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LANDSAT-C FLIGHT ACTIVATION PLAN

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Prepared By
GE LANDSAT OPERATIONS CONTROL CENTER (OCC)

For
EARTH RESOURCES PROGRAM
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND 20771

NOTE: DATA IN THIS BOOK IS VALID FROM LANDSAT–C LAUNCH THROUGH THE FIRST SEVEN DAYS AND WILL NOT BE UPDATED AFTER LAUNCH.

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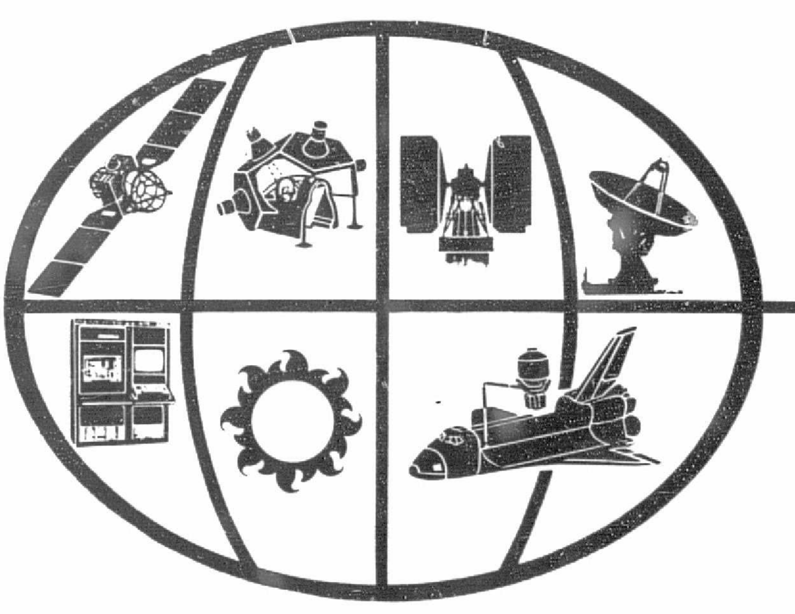

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NASA EARTH RESOURCES PROGRAM • LANDSAT •

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FOREWORD

Presented within this document is the Landsat-C Flight Activation Plan. Included are general objectives through Day 7, operational guidelines and restraints. Following the activation of all subsystems (through Day 3), a special series of payload operations will be performed to obtain data samples for the different combinations of Exposure/Gain settings.

This will take place from Day 4 through Day 7. The Orbit Adjust will be employed to perform vernier corrections after the orbit has been determined. The orbit data will be collected through Day 3, with the corrections being made from Day 4 through Day 7.

ECAM will be turned on in Day 3 and the memory dumped to a NBTR. A verification of memory will be done off line. ECAM will not be used for payload support mode until Day 7.

Outgassing of MSS Band 5 will begin in Day 2 and continue for approximately 28 days before commencing normal operations on Day 30.

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

SECTION 1

BASIC OBJECTIVES

1.1 GENERAL OBJECTIVES

The objectives of the first day are to determine the fundamental operation of the Spacecraft, activate USB and video S-bands transmitters, and move WBVTR's to their BOT switch.

The second day's objectives will be to record and retrieve pre-recorded Wideband Data. Days 3-6 will be used to activate the payloads, to assess the ability of the Spacecraft to maintain full operation, and to perform the initial orbit adjust maneuvers. After execution of the orbit adjust maneuvers, the routines for the first 18-day cycle will be considered operational. The Spacecraft turn-on sequence is shown in Figure 1-1.

All Wideband data retrieved during these orbits will be forwarded to IPF for processing and copies given to OCC for engineering evaluation.

1.2 DETAILED OBJECTIVES

1.2.1 DAY ZERO/ONE

1. Determine Spacecraft orbit.
2. Verify that all Spacecraft functions are in the configuration as defined in Section 5, Spacecraft Launch Configuration.
3. Monitor Spacecraft separation, initial stabilization and paddle deployment.
4. Verify that controls are in the following expected modes:

   Pneumatics Enable
   Pneumatics Interlock By Pass Disable
   Pneumatics Low Voltage Interlock Reset
   Roll Diff Tach Enable
   Roll Diff Tach Normal Gain
   Positive Yaw Position Bias
   0.1° Yaw Position Bias Disable

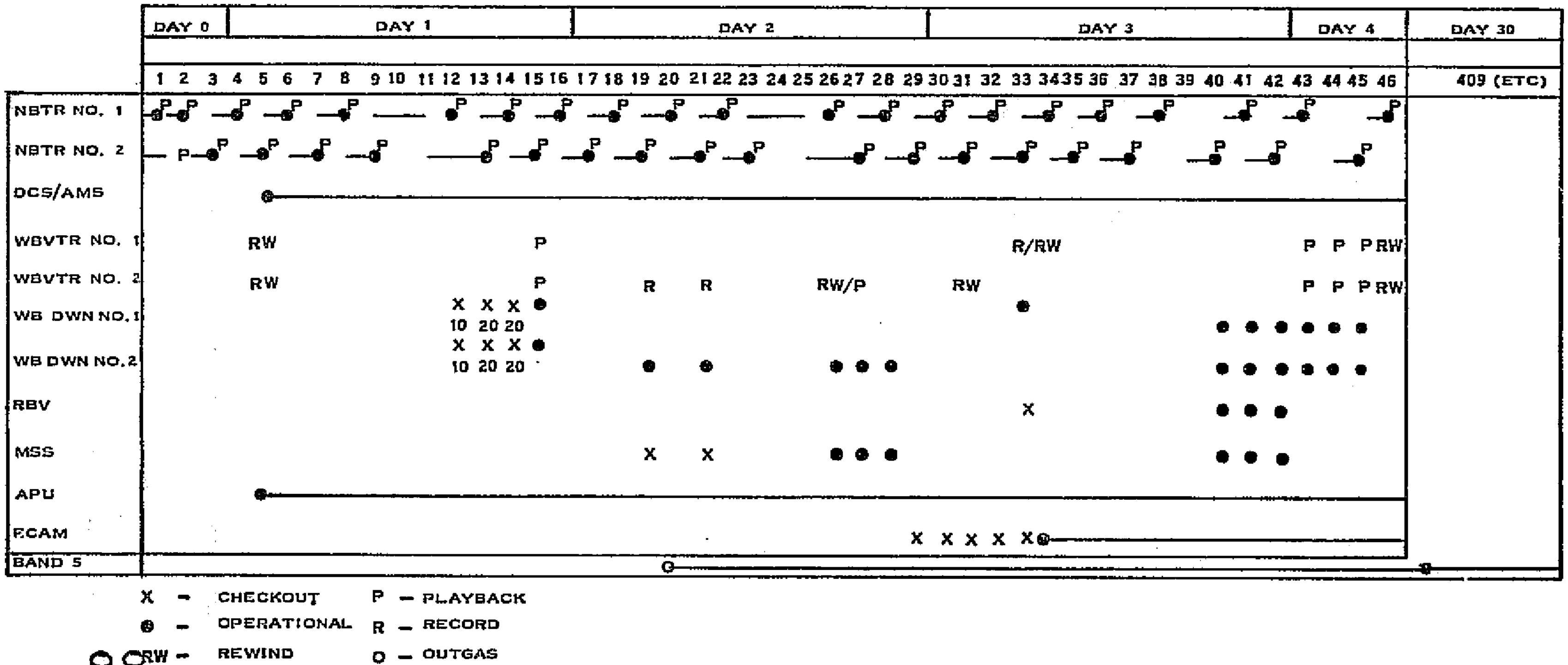

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Figure 1-1. Landsat-C Spacecraft Activation Sequence

0.3° Yaw Position Bias Disable
Pitch Position Bias Disable
Pitch Momentum Bias Mode Disable
Positive Pitch Position Bias
0.6° Pitch Position Bias Disable
2.0° Pitch Position Bias Disable
2.9° Pitch Position Bias Disable
400 RPM Interlock Enable
RLNA into Yaw Disable
Roll Unload Enable
Pitch Unload Enable
Yaw Acquisition Mode
Yaw Wheel Enable
Orbit Adjust Mode Disable
RMP B Enable
RMP A Heater & Electronics On
RMP B Heater & Electronics On
Right SAD Disable
Right SAD Normal Rate
Left SAD Enable
Left SAD Normal Rate
Right SAD Fused
Left SAD Fused
Lock Single Scanner Mode
Enable Scanners & Select A
RMP A Motor On
RMP B Motor On

5. Monitor controls system and if functioning correctly, command Yaw into normal mode, RMP A Lower Motor Voltage (410) & Heater OFF (271).

6. Evaluate pneumatics consumption, ACS Scanner Performance, SAD Drive Performance, and need for magnetic coil operation. Enable RSAD below sunline using comstor.

7. Verify full commanding ability (both separation switches closed), turn on and checkout both comstors, including recycle tick-tock commands.

8. Evaluate power and thermal performance to verify if the activation plan can be followed.

9. Correct Spacecraft time if necessary.

10. Verify MMCA flux density readings are normal and power, is off.

11. Activate Wideband Recorders, and Direct Readout System, and perform engineering analysis regarding their operation, data quality and effect on other systems.

12. Test AUX loads off commands 374 and 413 and compensation load off command 355 and 611.

13. Analyze TMP regarding matrix stability and validity and turn off redundant TMP power.

14. Monitor all pressurized systems to detect any leaks.

15. Verify that all systems which were turned on can remain on.

16. Establish new operational limits for update of MIT.

17. Activate Data Collection System (DCS) and Attitude Measuring System (AMS).

18. Monitor Beacon and USB signal strengths.

1.2.2 DAY TWO

1. Continue to evaluate controls, power and thermal to determine Spacecraft capability to sustain full operation.

2. Establish thermal profile of Spacecraft.

3. Continue to evaluate the thermal and power management procedures.

4. Begin retrieval of Wideband Data recorded on spacecraft, prior to launch.

5. Activate RBV and MSS sensors and retrieve in Real Time. In addition, record on Wideband tape recorders.

6. Begin outgassing of MSS cooler.

1.2.3 DAY THREE

1. Continue to monitor Spacecraft systems to verify ability of Spacecraft to sustain full operation.

2. Retrieve wideband recorded data from day 2.

3. Turn on, read out and verify ECAM memory.

4. Verify ECAM Load; and verify tick-tocks executed.

1.2.4 DAY FOUR

1. Verify thermal power profile for the Spacecraft.

2. Initiate Orbit Adjust maneuvers to correct to as near as possible to a nominal orbit.

3. Initiate collection of payload data.

1.2.5 DAY FIVE

1. Continue to update the overall flight operation procedures and exercise the full ground system time line for the OCC.

1.2.6 DAY SIX

1. Continue to exercise the full ground system time line and adjust accordingly.

1.2.7 DAY SEVEN

1. Using the knowledge gained during the previous days, update all operational procedures.

2. Using these updated procedures initiate the normal operational mode. All Spacecraft sensors and systems will continue to operate in this mode until a malfunction is observed or if there are power limitations. At that time, only the subsystem or subsystems affected will be turned off if necessary.

3. Commence operational use of ECAM.

1.2.8 DAY THIRTY

1. Commence operational use of the MSS 5th Band.

SECTION 2

OPERATIONAL GROUND RULES AND RESTRAINTS

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AND RESTRAINTS

SECTION 2

OPERATIONAL GROUND RULES AND RESTRAINTS

2.1 GENERAL

The following are guidelines for operating the Landsat-C spacecraft. Any deviation from these guidelines will be by direction of the NASA Flight Operations Manager or his designated representative. This activation sequence was designed for a circular orbit of approximately 500 nm. In the event of an elliptical orbit, the activation sequence will be adjusted to suit available interrogations until appropriate orbit corrections can be made.

1. The Spacecraft management-evaluation effort and command sequence generation will normally be accomplished at GSFC. Commands will be generated in the OCC and sent to Greenbelt, Goldstone, or Alaska for transmission to the Spacecraft. If required, each of these sites can generate real-time commands locally using the SCE (Spacecraft Command Equipment).

2. During Spacecraft launch and activation, additional USB and VHF sites will be utilized. Direct command capability exists from the OCC through all the USB sites and Santiago. If required, these sites can generate real-time commands locally using the SCE.

3. Emergency conditions may require additional remote station coverage. Under emergency conditions, any USB site and Santiago can be utilized in Spacecraft commanding from the OCC or OCC-directed local command.

4. Telemetry data can be received at the OCC from USB or VHF sites during interrogations. All USB and VHF sites have a local telemetry readout capability of 20 channels which can be relayed to the OCC if required.

5. In general, the redundant components within subsystems or the optional modes will not be tried until required.

6. For Spacecraft safety, command sets which place the Spacecraft in a minimum load will be available to be sent in a power emergency.

2.2 COMMAND SUBSYSTEM

1. Both Spacecraft COMDECS will be on at all times. One COMDEC will be used for VHF commanding and the other COMDEC used for USB commanding.

2. If a Matrix Driver fails causing a second command to execute, restore the original state if required. Evaluate the consequence of this failure before proceeding with further commanding (including COMSTOR commands).

   The redundant A&B Matrix Drives are to be selected only if required for emergency controls, minimum satellite commanding, or if authorized.

3. The minimum spacecraft configuration command sequence, will be sent only when specified in accordance with emergency procedures.

4. During normal operation, the primary clock components will be used. The redundant clock components will not be used unless required because of a failure. The exception will be the COMSTOR & COMDECS both of which will be used.

