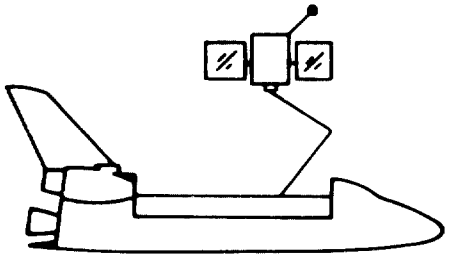
2



- Orbiter/MTV rendezvous
- MTV retrieved by RMS and stowed in payload bay

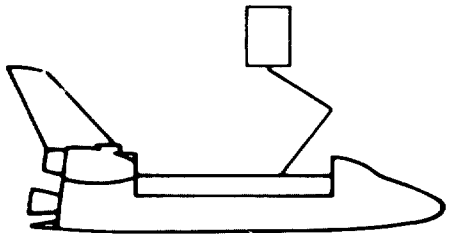
RETRIEVAL/SERVICING

3



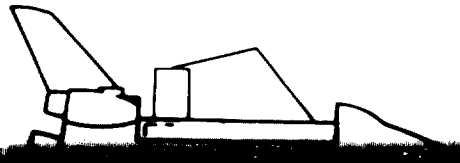
- Satellite safing, propellent venting, preparations for rendezvous
- Satellite ACS is active to maintain stability
- Orbiter rendezvous with satellite to within RMS reach distance, satellite examined via RMS TV or visual crew observation
- RMS attaches to satellite

4

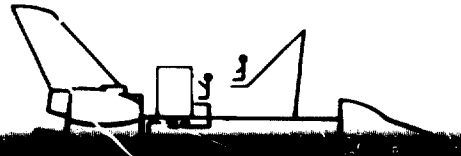


- Satellite appendages retracted
- Deactivate satellite by ground command

5



6



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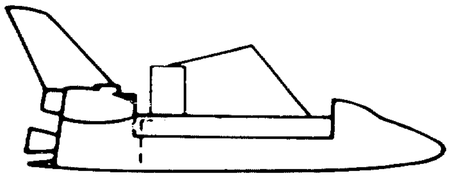
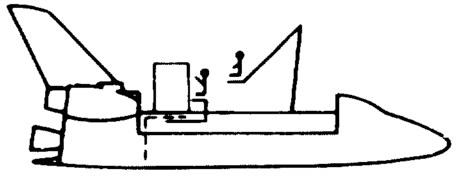
OF POOR QUALITY

(5)



- Satellite berthed to payload bay tilt table and umbilical connections verified
- Transfer satellite to orbiter power to maintain thermal control

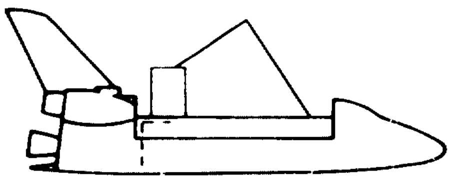
(6)



- Checkout status/health via umbilical in tilt table (comm via satellit.
- Implement servicing functions via tilt table work platform/OCP/RMS
  - Examine, repair, maintenance, resupply, reconfigure
- Checkout/verify status of on-orbit services performed (comm via satellite)

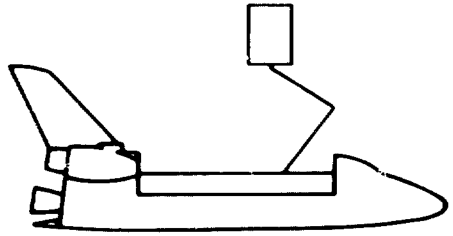
PAYLOAD REDEPLOYMENT

(7)



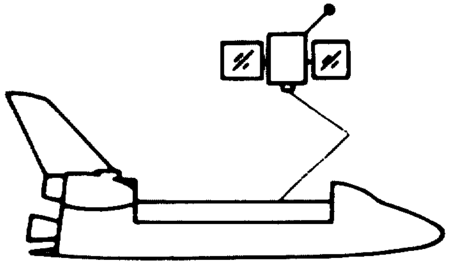
- RMS attaches to satellite
- State vector transfer
- Transfer satellite to internal power

(8)



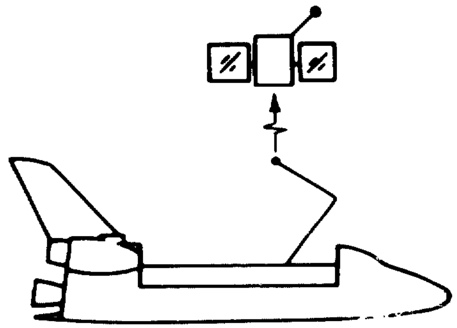
- Tilt table latches/umbilicals released
- RMS elevates payload within view of AFD and payload bay TV cameras
- Activation of selected subsystems via ground link (comm via satellite)

(9)



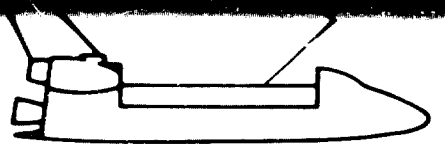
- Satellite appendages deployed by ground command and verified by orbiter crew
- Final status/health check prior to deployment **(comm via satellite)**

(10)



- RMS releases satellite in preferred attitude at ~ 1 ft/sec velocity
- Satellite activation of RCS at > 200 ft

(9)

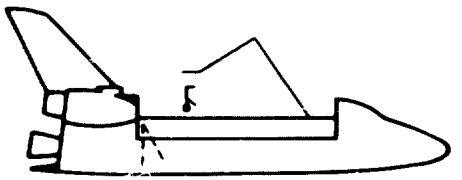


- Satellite appendages deployed by ground command and verified by orbiter crew
- Final status/health check prior to deployment (comm via satellite)

(10)

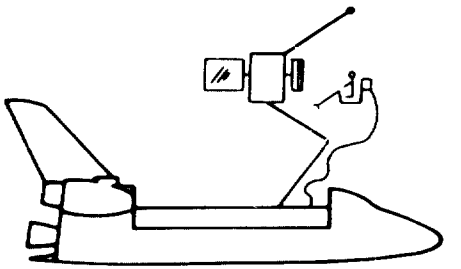
- RMS releases satellite in preferred attitude at ~ 1 ft/sec velocity
- Satellite activation of RCS at > 200 ft

BACKUP FOR RETENTION LATCH OR TILT TABLE HANGUP



- MFR/RMS deployed for manual release
  or
  EVA via handrails employed
- Latches in closed position (unlocked) to enable RMS attachment

BACKUP FOR APPENDAGE HANGUP



- MMU/WRU with stabilizer deployed for manual assist

R81-0181-148(T)

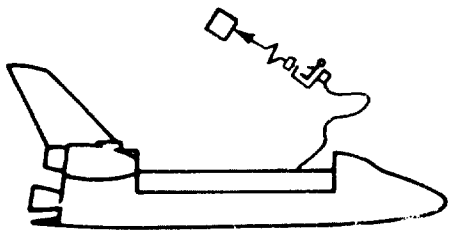
RAD

R1 Nominal Revisit Sequence – Direct Delivery Payload Class – MMS-Type Satellites – RMS/Tilt Table Usage

GRUMMAN

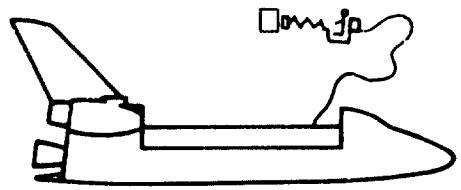
MTV DEPLOYMENT/PAYLOAD EXAMINATION

(1)



- Orbiter rendezvous with satellite to within ~ 1000 ft separation distance
- MTV is deployed by MMU/WRU with RMS end effector to examine satellite

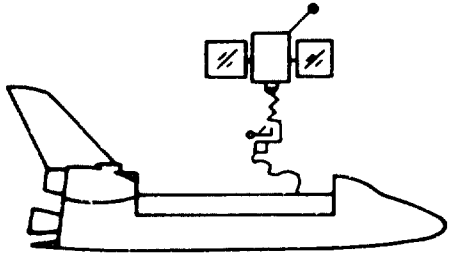
(2)



- Orbiter/MTV rendezvous
- MTV retrieved by MMU/WRU and stowed in payload bay

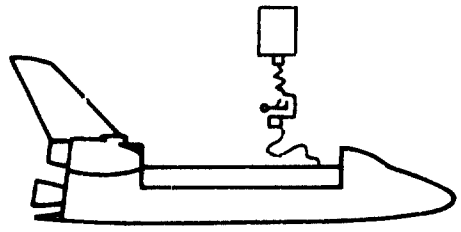
RETRIEVAL/SERVICING

(3)



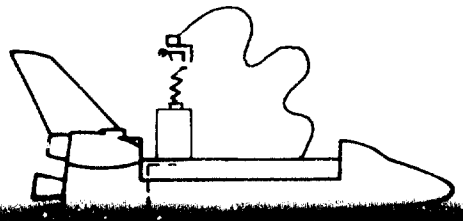
- Satellite safing, propellent venting, preparations for rendezvous
- Satellite ACS is active to maintain stability
- Orbiter rendezvous with satellite to within view of AFD/payload bay TV cameras, satellite examined via MMU/WRU or visual crew observation
- MMU/WRU with RMS end effector attaches to satellite

(4)

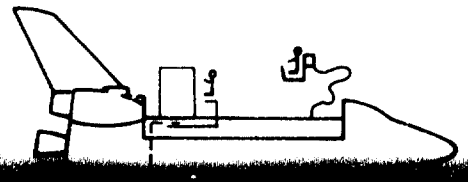


- Satellite appendages retracted
- Deactivate satellite by ground command

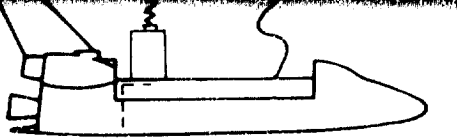
(5)



(6)

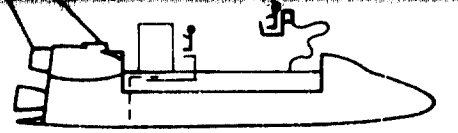


5



- Satellite berthed to payload bay tilt table and umbilical connections verified
- Transfer satellite to orbiter power to maintain thermal control

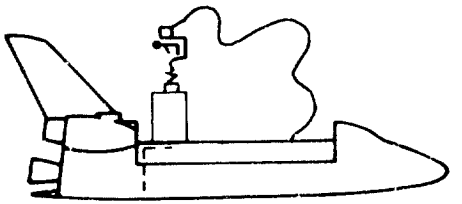
6



- Checkout status/health via umbilical in tilt table (comm via satellite)
- Implement servicing functions via OCP/Work Station on tilt table
  - Examine, repair, maintenance, resupply, reconfigure
- Transport packages to work station via MMU/WRU with payload handling capability
- Checkout/verify status of on-orbit services performed (comm via satellite)

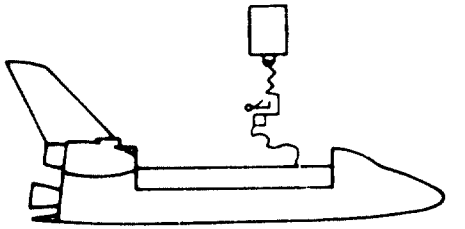
PAYLOAD REDEPLOYMENT

7



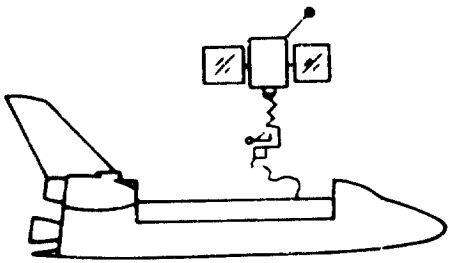
- MMU/WRU attaches to satellite
- State vector transfer
- Transfer satellite to internal power

8



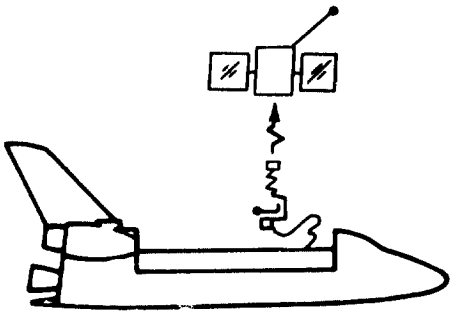
- Tilt table latches/umbilicals released
- MMU/WRU elevates payload within view of AFD and payload bay TV cameras
- Activation of selected subsystems via ground link (comm via satellite)

9



- Satellite appendages deployed by ground command and verified by orbiter crew
- Final status/health check prior to deployment (comm via satellite)

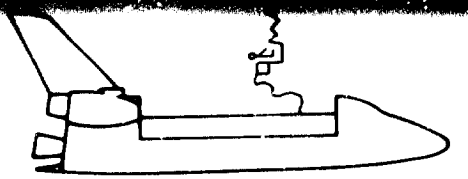
10



- MMU/WRU releases satellite in nominally preferred attitude at ~ 1 ft/sec velocity
- Satellite activation of RCS at > 200 ft

BACKUP FOR TILT TABLE HANGUP

BACKUP FOR APPENDAGE HANGUP



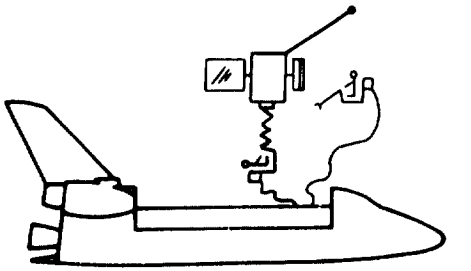
- Satellite appendages deployed by ground command and verified by orbiter crew
- Final status/health check prior to deployment (comm via satellite)

- MMU/WRU releases satellite in nominally preferred attitude at ~ 1 ft/sec velocity
- Satellite activation of RCS at > 200 ft

BACKUP FOR TILT TABLE HANGUP

- MMU/WRU with stabilizer deployed for manual release
  or
  EVA via handrails employed

BACKUP FOR APPENDAGE HANGUP



- First MMU/WRU maintains stability/position of satellite
- Second MMU with stabilizer deployed for manual assist

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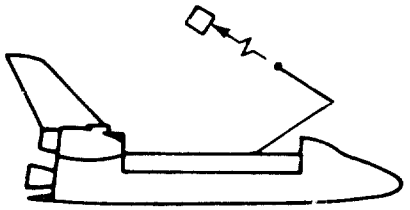
IRAD

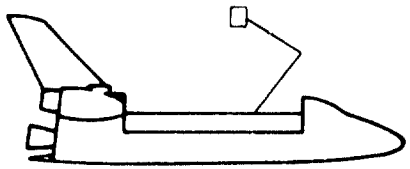
R2 Nominal Revisit Sequence – RMS Inoperative – Direct Delivery Payload Class – MMS-Type Satellites – Tilt Table Usage

GRUMMAN

MTV DEPLOYMENT/PAYLOAD EXAMINATION

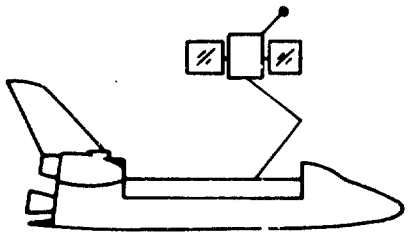
① 

- Orbiter rendezvous with satellite to within ~ 1000 ft separation distance
- MTV is deployed to examine satellite

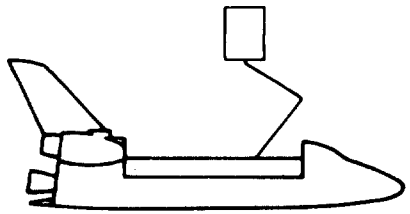
② 

- Orbiter/MTV rendezvous
- MTV retrieved by RMS and stowed in payload bay

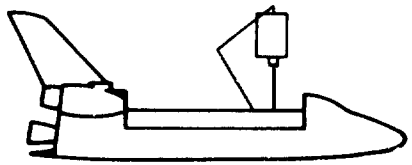
RETRIEVAL/SERVICING

③ 

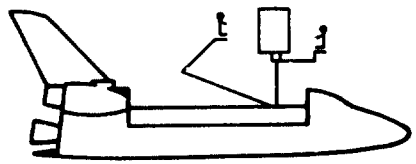
- Satellite safing, propellent venting, preparations for rendezvous
- Satellite ACS is active to maintain stability
- Orbiter rendezvous with satellite to within RMS reach distance, satellite examined via RMS TV or visual crew observation
- RMS attaches to satellite

④ 

- Satellite appendages retracted
- Deactivate satellite by ground command

⑤ 

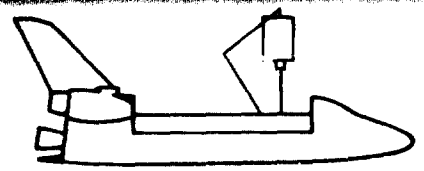
- Satellite berthed to Handling & Positioning Aid (HPA) and umbilical connections verified
- Transfer satellite to orbiter power to maintain thermal control

⑥ 

- Checkout status/health via umbilical in HPA (comm via satellite)
- Implement servicing functions via HPA/RMS/OCP

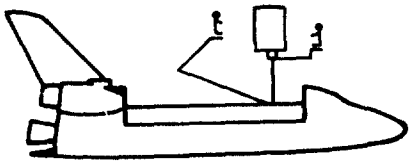
  Examine, repair, maintenance, resupply, reconfigure

(5)



- Satellite berthed to Handling & Positioning Aid (HPA) and umbilical connections verified
- Transfer satellite to orbiter power to maintain thermal control

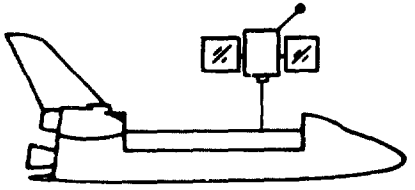
(6)



- Checkout status/health via umbilical in HPA (comm via satellite)
- Implement servicing functions via HPA/RMS/OCP
  - Examine, repair, maintenance, resupply, reconfigure
- Checkout/verify status of on-orbit services performed (comm via satellite)
- Activation of selected subsystems via ground link

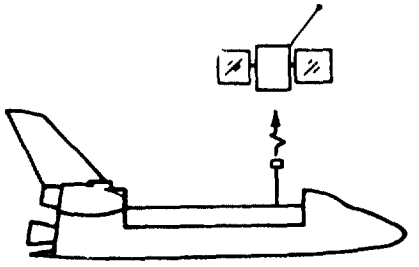
PAYLOAD REDEPLOYMENT

(7)



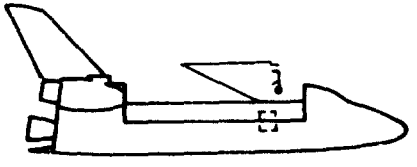
- Satellite appendages deployed by ground command and verified by orbiter crew
- State vector transfer
- Transfer satellite to internal power
- Final status/health check prior to deployment (comm via satellite)

(8)



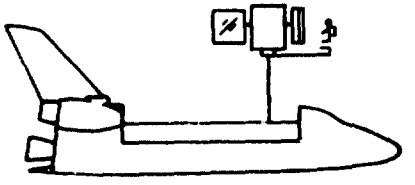
- HPA releases satellite at ~ 1 ft/sec velocity
- Satellite activation of RCS at > 200 ft separation

BACKUP FOR RETENTION LATCH HANGUP



- MFR/RMS deployed for manual release
  or
  EVA via handrails employed

BACKUP FOR APPENDAGE HANGUP



- Work station on HPA is utilized
  or
  MFR/RMS deployed for manual assist

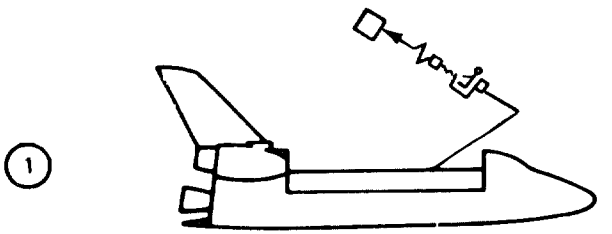
FOLDOUT FRAME 2

R3 Alternate No. 1 Revisit Sequence – Direct Delivery Payload Class – MMS-Type Satellites – RMS/HPA Usage

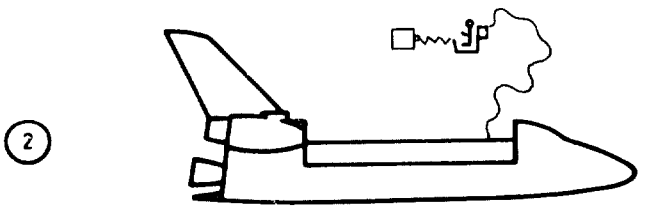
IRAD

GRUMMAN

MTV DEPLOYMENT/PAYLOAD EXAMINATION

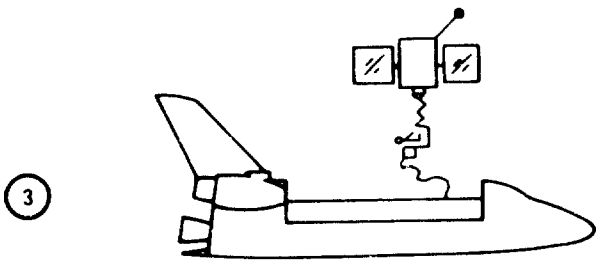


- Orbiter rendezvous with satellite to within ~ 1000 ft separation distance
- MTV is deployed by MMU/WRU (with RMS end-effector) to examine satellite

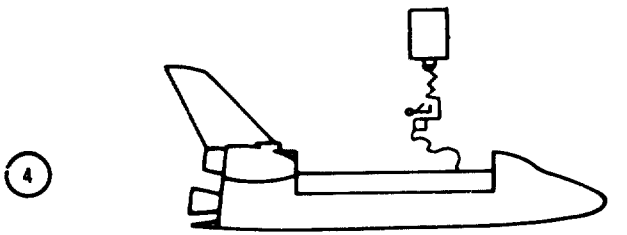


- Orbiter/MTV rendezvous
- MTV retrieved by MMU/WRU and stowed in payload bay

RETRIEVAL/SERVICING



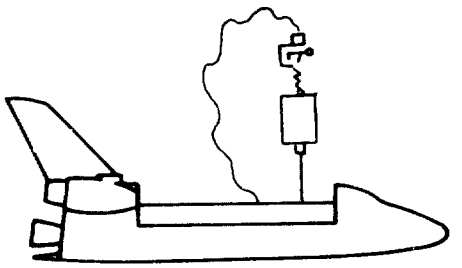
- Satellite safing, propellent venting, preparations for rendezvous
- Satellite ACS is active to maintain stability
- Orbiter rendezvous with satellite to within view of AFD/payload bay TV cameras, satellite examined via MMU/WRU or visual crew observation
- MMU/WRU (with RMS end-effector) attaches to satellite



- Satellite appendages retracted
- Deactivate satellite by ground command

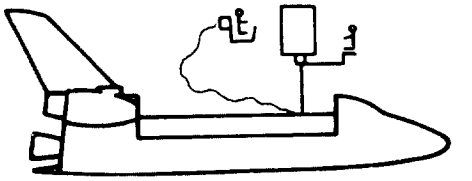
FOLDOUT FRAME 2

5



- Satellite berthed to HPA and umbilical connections verified
- Transfer satellite to orbiter power to maintain thermal control

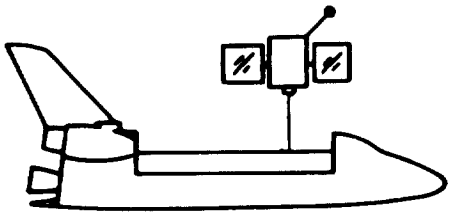
6



- Checkout status/health via umbilical in HPA (comm via satellite)
- Implement servicing functions via HPA
  Examine, repair, maintenance, resupply, reconfigure
- Transport packages to work station via MMU/WRU with payload handling capability
- Checkout/verify status of on-orbit services performed (comm via satellite)
- Activation of selected subsystems via ground link

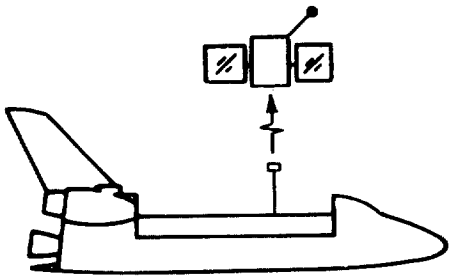
PAYLOAD REDEPLOYMENT

7



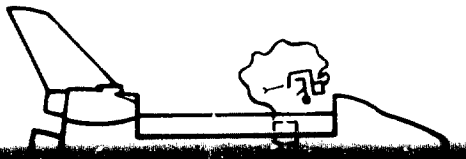
- Satellite appendages deployed by ground command and verified by orbiter crew
- State vector transfer
- Transfer satellite to internal power
- Final status/health check prior to deployment (comm via satellite)

8

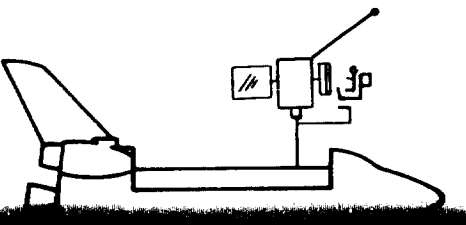


- HPA releases satellite at ~ 1 ft/sec velocity
- Satellite activation of RCS at > 200 ft separation

BACKUP FOR RETENTION LATCH HANGUP



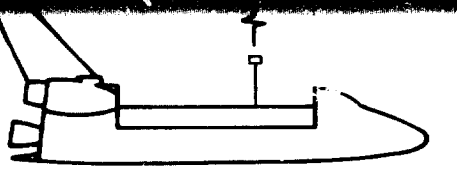
BACKUP FOR APPENDAGE HANGUP



⑦

- Satellite appendages deployed by ground command and verified by orbiter crew
- State vector transfer
- Transfer satellite to internal power
- Final status/health check prior to deployment (comm via satellite)

⑧

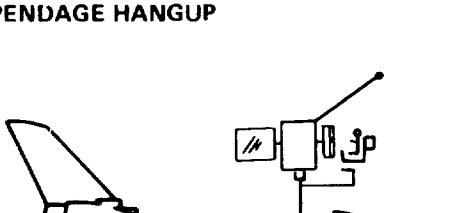


- HPA releases satellite at ~ 1 ft/sec velocity
- Satellite activation of RCS at > 200 ft separation

BACKUP FOR RETENTION LATCH HANGUP

- MMU/WRU with stabilizer deployed for manual release
  or
  EVA via handrails employed

BACKUP FOR APPENDAGE HANGUP



- Work station on HPA is utilized

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IRAD

R4 Alternate No. 1 Revisit Sequence – RMS Inoperative – Direct Delivery Payload Class – MMS-Type Satellites – HPA Usage

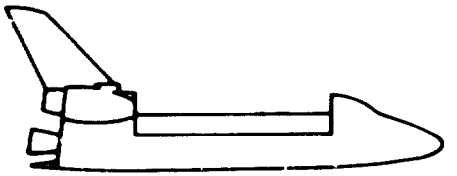
GRUMMAN

POM-MTV DEPLOYMENT/PAYLOAD RETRIEVAL

FOLDOUT FRAME 1

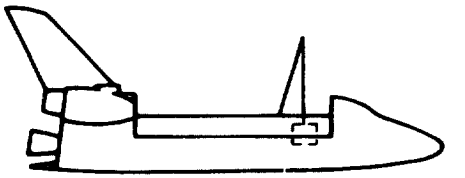
PRECEDING PAGE BLANK NOT FILMED

(1)



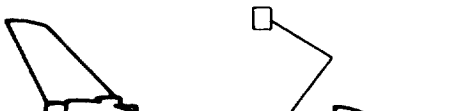
- Satellite safing, propellant venting, preparations for rendezvous
- Satellite ACS is active to maintain stability
- Orbiter rendezvous with satellite to 1000 ft separation distance

(2)



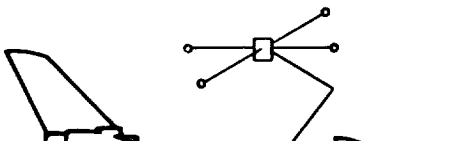
- Proximity Ops Module (POM-MTV) adaptation stowed in retention structure
- Status/health checks via umbilical in retention structure (comm via orbiter S-Band)
- RMS attaches to POM-MTV
- Transfer POM-MTV to internal power

(3)

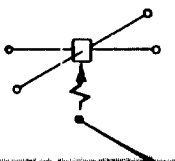


- POM-MTV released from retention structure/ umbilical and elevated within view of AFD/payload bay TV cameras
- Activation of selected POM subsystems via ground link (comm via POM)

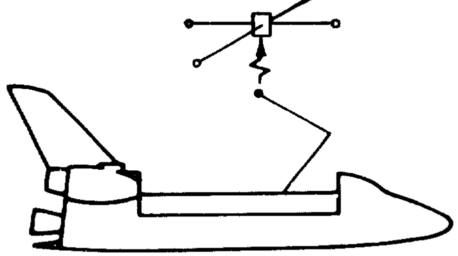
(4)



- POM appendages deployed by ground command and verified by orbiter crew
- Final status/health checks prior to deployment (comm via POM)

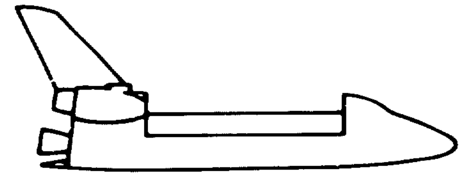


5



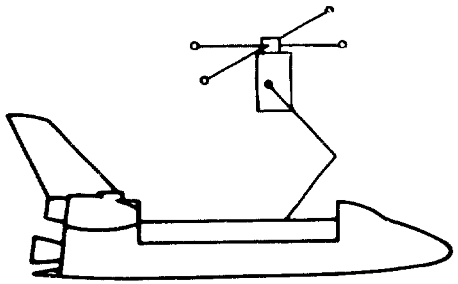
- RMS releases POM at ~ 1 ft/sec velocity to examine and retrieve satellite (MMU/WRU manned POM deployment is alternate)

6



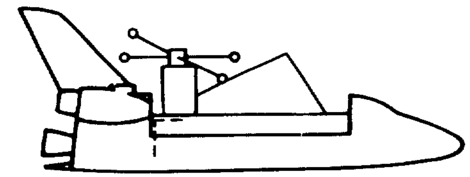
- POM docks to satellite
- Satellite appendages retracted
- Satellite ACS inactivated

7



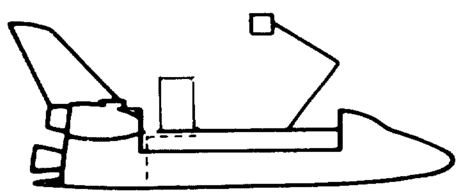
- POM transports satellite to orbiter within RMS reach distance
- RMS attaches to satellite and POM (POM ACS active)
- Deactivate satellite by ground command

8



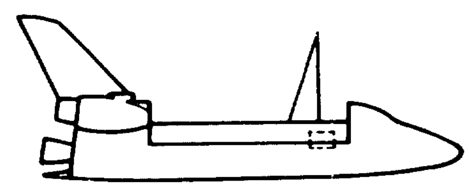
- Satellite berthed to payload bay tilt table and umbilical connections verified
- Transfer satellite to orbiter power to maintain thermal control
- Activate orbiter's non-contaminating ACS package or place orbiter in free drift

9



- RMS attaches to POM, releases from satellite and elevates within view of AFD/payload bay TV cameras
- POM appendages retracted
- POM inactivated, checked out for stowage and return

10

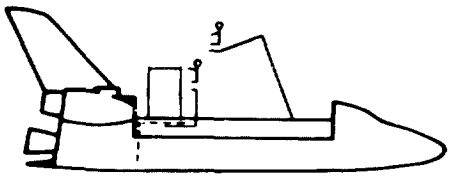


- POM stowed in retention structure, retention latches locked

SERVICING

SERVICING

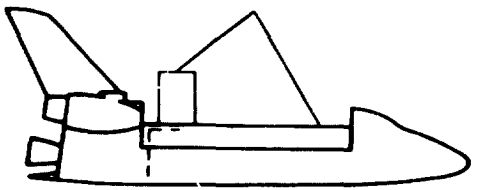
(11)



- Checkout satellite status/health via umbilical in tilt table (comm via satellite)
- Implement servicing functions via OCP/RMS & OCP/Work Platform on tilt table
  Examine, repair, maintenance, resupply, reconfigure
- Checkout/verify status of on-orbit services performed (comm via satellite)

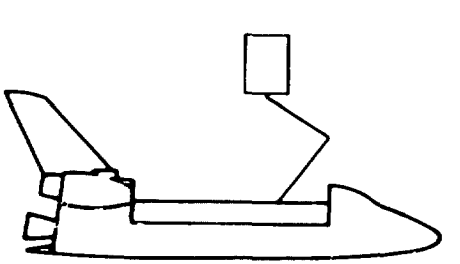
PAYLOAD REDEPLOYMENT

(12)



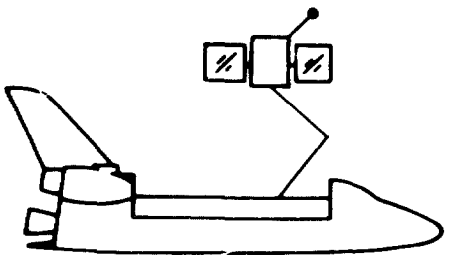
- RMS attaches to satellite
- State vector transfer
- Transfer satellite to internal power

(13)



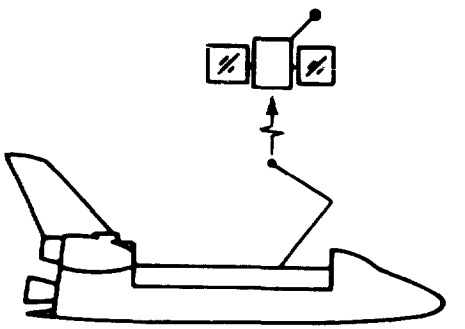
- Tilt table latches/umbilicals released
- RMS elevates payload within view of AFD and payload bay TV cameras
- Activation of selected subsystems via ground link (comm via satellite)

(14)



- Satellite appendages deployed by ground command and verified by orbiter crew
- Final status/health check prior to deployment (comm via satellite)

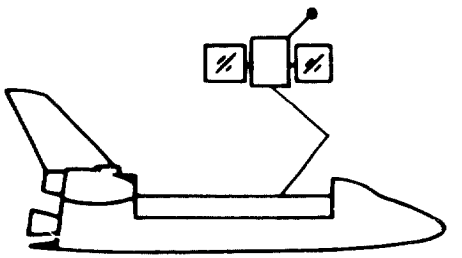
(15)



- RMS releases satellite in preferred attitude at ~ 1 ft/sec velocity
- Satellite activation of RCS at > 200 ft

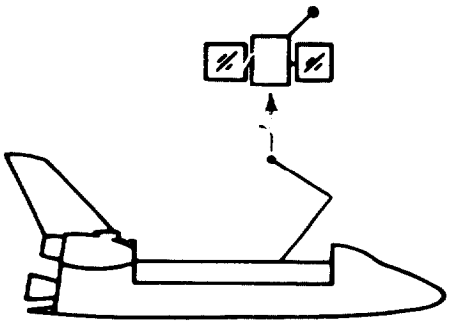
link (comm via satellite)

(14)



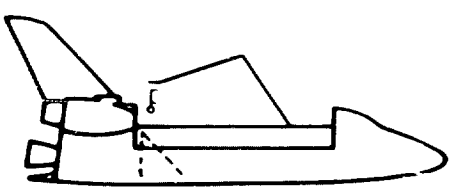
- Satellite appendages deployed by ground command and verified by orbiter crew
- Final status/health check prior to deployment (comm via satellite)

(15)



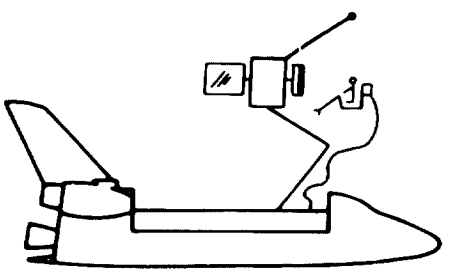
- RMS releases satellite in preferred attitude at ~ 1 ft/sec velocity
- Satellite activation of RCS at > 200 ft

BACKUP FOR RETENTION LATCH/TILT TABLE HANGUP



- MFR/RMS deployed for manual release
  or
  EVA via handrails employed

BACKUP FOR APPENDAGE HANGUP



- MMU/WRU with stabilizer deployed for manual assist

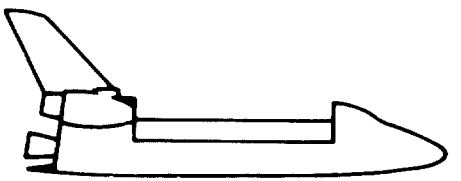
0181-0130
1472-028(T)
IRAD

R5 Nominal Revisit Sequence – Direct Delivery Payload Class – Contamination Sensitive Satellite – RMS/Tilt Table Usage

GRUMMAN

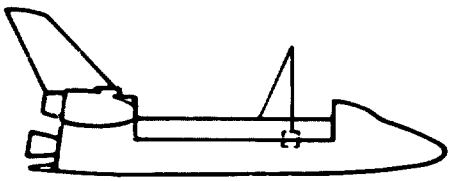
POM-MTV DEPLOYMENT/PAYLOAD RETRIEVAL

1



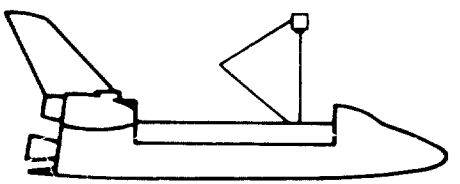
- Satellite safing, propellant venting, preparations for rendezvous
- Satellite ACS is active to maintain stability
- Orbiter rendezvous with satellite to 1000 ft separation distance

2



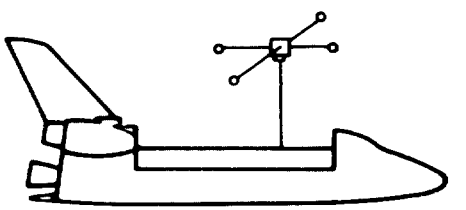
- Proximity Operations Module - MTV adaptation (POM-MTV) stowed in retention structure
- Status/health checks via umbilical in retention structure (comm via orbiter S-Band)
- RMS attaches to POM-MTV

3

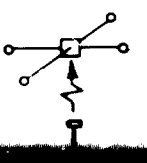


- POM-MTV released from retention structure/umbilical
- RMS berths POM MTV to HPA and umbilicals verified
- Transfer POM-MTV to orbiter power to maintain thermal control

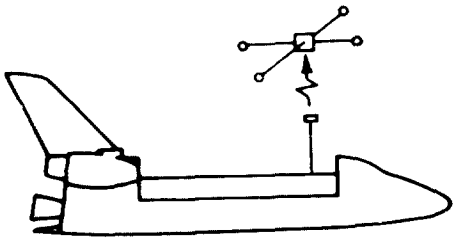
4



- Activation of selected POM-MTV subsystems via ground link (comm via POM-MTV)
- POM-MTV appendages deployed by ground command and verified by orbiter crew
- Final status/health checks prior to deployment (comm via POM-MTV)



5

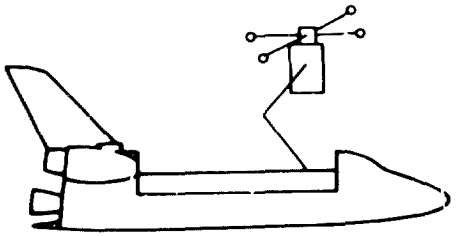


- Transfer POM-MTV to internal power
- HPA releases POM-MTV at ~ 1 ft/sec velocity to examine and retrieve satellite (MMU/WRU manned POM deployment is alternate)

6

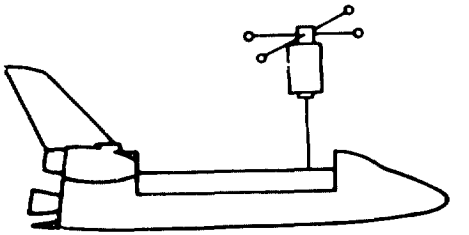
- POM-MTV docks to satellite
- Satellite appendages retracted
- Satellite ACS inactivated

7



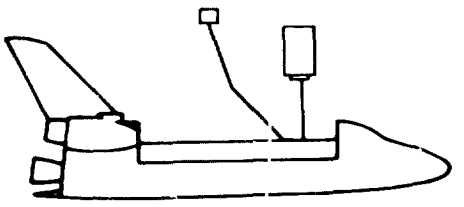
- POM-MTV transports satellite to orbiter within RMS reach distance
- RMS attaches to satellite and POM-MTV (POM-MTV ACS active)
- Deactivate satellite by ground command

8



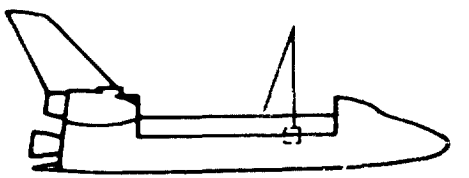
- Satellite berthed to HPA and umbilical connections verified
- Transfer satellite to orbiter power to maintain thermal control
- Activate orbiter's non-contaminating ACS package or place orbiter in free drift

9



- RMS attaches to POM-MTV, releases from satellite and elevates within view of AFD/payload bay TV cameras
- POM-MTV appendages retracted
- POM-MTV inactivated, checked out for stowage and return

10



- POM-MTV stowed in retention structure, retention latches locked

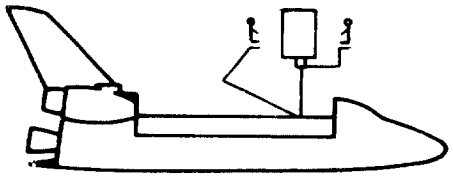
SERVICING

FOLDOUT FRAME 2

- POM-MTV inactivated, checked out for stowage and return

SERVICING

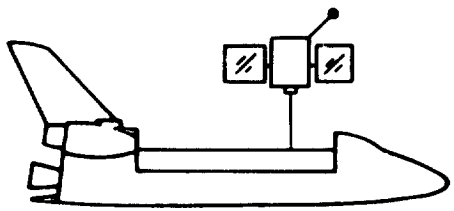
(11)



- Checkout status/health via umbilical in HPA (comm via satellite)
- Implement servicing functions via HPA/RMS/OCP
  Examine, repair, maintenance, resupply, reconfigure
- Checkout/verify status of on-orbit services performed (comm via satellite)
- Activation of selected subsystems via ground link

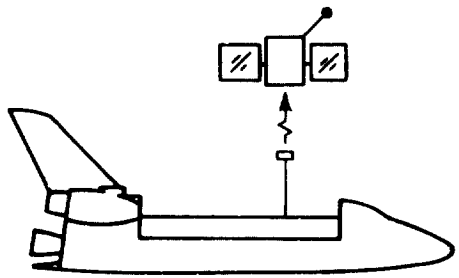
PAYLOAD REDEPLOYMENT

(12)



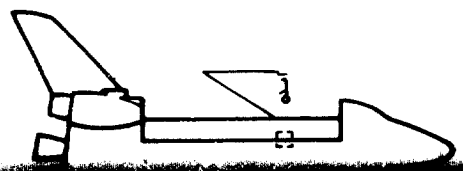
- Satellite appendages deployed by ground command and verified by orbiter crew
- State vector transfer
- Transfer satellite to internal power
- Final status/health check prior to deployment (comm via satellite)