5. All stored commands sent to the Spacecraft will be transmitted back to the ground station and verified for accuracy by the command ground station. The command operator will also verify that the correct commands were sent before issuing the activation command.

6. COMSTORS should be verified and/or refilled and Time Reset after any internal power switching is done in the command clock because they tend to be upset during internal switching transients.

7. Time in Spacecraft will be kept within ± 2 seconds of ground time.

8. The repeat command capability of the COMSTOR may be utilized for commanding that is required on an orbital basis.

9. Commands not required for normal operation will be included in a critical command matrix of the command ground station. Whenever a critical command or a sequence containing these commands is selected, a visual alarm will be activated at the command station and the transmission of these commands will be inhibited. This will allow the operations supervisor to confirm that the command was intended before the interlock is released and the command sent.

10. If an alternate component is commanded inadvertently and there is no adverse effect, maintain the new state of subsystems.

11. Do not change the frequency generator, oscillator, or power supply in the clock without turning OFF pneumatics, ECAM, and video tape recorders.

    061 - pneumatics disable
    042 - pneumatics interlock bypass disable
    651 - WBVTR No. 1 OFF
    715 - WBVTR No. 2 OFF
    220 - ECAM OFF

12. The VHF Transmitter RF Power Output Telemetry of the transmitter not powered will indicate some output level due to cross-coupling.

13. Maximum VHF Receiver power must not exceed 0 dbm.

14. The first command of a command message must be a real time command.

15. Internal commands will not execute when commands are disabled.

16. Matrix A Driver Pri/Red Tlm (Func 8031) is invalid when commands are disabled.

17. Sync pattern must be retransmitted and "Y" Enable Reset after sending Command 020. Command 020 must be a single command or last command in the sequence.

18. The time code word must immediately follow Command 017 (Load Time Code).

19. Serial data must immediately follow Command 007 (Serial Data Transfer On) and the transmission must be momentarily interrupted before sending any other type of commands.

20. Commands 003 and 023 (Comstors verify) must not be sent within 16 seconds of each other. One cycle of verification requires 16 seconds.

21. The time tag associated with a stored command must not be such that execution will fall within a verification sequence.

22. Turn both COMSTORS on prior to loading, if both are to be used.

23. CIU commands and command clock commands cannot be sent during the same transmission.

24. Only one CIU command can be sent during a transmission.

2.3 NARROWBAND TAPE RECORDERS (NBTR)

1. Uninterrupted orbital data recording (overlapping recorders) requires that the empty Narrowband recorder be commanded into the record mode at least one minute prior to the off time of the recorder that is recording.

2. Normally both Narrowband Tape Recorders will not be on simultaneously except when one tape recorder is in playback and the other is in record.

3. Maximum allowable NBTR temperature is 40°C as measured by its own telemetry

sensor. Turn the recorder off if the temperature exceeds 40°C.

4. Do not send the Record command while the Tape Recorder is in Playback. (This will cause the Tape Recorder to go into a standby mode). First send Power Off, then Record. (To get out of standby mode, send either Power Off or Playback.)

5. Do not command frequent repetitious changes in mode without allowing the motor to reach its run state (approximately 5 sec.).

6. During launch both tape recorders must be in record.

2.4 ATTITUDE CONTROL SUBSYSTEMS (ACS)

1. Commands that place the controls in alternate modes will be designated critical (see Section 3). The operational mode of the controls system will not be changed without special permission from the NASA Flight Operations Manager or his designated representative.

   Command sequences for alternative modes used for failure conditions will be provided by the NASA Flight Operations Manager.

   The controls will be in a launch mode at launch and will automatically go into the Acquisition Mode after separation. If the controls function correctly, the yaw control will be switched to the Normal Mode during the first Alaska interrogation at the direction of the ACS engineer in charge.

2. The SAD will be used in normal rate mode and fused. Procedures will be available for turning off each SAD in the event of malfunctions (see Appendix A).

3. Scanner Switching - The Spacecraft will be launched with both scanners enabled. If it is deemed necessary, one of the following alternate plans will be implemented:

   a. Switching of SCANNER A and B in and out of the loop.

   b. Switching SCANNER A in and out of the loop.

   c. Switching SCANNER B in and out of the loop.

NOTE

Pneumatics are to be disabled prior to scanner switching.

2.5 POWER SUBSYSTEM

The Landsat "Automatic Power Management Power Subsystem" is a name given to the Landsat Power Subsystem. In an isothermal environment; the power subsystem would almost take care of itself. The Landsat ring does not present such an environment, however, and excess amounts of power dissipations above certain limits (estimated 13 to 15 watts/Battery Bay) will cause thermal buildup (higher temperatures); and, because of differences in various aspects of structure, components, insulation, conduction paths, etc., the battery temperatures may rise unevenly. Power dissipation in the battery modules must be limited, and the power management procedures are designed to serve that end. Power management will assure that maximum flexibility in operation is allowed but within certain constraints that will assure a safe spacecraft. These constraints are as follows:

1. The minimum allowable unregulated bus voltage shall be -26.0 VDC.

CAUTION

> Playback during satellite night will drop the unregulated bus by approximately 1 volt. Therefore, WBVTR playbacks should not be initiated if battery voltages are below -28.2 VDC prior to playback.

2. The minimum allowable end of night battery voltage shall be -27.2 VDC.
3. Providing 1 and 2 are not violated, the depth of discharge shall be limited to 25% of rated capacity or approximately 500 ampere-minutes for total of eight battery modules. (To be modified with increasing battery age.)
4. Overcharge shall be limited to 35 ampere-minutes or less for a total of eight battery modules.
5. The charge controller "trickle charge mode" shall be normal.
6. Battery temperatures shall not be allowed to exceed +35°C.
7. Battery on-off commands shall be exercised only under the direction of the OCC Power Management Engineer/OCC Manager.

8. The total number of batteries that can be turned off will be determined by the power management procedure based on load requirements, but 2 battery packs are necessary for minimum satellite mode.

9. Only 1 battery may be turned off by on-line evaluation based on real-time data. This decision is reserved for failure modes; i. e., abnormally high charge rates. See Appendix B for emergency procedures.

10. The PRM Fuse Tap shall be OFF before turning off the PRM (Payload Regulator Module) and remain off while the PRM is off.

11. The Spacecraft regulated service bus load shall not exceed 22 amperes or the regulated bus will fall out of regulation.

12. The spacecraft regulated payload bus load shall not exceed 26 amperes or the regulated bus will fall out of regulation.

13. The automatic shunt dissipator loads shall never be turned off except in the event of failure. See (Section 4.3.3 of Flight Operations Manual) for emergency procedure.

14. In the event of erratic SAD operation, the procedure specified in Appendix A of this plan shall be used.

15. Battery mismatch will be handled as described in Appendix B or as the situation dictates under the direction of the Power Management Engineer/OCC Manager. The operations manager shall be kept informed of status.

2.6 TELEMETRY PROCESSOR (TMP) SUBSYSTEM

1. The TMP will be launched in its Format "1" or show ECAM verify mode. Prior to ECAM turn ON the TMP will be switched to the Format "0" or ECAM fast verify mode. It will remain in fast verify mode and will not be changed unless authorized.

2. When switching the TMP from Side B to Side A, switch the Power Supply (Cmds. 340 or 403) last to prevent possible noise generation in the telemetry data stream. Toggling the power supply or Control Logic will eliminate the noise generation.

3. For loss of VHF or VHF modulation, follow 1 kilobit decision tree in Appendix D.

4. For loss of USB or USB modulation, follow the 1 kilobit decision tree in Appendix D.

2.7 WIDEBAND VIDEO TAPE RECORDER (WBVTR)

1. There must be a minimum of 100 msec between commands. If commands are received simultaneously, the final operating state of the recorder cannot be predicted.

2. Record Current Adjust commands should not be given at a rate exceeding one command in 5 seconds. Each step should be verified on telemetry before another adjust command is given. (The recorder will respond to this command only when in the record mode.) Do not use unless authorized by NASA Flight Operations Manager.

3. At least 7 seconds must elapse between a WBVTR On command and the WBVTR Off command, the All Payloads Off command, or either PRM Off command.

4. At least 7 seconds must elapse between a WBVTR On command and a Rewind or Fast Forward command.

5. At least 4 seconds must elapse between either a Rewind or Fast Forward command and any other operating command (i. e., Record, Playback, MSS Standby, RBV Standby, Rewind, Fast Forward, WBVTR Off, All Payloads Off, PRM Off 1 or PRM Off 2).

6. The headwheel motor should not see repeated WBVTR On command (from OFF) at rates higher than one per minute.

7. The capstan motor should not be started repeatedly in the high-speed mode (Rewind or Forward) more frequently than once per minute.

8. The recorder should not be cycled into Record or Playback at rates higher than once per 5 seconds.

9. At least 1/2 second must elapse between application of WBVTR trickle charge power and the closing of the power relays.

10. The LAP command causes an abrasive portion of tape to pass over the heads, possibly degrading performance. Therefore, the LAP command is not be be exercised during orbit without prior approval of the NASA Flight Operations Manager.

11. The Voltage Protect Relay Reset command should be sent with the WBVTR Off only.

12. Do not execute the MSS Standby, RBV Standby, Playback or Record commands while the recorder is unpowered, since the recorder state is then indeterminate. The indeterminate state can be resolved by commanding Rewind with Power Off,

and then Power On, which will negate the commands. Then, the desired command may be sent. (First send appropriate Standby command to assure proper RBV/MSS status.)

13. Transport unit pressure is to be monitored in order to detect any leaks.

14. The internal temperature of the transport unit shall not be allowed to exceed $40^{\circ}C$, as determined by the TU temperature sensor. The electronics unit temperature shall not be allowed to exceed $40^{\circ}C$, as measured by the internal sensor.

15. The temperature at which MSS data is recorded must equal the temperature at which it is played back, within $\pm 10^{\circ}C$ in order to insure data quality.

16. No portion of the tape shall remain on either reel over a temperature change of $20^{\circ}C$ or greater. The tape must be moved from one end to the other (either direction and speed, not necessarily continuously) near the middle of the temperature transition.

17. Prior to launch, the tape should be moved without interruption from one end of tape to the other and then moved without interruption to the middle of the tape ± 50 feet. The WBVTR should then be set in either RBV or MSS Standby and turned off.

18. Do not interrupt the 50 KH_z Clock input while the tape recorder is on. (Do not switch Clock Oscillators, Freq. Generators or Power Supplies.)

19. With the RBV On, there must be at least 7 seconds between WBVTR No. 1 On and WBVTR No. 2 On to avoid overlapping starting transients.

20. The BOT/EOT Logic Disable commands (672 or 751) are not to be sent without prior approval of the NASA Landsat Flight Operation Manager. These commands disable normal Wideband Video Tape Recorder (WBVTR) internal BOT/EOT circuitry which provide automatic shut down at beginning or end of tape. When disabled the SMART routines must be enabled to provide automatic WBVTR BOT/EOT shut down protection. Execution of BOT/EOT logic disable requires command 717 (WBVTR: BOT/EOT Logic Disable Arm) followed by either 672 (WBVTR #1 BOT/EOT Logic Disable) or 751 (WBVTR #2 BOT/EOT Logic Disable) within 200 milliseconds. This can be accomplished with the commands being sent by COMSTOR with identical execute times.

2.8 WIDEBAND (WB) SYSTEM

1. The operation of the WBPA's for extended periods without an input signal from the WBFM will result in excessive thermal dissipation in the WBPA bay.

2. Not more than one data source should be connected to a single filter input at one time, since this will cause interference and garble data. The following constraints should be observed.

a. No more than one RBV data source should be connected to RBV Filter A at one time.

	12202 Aux Data to RBV Fltr. A	
TLM	12204 RT Data to RBV Fltr. A	No more than one
Points	12206 Tape 1 Data to RBV Fltr. A	"1"
	12208 Tape 2 Data to RBV Fltr. A	

b. No more than one RBV data source should be connected to RBV Filter B at one time.

	12203 Aux. Data to RBV Fltr. B	
TLM	12205 RT Data to RBV Fltr. B	No more than one
Points	12207 Tape 1 Data to RBV Fltr. B	"1"
	12209 Tape 2 Data to RBV Fltr. B	

c. No more than one MSS data source should be connected to MSS Filter A at one time.

	12212 RT Data 1 to MSS Fltr. A	
TLM	12214 RT Data 2 to MSS Fltr. A	No more than one
Points	12216 Tape 1 Data to MSS Fltr. A	"1"
	12218 Tape 2 Data to MSS Fltr. A	

d. No more than one MSS data source should be connected to MSS Filter B at one time.

	12213 RT Data 1 to MSS Fltr. B	
TLM	12215 RT Data 2 to MSS Fltr. B	No more than one
Points	12217 Tape 1 Data to MSS Fltr. B	"1"
	12219 Tape 2 Data to MSS Fltr. B	

3. When RBV or MSS data is fed through one input filter to the modulator, the other filter connected to the modulator must be out (or grounded) to prevent garbled data or data distortion. The following constraints must be observed.

a. RBV Filter A <u>or</u> MSS Filter A should be "IN".

TLM	12200 RBV Fltr. A OUT/IN	No more than one
Points	12210 MSS Fltr. A OUT/IN	"0"

b. RBV Filter B <u>or</u> MSS Filter B should be "IN".

TLM Points	12202 RBV Fltr. B OUT/IN 12211 MSS Fltr. B OUT/IN	No more than one "0"

3. The WB Power Amplifiers should not be turned on prior to 16 hours in orbit. This will assure outgassing of the output filters and minimize the possibility of an arc at 20 watts operation.

4. The Power Amplifier temperature should not exceed 50°C.

5. The WB Modulator temperature should not exceed 50°C.

6. The WB Modulator Power Supply temperature should not exceed 45°C.

7. The WBFM should be commanded ON one minute before modulation to permit warmup.

8. The Wideband Power Amplifier (WBPA) should be commanded ON three minutes before modulation to permit warmup.

9. Summed data to WBPA #1 should not be used when WBPA #2 is ON and operating normally and summed data to WBPA #2 should not be used when WBPA #1 is ON and operating normally.

10. Enabling the WBPA's (command 776 or 754) can cause the ACS pneumatics low voltage detector to sense a low voltage and open the Low Voltage Interlock; it may also cause a "Clear" to execute in ECAM. Therefore, when either WBPA Enable command is transmitted, the Low Voltage Interlock Reset Command (044) and an ECAM turn-on sequence as described in Paragraph 2.15.6 should follow.

11. Continuous operation limited by 32 minute timer.

2.9 UNIFIED S-BAND/PREMODULATION PROCESSOR (USB/PMP)

1. A minimum of 30 seconds must be allowed between the following commands:

   a. Modulator A ON (605) and Modulator A OFF (626)

   b. Modulator B ON (644) and Modulator B OFF (665)

   c. MSFN to CIU B (715/CA10/CB10) and MSFN to CIU A (616/CB10/CA10)

2. Continuous operation limited by 32-minute timer.

3. USB Transmitter turn-on (Cmds 676 or 775) may cause the USB Receiver to temporarily break lock with an existing S-Band command uplink (2106.4 MHz). As a result, command 676 or 775 should be the last command in any sequence (sent by S-Band) containing that command. In addition, no command should be sent via S-Band for 40 seconds after the USB Transmitter turn-on.

2.10 ORBIT ADJUST SUBSYSTEM (OAS)

1. The propellant temperature must exceed 40°F prior to initiating a burn operation and remain above 40°F during the burn.

2. The Rocket Engine Assembly (REA) chamber temperature must be above 40°F prior to initiating a burn operation.

3. The Orbit Adjust Heater must be turned OFF just prior to initiating an REA burn operation. Not catastrophic but potentially degrading to the REA.

4. The negative (-)Y REA plume can impinge on the Left Solar Panel. Therefore, negative (-)Y firings should be accomplished as follows:

   a. When the left solar panel is within $\pm$15 degrees of Spacecraft horizontal with the left solar panel canted down (Shaft position 75 to 105 degrees as read with the left cosine pot).

   b. When the left solar panel is within $\pm$80 degrees of Spacecraft horizontal with the left solar panel canted up (Shaft position 190 to 350 degrees as read with the left cosine pot).

5. No limits on cumulative starts on any REA are specified. However, REA efficiency will decline as the REA catalyst bed degrades. A total of 66 starts were performed during qualification test with no significant deterioration of burn efficiency.

6. Operation of any REA must be greater than 1.0 second duration to a maximum of 2400 seconds. The maximum limit is an arbitrary design limit with qualification tests of 2500 seconds showing no significant deterioration of burn efficiency.

7. Total cumulative burn time of any REA must be less than 20,000 seconds. The limit is an arbitrary limit with qualification tests on 20,018 seconds showing no significant deterioration of burn efficiency.

8. The ACS subsystem must be in the Orbit Adjust mode, 400 RPM Interlock Disable, Pneumatics Bypass Enable, and Pneumatic Enable prior to burn of any Rocket Engine Assembly. Burns of less than 10 sec. using the -X or +X REA may be

performed in normal ACS mode as the disturbance torques can be controlled by flywheels.

2.11 RETURN BEAM VIDICON (RBV)

1. Neither camera should be turned ON unless the RBV power is OFF. This will bypass warm-up cycle. Not catastrophic.

2. The RBV should not b. turned ON unless the Camera Controller Combiner (CCC) has been commanded ON. CCC Controls warm-up cycle for cameras. Not catastrophic.

3. There must be at least 50 seconds between an RBV ON Command and a subsequent CCC Power Off Command (it would interrupt warm-up and High Voltage would come on).

4. The "Cathode Reactivation" sequence should not be sent unless authorized by the Flight Operations Manager. The camera(s) to be reactivated must be turned off and the CCC on prior to the Reactivation Sequence.

5. The RBV should be commanded ON approximately 71.5 seconds prior to desired coverage to allow for warmup.

6. Operationally, Start Calibrate should only be sent when the cameras are in the Continuous Cycle mode and Start Calibrate commands should be separated by 37.5 seconds minimum. These two restrictions assure that the three calibration pictures will occur in the proper order; i.e., Cal 0 first, followed by Cal 1 and Cal 2.

7. DO NOT turn CCC Power OFF with Power ON Cameras.

8. To record RBV on WBVTR, the rephase signal from the selected WBVTR must be connected to the RBV (Command 372, WBVTR-1, or 473, WBVTR-2).

9. The RBV shall not be turned on before 16 hours after launch to prevent corona in the high voltage circuit.

2.12 MULTISPECTRAL SCANNER (MSS)

1. Do not turn (Power) System A (Cmd. 053, Sys. A On) and (Power) System B (Cmd. 072, Sys. B On) ON at the same time. Not damaging.

2. The following commands may be sent only with the MSS OFF (Cmd. 073), to avoid switching powered loads.

053	(Power) System A ON
072	(Power) System B ON
312	Scan Mirror Power Line 1
336	Scan Mirror Power Line 2

3. In the event of a malfunction, (Power) System A ON, and (Power) System B ON (Cmds. 053 or 072) shall not be interchanged and Scan Mirror Power Lines 1 or 2 (Cmds. 312 or 336) selection shall not be changed until sufficient diagnosis has been performed to insure that a condition does not exist which will cause additional failures.

4. The Multiplexer Normal/Inhibit command relay must be in the MUX normal (Cmd. 257) state prior to sending either System A ON (Cmd. 053) or System B ON (Cmd. 072) or the MUX will not properly activate and the Scan Mirror will not start. If System A ON or System B ON commands are executed after MUX Inhibit (Cmd. 276) it will be necessary to send System OFF (Cmd. 073) followed by MUX Normal and then either System A ON or System B ON. MUX Inhibit (Cmd. 276) should only be used for diagnostic purposes.

5. For initial orbital operation, the Band 1-3 sensors H. V. shall be applied only after 20 hrs. in orbit and then only with Band 4 ON and activation of Bands 1-3 one band at a time with qualified personnel monitoring to insure no corona effects.

6. The MSS shall be operated with the rotating shutter ON (Cmd. 152) and cooler door latched (Cmd. 254) during launch.

7. After launch, the Band 5 cooler door will be commanded to the outgas position and the cooler will be outgassed for 2 weeks prior to opening the door for normal operation.

8. The rotating shutter requires at least 40 Sec. to acquire a sync stabilized rotation with the Scan Mirror. PMT and some electronic component warmup time is of the order of 3 Min.; therefore, data from the MSS shall be considered invalid for radiometric purposes prior to this 3 Min. warmup time.

9. Turn the MSS OFF if any of the following temperatures exceed the given limits

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(TMV goes more positive):

F/No.	Name	Temp.	TMV
15022	Band 5 Preamp Case	$60^{\circ}C$	-0.85
15043	Fiber Optics Plate #1	$42.2^{\circ}C$	-1.50
15044	Fiber Optics Plate #2	$42.2^{\circ}C$	-1.50
15045	Multiplexer	$54.4^{\circ}C$	-1.90
15046	Electronics Cover	$50.6^{\circ}C$	-1.15
15047	Power Supply	$45.6^{\circ}C$	-1.38
15048	Scan Mirror Regulator	$60^{\circ}C$	-0.31
15049	Scan Mirror Drive Elect.	$60^{\circ}C$	-0.30
15050	Scan Mirror Drive Coil	$82.2^{\circ}C$	-0.18
15051	Scan Mirror Housing	$50^{\circ}C$	-0.40
15052	Rotating Shutter Housing	$43.3^{\circ}C$	-1.47
15080	RC 1st Stage	$67^{\circ}C$	-1.15
15081	RC 2nd Stage Wide (Outgas)	$60^{\circ}C$	-4.19
15082	RC 2nd Stage Narrow (Outgas)	$60^{\circ}C$	-3.88

10. Door Hold OFF (Cmd. 275) must be executed before Door Motor Move ON (Cmd. 252) to release door magnet when going from door closed to outgas position.

11. When going from the door outgas position to the door closed position, send Power System A or B ON (Cmd. 053 or 072) and Door Hold ON (Cmd. 254) immediately prior to Door Move (Cmd. 252) to energize door magnet and insure correct door position.

12. From the door open position, the door must be moved to the door closed position, then to the door outgas position, to obtain the correct door outgas position.

13. Before sending Door Override Actuate (Cmd. 216), verify that the status of the door override safety relay is in "safe" state. If commands Door Override Actuate (Cmd. 216) and Door Override Safety Arm (Cmd. 334) are sent and MSS Heater

Power ON (Cmd. 316) the door will open within 20 Secs. If this occurs, the door will remain in an open position and no command sequence will cause any further door motion.

14. If Door Override Actuate (Cmd. 216) and MSS Heater Power ON (Cmd. 316) are sent, the radiation cooler outgas heater will be powered in the manual (uncontrolled) outgas mode and excessive Band 5 detector temperatures may result.

15. In the event that the door position telemetry fails to indicate proper position, send the Door Move Command (252) again. Absence of telemetry occurs occasionally due to contact bounce in the switch which turns off the door motor and also provides position telemetry.

2.13 DATA COLLECTION SYSTEM (DCS)

1. After activation the DCS will be "Powered Full Time". The reliability and longer life gained by this procedure outweigh the 1.5-watt power penalty.

2. Only a single DCS receiver will be powered at a given time.

3. Switching alternately from Receiver #1 ON to Receiver #2 ON and vice versa should be minimized to preclude excessive wear of the coax relay. Note that alternately turning Receiver #1 ON and OFF (or Receiver #2 ON and OFF) does not significantly affect life of the coax relay, only switching between receivers.

4. There is no direct telemetry verification of the position of the coax relay. The relay position can be inferred by knowledge of which receiver was commanded "on" most recently, or by non-real-time examination of DCS downlink data to determine if expected data is being received.

2.14 AUXILIARY PROCESSING UNIT (APU)

1. APU Power Off/On may cause the Backup Timer Outputs to pulse (generation of an OFF pulse). Therefore, the P/L Timer and USBX/WBPA Timer must both be disabled prior to sending command number 737-APU Power Off. Both timers should be enabled following the transmission of the APU Power On Command - 656.

2. Do not switch the APU between standby and normal while either Back-up Timer is counting. This would cause the timer to hang-up. A reset (all timer inputs = 0) would be necessary to clear the timer.

2.15 EXTENDED COMMAND AUXILIARY MEMORY (ECAM)

1. Do not switch clock frequencies or TMP Major Frame Pulse with ECAM On. ECAM will go into a degraded mode leading to either a complete HALT or a condition where ECAM will ignore further interrupts (1 HZ & MFP). (For both conditions, follow Restraint #6 below.)

2. Real time commands sent to the B COMDEC will not reach the Clock if the ECAM Output is Enabled and:

   a. ECAM is OFF

   b. ECAM is ON but not initiated (AOP not running)

   c. ECAM is ON and issuing a command (either stored or from SMART)

3. ECAM must be in the proper mode (Command/Program) to accept 26 or 36 bit commands:

   a. If 26 bit commands are sent in the Command Mode, they will result in a 1 or 9 status bit being set. This will prevent any commands from being executed until the status bits are reset.

   b. If 36 bit commands are sent in the Program mode, they may stop the ECAM or change the contents of a memory location.

4. ECAM must be in the LOAD mode to accept either 26 or 36 bit commands. If serial data information (26 or 36 bit commands) is sent to ECAM in the EXECUTE mode, ECAM will not accept the command.

5. ECAM must be ON and in EXECUTE to reprogram VIP. Data is blocked to VIP if ECAM is OFF or in LOAD.

6. If ECAM halts (AOP stops processing - digital A telemetry all "1"s), the following sequence should be used to restart the ECAM:

CA11/CB11	ECAM Output Disable
051	ECAM Load
201	ECAM On
380	ECAM Initiate
381	ECAM Sw to Command
384	ECAM Set Verify Address to "0"
201	ECAM On
	Allow ~ 15 minutes for program dump
	Verify Dump

381	ECAM Sw to Command
382	ECAM Load Time (as required)
105/164	Select proper ECAM side (Run A/Run B)
065	ECAM Execute
324	ECAM Output Enable

7. If the ECAM outputs are disabled, the execution of an ECAM Output Enable Command (324) will cause a momentary interruption of the X, Y and W lines to the B COMDEC (relay transfer time). For this reason, an ECAM Output Enable Command sent to the B COMDEC must always be the last command in the sequence, since the Clock will lose sync when the command executes.

8. The ECAM command memory should be zeroed before a new load is entered. This is to prevent a status bit 4 (two locations with the same execute time) caused by a command in the new load having the same time as a command in the old load.

SECTION 3

CRITICAL COMMANDS

SECTION 3

CRITICAL COMMANDS

The following is a list of critical commands which will not be sent without special permission from the NASA Flight Operations Manager or his designated representative, unless specified in emergency procedures. This list will be used by the command station for detecting commands which should not be sent to the spacecraft. If the command station detects one of these commands, it will flag an alarm which the command operator must reset. Then he will send this command only on confirmation from the operations supervisor.