(13)

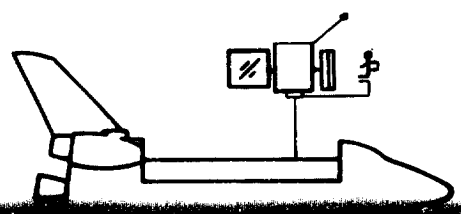


- HPA releases satellite at ~ 1 ft/sec velocity
- Satellite activation of RCS at > 200 ft separation

BACKUP FOR RETENTION LATCH HANGUP



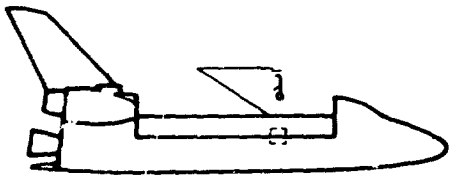
BACKUP FOR APPENDAGE HANGUP



- Satellite appendages deployed by ground command and verified by orbiter crew
- State vector transfer
- Transfer satellite to internal power
- Final status/health check prior to deployment (comm via satellite)

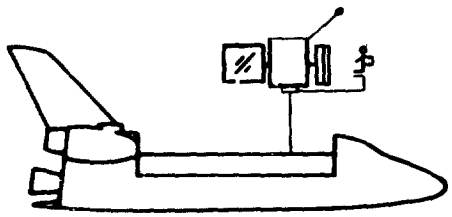
- HPA releases satellite at ~ 1 ft/sec velocity
- Satellite activation of RCS at > 200 ft separation

BACKUP FOR RETENTION LATCH HANGUP



- MFR/RMS deployed for manual release
  or
  EVA via handrails employed

BACKUP FOR APPENDAGE HANGUP



- Work station on HPA is utilized
  or
  MFR/RMS deployed for manual assist

0181-014D
1472-029(T)

IRAD

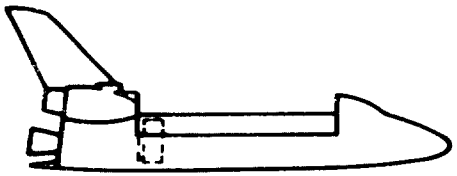
R6 Alternate No. 3 Revisit Sequence – Direct Delivery Payload Class – Contamination Sensitive Satellite – RMS/HPA Usage

GRUMMAN

FOLDOUT FRAME

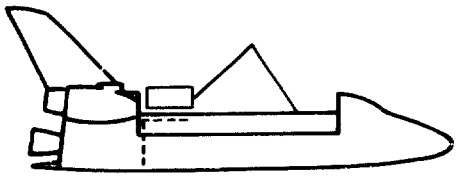
VSS DEPLOYMENT

(1)



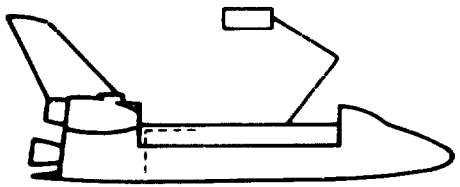
- VSS with rendezvous/docking capability stowed in retention structure/tilt table
- Status/health checks via umbilicals in tilt table (comm via orbiter S-Band)

(2)



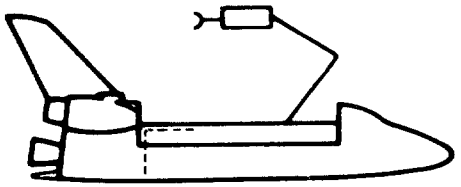
- VSS rotated to horiz position
- RMS attaches to VSS
- State vector transfer
- Transfer VSS to internal power

(3)



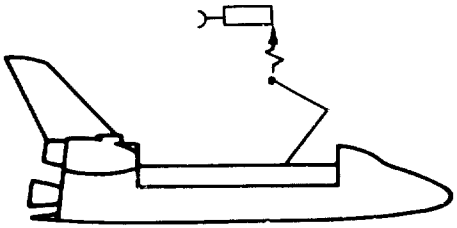
- VSS released from tilt table/umbilical and elevated within view of AFD/payload bay TV cameras
- Activation of selected VSS subsystems by ground link (comm via VSS)

(4)



- VSS appendages deployed by ground command and verified by orbiter crew
- Final status/health check prior to deployment (comm via VSS)

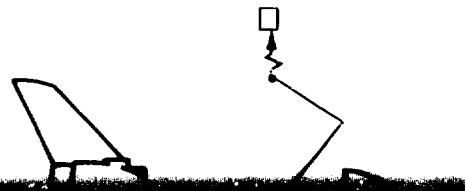
(5)



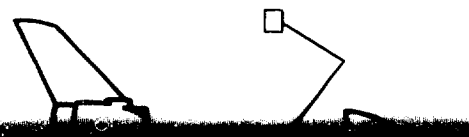
- RMS releases VSS at ~ 1 ft/sec velocity
- VSS activation of RCS at > 200 ft separation

MTV DEPLOYMENT

(6)



(7)

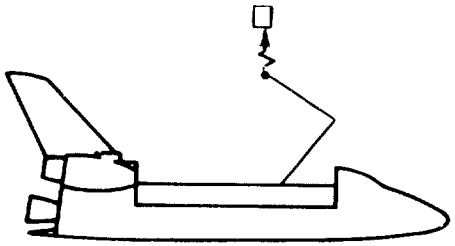


FOLDOUT FRAME

- VSS activation of RCS at > 200 ft separation

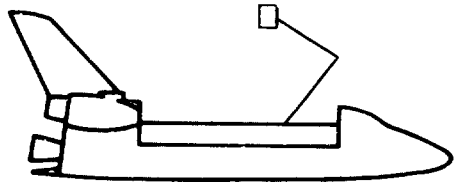
MTV DEPLOYMENT

6



- MTV deployed to view VSS firing
- VSS activates propulsion system at > 2700 ft separation

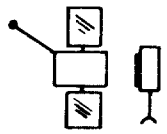
7



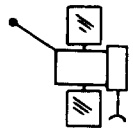
- Orbiter/MTV rendezvous (MTV active)
- MTV retrieved by RMS and stored in payload bay

8

VSS rendezvous/dock with satellite
and
Returns to orbiter

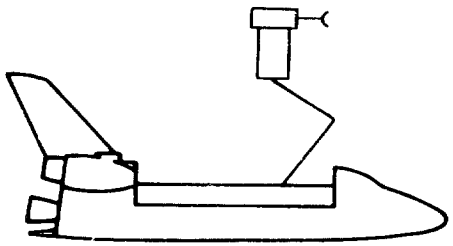


Rendezvous



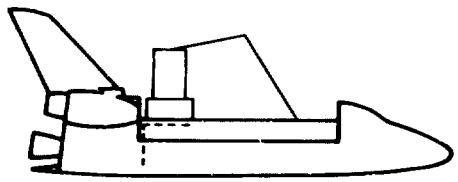
Dock

9



- Orbiter and VSS/satellite rendezvous (VSS active) within RMS reach distance and are examined by RMS TV or visual crew observation
- VSS ACS is active to maintain stability
- RMS attaches to satellite/VSS

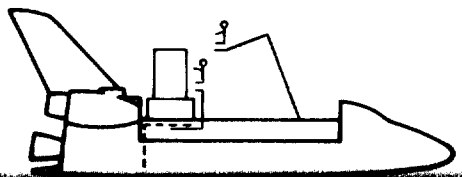
10



- VSS appendages retracted
- Deactivate VSS and satellite by ground command
- For contamination sensitive payloads, activate orbiter's non-contaminating ACS package or place orbiter in free drift
- Satellite/VSS berthed to payload bay tilt table and umbilical connections verified
- Transfer satellite/VSS to orbiter power to maintain thermal control

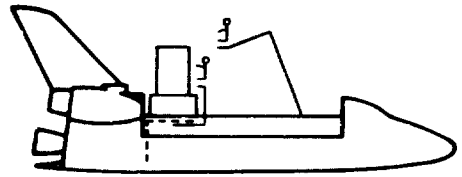
SERVICING

11



FOLDOUT FRAME 2

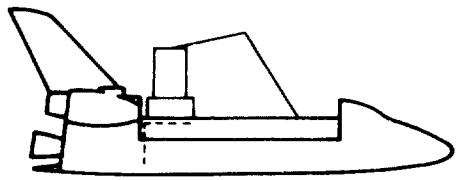
(11)



- Checkout status/health via umbilical in tilt table (comm via satellite)
- Implement servicing functions via OCP/RMS and OCP work platform on tilt table
  examine, repair, maintenance, resupply, reconfigure
- Checkout/verify status of on-orbit services performed (comm via satellite/VSS)

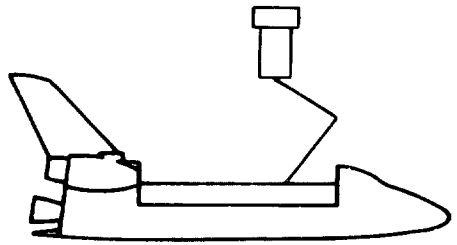
PAYLOAD REDEPLOYMENT

(12)



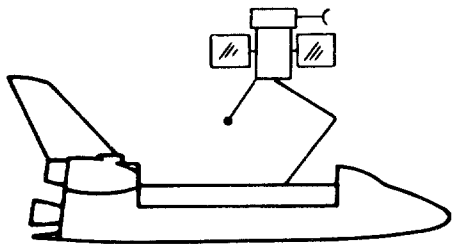
- RMS attaches to satellite/VSS
- State vector transfer
- Transfer satellite/VSS to internal power

(13)



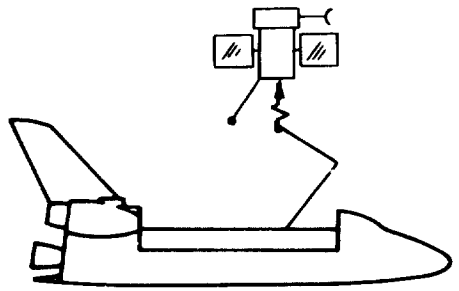
- Tilt table latches/umbilicals released
- RMS elevates payload within view of AFD and payload by TV cameras
- Activation of selected subsystems via ground link (comm via satellite/VSS)

(14)



- Satellite/VSS appendages deployed by ground command and verified by orbiter crew
- Final status/health check prior to deployment (comm via satellite/VSS)

(15)



- RMS releases satellite/VSS in preferred attitude at ~ 1 ft/sec velocity
- VSS activation of RCS at > 200 ft

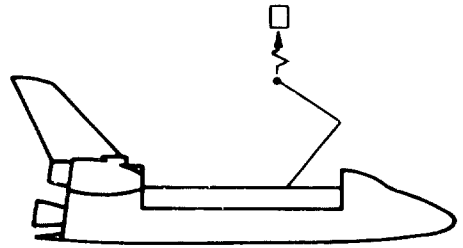
MTV REDEPLOYMENT

- Final status/health check prior to deployment (comm via satellite/VSS)

- VSS activation of RCS at > 200 ft

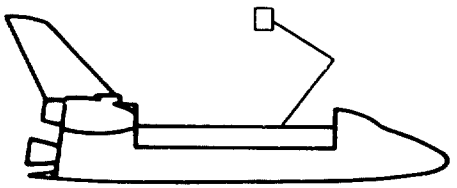
MTV REDEPLOYMENT

16



- MTV deployed to view VSS firing
- VSS stage activates propulsion system at > 2700 ft separation

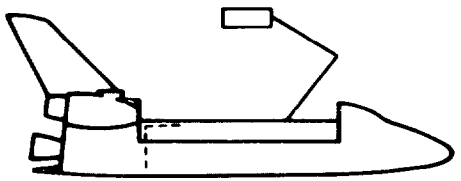
17



- Orbiter/MTV rendezvous (MTV active)
- MTV retrieved by RMS and stored in payload bay

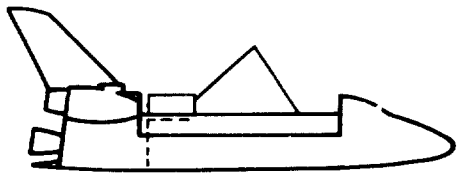
VSS RETRIEVAL

18



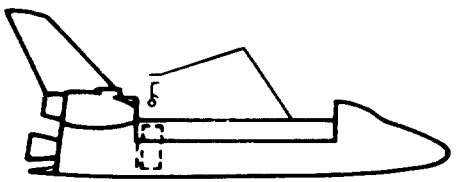
- Orbiter/VSS stage rendezvous (VSS active)
- VSS ACS active (RCS disabled, propellants vented)
- RMS attaches to VSS

19



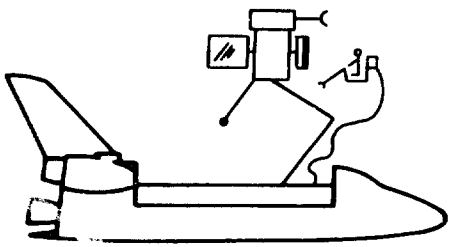
- VSS berthed to tilt table
- VSS inactivated, checked out for return
- VSS rotated to a stowed position
- Retention latches locked

BACKUP FOR RETENTION LATCH HANGUP



- MFR/RMS deployed for manual release
  or
  EVA via dandrails deployed
- Latches in closed position (unlocked) to enable RMS attachment

BACKUP FOR APPENDAGE HANGUP

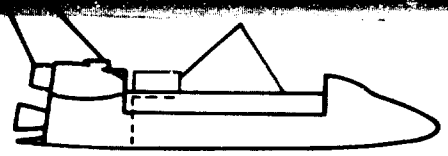


- MMU/WRU with stabilizer deployed for manual assist

(18)

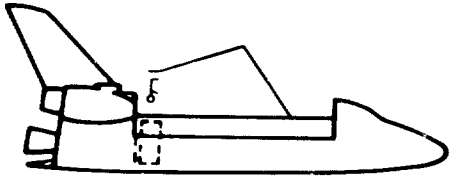
- Orbiter/VSS stage rendezvous (VSS active)
- VSS ACS active (RCS disabled, propellants vented)
- RMS attaches to VSS

(19)



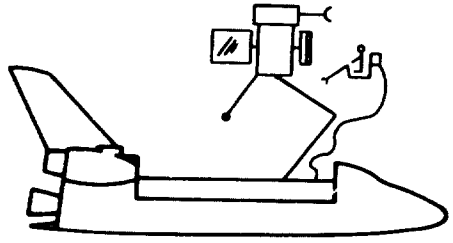
- VSS berthed to tilt table
- VSS inactivated, checked out for return
- VSS rotated to a stowed position
- Retention latches locked

BACKUP FOR RETENTION LATCH HANGUP



- MFR/RMS deployed for manual release
  or
  EVA via dandrails deployed
- Latches in closed position (unlocked) to enable RMS attachment

BACKUP FOR APPENDAGE HANGUP



- MMU/WRU with stabilizer deployed for manual assist

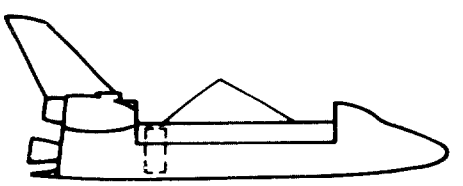
0181-015D
1472-030(T)
RAO

R7 Nominal Revisit Sequence — LEO/Propulsion Payload Class — Versatile Service Stage/ Nominal Payload — RMS/Tilt Table Usage

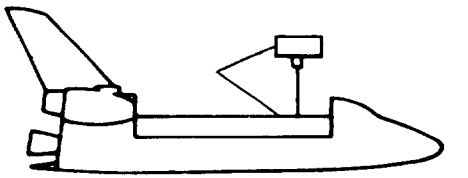
FOLDOUT FRAME 5

GRUMMAN

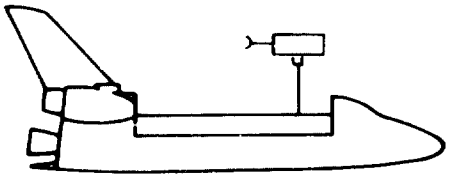
VSS DEPLOYMENT



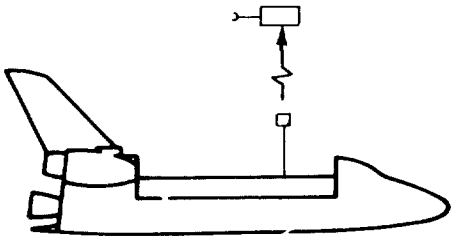
- VSS with rendezvous/docking capability stowed in retention structure
- Status/health checks via umbilical in retention structure (comm via orbiter S-Band)
- RMS attaches to VSS



- VSS retention latches/umbilical released
- RMS translates VSS and berths to HPA, umbilical connections verified

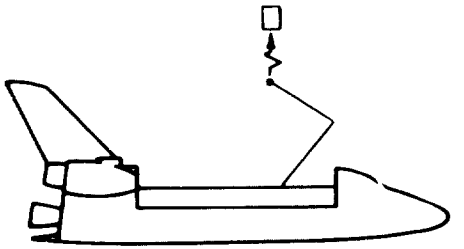


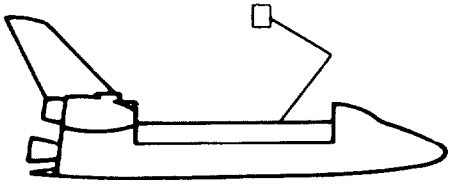
- Activation of selected VSS subsystem by ground link (comm via VSS)
- VSS appendages deployed by ground command and verified by orbiter crew
- Final status/health check prior to deployment (comm via VSS)
- State vector transfer
- Transfer VSS to internal power



- HPA releases VSS at ~ 1 ft/sec velocity
- VSS activation of RCS at > 200 ft separation

MTV DEPLOYMENT





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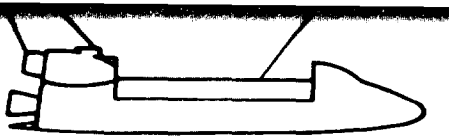
FOLDOUT FRAME

(5)

- MTV deployed to view VSS firing
- VSS activated propulsion system at ~ 2700 ft separation

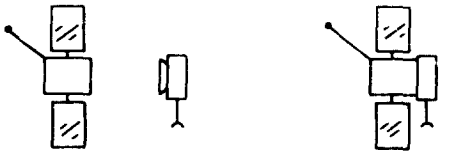
(6)



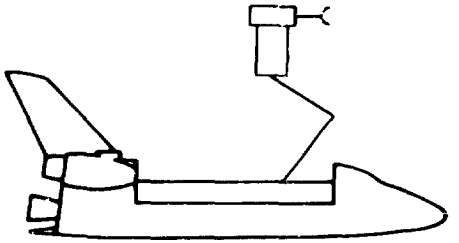
- Orbiter/MTV rendezvous (MTV active)
- MTV retrieved by RMS and stowed in payload bay

(7)

- VSS rendezvous/dock with satellite
  and
- Returns to orbiter

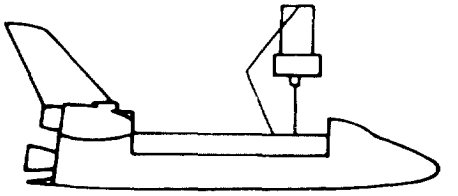


(8)



- Orbiter/VSS rendezvous (VSS active) within RMS reach distance, and examined by RMS TV or visual crew observation
- VSS ACS is active to maintain stability
- RMS attaches to satellite/VSS

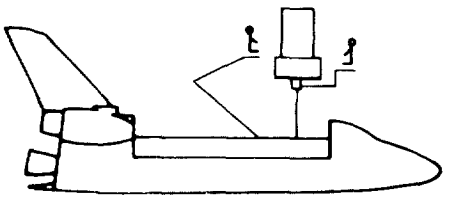
(9)



- VSS appendages retracted
- Deactivate VSS and satellite by ground command
- For contamination sensitive payloads, activate orbiter's non-contaminating ACS package or place orbiter in free drift
- Satellite/VSS berthed to HPA and umbilical connections verified
- Transfer satellite/VSS to orbiter power to maintain thermal control

SERVICING

(10)



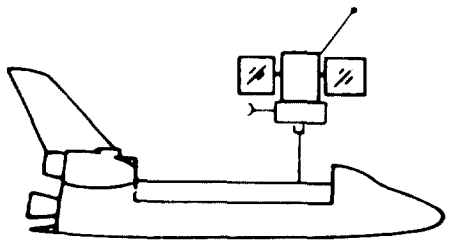
- Checkout status/health via umbilical in HPA (comm via satellite/VSS)
- Implement servicing functions via HPA/RMS/OCP
  Examine, repair, maintenance, resupply,

FOLDOUT FRAME 2

- Checkout status/health via umbilical in HPA (comm via satellite/VSS)
- Implement servicing functions via HPA/RMS/OCP
  Examine, repair, maintenance, resupply, reconfigure
- Checkout/verify status of on-orbit services performed (comm via satellite)
- Activation of selected subsystems via ground link (comm via satellite/VSS)

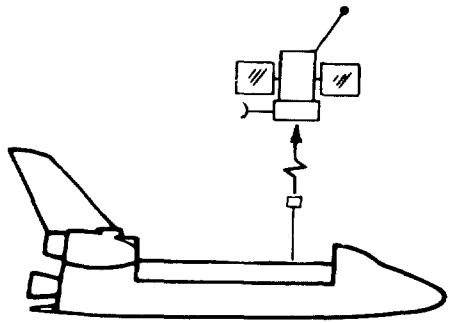
PAYLOAD REDEPLOYMENT

(11)



- Satellite/VSS appendages deployed by ground command and verified by orbiter crew
- State vector transfer
- Transfer satellite/VSS to internal power
- Final status/health check prior to deployment (comm via satellite/VSS)

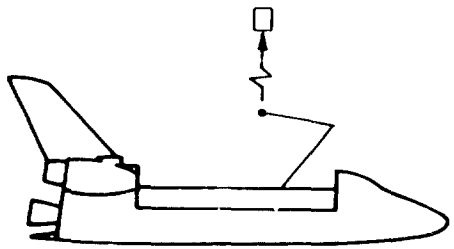
(12)



- HPA releases satellite/VSS at ~ 1 ft/sec velocity
- VSS activation of RCS at > 200 ft separation

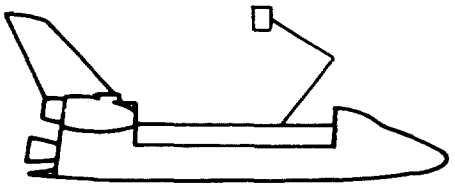
MTV DEPLOYMENT

(13)



- MTV deployed to view VSS firing
- VSS stage activates propulsion system at > 2700 ft separation

(14)



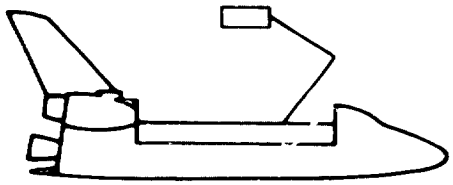
- Orbiter/MTV rendezvous (MTV active)
- MTV retrieved by RMS and stowed in payload bay

VSS RETRIEVAL

ft separation

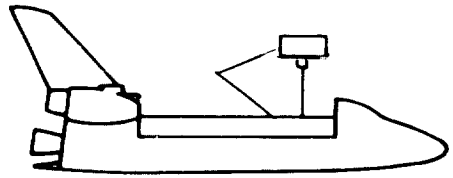
VSS RETRIEVAL

(15)



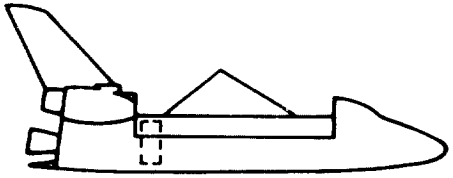
- Orbiter/VSS stage rendezvous (VSS active)
- VSS ACS active (RCS disabled, propellents vented)
- RMS attaches to VSS

(16)



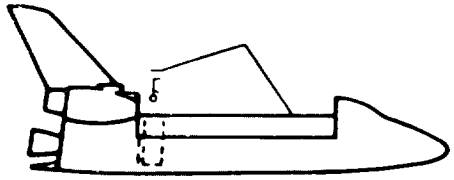
- VSS berthed to HPA
- VSS inactivated/checked out for return

(17)



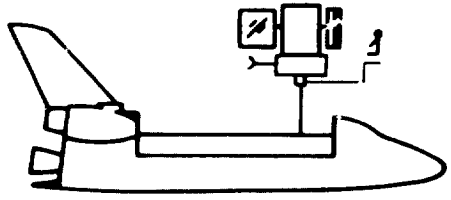
- RMS transfers VSS to retention structure
- Retention latches locked

BACKUP FOR RETENTION LATCH HANGUP



- MFR/RMS deployed for manual release
  or
  EVA via handrails employed
- Latches in closed position (unlocked) to enable RMS attachment

BACKUP FOR APPENDAGE HANGUP



- Work station on HPA is utilized
  and/or
  MFR/RMS deployed for manual assist

FOLDOUT FRAME 4

0181-016D
R81-0181-155(T)
1472-031(T)

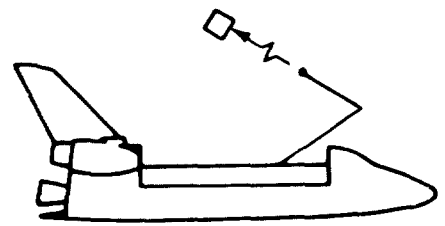
IRAC

R8 Alternate No. 1 Revisit Sequence – LEO/Propulsion Payload Class – Versatile Service Stage/Contamination Sensitive Satellite – RMS/HPA Usage

GRUMMAN

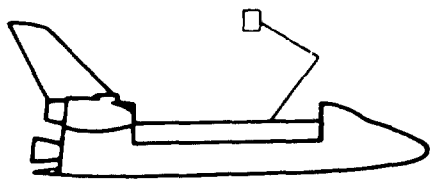
MTV DEPLOYMENT/PAYLOAD EXAMINATION

(1)



- Orbiter rendezvous with satellite to within ~ 1000 ft separation distance
- MTV is deployed to examine satellite

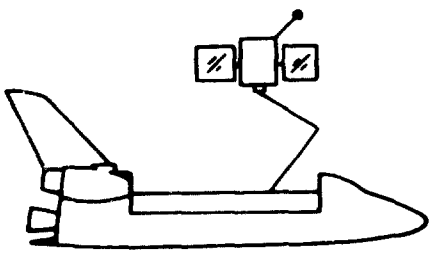
(2)



- Orbiter/MTV rendezvous (MTV active)
- MTV retrieved by RMS and stowed in payload bay

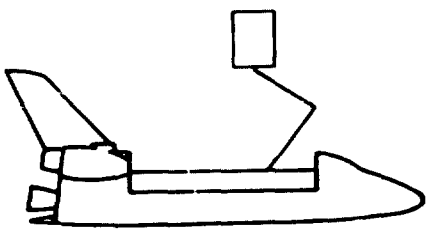
RETRIEVAL/STOWAGE

(3)



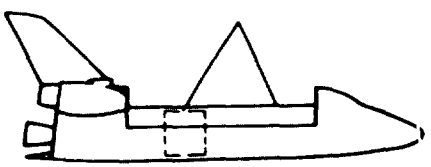
- Satellite safing, propellent venting, preparations for rendezvous
- Satellite ACS is active to maintain stability
- Orbiter rendezvous with satellite to within RMS reach distance, satellite examined via RMS TV or visual crew observation
- RMS attaches to satellite

(4)



- Satellite appendages retracted
- Deactivate satellite by ground command

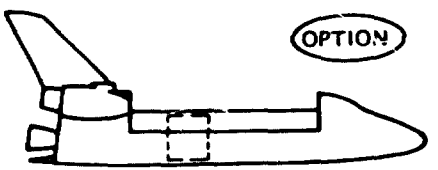
(5)



- RMS transfers satellite to retention structure
- Retention latches locked

(6)

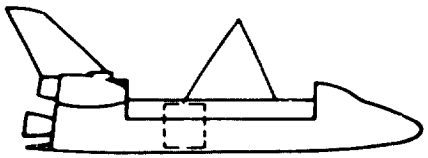
OPTION



- Umbilical connection verified
- Transfer satellite to orbiter power to maintain thermal control

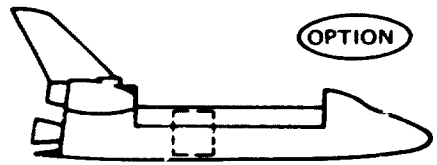
- Orbiter rendezvous with satellite to within RMS reach distance, satellite examined via RMS TV or visual crew observation
- RMS attaches to satellite

(5)



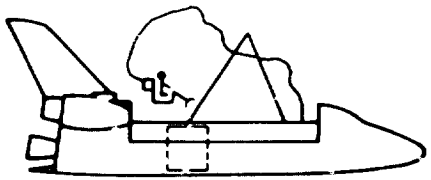
- RMS transfers satellite to retention structure
- Retention latches locked

(6)

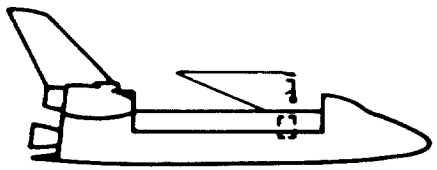


- Umbilical connection verified
- Transfer satellite to orbiter power to maintain thermal control

BACKUP FOR RETENTION LATCH HANGUP

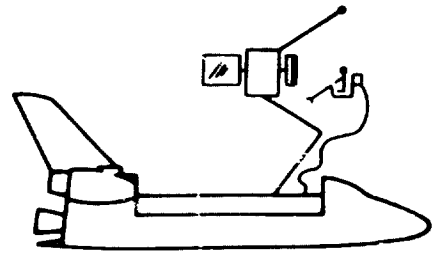


- MMU/WRU with stabilizer deployed for manual assist
  or
  EVA via handrails employed



- MFR/RMS deployed for manual assist
  or
  EVA via handrails employed

BACKUP FOR APPENDAGE HANGUP



- MMU/WRU with stabilizer deployed for manual assist

R81-0181-156(T)
0181-005D

RAD

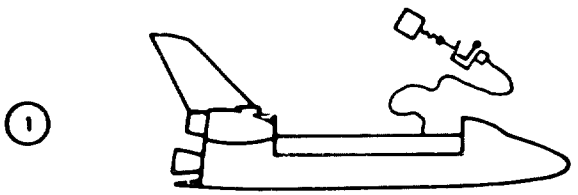
ER1 Nominal Earth Return Sequence – Direct Delivery Payload Class – Cooperative MMS-Type Satellites – RMS Usage

FOLDOUT FRAME 2

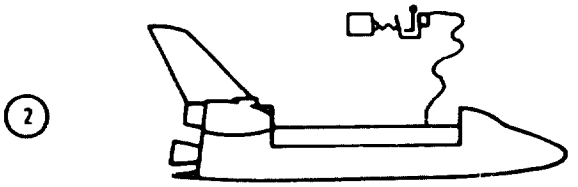
GRUMMAN

FOLDOUT FRAME

MTV DEPLOYMENT/PAYLOAD EXAMINATION

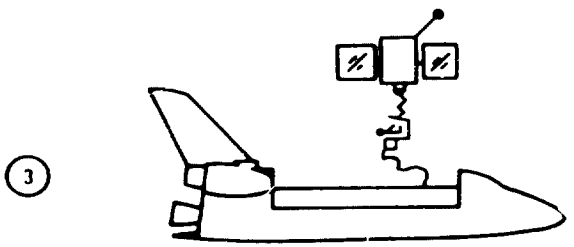


- Orbiter rendezvous with satellite to within ~ 1000 ft separation distance
- MTV is deployed by MMU/WRU with RMS end effector to examine satellite

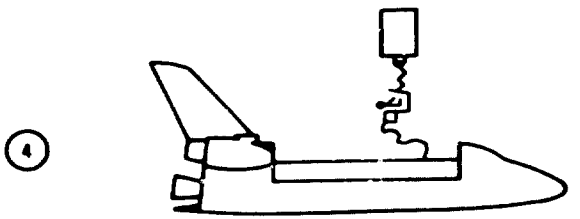


- Orbiter/MTV rendezvous (MTV active)
- MTV retrieved by MMU/WRU and stowed in payload bay

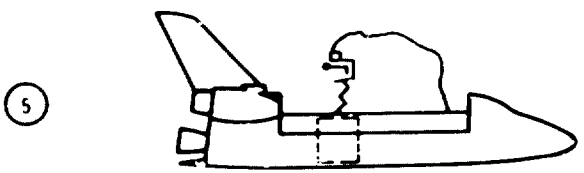
RETRIEVAL/STOWAGE



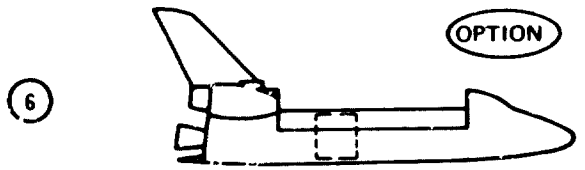
- Satellite safing, propellant venting, preparations for rendezvous
- Satellite ACS is active to maintain stability
- Orbiter rendezvous with satellite to within view of AFD/payload bay TV cameras, satellite examined via MMU/WRU or visual crew observation
- MMU/WRU with RMS end-effector attaches to satellite



- Satellite appendages retracted
- Deactivate satellite by ground command



- MMU/WRU transfers satellite to retention structure
- Retention latches locked

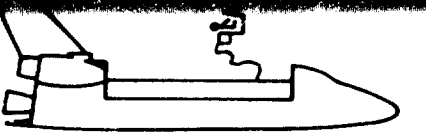


- Umbilical connection verified
- Transfer satellite to orbiter power to maintain

3

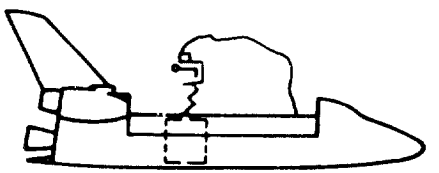
- Satellite safing, propellant venting, preparations for rendezvous
- Satellite ACS is active to maintain stability
- Orbiter rendezvous with satellite to within view of AFD/payload bay TV cameras, satellite examined via MMU/WRU or visual crew observation
- MMU/WRU with RMS end-effector attaches to satellite

4



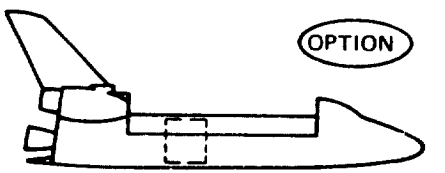
- Satellite appendages retracted
- Deactivate satellite by ground command

5



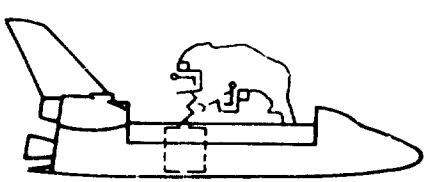
- MMU/WRU transfers satellite to retention structure
- Retention latches locked

6



- Umbilical connection verified
- Transfer satellite to orbiter power to maintain thermal control

BACKUP FOR RETENTION LATCH HANGUP

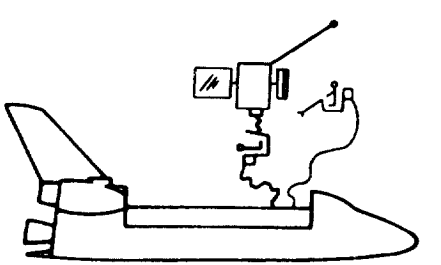


- First MMU/WRU maintains stability/position of satellite in payload bay
- Second MMU with stabilizer deployed for manual release

or

EVA via handrails employed

BACKUP FOR APPENDAGE HANGUP



- First MMU/WRU maintains stability/position of satellite
- Second MMU with stabilizer deployed for manual assist

0181-006D
1472-032(T)

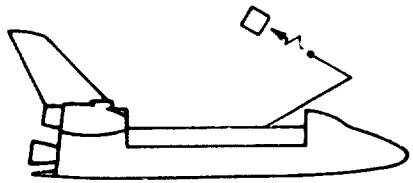
IRAD

ER2 Nominal Earth Return Sequence – Direct Delivery Payload Class – Cooperative MMS-Type Satellites – RMS Inoperative

GRUMMAN

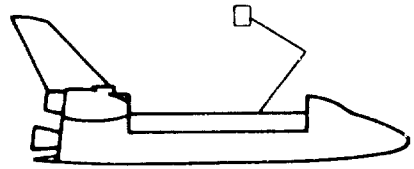
MTV DEPLOYMENT/PAYLOAD EXAMINATION

1



- Orbiter rendezvous with satellite to within ~ 1000 ft separation distance
- MTV is deployed to examine satellite

2

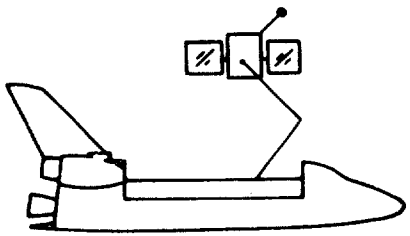


- Orbiter/MTV rendezvous (MTV active)
- MTV retrieved by RMS and stowed in payload bay

FOLDOUT FRAME

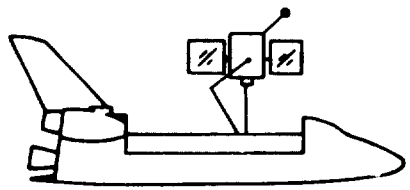
RETRIEVAL/STOWAGE

3



- Satellite safing, propellent venting, preparations for rendezvous
- Satellite ACS is active to maintain stability
- Orbiter rendezvous with satellite to within RMS reach distance, satellite examined via RMS TV or visual crew observation
- RMS attaches to satellite

4

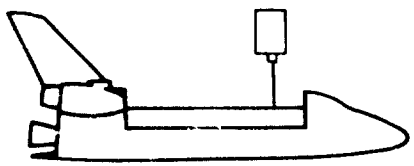


- Satellite berthed to HPA

OPTION

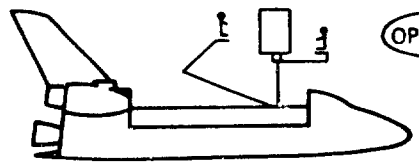
- Umbilical connections verified
- Transfer satellite to orbiter power to maintain thermal control

5



- Satellite appendages retracted by ground command and verified by orbiter crew
- Satellite inactivated by ground command and checked-out for return

6



OPTION

- Implement manual removal/stowage of selected equipment via HPA work station and RMS/OCP, if required

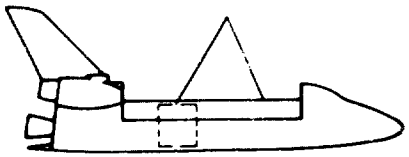
5

- Satellite appendages retracted by ground command and verified by orbiter crew
- Satellite inactivated by ground command and checked-out for return

6

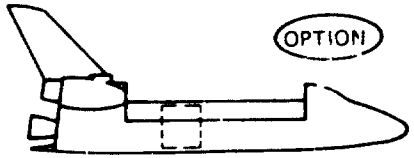
- Implement manual removal/stowage of selected equipment via HPA work station and RMS/OCP, if required

7



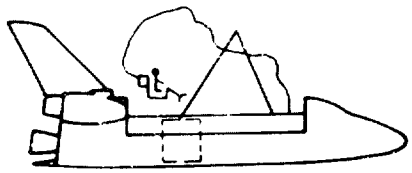
- RMS transfers satellite to retention structure
- Retention latches locked

8



- Umbilical connection verified
- Transfer satellite to orbiter power to maintain thermal control

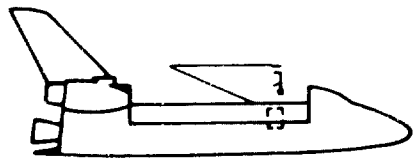
BACKUP FOR RETENTION LATCH HANGUP



- MMU/WRU with stabilizer deployed for manual assist

  or

  EVA via handrails employed

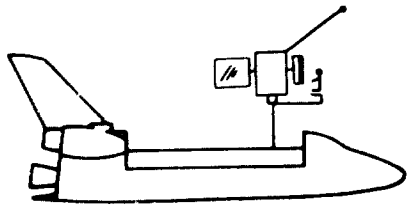


- MFR/RMS deployed for manual assist

  or

  EVA via handrails employed

BACKUP FOR APPENDAGE HANGUP



- Work station on HPA is utilized

  or

  MFR/RMS deployed for manual assist

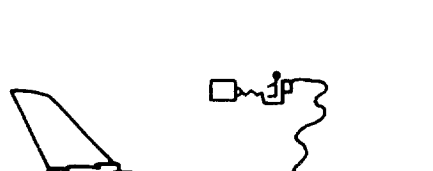
ER3 Alternate No. 1 Earth Retu rn Sequence – Direct Delivery Payload Class – Cooperative MMS-Type Satellites – RMS/HPA Usage

MTV DEPLOYMENT/PAYLOAD EXAMINATION

1

- Orbiter rendezvous with satellite to within ~ 1000 ft separation distance
- MTV is deployed by MMU/WRU with RMS end effector to examine satellite

2



- Orbiter/MTV rendezvous (MTV active)
- MTV retrieved by MMU/WRU and stowed in payload bay

RETRIEVAL/STOWAGE

3

- Satellite safing, propellent venting, preparations for rendezvous
- Satellite ACS is active to maintain stability
- Orbiter rendezvous with satellite to within view of AFD/payload bay TV cameras, satellite examined via MMU/WRU or visual crew observation
- MMU/WRU with RMS end effector attaches to satellite

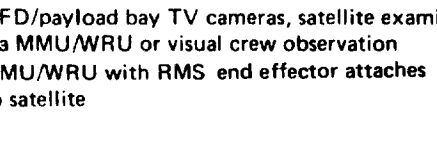
4

- Satellite berthed to HPA

OPTION

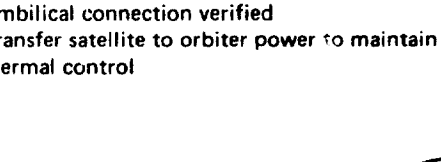
- Umbilical connection verified
- Transfer satellite to orbiter power to maintain thermal control

5



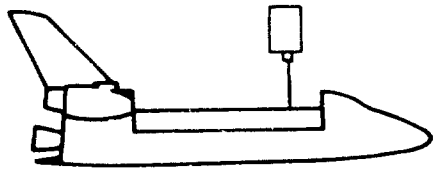
6

OPTION



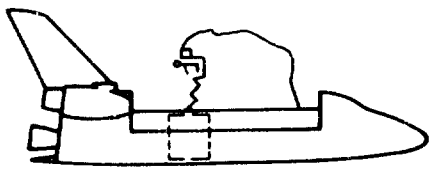
- Orbiter rendezvous with satellite to within view of AFD/payload bay T'V cameras, satellite examined via MMU/WRU or visual crew observation
- MMU/WRU with RMS end effector attaches to satellite

(5)



- Satellite appendages retracted by ground command and verified by orbiter crew
- Satellite inactivated by ground command and checked-out for return

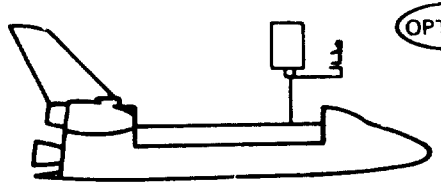
(7)