Landsat-C Spacecraft, Site-Restricted Commands (OCC Critical)

Command Number	Spacecraft Subsystem	Command Description
142	Attitude Control	Yaw wheel disable
200	Attitude Control	Orbit adjust Mode Enable
204	Attitude Control	Yaw Acquisition mode
352	Return beam vidicon	Cathode reactivation on
507	WB video tape recorder 1	WBVTR-1 Lap
574	WB video tape recorder 2	WBVTR-2 Lap
627	Orbit Adjust	Orbit Adjust on 1
670	Orbit Adjust	OA Solenoid 1 ON
711	Orbit Adjust	OA Solenoid 2 ON
732	Orbit Adjust	OA Solenoid 3 ON
746	Orbit Adjust	Orbit Adjust on 2

Total 11

Landsat-C Spacecraft, CIU Commands (Site and OCC Critical)

Command Number	Spacecraft Subsystem	Command Description
780 (CA00)	Command integrator unit	Switch spacecraft regulator
781 (CA01)	Command integrator unit	Channel B off
782 (CA10)	Command integrator unit	Channel B on/Switch STADAN/MSFN Cmd Links
783 (CA11)	Command integrator unit	Command clock PS/COMDECs on ECAM Output Disable
784 (CB00)	Command integrator unit	Switch spacecraft regulator
785 (CB01)	Command integrator unit	Channel A off
786 (CB10)	Command integrator unit	Channel A on/Switch STADAN/MSFN Cmd Links
787 (CB11)	Command integrator unit	Command Clock PS/COMDECs on ECAM Output Disable

Total: 8

Landsat-C Spacecraft, Critical Commands

Command Number	Spacecraft Subsystem	Command Description	Critical Commands Remote Site	Critical Commands Landsat OCC
003	Clock	Primary COMSTOR verify	X	
005	Clock	Primary COMSTOR off	X	X
006	Clock	Primary COMSTOR activate	X	
007	Clock	Serial data transfer on	X	
011	Clock	Select Primary Matrix Decoder	X	
012	Clock	Select Primary Matrix A Drivers	X	
013	Clock	Select Primary Matrix B Drivers	X	
014	Clock	Select Primary oscillator	X	X
015	Clock	Select primary frequency generator	X	X
017	Clock	Load time code	X	X
020	Clock	Turn non-keyed PS/COMDEC off	X	X
023	Clock	Redundant COMSTOR verify	X	
025	Clock	Redundant COMSTOR off	X	X
026	Clock	Redundant COMSTOR activate	X	
031	Clock	Select Redundant matrix Decoder	X	
032	Clock	Select Redundant matrix A Drivers	X	
033	Clock	Select Redundant matrix B Drivers	X	
034	Clock	Select redundant oscillator	X	X
035	Clock	Select redundant frequency generator	X	X
040	Attitude Control	Pneumatics enable	X	X
041	Attitude Control	0.3-degree yaw position bias enable	X	X
042	Attitude Control	Pneumatics interlock by-pass disable	X	X
044	Attitude Control	Pneumatic low voltage interlock reset	X	X

Landsat-C Spacecraft, Critical Commands (Cont)

Command Number	Spacecraft Subsystem	Command Description	Critical Commands Remote Site	Critical Commands Landsat OCC
045	Attitude Control	Differential Tachometer disable	X	X
046	Wideband Power Amplifier 2	Power on	X	
047	Wideband Power Amplifier 2	Select 10 watt output	X	X
050	Auxiliary Processing Unit	Standby Mode	X	X
051	ECAM	ECAM Load	X	
053	Multi-spectral Scanner	System A ON	X	
060	Attitude Control	0.3 Deg. Yaw Position Bias Disable	X	X
061	Attitude Control	Pneumatics disable	X	X
063	Attitude Control	Pneumatics interlock by-pass enable	X	X
064	Attitude Control	Differential Tachometer Enable	X	X
065	ECAM	ECAM execute	X	
070	Aux Load Controller	MSS Mag. Comp. OFF	X	
072	MSS	System B ON	X	X
074	MSS	Select Band 2 High Voltage B	X	X
075	MSS	Select Band 1 High Voltage B	X	X

Landsat-C Spacecraft, Critical Commands (Cont)

Command Number	Spacecraft Subsystem	Command Description	Critical Commands Remote Site	Landsat OCC
076	MSS	Band 1 OFF	X	X
077	MSS	Select Band 3 High Voltage B	X	X
100	Attitude Control	Diff Tach Normal Gain	X	X
101	Attitude Control	0.1-degree yaw position bias enable	X	X
102	Attitude Control	RLNA into yaw disable	X	X
103	Attitude Control	2.9-degree pitch position bias enable	X	X
104	Attitude Control	Pitch Momentum Bias Mode Disable	X	X
105	ECAM	ECAM Run A	X	
110	USB Trans.	USB Select TRANS B	X	
111	Aux load controller	MSS Mag. Comp. ON	X	
112	MSS	High Voltage ON	X	
120	Attitude Control	0.1 yaw position bias disable	X	X
121	Attitude Control	Differential Tachometer high gain	X	X
122	Attitude Control	2.9-degree pitch position bias disable	X	X
123	Attitude Control	RLNA into yaw enable	X	X
125	Attitude Control	Pitch momentum bias mode enable	X	X
126	USB TRANS.	USB Select TRANS A	X	

Landsat-C Spacecraft, Critical Commands (Cont)

Command Number	Spacecraft Subsystem	Command Description	Critical Commands Remote Site	Critical Commands Landsat OCC
130	USB Transponder	Modulation input crossed	X	X
132	MSS	Band 2 OFF	X	X
134	MSS	Band 4 OFF	X	X
135	MSS	Band 3 OFF	X	X
136	MSS	Select Calibration Lamp B	X	X
137	MSS	Band 5 OFF	X	X
140	Attitude Control	Roll unload disable	X	X
144	Attitude Control	Pitch unload disable	X	X
162	Attitude Control	Penumatics momentary enable	X	X
164	ECAM	ECAM Run B	X	
166	VHF Transmitter	Playback NBTR 2	X	X
167	VHF Transmitter	Power 1 OFF	X	X
172	MSS	Scan monitor OFF	X	X
176	MSS	Band 1 High Voltage OFF	X	X
177	MSS	Calibration Lamp OFF	X	X
201	ECAM	ECAM ON	X	
202	Attitude Control	RMP A enable	X	X
205	Power Switching Module	VTR 1 Power Bypass ON	X	

Landsat-C Spacecraft, Critical Commands (Cont)

Command Number	Spacecraft Subsystem	Command Description	Critical Commands Remote Site	Critical Commands Landsat OCC
211	VHF transmitter	Power 2 OFF	X	X
215	MSS	Door Direction Open	X	
216	MSS	Door Override Activate	X	X
220	ECAM	ECAM OFF	X	
221	Attitude Control	Orbit adjust mode disable	X	X
222	Attitude Control	400-rpm interlock disable	X	X
223	Attitude Control	RMP B enable	X	X
224	Power Switching Module	VTR 1 Power By-pass OFF	X	
232	MSS	Band 3 High Voltage OFF	X	X
233	MSS	Band 2 High Voltage OFF	X	X
234	MSS	Door Direction Close	X	
235	MSS	Select Shutter Monitor Source B	X	X
237	MSS	Door Motor Power ON	X	
241	Power Switching Module	VTR 2 Power By-pass ON	X	
245	ECAM	Inhibit Store Commands/zero Time	X	X
246	Power	Battery 1 OFF	X	X
250	VHF transmitter	Select Transmitter B	X	X
251	VHF transmitter	Playback NBTR 1	X	X
252	MSS	Door Move	X	X
253	MSS	Band 5A Gain Step	X	X
254	MSS	Door Hold ON	X	

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Landsat-C Spacecraft, Critical Commands (Cont)

Command Number	Spacecraft Subsystem	Command Description	Critical Commands Remote Site	Critical Commands Landsat OCC
256	MSS	Scan Mirror Inhibit	X	X
262	Telemetry Processor	Select Format 1	X	X
264	Power	Battery 5 OFF	X	X
265	Power	Battery 6 off	X	X
266	Attitude Control	RMP B off	X	X
267	Power	Battery 2 OFF	X	X
270	Attitude Control	Right SAD disable	X	X
271	Attitude Control	RMP A motor start	X	X
272	MSS	Band 5B gain step	X	X
273	MSS	Door override RESET	X	
274	MSS	Select scan monitor source B	X	X
275	MSS	Door hold off	X	
276	MSS	MUX inhibit	X	X
301	Telemetry Processor	A/D B ON	X	X
302	Telemetry Processor	Output Circuit B ON	X	X
303	Telemetry Processor	Select Format 0	X	X
304	Attitude Control	RMP B motor on	X	X
305	Attitude Control	RMP B heater and electronics on	X	X
306	Power	Battery 7 off	X	X
307	Attitude Control	RMP A off	X	X
310	Power	Battery 3 off	X	X

Landsat-C Spacecraft, Critical Commands (Cont)

Command Number	Spacecraft Subsystem	Commands Description	Critical Commands Remote Site	Critical Commands Landsat OCC
313	MSS	Power override safety - safe	X	
316	Power Switching Module	MSS Heater On	X	X
317	MSS	Radiation cooler power on	X	
320	Power Switching Module	VTR 2 Power By-pass Off	X	
321	Telemetry Processor	Control Logic B On	X	X
324	ECAM	ECAM Output Enable	X	
325	Attitude Control	Left SAD high rate	X	X
326	Attitude Control	RMP A On	X	X
327	Power	Battery 8 off	X	X
330	Attitude Control	RMP B lower motor voltage	X	X
331	Power	Battery 4 off	X	X
332	MSS	Radiation Cooler Power Off	X	
334	MSS	Door override safety arm	X	X
336	MSS	Scan Mirror Power Line 2	X	X
337	Power Switching Module	MSS Heater Off	X	
340	Telemetry Processor	Power A ON/B OFF	X	X
344	Attitude Control	Left SAD disable	X	X
346	Power	Trickle charge normal	X	X
347	Power Switching Module	Enable USB transponder OFF	X	X

Landsat-C Spacecraft, Critical Commands (Cont)

Command Number	Spacecraft Subsystem	Commands Descriptions	Critical Commands Remote Site	Critical Commands Landsat OCC
350	DCS	Receiver 2 On	X	X
353	Power	All batteries on (PRI)	X	X
354	Power	Shunt load A off	X	X
355	Power	All comp Loads Off (PRI)	X	X
361	Telemetry Processor	Power A Off	X	X
362	Telemetry Processor	BI Level MUX B On	X	X
363	Telemetry Processor	Analog MUX BI On	X	X
367	Power	Trickle charge override	X	X
370	Attitude Control	RMP A Heater On	X	X
375	Power	Shunt Load B Off	X	X
403	Telemetry Processor	Power B On/A Off	X	X
404	Attitude Control	Right SAD high rate	X	X
407	DCS	Receiver 1 Off	X	X
410	Attitude Control	RMP A lower motor voltage	X	
411	RBV	CCC Power on	X	X
415	Power	Shunt load C off	X	X
420	Telemetry Processor	Analog MUX B2 On	X	X
421	Telemetry Processor	Serial MUX B On	X	X
422	Telemetry Processor	Power B Off	X	X
424	Power Switching Module	RBV primary control disable	X	X

Landsat-C Spacecraft, Critical Commands (Cont)

Command Number	Spacecraft Subsystem	Commands Description	Critical Commands Remote Site	Critical Commands Landsat OCC
427	RBV	Single Cycle	X	X
430	RBV	Start Prepare	X	X
432	RBV	CCC Power Off	X	X
433	RBV	Camera 1 On	X	X
436	Power	Auxiliary load 4 on	X	
444	WBVTR-1	Voltage protect relay reset	X	X
445	WBVTR-1	Record current adjustment	X	X
446	WBVTR-1	Bot/Eot Logic enable	X	X
450	RBV	Exposure 1	X	X
451	RBV	Exposure 2	X	X
452	RBV	Exposure 5	X	X
453	RBV	Exposure 3	X	X
454	RBV	Exposure 4	X	X
455	Power	Auxiliary load 5 on	X	
456	Power	Shunt load D off	X	X
470	RBV	Continuous cycle	X	X
471	RBV	Camera 2 on	X	X
472	RBV	Start calibration	X	X
506	WBVTR-1	Voltage protect disable	X	X
510	RBV	Camera 2 off	X	X
511	RBV	Camera 1 off	X	X
512	Power	All batteries on (B/U)	X	X
530	WBFM	Disable modulator B AFC	X	X
532	WBVTR-2	Record current adjust	X	X
533	WBVTR-2	BOT/EOT Logic Enable	X	X
540	Wideband Power Amplifier 1	Power on	X	

Landsat-C Spacecraft, Critical Commands (Cont)

Command Number	Spacecraft Subsystem	Command Description	Critical Commands Remote Site	Critical Commands Landsat OCC
541	Wideband Power Amplifier 1	Select 10 watt output	X	X
545	WBFM	Disable modulator A AFC	X	X
547	WBFM	Select VCO A2	X	X
553	WBVTR-2	Voltage protect relay reset	X	X
563	Power Switching Module	WBVTR search track switched	X	X
565	WBFM	Select VCO B2	X	X
573	WBVTR-2	Voltage protect disable	X	X
602	Attitude Control	Pitch Pos. Bias Arm	X	X
603	Power Switching Module	Orbit adjust timer disable	X	X
610	Power Switching Module	Multispectral Scanner Enable (primary)	X	
611	Power	All comp loads off (B/U)	X	X
612	Power Switching Module	RBV 1 TEM disable	X	X
613	Interface Switching Module	Disable selected scanner	X	X
615	Interface Switching Module	Orbit Adjust Thruster Heater On	X	X
616	Interface Switching Module	USB A/VHF B	X	X