- MMU/WRU transfers satellite to retention structure
- Retention latches locked

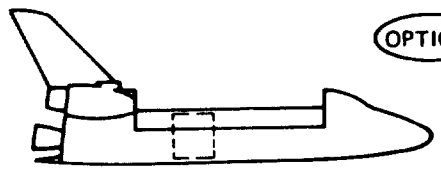
- Umbilical connection verified
- Transfer satellite to orbiter power to maintain thermal control

(6) OPTION



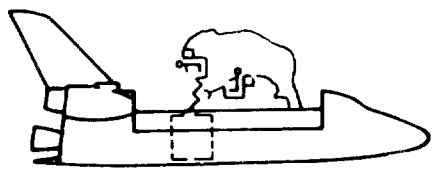
- Implement manual removal/storage of selected equipment via HPA work station, if required

(8) OPTION



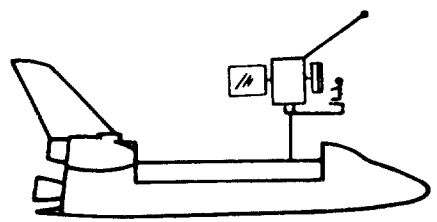
- Umbilical connection verified
- Transfer satellite to orbiter power to maintain thermal control

BACKUP FOR RETENTION LATCH HANGUP



- First MMU/WRU maintains stability/position of satellite in payload bay
- Second MMU with stabilizer deployed for manual release
  or
  EVA via handrails employed

BACKUP FOR APPENDAGE HANGUP



- Work station on HPA is utilized

0181-008D
1472-034(T)

IRAD

ER4 Alternate No. 1 Earth Return Sequence – Direct Delivery Payload Class – Cooperative MMS-Type Satellites – RMS Inoperative – HPA Usage

GRUMMAN

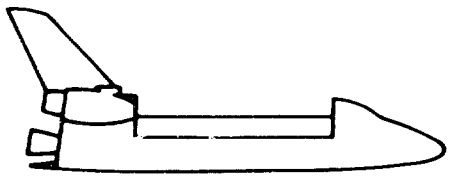
FOLDOUT FRAME 2

POM-MMU/WRU DEPLOYMENT/PAYLOAD RETRIEVAL

FOLDOUT FRAME

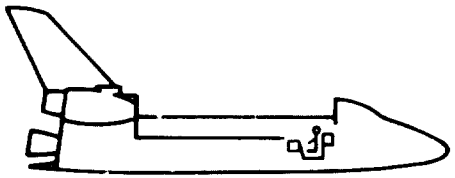
PRECEDING PAGE BLANK NOT FILMED

1



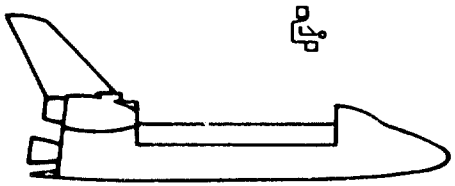
- Satellite safing, propellant venting, preparations for rendezvous
- Satellite ACS is active to maintain stability
- Orbiter rendezvous with satellite to within 1000 ft separation distance

2



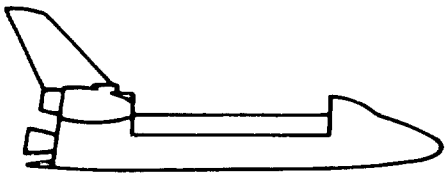
- Proximity Operations Module (POM)-MMU/WRU adaptation stowed in retention structure (AESA)
- Status/health checks via umbilical in retention structure (comm via orbiter S-Band)
- EVA crewman mounts POM-MMU/WRU
- Activation/checkout of POM-MMU/WRU

3



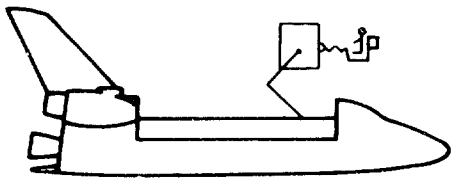
- POM-MMU/WRU released from retention structure/umbilical
- POM-MMU/WRU initiates closure maneuver to examine and retrieve satellite

4

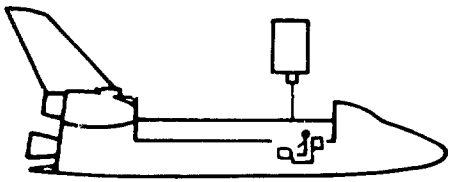


- POM-MMU/WRU docks to satellite grapple fitting
- Satellite appendages retracted
- Satellite ACS deactivated

5



6

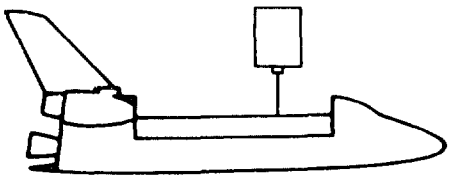


- POM-MMU/WRU transports satellite to orbiter within RMS reach distance
- RMS attaches to satellite and POM (POM ACS active)
- Deactivate satellite by ground command POM-MMU/WRU separates from satellite

- Satellite berthed to HPA and umbilical connection verified
- Transfer satellite to orbiter power to maintain thermal control
- POM-MMU/WRU stowed in retention structure (AESA), retention latches locked

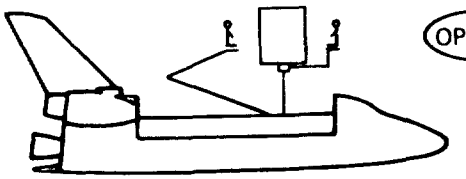
SATELLITE STOWAGE

(7)



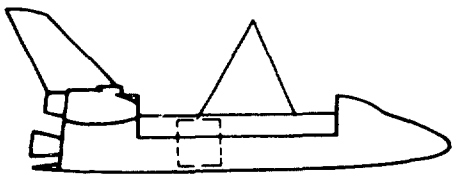
- Satellite inactivated by ground command and checked-out for return

(8)



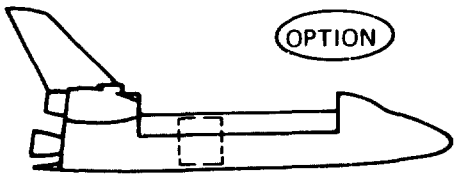
- Implement manual removal/stowage of selected equipment via HPA and RMS/OCP, if required

(9)



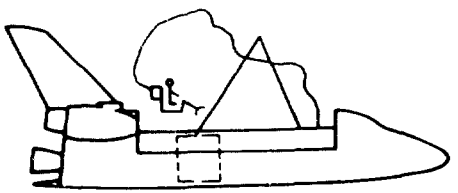
- RMS transfers satellite to retention structure
- Retention latches locked

(10)



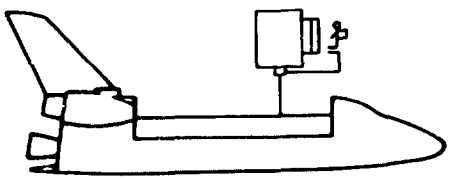
- Umbilical connection verified
- Transfer satellite to orbiter power to maintain thermal control

BACKUP FOR RETENTION LATCH HANGUP



- MMU/WRU with stabilizer deployed for manual assist
  or
  EVA via handrails employed

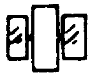
BACKUP FOR APPENDAGE HANGUP



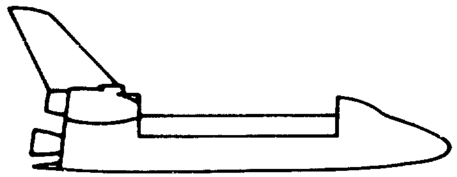
- Work Station on HPA is utilized
  or
  MFR/RMS deployed for manual assist

FOLDOUT FRAME 2

MANNED-POM DEPLOYMENT/PAYLOAD RETRIEVAL

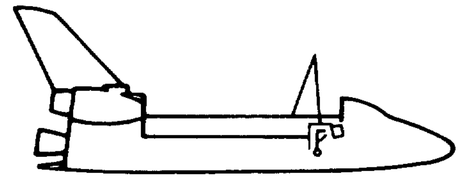


1



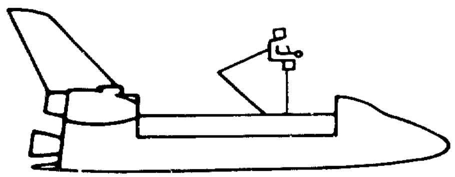
- Satellite safing, propellant venting, preparations for rendezvous
- Satellite ACS is active to maintain stability
- Orbiter rendezvous with satellite to 1000 ft separation distance

2



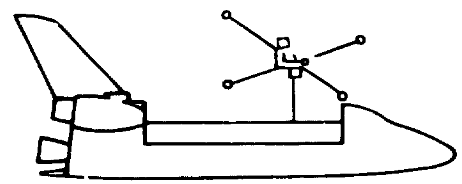
- Proximity Operations Module (POM), Manned Version, stowed in retention structure
- Status/health checks via umbilical in retention structure (comm via orbiter S-Band)
- EVA crewman mounts POM-Manned Version
- RMS attaches to POM Manned Version

3



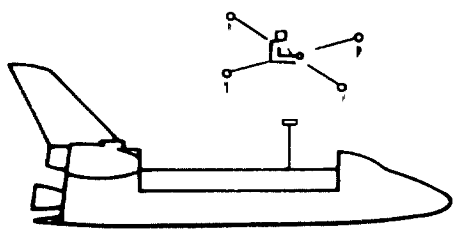
- POM released from retention structure/umbilical
- RMS berths POM to HPA and umbilicals verified
- Transfer POM to orbiter power to maintain thermal control

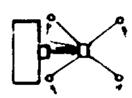
4



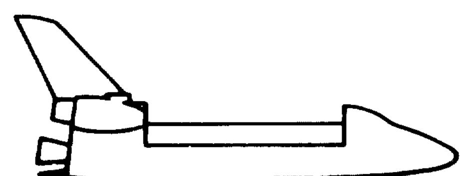
- Activation of POM subsystems via orbiter command (comm via orbiter)
- POM appendages deployed by orbiter command and verified by orbiter crew
- Final status/health checks prior to deployment (comm via orbiter)

5





6



FOLDOUT FRAME

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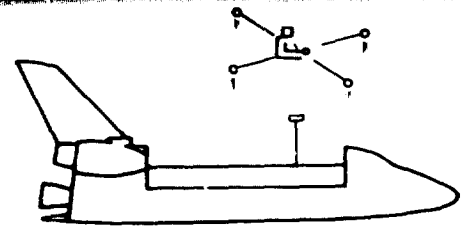
5

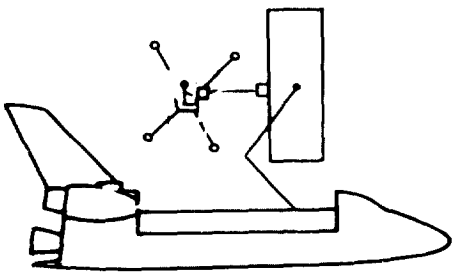


- Transfer POM to internal power
- HPA releases Manned POM to examine and retrieve satellite
- POM initiates closure maneuver

6

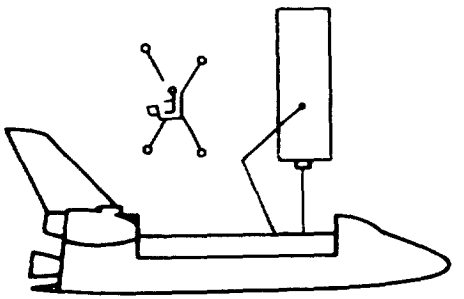
- POM docks to satellite grapple fitting
- Satellite appendages retracted
- Satellite ACS inactivated

7



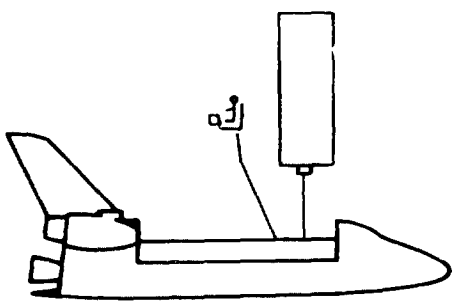
- Manned POM transports satellite to orbiter within RMS reach distance
- RMS attaches to Satellite (POM ACS active)
- Deactive satellite by ground command
- POM separates from satellite

8



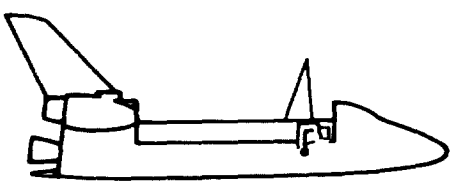
- Satellite berthed to HPA and umbilical connections verified
- Transfer satellite to orbiter power to maintain thermal control

9



- RMS attaches to Manned POM and elevated within view of AFD/payload bay TV cameras
- POM appendages retracted
- POM inactivated, checked out for stowage and return

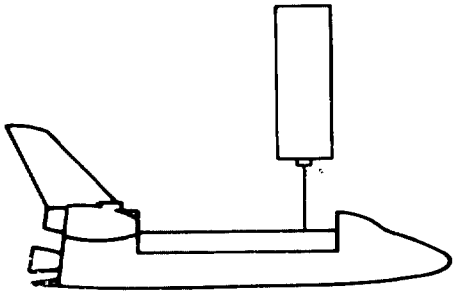
10



- POM stowed in retention structure, retention latches locked

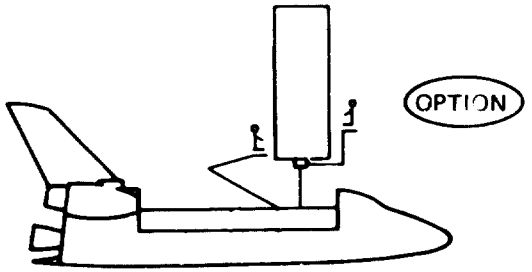
SATELLITE STOWAGE

(11)



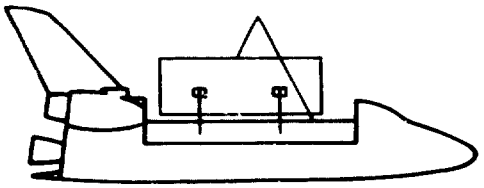
- Satellite inactivated by ground command and checked-out for return

(12)



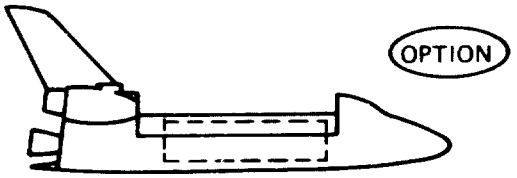
- Implement manual removal/stowage of selected equipment via HPA and RMS/OCP, if required

(13)



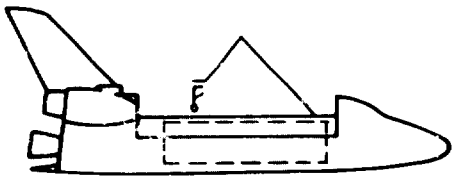
- RMS transfers satellite to PIDA
- PIDA lowers satellite in retention structure
- Retention latches locked

(14)



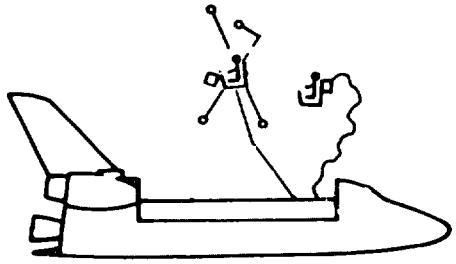
- Umbilical connection verified
- Transfer satellite to orbiter power to maintain thermal control

BACKUP FOR RETENTION LATCH HANGUP



- MFR/RMS deployed for manual assist
  or
  EVA via handrails employed

BACKUP FOR APPENDAGE HANGUP



- MMU/WRU with stabilizer deployed for manual assist

FOLDOUT FRAME 2

0181-042D
1472-036(T)

ER6 Alternate No. 2 Earth Return Sequence – Direct Delivery Payload Class – Cooperative Large Satellites – RMS/HPA Usage – Manned Retrieval of Satellites at 1000 ft Separation

IRAD

GRUMMAN

POM-MTV DEPLOYMENT/PAYLOAD RETRIEVAL

FOLDOUT FRAME

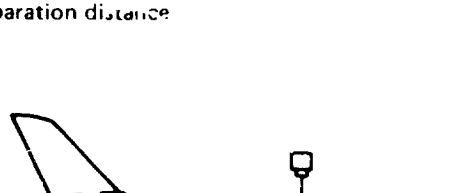
1

- Satellite safing, propellent venting, preparations for rendezvous
- Satellite ACS is active to maintain stability
- Orbiter rendezvous with satellite to 1000 ft separation distance

2

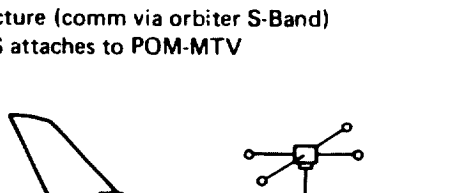
- Proximity Operations Module – MTV adaptation (POM-MTV) stowed in retention structure
- Status/health checks via umbilical in retention structure (comm via orbiter S-Band)
- RMS attaches to POM-MTV

3



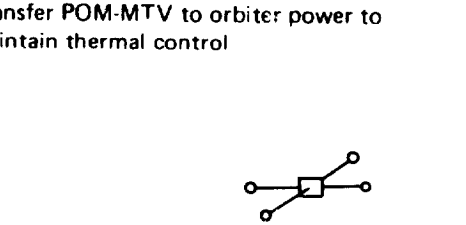
- POM-MTV released from retention structure/umbilical
- RMS berths POM-MTV and umbilicals verified
- Transfer POM-MTV to orbiter power to maintain thermal control

4



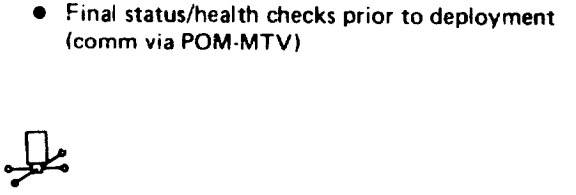
- Activation of selected POM-MTV subsystems via ground link (comm via POM-MTV)
- POM-MTV appendages deployed by ground command and verified by orbiter crew
- Final status/health checks prior to deployment (comm via POM-MTV)

5



- Transfer POM-MTV to internal power
- HPA releases POM-MTV at ~ 1 ft/sec velocity to examine and retrieve satellite (MMU/WRU manned POM deployment is alternate)

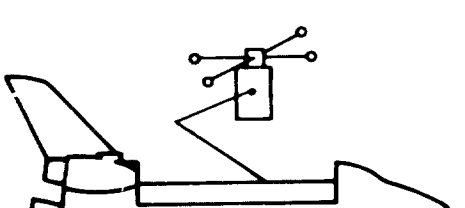
6



- POM-MTV docks to satellite grapple fitting
- Satellite appendages retracted
- Satellite ACS inactivated

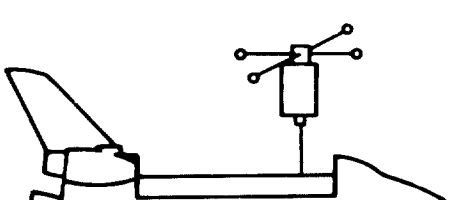
- **HPA releases POM-MTV at ~ 1 ft/sec** velocity to examine and retrieve satellite (MMU/WRU manned POM deployment is alternate)

(7)



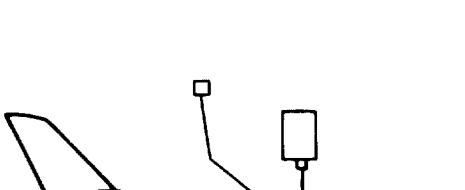
- POM-MTV transports satellite to orbiter within RMS reach distance
- RMS attaches to satellite (POM ACS active)
- Deactivate satellite by ground command

(8)



- Satellite berthed to HPA and umbilical connections verified
- Transfer satellite to orbiter power to maintain thermal control
- Activate orbiter's non-contaminating ACS package or place orbiter in free drift

(9)



- RMS attaches to POM-MTV, releases from satellite, and elevates within view of AFD/ payload bay TV cameras
- POM-MTV appendages retracted
- POM-MTV inactivated, checked out for stowage and return

(10)

- POM-MTV stowed in retention structure, retention latches locked

SATELLITE STOWAGE

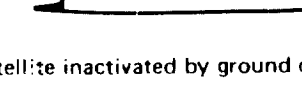
(11)

- Satellite inactivated by ground command and checked-out for return

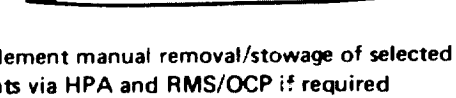
OPTION

(12)

- Implement manual removal/stowage of selected equipments via HPA and RMS/OCP if required



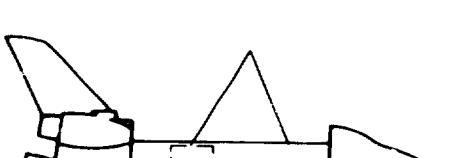
OPTION



- Satellite inactivated by ground command and checked-out for return

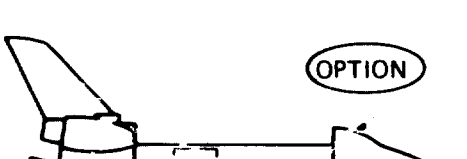
- Implement manual removal/stowage of selected equipments via HPA and RMS/OCP if required

(13)



- RMS transfers satellite to retention structure
- Retention latches locked

(14)



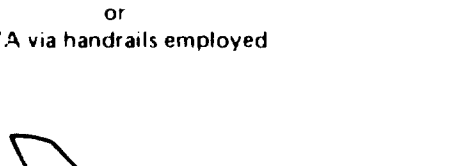
- Umbilical connection verified
- Transfer satellite to orbiter power to maintain thermal control

BACKUP FOR RETENTION LATCH HANGUP

- MMU/WRU with stabilizer deployed for manual assist

  or

  EVA via handrails employed

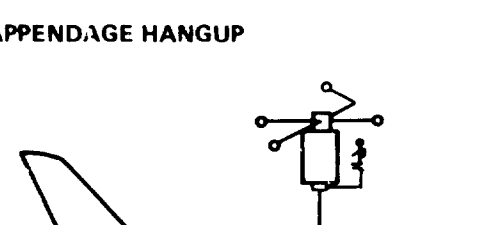


- MFR/RMS deployed for manual assist

  or

  EVA via handrails employed

BACKUP FOR APPENDAGE HANGUP



- Work Station on HPA is utilized

  or

  MFR/RMS deployed for manual assist

(81-043D)
1472-037(T)

ER7 Alternate No. 3 Earth Return Sequence – Direct Delivery Payload Class – Cooperative Contamination Sensitive Satellite – RMS/HPA Usage – Unmanned Retrieval of Satellites at 1000 ft Separation

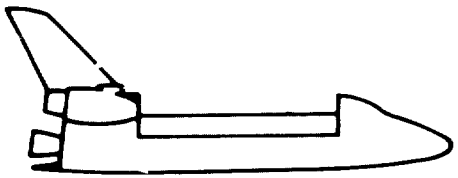
RAC

GRUMMAN

FOLDOUT FRAME

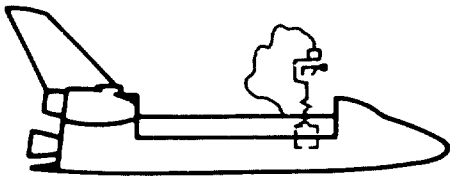
POM-MTV DEPLOYMENT/PAYLOAD RETRIEVAL

1



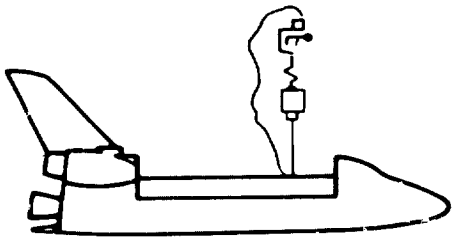
- Satellite safing, propellent venting, preparations for rendezvous
- Satellite ACS is active to maintain stability
- Orbiter rendezvous with satellite to 1000 ft separation distance

2



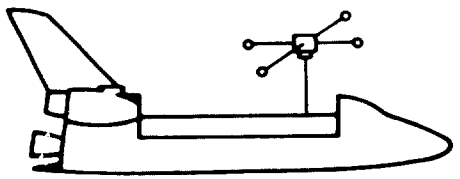
- Proximity Operations Module - MTV adaptation (POM-MTV) stowed in retention structure
- Status/health checks via umbilical in retention structure (comm via orbiter S-Band)
- MMU/WRU with RMS end-effector attaches to POM-MTV

3



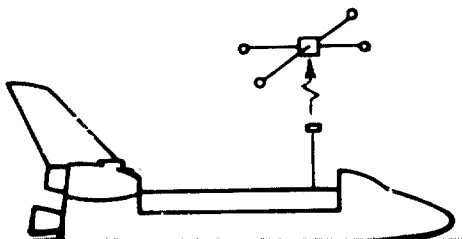
- POM-MTV released from retention structure/ umbilical
- MMU/WRU berths POM-MTV to HPA and umbilical verified
- Transfer POM-MTV to orbiter power to maintain thermal control

4

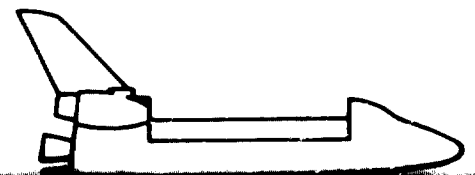


- Activation of selected POM-MTV subsystems via ground link (comm via POM-MTV)
- POM-MTV appendages deployed by ground command and verified by orbiter crew
- Final status/health checks prior to deployment (comm via POM-MTV)

5



6



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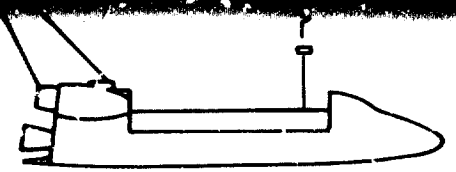
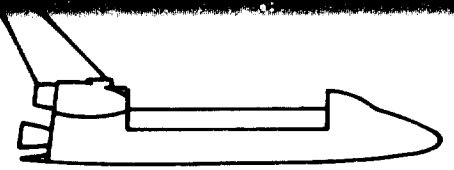
5



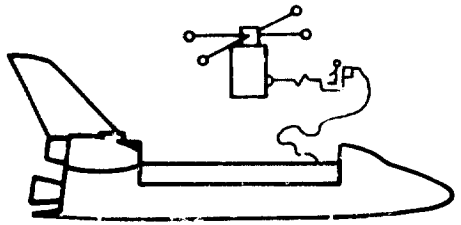
- Transfer POM-MTV to internal power
- HPA releases POM-MTV at ~ 1 ft/sec velocity to examine and retrieve satellite (MMU/WRU manned POM deployment is alternate)

6



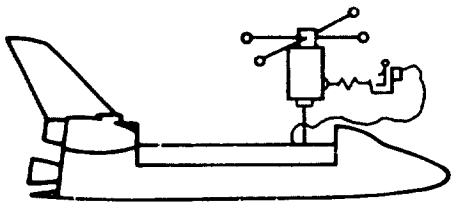
- POM-MTV docks to satellite grapple fitting
- Satellite appendages retracted
- Satellite ACS inactivated

7



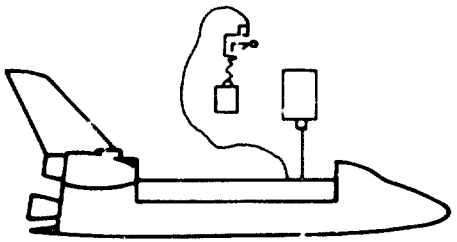
- POM-MTV transports satellite to orbiter within view of AFD/payload bay TV cameras
- MMU/WRU attaches to satellite (POM ACS active)
- Deactivate satellite by ground command

8



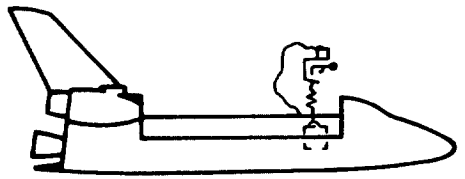
- Satellite berthed to HPA and umbilical connections verified
- Transfer satellite to orbiter power to maintain thermal control
- Activate orbiter's non-contaminating ACS package or place orbiter in free drift

9



- MMU/WRU attaches to POM-MTV, releases from satellite and elevates within view of AFD/payload bay TV cameras
- POM-MTV appendages retracted
- POM-MTV inactivated, checked out for stowage and return

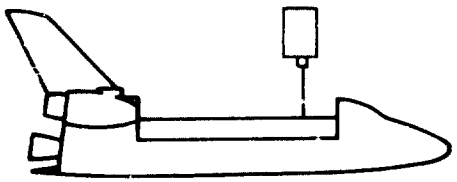
10



- POM-MTV stowed in retention structure, retention latches locked

SATELLITE STOWAGE

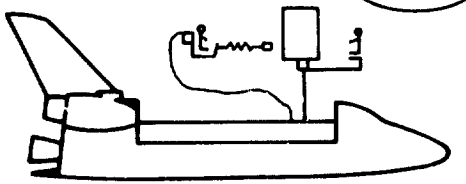
11



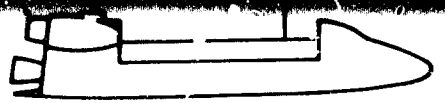
- Satellite inactivated by ground command and checked

12

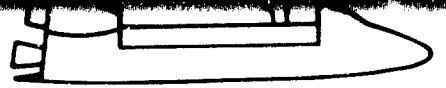
OPTION



- Implement manual removal/stowage of selected

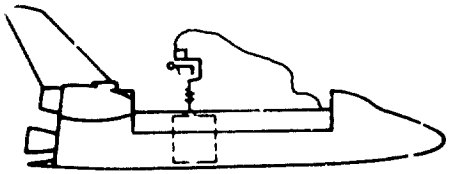


- Satellite inactivated by ground command and checked-out for return



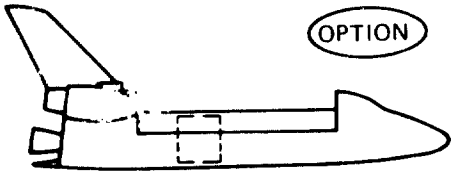
- Implement manual removal/stowage of selected equipments via HPA, if required

(13)



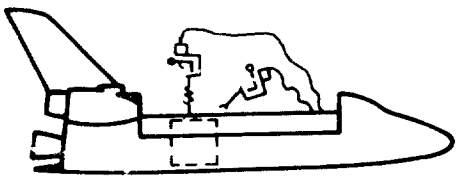
- MMU/WRU transfers satellite to retention structure
- Retention latches locked

(14)



- Umbilical connection verified
- Transfer satellite to orbiter power to maintain thermal control

BACKUP FOR RETENTION LATCH HANGUP

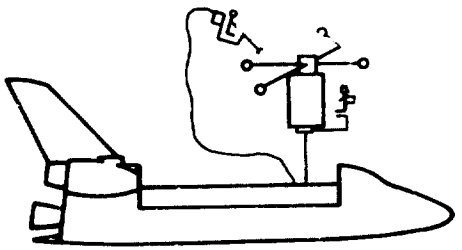


- First MMU/WRU maintains stability/position of satellite in payload bay
- Second MMU with stabilizer deployed for manual release

or

EVA via handrails employed

BACKUP FOR APPENDAGE HANGUP



- Work station on HPA is utilized

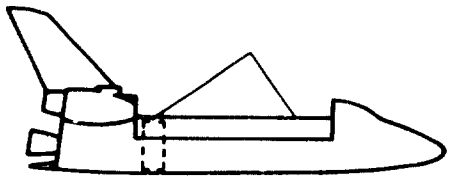
or

MMU with stabilizer deployed for manual release

FOLDOUT FRAME

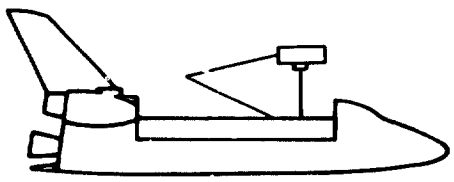
VSS DEPLOYMENT

1



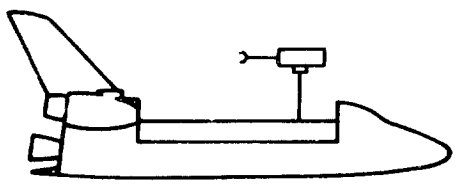
- VSS with docking/rendezvous capability stowed in retention structure
- Status/health checks via umbilical in retention structure (comm via orbiter S-Band)
- RMS attaches to VSS

2



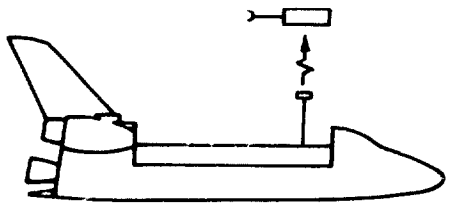
- VSS retention latches/umbilical released
- RMS translates VSS and berths to HPA, umbilical connections verified

3



- Activation of selected VSS subsystem by ground link (comm via VSS)
- VSS appendages deployed by ground command and verified by orbiter crew
- Final status/health check prior to deployment (comm via VSS)
- State vector transfer
- Transfer VSS to internal power

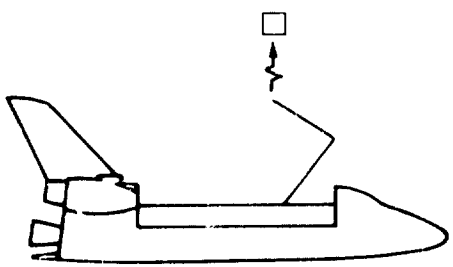
4



- HPA releases VSS at ~ 1 ft/sec velocity
- VSS activation of RCS at > 200 ft separation

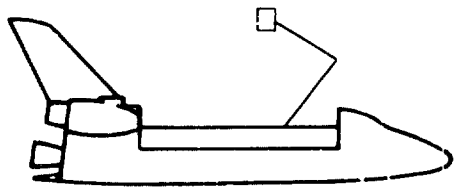
MTV DEPLOYMENT

5



- MTV deployed to view VSS firing
- VSS activates propulsion system at > 2700 ft separation

6



- Orbiter/MTV rendezvous (MTV active)
- MTV retrieved by RMS and stowed in payload bay

FOLDOUT FRAME

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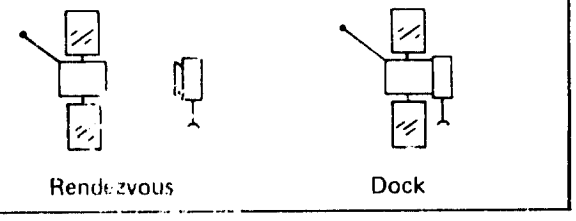
- MTV deployed to view VSS firing
- VSS activates propulsion system at > 2700 ft separation

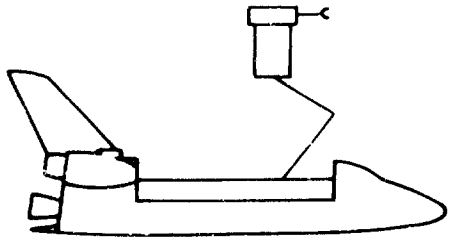
- Orbiter/MTV rendezvous (MTV active)
- MTV retrieved by RMS and stowed in payload bay

(7)

VSS rendezvous/dock with satellite
and
Returns to orbiter

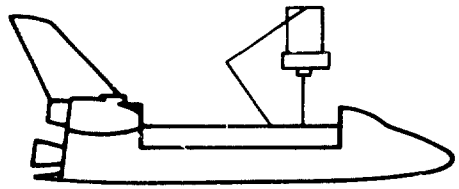


(8)



- Orbiter/VSS rendezvous (VSS active) within RMS reach distance and examined by RMS TV or visual crew observation
- VSS ACS is active to maintain stability
- RMS attaches to satellite/VSS

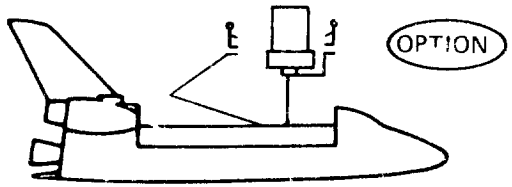
(9)



- VSS appendages retracted
- Deactivate VSS and satellite by ground command
- For contamination sensitive payloads, activate orbiter's non-contaminating ACS package, or place orbiter in free drift
- Satellite/VSS berthed to HPA and umbilical connections verified
- Transfer satellite/VSS to orbiter power to maintain thermal control

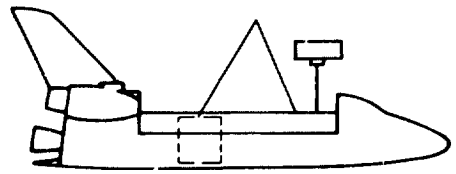
SATELLITE STOWAGE

(10)



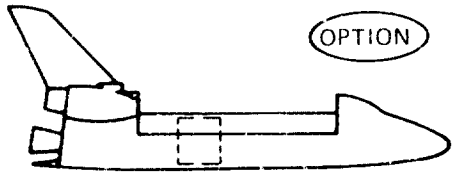
- Implement manual removal/stowage of selected equipment via HPA and RMS/OCP, if required

(11)



- RMS transfers satellite to retention structure
- Retention latches locked

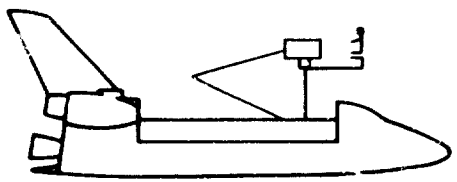
OPTION



- Umbilical connection verified
- Transfer satellite to orbiter power to maintain thermal control

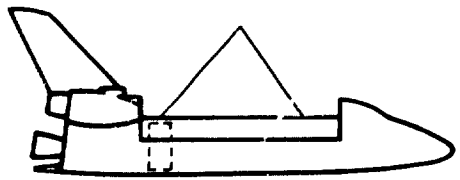
VSS STOWAGE

(13)



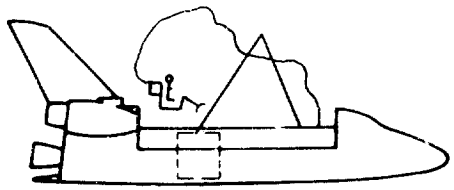
- VSS checked out for earth return
- PMS attaches to VSS

(14)



- RMS transfers VSS to retention structure
- Retention latches locked

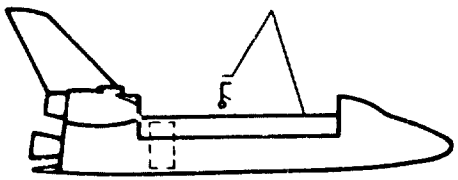
BACKUP FOR RETENTION LATCH HANGUP



- MMU/WRU with stabilizer deployed for manual assist

  or

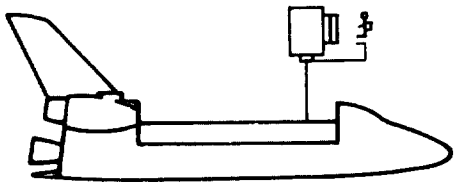
  EVA via handrails employed



- MFR/RMS deployed for manual assist

  or

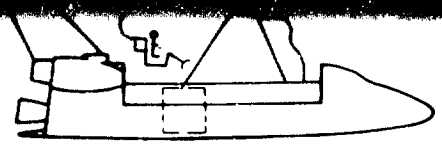
BACKUP FOR APPENDAGE HANGUP



- Work Station on HPA is utilized

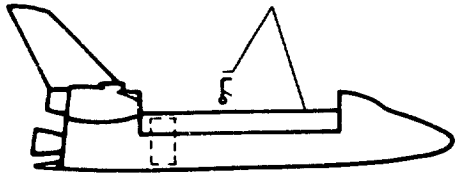
  or

  MFR/RMS deployed for manual assist

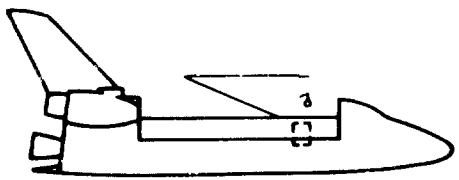


- MMU/WRU with stabilizer deployed for manual assist
  or
  EVA via handrails employed

- Work Station on HPA is utilized
  or
  MFR/RMS deployed for manual assist



- MFR/RMS deployed for manual assist
  or
  EVA via handrails employed



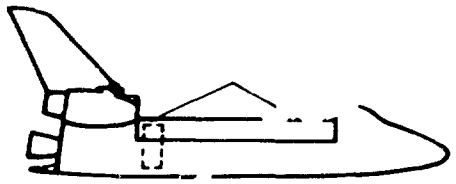
- MFR/RMS deployed for manual assist
  or
  EVA via handrails employed

FOLDOUT FRAME 4

ER9 Alternate No. 1 Earth Return Sequence – LEO/Propulsion Payload Class – Cooperative Nominal Payload – RMS/HPA Usage – Versatile Service Stage Application

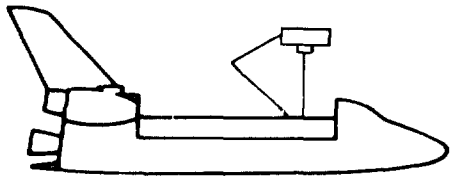
VSS DEPLOYMENT

1



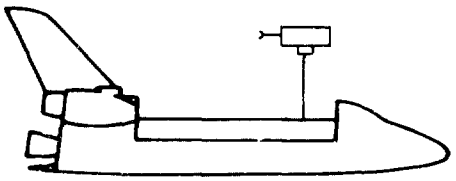
- VSS with docking/rendezvous capability stowed in retention structure
- Status/health checks via umbilical in retention structure (comm via orbiter S-Band)
- RMS attaches to VSS

2



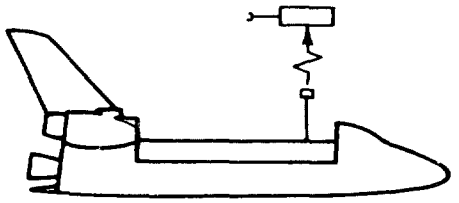
- VSS retention latches/umbilical released
- RMS translates VSS and berths to HPA, umbilical connections verified

3



- Activation of selected VSS subsystem by ground link (comm via VSS)
- VSS appendages deployed by ground command and verified by orbiter crew
- Final status/health check prior to deployment (comm via VSS)
- State vector transfer
- Transfer VSS to internal power

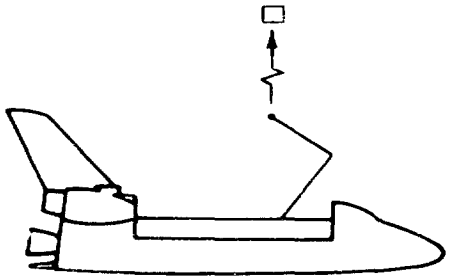
4



- HPA releases VSS at ~ 1 ft/sec velocity
- VSS activation of RCS at > 200 ft separation

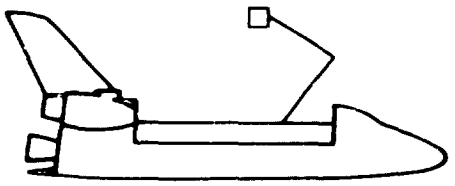
MTV DEPLOYMENT

5



- MTV deployed to view VSS firing

6



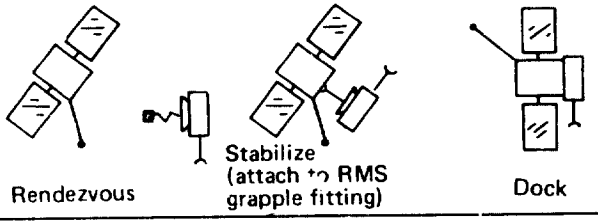
- Orbiter/MTV rendezvous (MTV active)