Landsat-C Spacecraft, Critical Commands (Cont)

Command Number	Spacecraft Subsystem	Command Description	Critical Commands Remote Site	Critical Commands Landsat OCC
617	Interface Switching Module	Disable PSM relay bus	X	X
622	Power Switching Module	PRM fuse tap on	X	X
632	Power Switching Module	MSS Enable (both)	X	
633	Interface Switching Module	Right SAD unfused	X	X
634	Interface Switching Module	Command clock relays on 5A fuse	X	X
636	Interface Switching Module	Enable scan and select A	X	X
640	Attitude Control	2.0-degree pitch position bias enable	X	X
642	Attitude Control	0.6-degree pitch position bias enable	X	X
643	Power Switching Module	WBVTR-1 control reversed	X	X
647	Power Switching Module	MSS disable	X	X
654	Interface Switching Module	Left SAD unfused	X	X
657	Interface Switching Module	Orbit adjust thruster heater off	X	X

Landsat-C Spacecraft, Critical Commands (Cont)

Command Number	Spacecraft Subsystem	Command Description	Critical Commands Remote Site	Critical Commands Landsat OCC
661	Attitude Control	2.0-degree pitch position bias disable	X	X
662	Power Switching Module	Multispectral scanner enable (redundant)	X	
663	Attitude Control	0.6-degree pitch position bias disable	X	X
664	USB/PMP	Select WBVTR	X	X
667	Power Switching Module	RBV on (primary)	X	
672	Power Switching Module	WBVTR #1 BOT/EOT Logic Disable	X	X
673	Interface Switching Module	Switched telemetry power off	X	X
675	Interface Switching Module	Lock SSM	X	X
700	Magnetic Moment Compensation Assembly	Power on	X	X
706	Magnetic Moment Compensation Assembly	Capacitor Dump	X	X
707	Power Switching Module	RBV 2 TEM disable	X	X
710	Power Switching Module	RBV on (Redundant)	X	X

Landsat-C Spacecraft, Critical Commands (Cont)

Command Number	Spacecraft Subsystem	Command Description	Critical Commands Remote Site	Critical Commands Landsat OCC
714	Interface Switching Module	Unlock SSM	X	X
715	Clock	VHF to CIU A/USB to CIU B	X	X
717	Interface Switching Module	WBVTR BOT/EOT Logic Disable ARM	X	X
720	Power Switching Module	Disable payload timer signal	X	X
724	Power Switching Module	Sum Data to WBPA #1	X	X
725	Magnetic Moment Compensation Assembly	Capacitor charge	X	X
726	Power Switching Module	WBVTR 2 Control Reversed	X	X
733	Interface Switching Module	Switch payload regulator	X	X
734	Interface Switching Module	Enablc scan and select B	X	X
737	Interface Switching Module	APU power off	X	X
743	WBPA	Sum data to WBPA 2	X	X
747	Power Switching Module	RBV on (both)	X	X
750	Power Switching Module	PRM off (1)	X	X

Landsat-C Spacecraft, Critical Commands (Cont)

Command Number	Spacecraft Subsystem	Command Description	Critical Commands Remote Site	Critical Commands Landsat OCC
751	Power Switching Module	WBVTR #2 BOT/EOT Logic Disable	X	X
754	Interface Switching Module	Enable redundant WBPA	X	X
767	Power Switching Module	PRM fuse tap off	X	X
771	Power Switching Module	PRM off (2)	X	X
772	Power Switching Module	Disable USB transmitter/WBPA timer signal	X	X
774	Interface Switching Module	Attitude sensor power off	X	X
776	Interface Switching Module	Enable primary wideband power amplifier	X	X

Total: 239

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SECTION 4

MINIMUM SPACECRAFT CONFIGURATION

SECTION 4
MINIMUM
SPACECRAFT
CONFIGURATION

SECTION 4
MINIMUM SPACECRAFT CONFIGURATION

4.1 GENERAL

The spacecraft will be placed in the Level I configuration in the event of a power emergency. Further reductions in power consumption may be achieved by going to Levels II and III; however, prior permission must be received from the OCC Operations Manager or his designate before using Levels II and III.

4.1.1 LEVEL I

SYSTEM	FUNCTION OR MODE
ORBIT ADJUST	OFF
POWER	ALL AUX LOADS OFF
THERMAL	ALL COMP LOADS OFF
RBV	OFF
MSS	PWR OFF - HEATER OFF
WBVTR	BOTH OFF
DCS	OFF
WFM/WPA	OFF
AMS	OFF
APU	STANDBY
ACS	PENUMATICS DISABLE
USB	RANGING OFF
COMMAND	ECAM DISABLE
MSS	MAG COMP OFF

To reach Level I send the following:

CMD/SEQ	FUNCTION OR MODE
SEQ 846, MIN S/C MODE 1	SEE Table 4-1

If not required, execute the following:

CMD 001	COMSTOR A ON/FILL
CMD 021	COMSTOR B ON/FILL

4.1.2 LEVEL II

SYSTEM	FUNCTION
COMMAND	RED COMSTOR OFF
ACS	BOTH RMP HEATERS OFF
APU	OFF
TMP	SWITCHED TLM PWR OFF
POWER	PRM FUSE TAP OFF
POWER	PRM OFF
COMMAND	ECAM OFF
ACS	ONE RMP OFF

To reach Level II send the following:

CMD/SEQ	FUNCTION
SEQ 847 MIN S/C MODE 2	SEE Table 4-2

Turn off RMP not in use:

CMD 307	RMP A OFF

or

CMD 266	RMP B OFF

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4.1.3 LEVEL III

SYSTEM	FUNCTION
COMMAND	BOTH COMSTORS OFF
VHF	BEACON OFF
COMMAND	ONE COMDEC OFF

To reach Level III send the following:

CMD/SEQ	FUNCTION
SEQ 848 MIN S/C MOD 3	SEE Table 4-3

Turn off one COMDEC:

CMD 020	TURN OFF NONKEYED PS/COMDEC OFF

Table 4-1. Critical Sequence No. 846 Min S/C Mode 1

Line	CMD	Command Name	Flag	Critical CMD
10	764	ORBIT ADJUST OFF	0	
20	764	ORBIT ADJUST OFF	0	
30	000			
40	000			
50	374	ALL AUX LOADS OFF A	0	
60	355	ALL COMP LOADS OFF	0	
70	000			
80	000			
90	766	PAYLOADS OFF	0	
100	000			
110	000			
120	407	DCS RCVR 1 OFF	0	
130	406	DCS RCVR 2 OFF	0	
140	000			
150	000			
160	566	WFM INV A POWER OFF	0	
170	527	WFM INV B POWER OFF	0	
180	000			
190	000			
200	561	WPA POWER OFF 1	0	
210	067	WPA POWER OFF 2	0	
220	000			
230	000			
240	673	SWITCHD TLM PWR OFF	1	YES
250	000			
260	000			
270	774	ATTUDE SENS PWR OFF	0	
280	000			
290	000			
300	050	APU STBY MODE	0	
310	000			
320	000			
330	000			
340	000			
350	061	PENU DISABLE	1	YES
360	000			
370	000			
380	070	MAG COMP OFF	0	
390	000			
400	000			
410	146	RANGING OFF	0	
420	000			
430	000			
440	245	INHIBIT STORED CMDS	1	YES

Table 4-2. Critical Sequence No. 847 Min S/C Mode 2

Line	CMD	Command Name	Flag	Critical CMD
10	025	RED COMSTOR OFF	1	YES
20	247	RMP B HEATER OFF	1	YES
30	370	RMP A HEATER ON	1	YES
40	737	APU POWER OFF	1	YES
50	673	SWITCHD TLM PWR OFF	1	YES
60	767	PRM FUSE TAP OFF	1	YES
70	750	PRM OFF 1	1	YES
80	771	PRM OFF 2	1	YES

Table 4-3. Critical Sequence No. 848 Min S/C Mode 3

Line	CMD	Command Name	Flag	Critical CMD
10	005	PRI COMSTOR OFF	1	YES
20	000			
30	000			
40	025	RED COMSTOR OFF	1	YES
50	000			
60	000			
70	167	VHF XMTR PWR 1 OFF	1	YES
80	000			
90	000			
100	211	VHF XMT PWR 2 OFF	1	YES

SECTION 5

SPACECRAFT LAUNCH CONFIGURATION

SECTION 5
SPACECRAFT
LAUNCH
CONFIGURATION

SECTION 5

SPACECRAFT LAUNCH CONFIGURATION

The Landsat-C spacecraft will be placed in the required configuration prior to launch to ensure that all subsystems are in the desired status at lift-off and in a safe configuration at separation. Table 5-1 lists the planned launch status of the subsystems shown. The appropriate commands will be transmitted to the spacecraft from the command complex at WTR sometime prior to liftoff to configure the subsystems in the desired status. Command verification of the transmitted commands will be made at the WTR command complex.

Table 5-1. Status of Subsystems

TMP Subsystem			Verification
POWER A	ON	260	ANALOG & DIGITAL A
OUTPUT	ON	261	OUTPUT CIRCUIT A
FORMAT	ON	262	SELECT FORMAT 1
LOGIC	ON	300	CONTROL LOGIC A
POWER	ON	340	POWER A ON/B OFF
BI-LEVEL MUX	ON	341	BI-LEVEL MUX A ON
ANALOG MUX A1	ON	342	ANALOG MUX A1 ON
ANALOG MUX A2	ON	401	ANALOG MUX A2 ON
VHF Transmitter			
VHF MODE	RT	207	VHF MODE RT
VHF PB O/R	ON	230	NONE
VHF RF PWR	LO	210	VHF XMTR A-LO
VHF PWR 1	ON	206	
VHF PWR 2	ON	170	
VHF XMTR	A	231	

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Table 5-1. Status of Subsystems (Cont)

Command Subsystem			Verification
COMSTOR A	OFF	005	P COMSTOR
COMSTOR B	OFF	025	P COMSTOR OFF
MTX DECODER	PR1	011	PRIME MATRIX DECODER
MTX A DRIVE	PR1	012	PRIME MATRIX A/B DRIVERS
MTX B DRIVE	PR1	013	
OSCILLATOR	PR1	014	PRIME OSC/FREQ GEN
FREQ GEN	PR1	015	
VERIFY	TOCK	457	FN8057 - TIC TOC
MSFN/STADAN	A/B	616	DISC A ON RCVR A ON
CLOCK FUSE	1A	653	PRIME CLOCK FUSE
CIU CH B	ON	782	CIU CHAN BOTH
CIU CH A	ON	786	CHAN CONFIG UAVB
CLOCK PS/COM	ON	783	CLOCK POWER ON
ECAM	OFF	220	CLOCK POWER ON
NBTR			
NBTR 1	REC	543	NBR 1 REC
NBTR 2	REC	601	NBR 2 REC
USB Transmitter			
USB XMTR PWR	EN	347	FN 11022 - EN USB TRANSMITTER OFF
USB XMTR	DIS	757	TRANSMITTER POWER OFF
AUX OSC	EN	150	AUX OSC EN
SEL XMTR	A	126	TRANSMITTER A ON
RANGING	OFF	146	RANGING OFF
MOD INPUT	NORM	147	MOD INPUT NORMAL
Magnetic Moment Subsystem			
POWER	OFF	765	POWER OFF
CAPACITOR	HI	744	CAPACITOR H CHARGE
CAPACITOR	DUMP	706	CAPACITOR - DUMP
POLARITY	+	742	POLARITY - POS
PITCH COIL	OUT	702	PITCH COIL - OUT
ROLL COIL	OUT	761	ROLL COIL - OUT
YAW COIL	OUT	704	YAW COIL - OUT

Table 5-1. Status of Subsystems (Cont)

AMS Subsystem			Verification
POWER	OFF	774	POWER - OFF
Data Collection Subsystem			
RECEIVER 1	OFF	407	RECEIVER - OFF
RECEIVER 2	OFF	406	RECEIVER - OFF
Orbit Adjust Subsystem			
POWER 1 POWER 2	OFF	764	POWER OFF
SOL 1 SOL 2 SOL 3	OFF	745	SOLENOIDS OFF
SOL TIMER	EN	560	TIMER OFF
TH HEAT	OFF	657	HEATERS OFF
WBVTR			
WBVTR 1	OFF	651	POWER OFF
WBVTR 2	OFF	712	POWER OFF
RBV STBY	1	464	STANDBY MODE RBV
MSS STBY	2	572	STANDBY MODE MSS
VO PROT 1	EN	554	VOLTAGE PROTECT ENABLE
VO PROT 2	EN	467	VOLTAGE PROTECT ENABLE
SEARCH TRACK	NORM	631	SEARCH TRACK - NORMAL
WBPA			
WBPA ENA	PRIME/ REL	776/ 754	WPA POWER - BOTH
WBPA1	OFF	561	WPA 1 POWER - OFF
OUTPUT SEL 1	LO	541	WPA 1 POWER MODE -0-
WBPA2	OFF	067	WPA 2 POWER - OFF
OUTPUT SEL 2	LO	047	WPA 2 POWER MODE -0-

Table 5-1. Status of Subsystems (Cont)