FOLDOUT FRAME

- MTV deployed to view VSS firing
- VSS activates propulsion system at > 2700 ft separation

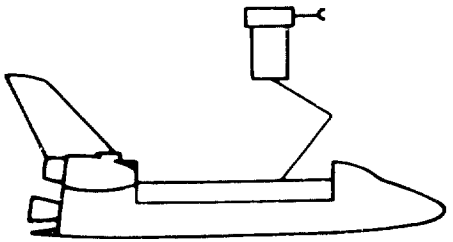
- Orbiter/MTV rendezvous (MTV active)
- MTV retrieved by RMS and stowed in payload bay

(7) VSS rendezvous and stabilizes satellite then docks and returns to orbiter



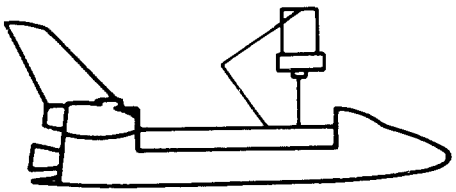
FOLDOUT FRAME 2

(8)



- Orbiter/VSS rendezvous (VSS active) within RMS reach distance, and examined by RMS TV or visual crew observation
- VSS ACS is active to maintain stability
- RMS attaches to satellite/VSS

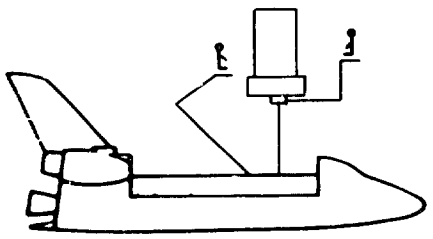
(9)



- VSS appendages retracted
- Deactivate VSS and satellite by ground command
- For contamination sensitive payloads, activate orbiter's non-contaminating ACS package, or place orbiter in free drift
- Satellite/VSS berthed to HPA and umbilical connections verified
- Transfer satellite/VSS to orbiter power to maintain thermal control

SATELLITE STOWAGE

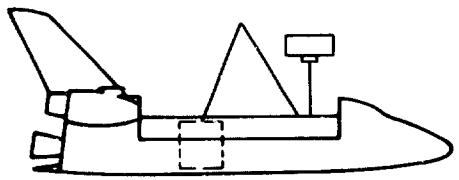
(10)



OPTION

- Implement manual removal/stowage of selected equipments via HPA and RMS/OCP, if required

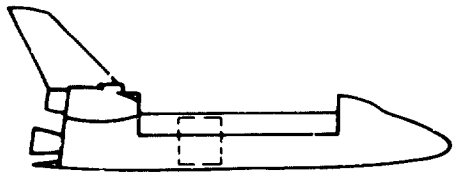
(11)



- RMS transfer satellite to retention structure
- Retention latches locked

OPTION

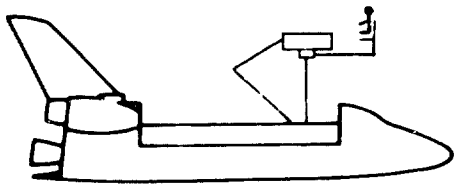
12



- Umbilical connection verified
- Transfer satellite to orbiter power to maintain thermal control

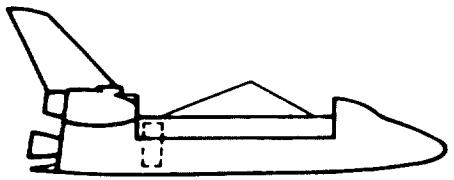
VSS STOWAGE

13



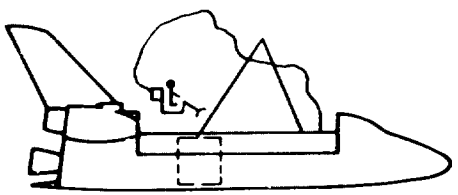
- VSS checked out for earth return
- RMS attaches to VSS

14



- RMS transfers VSS to retention structure
- Retention latches locked

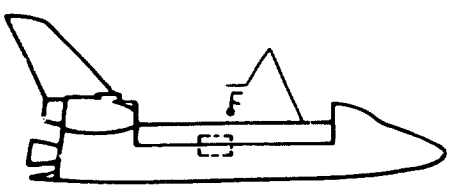
BACKUP FOR RETENTION LATCH HANGUP



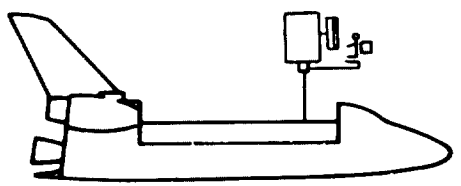
- MMU/WRU with stabilizer deployed for manual assist

  or

  EVA via handrails employed



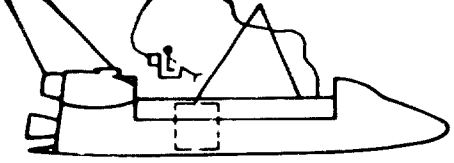
BACKUP FOR APPENDAGE HANGUP



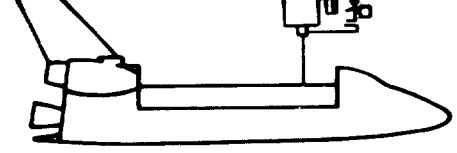
- Work Station on HPA is utilized

  or

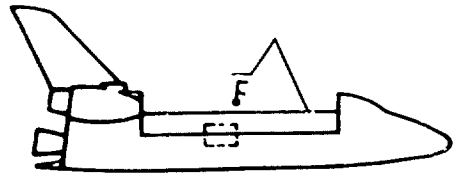
  MFR/RMS deployed for manual assist



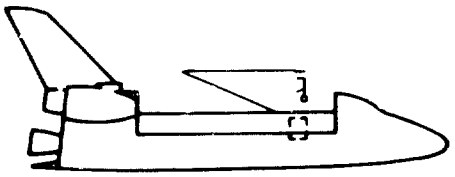
- MMU/WRU with stabilizer deployed for manual assist
  or
  EVA via handrails employed



- Work Station on HPA is utilized
  or
  MFR/RMS deployed for manual assist



- MFR/RMS deployed for manual assist
  or
  EVA via handrails employed



- MFR/RMS deployed for manual assist
  or
  EVA via handrails employed

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1472-040(T)

IRAD

ER10 Alternate No. 1 Earth Return Sequence – LEO/Propulsion Payload Class – Noncooperative Nominal Payload – RMS/HPA Usage – Versatile Service Stage Application

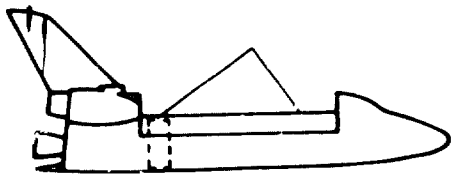
FOLDOUT FRAME 4

GRUMMAN

FOLDOUT FRAME

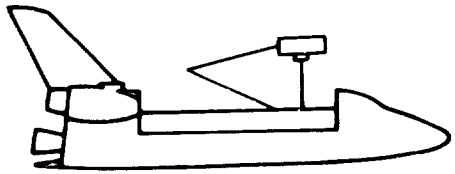
VSS DEPLOYMENT

1



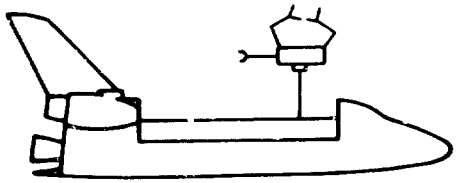
- VSS with debris capture capability stowed in retention structure
- Status/health checks via umbilicals in retention structure (comm via orbiter S-Band)
- RMS attaches to VSS

2



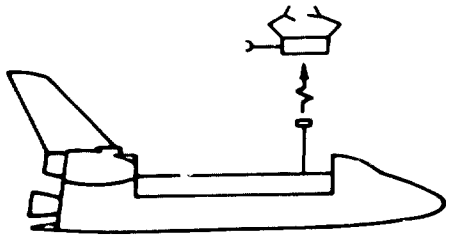
- VSS retention latches/umbilical released
- RMS translates VSS and berths to HPA, umbilical connection verified

3



- Activation of selected VSS subsystems by ground link (comm via VSS)
- VSS appendages and manipulator arms deployed by ground command and verified by orbiter crew
- Final status/health check prior to deployment (comm via VSS)
- State vector transfer
- Transfer VSS to internal power

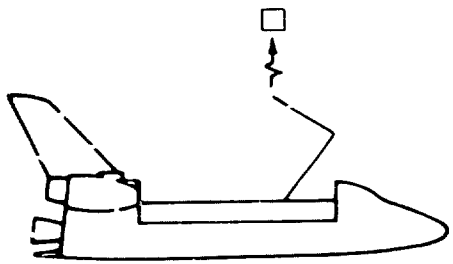
4



- HPA releases VSS at ~ 1 ft/sec velocity
- VSS activation of RCS at > 200 ft separation

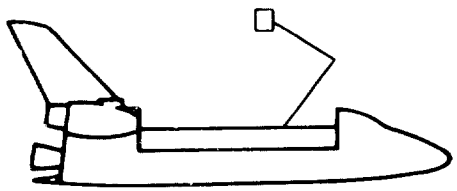
MTV DEPLOYMENT

5



- MTV deployed to view VSS firing

6

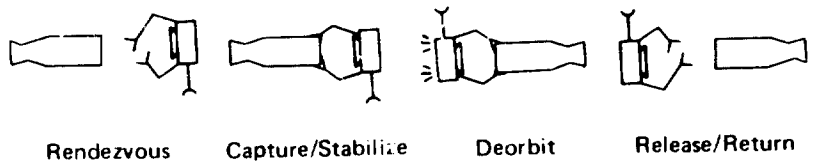


- Oribter/MTV rendezvous (MTV active)
- MTV retrieved by RMS and stowed in payload bay

- MTV deployed to view VSS firing
- VSS activates propulsion system at > 2700 ft separation

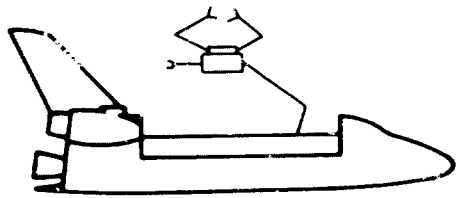
- Oribter/MTV rendezvous (MTV active)
- MTV retrieved by RMS and stowed in payload bay

(7) VSS rendezvous, deorb'ts large debris and Returns to orbiter



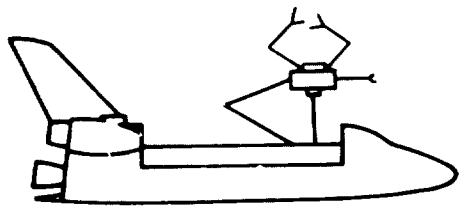
VSS RETRIEVAL/STOWAGE

(8)



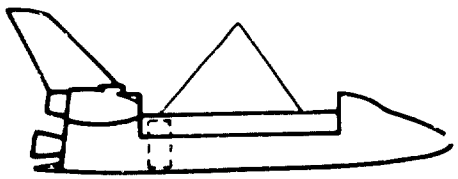
- Orbiter/VSS rendezvous (VSS active)
- VSS ACS active (RCS disabled, propellents vented)
- RMS attaches to VSS
- VSS ACS inactivated

(9)



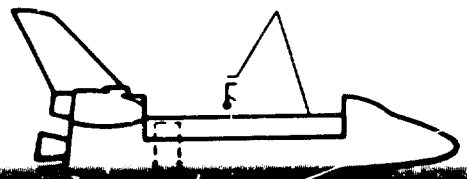
- VSS berthed to HPA
- VSS manipulator arms and appendages retracted
- VSS inactivated/checked out for return
- RMS attaches to VSS

(10)

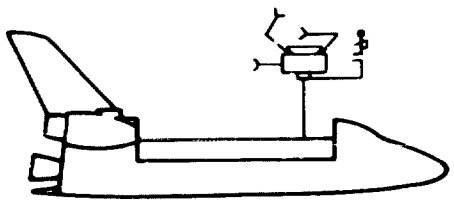


- RMS transfers VSS to retention structure
- Retention latches locked

BACKUP FOR RETENTION LATCH HANGUP

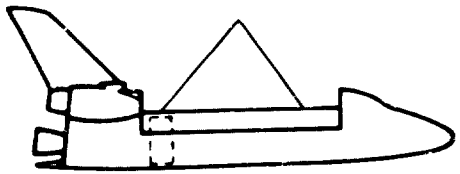


BACKUP FOR APPENDAGE HANGUP



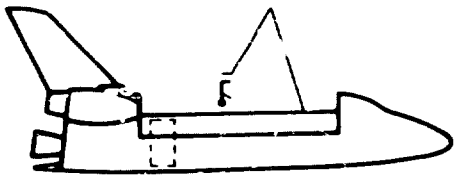
- VSS ACS inactivated

(10)

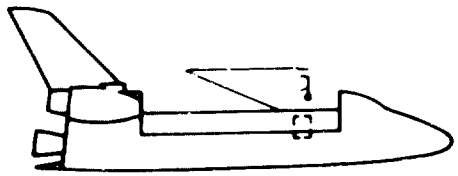


- RMS transfers VSS to retention structure
- Retention latches locked

BACKUP FOR RETENTION LATCH HANGUP

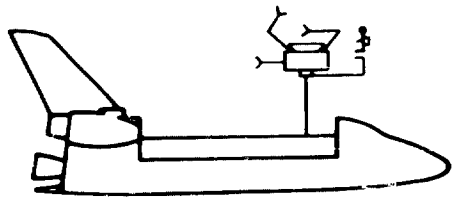


- MFR/RMS deployed for manual assist
  or
  EVA via handrails employed



- MFR/RMS deployed for manual assist
  or
  EVA via handrails employed

BACKUP FOR APPENDAGE HANGUP



- Work Station on HPA is utilized
  or
  MFR/RMS deployed for manual assist

R81-0181-166(T)

ER11 Alternate No. 1 Earth Return Sequence – Debris Deorbit Payload Class – Noncooperative Large Debris – RMS/HPA Usage – Versatile Service Stage Application

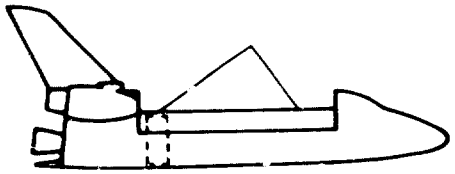
RAD

GRUMMAN

FOLDOUT FRAME

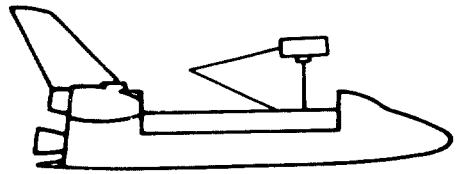
VSS DEPLOYMENT

1



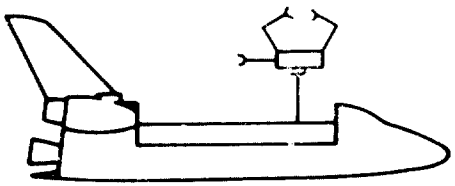
- VSS with debris capture capability stowed in retention structure
- Status/health checks via umbilical in retention structure (comm via orbiter S-Band)
- RMS attaches to VSS

2



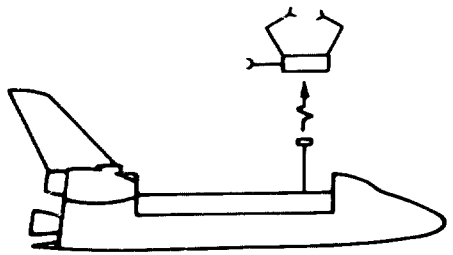
- VSS retention latches/umbilical released
- RMS translates VSS and berths to HPA, umbilical connections verified

3



- Activation of selected VSS subsystems by ground link (comm via VSS)
- VSS appendages and manipulator arms deployed by ground command and verified by orbiter crew
- Final status/health check prior to deployment (comm via VSS)
- State vector transfer
- Transfer VSS to internal power

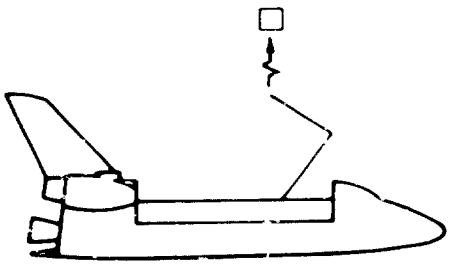
4



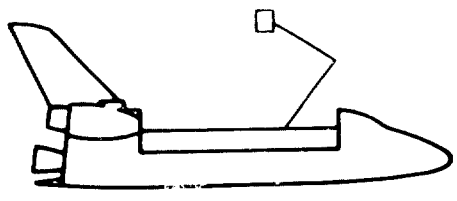
- HPA releases VSS at ~ 1 ft/sec velocity
- VSS activation of RCS at > 200 ft separation

MTV DEPLOYMENT

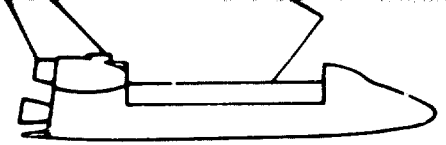
5



6

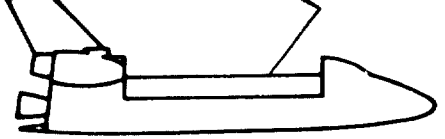


5



- MTV deployed to view VSS firing
- VSS activates propulsion system at > 2700 ft separation

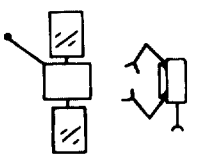
6



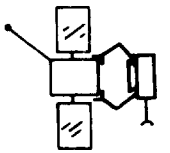
- Orbiter/MTV rendezvous (MTV active)
- MTV retrieved by RMS and stowed in payload bay

7

VSS rendezvous and captures/stabilizes debris satellite (e.g. OAO)
and
Returns to orbiter

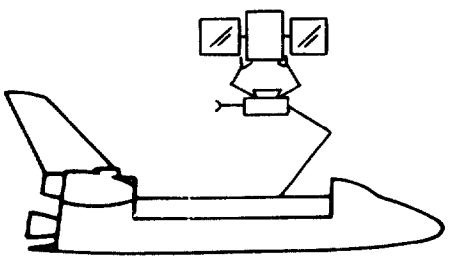


Rendezvous



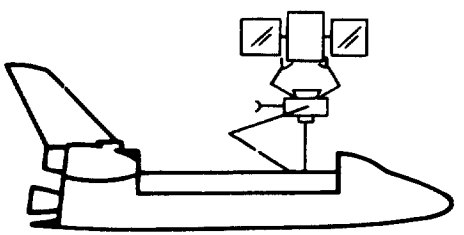
Capture/Stabilize

8



- Orbiter/VSS rendezvous (VSS active) within RMS reach distance and examined by RMS TV or visual crew observation
- VSS ACS is active to maintain stability
- RMS attaches to VSS
- VSS ACS deactivated

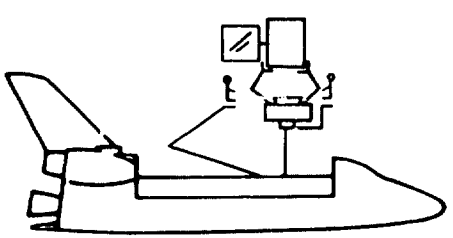
9



- Debris satellite/VSS berthed to HPA and umbilical connections verified
- VSS appendages retracted except manipulator arms
- Transfer VSS to orbiter power to maintain debris capture and VSS thermal control

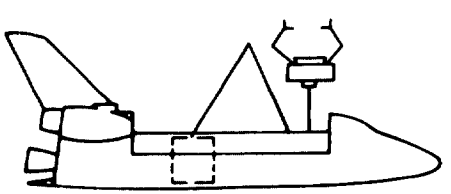
DEBRIS SATELLITE STOWAGE

10



- Remove appendages/solar arrays from debris satellite via HPA and RMS/OCP
- Attach grapple fitting to debris satellite

11



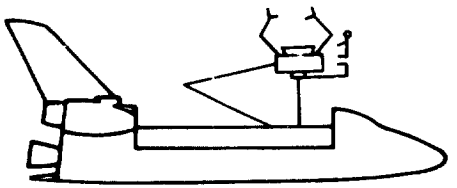
- RMS attaches to debris satellite
- RMS transfers satellite to special retention structure
- Retention latches locked

- Attach grapple fitting to debris satellite

- Retention latches locked

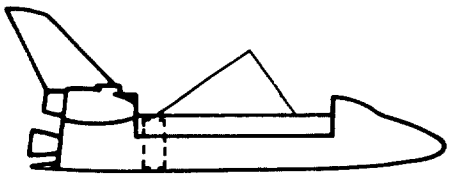
VSS STOWAGE

(12)



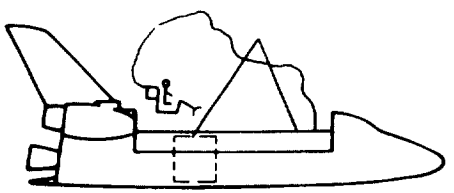
- VSS manipulator arms retracted
- VSS checked out for earth return
- RMS attaches to VSS

(13)