MSS Subsystem			Verification
MSS ENABLE	BOTH	632	SYSTEM ENABLED
MSS SYSTEM	OFF	073	SYSTEM OFF
BAND 1	OFF	076	LV BAND 1, 2 OFF
BAND 2	OFF	132	
BAND 3	OFF	135	LV BAND 3, 4 OFF
BAND 4	OFF	134	
BAND 5	OFF	137	LV BAND 5 OFF
BAND 1 HV	A	054	HV BAND 1 OFF A
BAND 1 HV	OFF	176	
BAND 2 HV	A	055	HV BAND 2 OFF A
BAND 2 HV	OFF	233	
BAND 3 HV	A	256	HV BAND 3 OFF A
BAND 3 HV	OFF	232	
SHUTTER MON SOURCE	A	214	ROT SHUTTER ON A
ROT SHUTTER	ON	152	
CAL LAMP	A	117	CAL LAMP OFF A
CAL LAMP	OFF	177	
SELECT SCAN MON	A	255	SCAN MON OFF A
SCAN MON	OFF	172	
SCAN MIRROR	INH	256	SCAN MIRROR INH 1
SCAN MIR PWR	1	312	
MIR SCAN	OFF	335	MID SCAN CODE OFF
MUX	INH	276	MUX MODE COMP
MUX MODE	COMP	315	
HEATER	OFF	337	HEATER OFF
BAND 1 GAIN	LO	175	1/2 GAIN L/L
BAND 2 GAIN	LO	174	
DOOR MOTOR POWER	OFF	133	DOOR POWER OFF
DOOR DIRECTION	CLOSE	234	DOOR CLOSE
DOOR OVERRIDE RESET	RESET	273	DOOR RESET
DOOR HOLD	ON	254	DOOR HOLD ON
DOOR OVERRIDE SAFETY	SAFE	313	DOOR SAFE
RADIATION COOLER PWR	OFF	332	COOLER PWR OFF
MAG COMP	OFF	070	MAG COMP OFF

Table 5-1. Status of Subsystems (Cont)

ACS Subsystem			Verification
LO VOLT INT	RESET	044	PNEUMATICS ENABLE
RSAD RATE	OFF	425	SAD RIGHT RATE - OFF
LSAD RATE	NORM	244	SAD LEFT RATE - NORMAL
RSAD RATE	EN	311	RIGHT SAD CCW RESET CW
LSAD RATE	EN	365	LEFT SAD RESET CW, CCW
RSAD PWR	FUSE	674	SAD RIGHT POWER - FUSD
LSAD PWR	FUSE	713	SAD LEFT POWER FUSD
PNEU	EN	040	PNEUMATICS - ENABLE
PNEU INTLK	DIS	042	PNEUMATICS INTERLOCK - BYPASS
PMB MODE	DIS	104	NONE
P POS BIAS	+	145	PITCH BIAS - POSITION
0.6 PPB	DIS	663	PITCH BIAS -4.87,
2.0 PPB	DIS	661	4.87 TMV
2.9 PPB	DIS	122	4.87 TMV
P UNLOAD	EN	165	PITCH - ROLL UNLOAD, BOTH
R UNLOAD	EN	161	PITCH - ROLL UNLOAD, BOTH
TACH	EN	064	R DFT ST - NORMAL
TACH GAIN	NORM	100	R DFT ST - NORMAL
YAW WHEEL	EN	163	YAW WHEEL ENABLE
YAW POS BIAS	+	160	YAW BIAS 6.35 TMV
0.1 YPB	DIS	120	YAW BIAS 6.35 TMV
0.3 YPB	DIS	060	YAW BIAS 6.35 TMV
0.6 YPB	DIS	623	YAW BIAS 6.35 TMV
RLNA/YAW	DIS	102	RLNA - YAW - DISABLE
YAW MODE	ACQ	204	YAW MODE - ACQUISITION
0.A MODE	DIS	221	ORBIT ADJ - DISABLE
400 RPM INT	EN	203	400 RPM - ENABLE
RMP B	EN	223	SELECT RMP - NO. 2
RMP B HTR	ON	305	RP2 STAT NORMAL
RMP B MTR	ON	304	RP2 STAT NORMAL
RMP A MTR	ON		
AND HTR	ON	307	RMP A OFF
		271	RMP A MOTOR START
		307	RMP A OFF
		326	RMP A ON
		271	RMP A MOTOR START
			8 SEC DELAY
		326	RMP A ON
			30 SEC DELAY
		370	RMP A HTR ON
EN SCAN SEL	A	636	SCANNERS BOTH 1
SSM	LOCK	675	SCANNER - LOCK

Table 5-1. Status of Subsystems (Cont)

Power Subsystem			Verification
BATT 1 BATT 2 BATT 3 BATT 4 BATT 5 BATT 6 BATT 7 BATT 8	ON	353	BATT 1 - 8 ON
AUX LD 1 AUX LD 2 AUX LD 3 AUX LD 4 AUX LD 5	OFF	374	AUX LOADS OFF
SHUNT LD A SHUNT LD B SHUNT LD C SHUNT LD D	ON	437	SHUNT LOADS ENABLE
COMP LD 1 COMP LD 2 COMP LD 3 COMP LD 4 COMP LD 5 COMP LD 6 COMP LD 7 COMP LD 8	OFF	355	COMP LOADS OFF
TR CHARGE	NORM	346	TRICKLE CHARGE NORMAL
PRM	ON	727	PRM ON
PRM FTAP	ON	622	PRM FUSE TAP ON
PSM BUSS	EN	655	PRM RELAYS ENABLE
SW TMP PWR ON	ON	614	TELEMETRY POWER ON

Table 5-1. Status of Subsystems (Cont)

WBFM Subsystem			Verification
SEL VCO	A1	524	VCO A/B - 1/1
SEL VCO	B1	466	
MOD A AFC	EN	526	AFC A/B - 1/1
MOD B AFC	EN	567	
INV A PWR	OFF	566	INVERTER A SELECT
INV PWR/WBFM	A	641	
INV B PWR	OFF	527	
RBV FILTER	A	544	FILTER A RBV
MSS FILTER	B	576	FILTER B - MSS
RT 1/MSS FLT	B	475	M FIL B IN RT - 1 M FIL B IN NONE
RT RBV FLT	A	515	R FIL A IN RT R FIL B IN NONE
IN RBV/MSS FIL	B/A	666	FN 12200 R FIL A IN FN 12201 R FIL B OUT FN 12210 M FIL A OUT FN 12211 M FIL B IN
RBV BIAS	A	546	RBV BIAS VLT A
DATA WBPA	PRIME	705	DATA TO POWER AMPS NORMAL
RBV Subsystem			
APERTURE CORR	OUT	431	APERTURE CORR OUT
EXPOSURE	4	454	EXPOSURE 4
CYCLE	CONT	470	CYCLE CONT
CATH REACT	OFF	371	CATH REACT OFF
THER MOD 1	EN	770	THERMAL MODE 1
THER MOD 2	EN	730	THERMAL MODE 2
RBV PWR	OFF	731	SYSTEM POWER OFF
CCC	OFF	432	CCC - POWER OFF
CAM 1	OFF	511	CAMERA 1 OFF
CAM 2	OFF	510	CAMERA 2 OFF
PMP Subsystem			
MOD A	OFF	626	MODE OFF
MOD B	OFF	665	
SEL	NBR	606	RCDR MODE NBR 1
NBTR SEL	1	646	
WBVTR SEL	1	624	

Table 5-1. Status of Subsystems (Cont)

APU Subsystem			Verification
POWER	ON	656	POWER MODE OFF
MOD	STBY	050	
P/L TIMER	DIS	720	P/L TIMER ON/DISABLE
SEARCH TRACK	NORM	631	SEARCH TRACK DATA NORMAL
USB/WPA TIM	EN	755	VIP TIMER ON/DISABLE

SECTION 6

SPACECRAFT ACTIVATION SEQUENCE

SECTION 6
SPACECRAFT
ACTIVATION
SEQUENCE

SECTION 6

SPACECRAFT ACTIVATION SEQUENCE

6.1 ACTIVATION SEQUENCE

The following paragraphs describe the activation sequence for the spacecraft through Orbit 46. This sequence is subdivided by orbit and interrogation. For each interrogation, the station is listed together with the maximum elevation and interrogation time. The activities planned for each interrogation are also listed with corresponding command numbers or activity number when applicable. The spacecraft command activities are listed in Appendix C.

6.2 PRELAUNCH AND LAUNCH (FROM WTR)

1. TLM and report on exact launch configuration.
2. Report on Narrow Band Recorder No. 1 and No. 2 on in record.
3. Report on Wide Band Video Tape Recorder record track number and residual data left on recorder.
4. Time of spacecraft switch to internal power (on batteries).
5. Report on selected telemetry at liftoff.
    - a. Spacecraft Regulated Bus Current
    - b. Payload Regulated Bus Current
    - c. Orbit Adjust Tank Pressure and Temperature
    - d. Command Execution Counter value
6. Report on Delta second-burn performance from Orbit Determination Group (ODG).

6.3 ORBIT 1

6.3.1 INTERROGATION 1 WINKFIELD (13 MIN. 23°) AOS = L + 71 MIN.

1. VHF beacon on commands if required.
2. Measure telemetry signal strength.
3. Verify separation, controls stabilization, and that controls are in the expected mode.
4. VHF data transmitted to GSFC.
5. Establish command ability.
6. Command USB on (775, 605).
7. Report antenna X - Y coordinates.
8. Evaluate solar array output.

6.3.2 INTERROGATION 1 MADRID (6 MIN. 8°) AOS = L + 71 MIN

1. Establish nature of orbit; report antenna X - Y coordinate.
2. CMD ranging on (127).
3. USB data transmitted to GSFC.
4. Establish command link checking each COMDEC with tick-tocks in Real Time (373)/(457) (follow command decision tree).
5. Monitor controls operation.
6. ACS command if required, RMP "A" Low Motor Voltage (410). RMP Motor start (turns Heater OFF) (271).
7. Reset S/C clock if required.
8. CMD USB OFF (Activity No. 54).

9. Landsat Commands using decision tree.

   a. Separation switch bypass (635).

   b. Pneumatics disable (061).

   c. Yaw mode normal (225).

6.3.3 INTERROGATION 1 ALASKA (11 MIN, 43^{o}) AOS = L + 88 MIN

1. Continue to establish nature of orbit.

2. Command USB ON (Activity No. 53).

3. S/C status verification and establish command link with Tick-Tock Command (373) (457).

4. Reset S/C time if required.

5. Transmit separation switch bypass (635), if required.

6. Monitor controls operations and determine remaining pound/seconds.

7. ACS commands if required (yaw normal, 225).

8. Follow ACS sun and earth acquisition decision trees (Appendix D).

9. Perform Power and Thermal Management.

10. P/B NBTR No. 1 (Activity No. 56, No. 57).

11. Turn ON in REC NBTR No. 1 (Activity No. 55).

12. Turn OFF NBTR No. 2 (Activity No. 51).

13. Turn on COMSTOR No. 1 (001) and COMSTOR No. 2 (021), load time code (017), and load both COMSTORS with USB ON for 2 MADRID (AOS - 1 min) and 2 ALASKA (AOS - 1 min). LOAD the momentary pneumatic enable command (162) for the following times with one orbital period recycle time: SN/SD +20 min, 35 min, 50 min, 65 min, 80 min, and 95 min. Load all nonused COMSTOR locations with tick tock commands (373/457) to execute during the Madrid interrogation in orbit 2 and have 1 orbital period recycle times.

    Note: The assumption being that the pneumatics disable command (061) is sent at this interrogation and that the momentary (162) enable will be used until the MMCA adjustments have been implemented.

14. Verify the S/C is in roll tach normal gain (100).

15. Check Aux Load OFF cmds (374) (413) using Aux No. 1 on (356).

16. Send MSS OFF (use payloads off, 766).

17. Enable Payload timer (701).

6.3.4 INTERROGATION 1 HAWAII (14 MIN, 33°) AOS = L + 100 MIN

1. Monitor S/C status.

2. Verify that controls are operating normally and determine gas remaining.

3. ACS commands if necessary.

4. Command USB OFF (Activity No. 54).

6.4 ORBIT 2

6.4.1 INTERROGATION 2 MADRID (14 MIN, 57°)

1. Command USB ON (Activity No. 53) if not already ON by stored command.

2. Verify S/C status and Command Capability.

3. P/B NBTR No. 2 (604, 542).

4. Verify that stored Tick-Tock commands activated on time.

5. Command USB OFF (Activity No. 54).

6.4.2 INTERROGATION 2 ALASKA (13 MIN, 68°)

1. Verify S/C status, normal controls, and command capability.

2. Turn ON in REC NBTR No. 2 (601).

3. Stop NBTR No. 1 (562).

4. P/B NBTR No. 1 (646, 621).

5. Check comp load OFF (Cmd (355) using comp load No. 8 ON (773).
   Comp Load No. 3/WB Elec. No. 1 (414)
   Comp Load No. 4/WBRAD Plate (416)
   Comp Load No. 5/RBV Sensor (417)
   Comp Load No. 7/WB Elec. No. 2 (756)
   Comp Load No. 8/MSS Sensor (773)

6. Perform power and thermal management.

7. Verify S/C is in roll tach normal gain (100).

8. ACS Command RSAD Normal (425), RMP A OFF (307).

9. Store USB on CMD in COMSTOR No. 2 to execute 3 MADRID (AOS - 1 min.) and 3 ALASKA (AOS - 1 min.) (Activity No. 53).

10. Reset time if required.

11. CMD USB OFF (Activity No. 54).

6.5 ORBIT 3

6.5.1 INTERROGATION 3 MADRID (12 MIN, 20°)

1. Verify S/C Status and Command Capability.

2. Monitor Controls, Power, and Thermal Subsystems.

3. Verify that all stored Tick-Tock commands activated as scheduled.

4. Cmd USB OFF (Activity No. 54).

6.5.2 INTERROGATION 3 ALASKA (11 MIN, 30°)

1. Verify S/C Status.

2. Verify controls are operating normally.

3. Turn ON in REC NBTR No. 1 (Activity No. 55).

4. P/B NBTR No. 2 (Activity No. 51, No. 52).

5. Perform Power and Thermal Management.

6. Store USB on CMD in COMSTOR No. 2 to execute at 4 GREENBELT AOS - 1 min. (Activity No. 53). Momentary enables as directed.