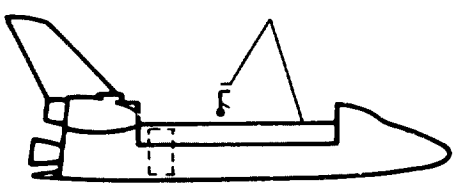


- RMS transfers VSS to retention structure
- Retention latches locked

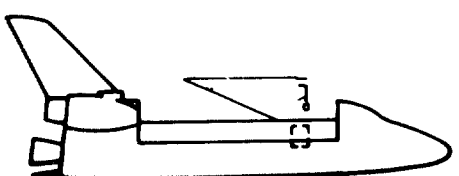
BACKUP FOR RETENTION LATCH HANGUP



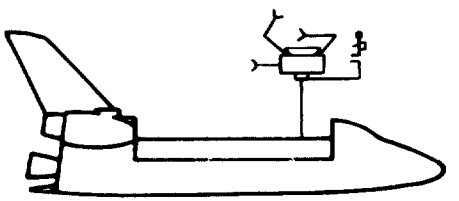
- MMU/WRU with stabilizer deployed for manual assist
  or
  EVA via handrails employed



- MFR/RMS deployed for manual assist
  or
  EVA via handrails employed

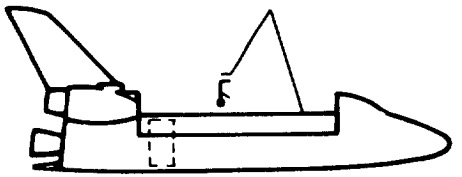


BACKUP FOR APPENDAGE HANGUP

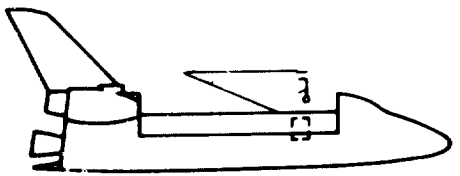


- Work Station on HPA is utilized
  or
  MFR/RMS deployed for manual assist

- MMU/WRU with stabilizer deployed for manual assist
  or
  EVA via handrails employed



- MFR/RMS deployed for manual assist
  or
  EVA via handrails employed



- MFR/RMS deployed for manual assist
  or
  EVA via handrails employed

- Work Station on HPA is utilized
  or
  MFR/RMS deployed for manual assist

FOLDOUT FRAME 4

0181-048D
1472-041(T)

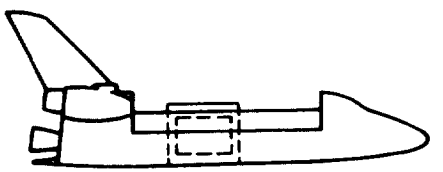
IRAD

ER12 Alternate No. 1 Earth Return Sequence – Debris Return Payload Class – Noncooperative Small Debris Satellite – RMS/HPA Usage – Versatile Service Stage Application

GRUMMAN

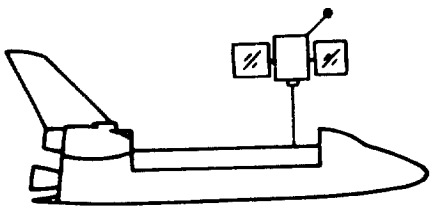
FOLDOUT FRAME

1



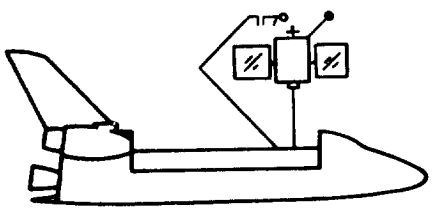
- Payload stowed in thermal enclosure on-orbit

2



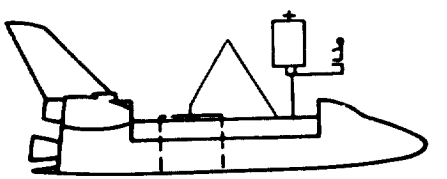
- Checkout/preparation for deployment indicates malfunction precluding operational deployment
- Prepare spacecraft for orbital storage
- Satellite on orbiter power to maintain thermal control

3



- RMS/OCP deployed to attach additional grapple fixture
  or
  Original grapple fixture utilized if applicable

4

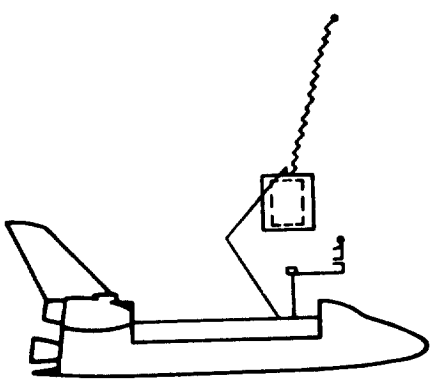


- Satellite appendages retracted by ground command and verified by orbiter view
- Satellite inactivated by ground command and checked out for storage
- RMS attaches to thermal enclosure

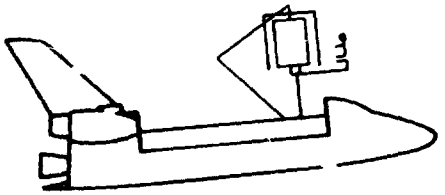
5

- Thermal enclosure retention latches released
- RMS transfers thermal enclosure over satellite and

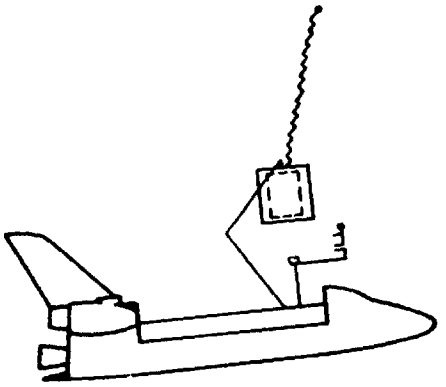
6



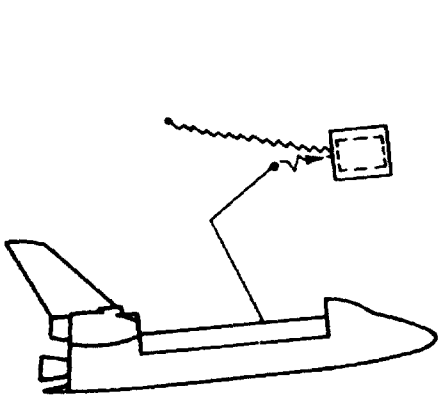
- Satellite released from HPA
- RMS elevates satellite/thermal enclosure
- Thermal enclosure activated to envelop satellite



- Thermal enclosure retention latches released
- RMS transfers thermal enclosure over satellite and attaches to grapple fixture



- Satellite released from HPA
- RMS elevates satellite/thermal enclosure
- Thermal enclosure activated to envelop satellite
- Gravity stabilization boom deployed from thermal enclosure



- RMS releases satellite at ~ 1 ft/sec velocity

OS1 Orbital Storage Option — RMS/HPA Usage — Satellites < 15 ft Length

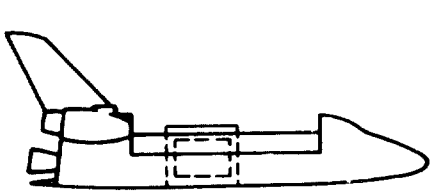
GRUMMAN

0181-001D
1472-042(T)

IRAD

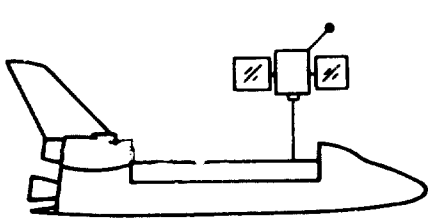
FOLDOUT FRAME 2

1



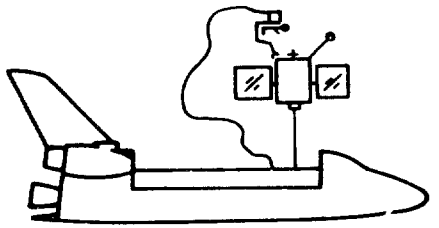
- Payload stored in thermal enclosure on-orbit

2



- Checkout/preparation for deployment indicates malfunction precluding operational deployment
- Prepare spacecraft for orbital storage
- Satellite on orbiter power to maintain thermal control

3

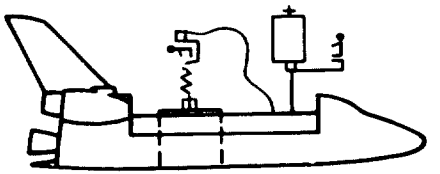


- MMU/WRU with stabilizer deployed to attach additional grapple fixture

  or

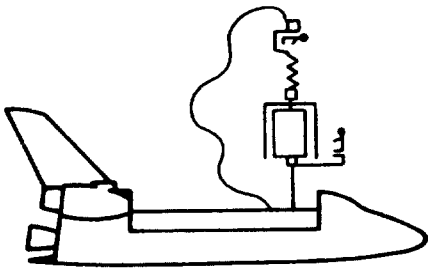
  Original grapple fixture utilized if applicable

4



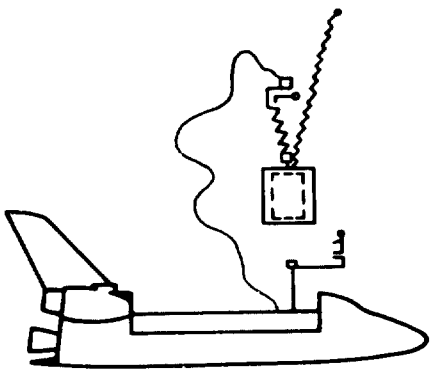
- Satellite appendages retracted by ground command and verified by orbiter crew
- Satellite inactivated by ground command and checked out for storage
- MMU/WRU with RMS end effector attaches to thermal enclosure

5

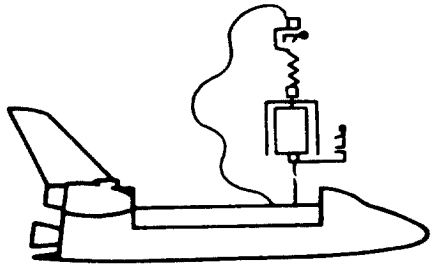


- Thermal enclosure retention latches released
- MMU/WRU transfers thermal enclosure over satellite and attaches to grapple fixture

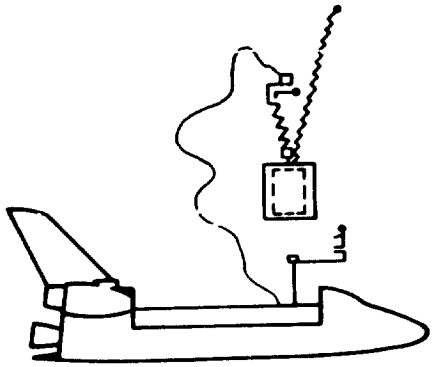
6



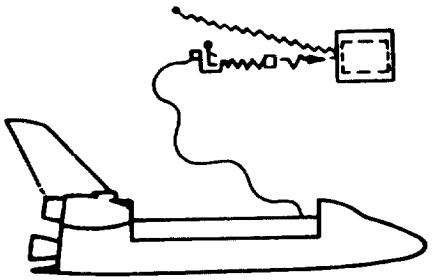
- Satellite released from HPA
- MMU/WRU elevates satellite/thermal enclosure
- Thermal enclosure activated to envelop satellite
- Gravity stabilization boom deployed from thermal enclosure



- Thermal enclosure retention latches released
- MMU/WRU transfers thermal enclosure over satellite and attaches to grapple fixture



- Satellite released from HPA
- MMU/WRU elevates satellite/thermal enclosure
- Thermal enclosure activated to envelop satellite
- Gravity stabilization boom deployed from thermal enclosure



- MMU/WRU releases satellite at ~ 1 ft/sec velocity

1472-043(T)'
0181-002D

IRAD

OS2 Orbital Storage Option – HPA Usage – RMS Inoperative – Sctellites < 15 ft Length

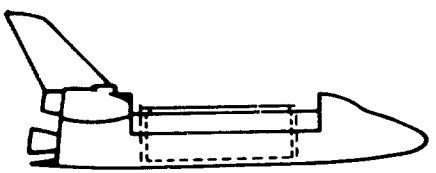
GRUMMAN

FOLLOUT FRAME

FOLDOUT FRAME

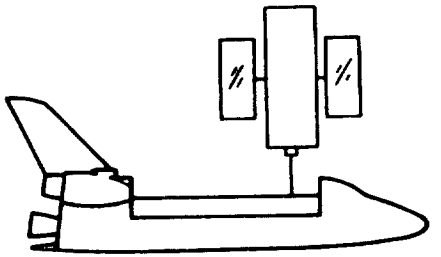
PRECEDING PAGE BLANK NOT FILMED

1



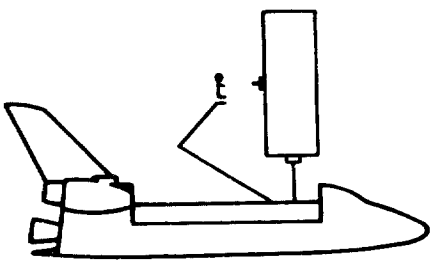
- Payload stowed in thermal enclosure on orbit

2



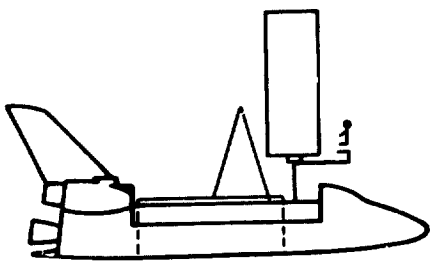
- Checkout/preparation for deployment indicates malfunction precluding operational deployment
- Prepare spacecraft for orbital storage
- Satellite on orbiter power to maintain thermal control

3



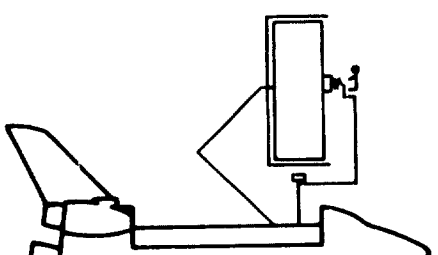
- Satellite appendages retracted by ground command and verified by orbiter crew
- RMS/OCP deployed to attach additional grapple fixture

4



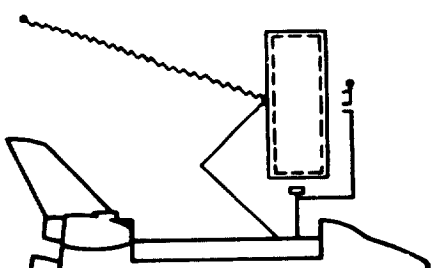
- Satellite inactivated by ground command and checked out for storage
- RMS attaches to thermal enclosure

5



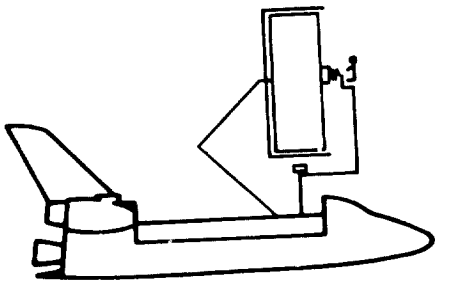
- HPA work platform's RMS end effector attached to satellite grapple fixture
- Satellite released from HPA
- HPA work platform (via grapple attachment) elevates satellite
- Thermal enclosure retention latches released

6



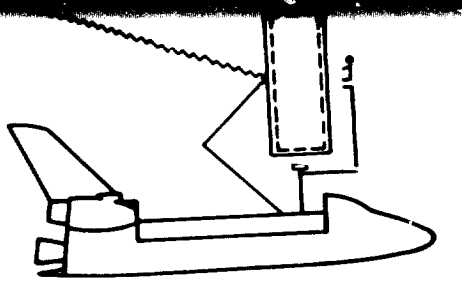
- Thermal enclosure activates to envelop satellite
- Gravity stabilization boom deployed from thermal enclosure

(5)



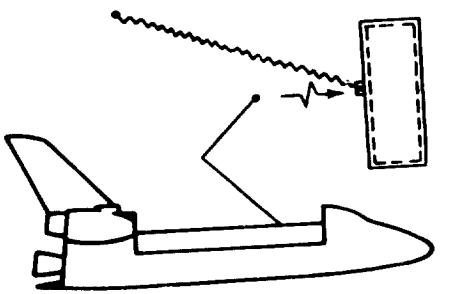
- HPA work platform's RMS end effector attached to satellite grapple fixture
- Satellite released from HPA
- HPA work platform (via grapple attachment) elevates satellite
- Thermal enclosure retention latches released
- RMS transfers thermal enclosure over satellite and attaches to grapple fixture

(6)



- Thermal enclosure activates to envelop satellite
- Gravity stabilization boom deployed from thermal enclosure

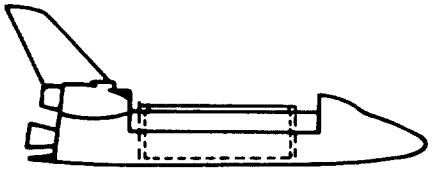
(7)



- RMS releases satellite at ~ 1 ft/sec velocity

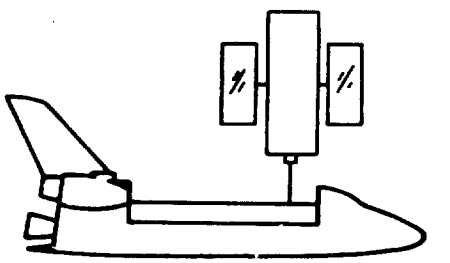
OS3 Orbital Storage Option – RMS/HPA Usage – Satellites > 15 ft Length

1



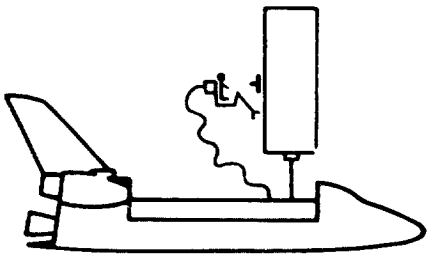
- Payload stowed in thermal enclosure on orbit

2



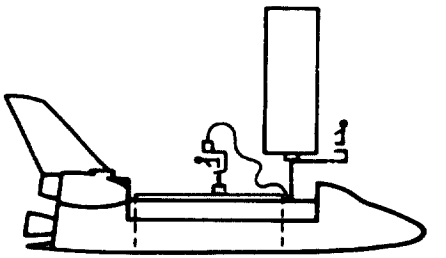
- Checkout/preparation for deployment indicates malfunction precluding operational deployment
- Prepare spacecraft for orbital storage
- Satellite on orbiter power to maintain thermal control

3



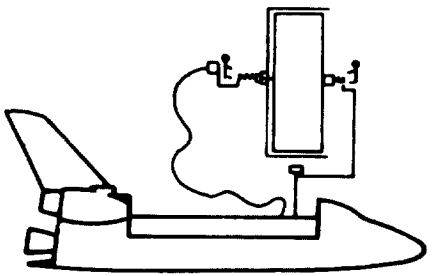
- Satellite appendages retracted by ground command and verified by orbiter crew
- MMU/WRU with stabilizer deployed to attach additional grapple fixture

4



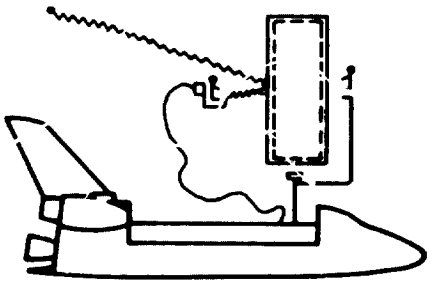
- Satellite inactivated by ground command and checked out for storage
- MMU/WRU with RMS end effector attaches to thermal enclosure

5



- HPA work platform's RMS end effector attached to satellite grapple fixture
- Satellite released from HPA
- HPA work platform (via grapple attachment) elevates satellite
- Thermal enclosure retention latches released

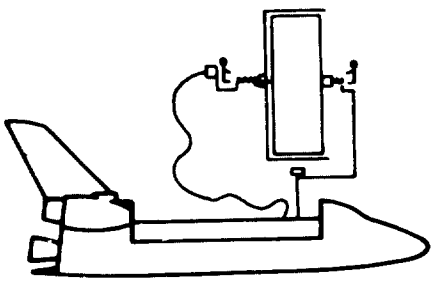
6



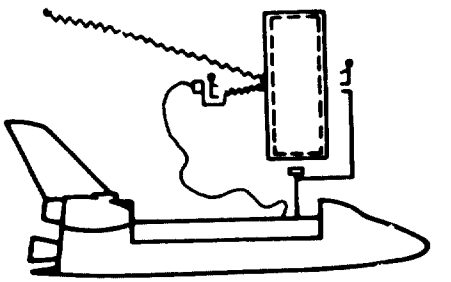
- Thermal enclosure activates to envelop satellite
- Gravity stabilization boom deployed from thermal enclosure

- Satellite appendages retracted by ground command and verified by orbiter crew
- MMU/WRU with stabilizer deployed to attach additional grapple fixture

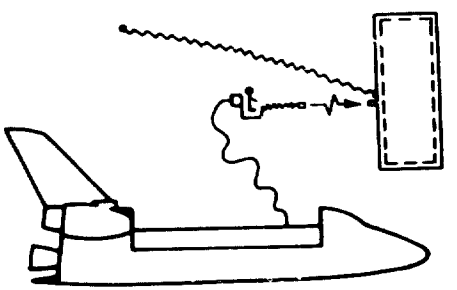
- Satellite inactivated by ground command and checked out for storage
- MMU/WRU with RMS end effector attaches to thermal enclosure



- HPA work platform's RMS end effector attached to satellite grapple fixture
- Satellite released from HPA
- HPA work platform (via grapple attachment) elevates satellite
- Thermal enclosure retention latches released
- MMU/WRU transfers thermal enclosure over satellite and attaches to grapple fixture



- Thermal enclosure activates to envelop satellite
- Gravity stabilization boom deployed from thermal enclosure



- MMU/WRU releases satellite at ~ 1 ft/sec velocity

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OS4 Orbital Storage Option – HPA Usage–RMS Inoperative – Satellites > 15 ft Length

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