7. Cmd USB OFF (Activity No. 54).

6.6 ORBIT 4

6.6.1 INTERROGATION 4 GREENBELT (7 MIN, 11^{o})

1. Determine slant range effect on USB telemetry signals.

2. Establish CMD Capability.

6.6.2 INTERROGATION 4 ALASKA (9 MIN, 19^{o})

1. Verify S/C status and ability to CMD.

2. Perform power and thermal management.

3. Turn ON in REC NBTR No. 2 (Activity No. 50).

4. P/B NBTR No. 1 (Activity No. 56, No. 57).

5. Store USB ON cmd in COMSTOR No. 2 to execute at 5 GREENBELT AOS - 1 Min. (Activity No. 53).

6. Turn OFF USB (Activity No. 54).

6.7 ORBIT 5

6.7.1 INTERROGATION 5 GREENBELT (13 MIN, 78^{o})

1. Verify S/C Status and CMD Capability.

2. Turn ON in REC NBTR No. 1 (Activity No. 53).

3. P/B NBTR No. 2 (Activity No. 51, No. 52).

4. Turn on DCS No. 1 Receiver (366).

5. Send APU Normal Mode (071).

6. Perform PWR and Thermal Management.

7. Turn on WBVTR No. 1 and No. 2 (607, 464, 650, 572).

8. Rewind WBVTR 1 and 2 for 2 Min. (tapes will be approximately 7 Min. from BOT after rewind). (Activity No. 41 and No. 46).

9. Store USB ON CMD in COMSTOR No. 2 to execute at 6 GOLDSTONE AOS - 1 Min. (Activity No. 53).

10. Turn on Attitude Measuring System (AMS) (716).

6.7.2 INTERROGATION 5 ALASKA (8 MIN., 19°)

1. Monitor Real Time Telemetry.

2. CMD USB OFF (Activity No. 54).

6.8 ORBIT 6 (TOTAL COMPOSITE TIME, 21 MIN.)

6.8.1 INTERROGATION 6 GOLDSTONE (12 MIN., 23°)

1. Verify S/C status and establish CMD capability.

6.8.2 INTERROGATION 6 GREENBELT (6 MIN., 30°)

1. Monitor Real Time Telemetry.

6.8.3 INTERROGATION 6 ALASKA (11 MIN., 30°)

1. Verify S/C status and establish CMD capability.

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2. Continue to evaluate S/C Power, Controls, and Thermal Subsystems.

3. Store USB ON CMD for 7 GOLDSTONE AOS - 1 Min. (Activity No. 53).

4. Turn ON in REC NBTR No. 2 (Activity No. 50).

5. P/B NBTR No. 1 (Activity No. 56, No. 57).

6. Cmd USB OFF (Activity No. 54).

6.9 ORBIT 7 (TOTAL COMPOSITE TIME, 23 MIN.)

6.9.1 INTERROGATION 7 GOLDSTONE (15 MIN., 45^{o})

1. Verify S/C status and CMD capability.

6.9.2 INTERROGATION 7 ALASKA (13 MIN., 71^{o})

1. Verify S/C status and establish Command capability.

2. Turn ON in REC NBTR No. 1 (Activity No. 55).

3. P/B NBTR No. 2 (Activity No. 51, No. 52).

4. Verify that all recycle command sets are coincident with S/C orbit.

5. Store USB ON CMD for 8 ALASKA AOS - 1 Min. (Activity No. 53).

6. CMD USB OFF (Activity No. 54).

6.10 ORBIT 8

6.10.1 INTERROGATION 8 ALASKA (12 MIN., 41^{o})

1. Verify S/C status.

2. Establish Command Capability and store USB ON CMD to execute at 9 ALASKA, 10 MADRID, 11 BERMUDA, and 12 GREENBELT AOS - 1 Min. (Activity No. 53).

3. Store NBTR No. 2 REC for NBTR No. 1 REC EOT - 1 Min. (Activity No. 50).

4. Turn ON in REC NBTR No. 2 (Activity No. 50).

5. P/B NBTR No. 1 (Activity No. 56, No. 57).

6. CMD USB OFF (Activity No. 54).

6.11 ORBIT 9

6.11.1 INTERROGATION 9 ALASKA (5 MIN., 13^{o})

1. Verify S/C status.
2. Verify Command Capability.
3. Turn ON in REC NBTR No. 1 (Activity No. 55).
4. P/B NBTR No. 2 (Activity No. 51, No. 52).
5. CMD USB OFF (Activity No. 54).

6.12 ORBIT 10

6.12.1 INTERROGATION 10 MADRID (14 MIN., 38^{o})

1. Verify S/C status.
2. Establish CMD Capability.
3. CMD USB OFF (Activity No. 54).

6.13 ORBIT 11

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6.13.1 INTERROGATION 11 BERMUDA (14 MIN., 16^{o})

1. Verify S/C status.

2. Establish CMD capability.

3. CMD USB OFF (Activity No. 54).

6.14 ORBIT 12

6.14.1 INTERROGATION 12 GREENBELT (12 MIN., 46°)

1. Verify S/C Status.

2. P/B NBTR No. 1 at +2 Min. (Activities No. 56, No. 57).

3. Turn on both Wideband Downlinks (Activities No. 22, No. 23) with all input filters inhibited (760, 741, 703, 722) (666, 625) and in LOW POWER MODE (541, 047). Leave on for 7 minutes, then CMD OFF (Activity No. 30).

4. Store NBTR No. 1 REC for NBTR No. 2 REC +109 mins. (Activity No. 55).

5. Store USB ON for 13 ETC AOS - 1 min. (Activity No. 53).

6. CMD USB OFF (Activity No. 54).

6.15 ORBIT 13 (TOTAL COMPOSITE TIME, 15 MINS.)

6.15.1 INTERROGATION 13 GREENBELT (11 MIN., 26°)

1. Verify S/C status.

2. Establish CMD Capability.

3. P/B NBTR No. 2 (Activity No. 51, No. 52).

4. Turn on both Wideband Downlinks (Activity No. 22, No. 23) with input filters inhibited (760, 741, 703, 722) (666, 625) and in high power mode (600, 106). Leave on for 7 minutes then CMD OFF (Activity No. 30).

5. Store USB ON for AOS 14 ALASKA - 1 Min. (Activity No. 53).

6.15.2 INTERROGATION 13 GOLDSTONE (10 MIN., 14°)

1. Verify S/C status.

2. CMD USB OFF (Activity No. 54).

6.16 <u>ORBIT 14 (TOTAL COMPOSITE TIME, 19 MINS.)</u>

6.16.1 INTERROGATION 14 ALASKA (8 MIN., 15°)

1. Monitor S/C Status.

6.16.2 INTERROGATION 14 GOLDSTONE (14 MIN., 66°)

1. Verify S/C Status.

2. Verify Command Capability.

3. Turn ON in REC NBTR No. 2 (Activity No. 50).

4. P/B NBTR No. 1 (Activity No. 56, No. 57).

5. Turn on Wideband Downlinks (Activity No. 22, No. 23) with RBV input to RBV Filter A (515, 544) and MSS input to MSS Filter B (516, 576) and in high Power Mode (600, 106). Leave on for 7 minutes then CMD OFF (Activity No. 30).

6. Store USB ON for 15 ALASKA AOS - 1 Min. (Activity No. 53) and Wideband Downlinks ON for AOS - 2 min. (Activity No. 22, No. 23). WBPA No. 2 Low Power (047).

7. CMD USB OFF (Activity No. 54).

6.17 <u>ORBIT 15</u>

6.17.1 INTERROGATION 15 ALASKA (11 MIN., 45°)

1. Verify S/C Status.

2. Establish Command Capability.

3. Turn ON in REC NBTR No. 1 (Activity No. 1 (Activity No. 55).

4. P/B NBTR No. 2 (Activity No. 51, No. 52).

5. Send stored Payload Configuration at AOS +1 Min. (Activity No. 45, No. 38).

6. WBVTR No. 1 P/B at AOS +2 Min. (Activity No. 43).

7. WBVTR No. 2 P/B at AOS +4 Min. (Activity No. 39).

8. WBVTR No. 1 Pwr OFF at P/B +5 Min. 00 Sec. (Activity No. 9).

9. WBVTR No. 2 Pwr OFF at P/B +5 Min. 00 Sec. (Activity No. 19).

10. Store USB ON for 16 ALASKA AOS - 1 Min. (Activity No. 53).

11. Send Wideband downlinks OFF (Activity No. 30).

12. CMB USB OFF (Activity No. 54).

6.18 ORBIT 16

6.18.1 INTERROGATION 16 ALASKA (13 MIN., 64°)

1. Verify S/C Status and CMD Capability.

2. Turn ON in REC NBTR No. 2 (Activity No. 50).

3. P/B NBTR No. 1 (Activity No. 56, No. 57).

4. Store USB ON for 17 ALASKA AOS - 1 Min. (Activity No. 53).

5. CMD USB OFF (Activity No. 54).

6.19 ORBIT 17

6.19.1 INTERROGATION 17 ALASKA (11 MIN., 29°)

1. Verify S/C status.

2. Turn ON in REC NBTR No. 1 (Activity No. 55).

3. P/B NBTR No. 2 (Activity No. 51, No. 52).

4. Store USB ON for 18 ETC AOS - 1 Min. (Activity No. 53).

5. CMD USB OFF (Activity No. 54).

6.20 ORBIT 18

6.20.1 INTERROGATION 18 GREENBELT (9 MIN., 13^{o})

1. Verify S/C status.

2. Turn ON in REC NBTR 2 (Activity No. 50).

3. P/B NBTR No. 1 (Activity No. 56, No. 57).

6.20.2 INTERROGATION 18 ALASKA (7 MIN., 19^{o})

1. Monitor S/C status.

2. Configure MSS Filters to Link 3 (Activity No. 21).

3. CMD USB OFF (Activity No. 54).

4. Store USB ON for 19 GREENBELT AOS - 1 Min. (Activity No. 53).

5. Store Wideband PA No. 2 ON for 19 GREENBELT AOS - 2 Min. (046).

6. Store Inverter A ON for 19 GREENBELT AOS (525).

6.21 ORBIT 19

6.21.1 INTERROGATION 19 GREENBELT (13 MIN., 87^{o})

1. Turn ON in REC NBTR No. 1 (Activity No. 55).

2. MSS S-Band on at AOS (stored command).

3. P/B NBTR No. 2 (Activity No. 51, No. 52).

4. Configure MSS, AOS + 3 Min.

WBVTR No. 2 ON, REC	(650, 513)
Cal Lamp On	(156)
Scan Monitor On	(153)
Scan Mirror Normal	(277)
Mid Scan Code On	(314)
MSS Enable	(610)
MSS System On	(052)
Band 4 On	(115)

5. At Band 4 on plus 90 Sec.

Band 4 OFF
Band 1 ON

Verify High Voltage 1, 2, 3 OFF.

6. Send MSS High Voltage ON (112).

7. Send Band 1 HV ON (157).

8. At Band 1 HV ON plus 90 Sec.

Band 1 HV OFF	(176)
Band 1 OFF	(076)
Band 2 ON	(113)

9. Send Band 2 HV ON (212).

10. At Band 2 HV ON plus 90 Sec.

Band HV OFF	(233)
Band 2 OFF	(132)
Band 3 ON	(114)

11. Send Band 3 HV ON (213).

12. At Band 3 HV ON plus 90 sec.

Band 4 ON	(115)
Band 1 ON	(057)
Band 1 HV ON	(157)
Band 2 ON	(113)
Band 2 HV ON	(212)

13. At Band 3 HV ON plus 180 sec.

    Payloads OFF (766)

14. Wideband Downlinks OFF (Activity No. 30).

6.21.2 INTERROGATION 19 ALASKA (8 MIN., 19°)

1. Monitor and record MSS.
2. CMD USB OFF (Activity No. 54).
3. Store USB ON for 20 GREENBELT AOS - 1 Min. (Activity No. 53).

6.22 <u>ORBIT 20 (TOTAL COMPOSITE TIME, 21 MINS.)</u>

6.22.1 INTERROGATION 20 GREENBELT (7 MIN., 12°)

1. Verify S/C status.
2. MSS Band 5 Outgas.

6.22.2 INTERROGATION 20 GOLDSTONE (13 MIN., 25°)

1. Verify S/C status.

6.22.3 INTERROGATION 20 ALASKA (11 MIN., 32°)

1. Turn on REC NBTR No. 2.
2. P/B NBTR No. 1 (Activity No. 56, No. 57).
3. Store USB ON for 21 GOLDSTONE AOS - 1 Min. (Activity No. 53).
4. CMD USB OFF (Activity No. 54).

6.23 <u>ORBIT 21 (TOTAL COMPOSITE TIME, 23 MINS.)</u>

6.23.1 INTERROGATION 21 GOLDSTONE (14 MIN., 40^{o}) ALASKA (12 MIN., 73^{o})

1. Verify S/C status.
2. CMD WBPA No. 2 ON AOS + 10 Min. (046).
3. CMD Inverter A ON AOS + 11 Min. (525).
4. CMD MSS ON AOS + 14 Min. (Activity No. 28, WBVTR No. 2 Record (Activity No. 37).

6.23.2 INTERROGATION 21 ALASKA (13 MIN., 74^{o})

1. Turn On in REC NBTR No. 1 (Activity No. 55).
2. P/B NBTR No. 2 (Activity No. 51, No. 52).
3. Payloads OFF After Cal (766).
4. Command Wideband Downlinks OFF.
5. Store USB ON for 22 ALASKA AOS - 1 Min. (Activity No. 53).
6. CMD USB OFF (Activity No. 54).

6.24 ORBIT 22

6.24.1 INTERROGATION 22 ALASKA (12 MIN., 38^{o})

1. Verify S/C status.
2. Turn ON in REC NBTR No. 2 (Activity No. 50).
3. P/B NBTR No. 1 (Activity No. 56, No. 57).
4. Store USB ON 23 ALASKA AOS - 1 Min. (Activity No. 53) COMSTOR No. 1.
5. Store USB ON 24 MAD AOS - 2 Min. (Activity No. 53) COMSTOR No. 1.

6. Store NBTR CMDS - Start NBTR No. 2 for AOS 23 ALA plus 209 Min. (Activity No. 50) COMSTOR No. 1.

7. CMD USB OFF (Activity No. 54).

6.25 ORBIT 23

6.25.1 INTERROGATION 23 ALASKA (8 MIN., 12°)

1. Verify S/C Status.

2. Turn ON in REC NBTR No. 1 (Activity No. 55).

3. P/B NBTR No. 2 (Activity No. 51, No. 52).

4. CMD USB OFF (Activity No. 54).

6.26 ORBIT 24

6.26.1 INTERROGATION 24 MADRID (14 MIN., 34°)

1. Verify S/C status.

2. Verify ability to command.

3. Store USB ON for 25 BERMUDA AOS - 1 Min. and 26 GREENBELT AOS - 1 Min. (Activity No. 53) COMSTOR No. 2.

4. Store MSS ON at T_f = AOS 26 GREENBELT (Activity No. 28).

5. Store Wideband links ON for AOS 26 GREENBELT (Activity No. 23).

6. CMD USB OFF (Activity No. 54).

6.27 ORBIT 25

6.27.1 INTERROGATION 25 BERMUDA (14 MIN., 18°)

1. Verify S/C status.

2. R/T data only.

3. CMD USB OFF (Activity No. 54).

6.28 ORBIT 26

6.28.1 INTERROGATION 26 GREENBELT (12 MIN., 51°)

1. Verify S/C status.

2. P/B NBTR No. 1 (Activity No. 56, No. 57).

3. Downlink 3 and MSS (Stored Commands).

4. Store USB ON for 27 GREENBELT AOS - 1 Min. (Activity No. 53).

5. Store MSS ON at T_f = AOS 27 GREENBELT (Activity No. 28).

6. Store Wideband links ON for 27 GREENBELT AOS (Activity No. 23).

7. Store NBTR No. 1 ON 27 GREENBELT AOS - 20 Min. (Activity No. 55).

8. Store NBTR No. 2 OFF 27 GREENBELT AOS - 18 Min. (Activity No. 51).

9. Rewind WBVTR No. 2 (Activity No. 37) for 70 Sec.

10. MSS OFF at AOS + 5 Min.

11. Configure filters for MSS P/B (Activity No. 38).

12. WBVTR No. 2 P/B AOS + 5 Min. 30 Sec. (Activity No. 39) for 5 Min.

13. WBVTR No. 2 OFF (Activity No. 87).

14. Wideband downlinks OFF.

15. Configure filters MSS to Link 3 (Activity No. 21).

16. CMD USB OFF (Activity No. 54).

6.29 ORBIT 27 (TOTAL COMPOSITE TIME, 15 MIN.)

6.29.1 INTERROGATION 27 GREENBELT (11 MIN., 23°)

1. Verify S/C status.
2. Downlink 3 and MSS ON (Stored Commands).
3. P/B NBTR No. 2 (Activity No. 51, No. 52).
4. Store USB ON for 28 GOLDSTONE AOS - 1 Min. (Activity No. 53).
5. Store MSS ON at T_f = 28 GOLDSTONE AOS (Activity No. 28).
6. Store Wideband links ON for 28 GOLDSTONE AOS (Activity No. 23).

6.29.2 INTERROGATION 27 GOLDSTONE (11 MIN., 17°)

1. Payloads OFF at AOS + 9 Min. (766).
2. Wideband links OFF at AOS + 9 Min. 10 Sec. (Activity No. 30).
3. CMD USB OFF (Activity No. 54).

6.30 ORBIT 28 (TOTAL COMPOSITE TIME, 19 MIN.)

6.30.1 INTERROGATION 28 ALASKA (8 MIN., 16°)

1. Verify S/C status.
2. Turn on REC NBTR No. 2 (Activity No. 50).
3. P/B NBTR No. 1 (Activity No. 56, No. 57).

6.30.2 INTERROGATION 28 GOLDSTONE (14 MIN., 59°)

1. Downlinks and MSS ON (Stored Commands).

2. Store USB ON for 29 ALASKA AOS - 1 Min. (Activity No. 53).

3. Payloads OFF at AOS + 8 Min. (766).

4. Wideband links OFF at AOS + 8 Min. 10 Sec.

5. CMD USB OFF (Activity No. 54).

6.31 ORBIT 29

6.31.1 INTERROGATION 29 ALASKA (11 MIN., 48°)

1. Verify S/C status.

2. Turn ON REC NBTR No. 1 (Activity No. 55).

3. Switch Spacecraft VIP to "00" Mode, Turn ON ECAM, Dump Program to NBTR No. 1.

4. P/B NBTR No. 2 (Activity No. 51, No. 52).

5. Store USB ON for 30 ALASKA AOS - 1 Min. (Activity No. 53).

6. CMD USB OFF (Activity No. 54).

6.32 ORBIT 30

6.32.1 INTERROGATION 30 ALASKA (13 MIN., 61°)

1. Verify S/C status.

2. Turn ON REC NBTR No. 2 (Activity No. 50).

3. P/B NBTR No. 1 (Activity No. 56, No. 57).

4. Store USB ON for 31 ALASKA AOS - 1 Min. (Activity No. 53).

5. CMD USB OFF (Activity No. 54).

6. Verify ECAM Memory Dump.

7. Switch to ECAM Command Mode.

6.33 ORBIT 31

6.33.1 INTERROGATION 31 ALASKA (11 MIN., 28°)

1. Verify S/C status.

2. Turn ON REC NBTR No. 1 (Activity No. 55).

3. P/B NBTR No. 2 (Activity No. 51, No. 52).

4. Rewind WBVTR No. 2 to BOT plus 11 minutes.

5. Store USB ON for 32 GREENBELT AOS - 1 Min.

6. CMD USB OFF (Activity No. 54).

6.34 ORBIT 32

6.34.1 INTERROGATION 32 GREENBELT (10 MIN., 14°)

1. Verify S/C status.

2. Store USB ON for 33 GREENBELT AOS - 1 Min. (Activity No. 53).

3. Store Wideband Link 2 ON for 33 GREENBELT (Activity No. 22).

4. Configure Filters for RBV Real Time Link 2 (Activity No. 24).

6.34.2 INTERROGATION 32 ALASKA (7 MIN., 18°)

1. Turn ON REC NBTR No. 2 (Activity No. 50).

2. P/B NBTR No. 1 (Activity No. 56, No. 57).

3. CMD USB OFF (Activity No. 54).

4. Load ECAM (Side A) with Tick-Tocks.

6.35 ORBIT 33 (TOTAL COMPOSITE TIME, 23 MIN.)

6.35.1 INTERROGATION 33 GREENBELT (13 MIN., 84°)

1. Verify S/C status.

2. Turn ON in REC NBTR No. 1 (Activity No. 55).

3. RBV S-Bands ON at AOS (Stored Command).

4. P/B NBTR No. 2 (Activities No. 51, No. 52).

5. RBV OFF (731).
   Turn ON OCC Pwr (411).

6. Turn ON Camera No. 1 (433).

7. Turn ON RBV at AOS + 1 Min. (667).

8. Turn ON WBVTR No. 1 at AOS + 1 Min. (607, 426).

9. RBV OFF at ON + 1 Min. 45 Sec. (731).

10. Camera No. 1 OFF (511).
    Camera No. 2 ON (471).

11. RBV ON at ON + 2 Min. 15 Sec. (667).

12. RBV OFF at ON (1) + 4 Min. 25 Sec. (731).

13. Camera No. 1 ON (433).

14. RBV ON at ON (1) + 4 Min. 55 Sec. (667).

15. RBV Cal at ON (1) + 7 Min. 55 Sec. (372, 472).

16. Payloads OFF at ON (1) + 9 Min. 26 Sec. (766).

17. Command Wideband Downlinks OFF (Activity No. 30).

18. Store USB ON for 34 GOLDSTONE AOS - 1 Min. (Activity No. 53).

6.35.2 INTERROGATION 33 ALASKA (10 MIN., 20°)

1. Verify S/C status.
2. Rewind WBVTR No. 1 to BOT + 11 Min. (Activity No. 32).
3. CMD USB OFF (Activity No. 54).
4. Load ECAM (Side B) with Tick-Tocks.

6.36 ORBIT 34 (TOTAL COMPOSITE TIME, 22 MIN.)

6.36.1 INTERROGATION 34 GOLDSTONE (13 MIN., 29°)

1. Verify S/C status.

6.36.2 INTERROGATION 34 ALASKA (11 MIN., 33°)

1. Verify S/C status.
2. Turn ON REC NBTR No. 2 (Activity No. 50).
3. P/B NBTR No. 1 (Activity No. 56, No. 57).
4. Store USB ON for 35 GOLDSTONE AOS - 1 Min. (Activity No. 53).
5. CMD USB OFF (Activity No. 54).

6.37 ORBIT 35 (TOTAL COMPOSITE TIME, 23 MIN.)

6.37.1 INTERROGATION 35 GOLDSTONE (14 Min., 36°)

1. Verify S/C status.

2. Verify all ECAM Tick-Tocks executed.

6.37.2 INTERROGATION 35 ALASKA (13 MIN., 78°)

1. Verify S/C status.
2. Turn ON REC NBTR No. 1 (Activity No. 55).
3. P/B NBTR No. 2 (Activity No. 51, No. 52).
4. Store USB ON 36 ALASKA AOS - 1 Min. (Activity No. 52).
5. CMD USB OFF (Activity No. 54).

6.38 ORBIT 36

6.38.1 INTERROGATION 36 ALASKA (11 MIN., 36°)

1. Verify S/C status.
2. Turn ON REC NBTR No. 2 (Activity No. 50).
3. P/B NBTR No. 1 (Activity No. 56, No. 57).

6.39 ORBIT 37

6.39.1 INTERROGATION 37 MADRID (14 MIN., 38°)

1. Verify S/C status.
2. Turn ON REC NBTR No. 1 (Activity No. 55).
3. P/B NBTR No. 2 (Activity No. 51, No. 52).

6.40 ORBIT 38

6.40.1 INTERROGATION 38 GUAM (15 MIN., 33°).

1. Verify S/C status.
2. Turn ON REC NBTR No. 2 (Activity No. 50).
3. P/B NBTR No. 1 (Activity No. 56, No. 57).
4. Store USB ON for 39 SANH AOS - 1 Min. (Activity No. 53).

6.41 ORBIT 39

6.41.1 INTERROGATION 39 SANTIAGO (11 MIN., 51°)

1. Verify S/C status.
2. Store USB ON for 40 GREENBELT AOS - 1 Min. (Activity No. 53).
3. Store MSS ON for 40 GREENBELT (Activity No. 28).
4. Store RBV ON for 40 GREENBELT (Activity No. 26).
5. Store Downlinks ON for 40 GREENBELT (Activity No. 22, No. 23).
6. Configure Real Time Filters (Activity No. 21, No. 24).
7. CMD USB OFF (Activity No. 54).

6.42 ORBIT 40

6.42.1 INTERROGATION 40 GREENBELT (12 MIN., 57°)

1. Verify S/C status.
2. Turn ON REC NBTR No. 1 (Activity No. 55).
3. P/B NBTR No. 2 (Activity No. 51, No. 52).
4. Downlinks, MSS & RBV ON (Stored Commands).
5. Store USB ON for 41 GREENBELT AOS - 1 Min. (Activity No. 53).

6. Store MSS & RBV at T_f = AOS 41 GREENBELT (Activity No. 26, No. 28).

7. Store Wideband links ON for 41 GREENBELT AOS (Activity No. 22, No. 23).

8. Payloads OFF at 10 Min. (766).

9. Wideband downlinks OFF at AOS + 10 Min. 10 Sec. (Activity No. 30).

10. CMD USB OFF (Activity No. 54).

6.43 ORBIT 41 (TOTAL COMPOSITE TIME, 15 MIN.)

6.43.1 INTERROGATION 41 GREENBELT (10 MIN., 19°)

1. Verify S/C status.
2. Turn ON REC NBTR No. 2 (Activity No. 50).
3. P/B NBTR No. 1 (Activity No. 56, No. 57).
4. Downlinks, MSS & RBV ON (Stored Commands).

6.43.2 INTERROGATION 41 GOLDSTONE (12 MIN., 19°)

1. Wideband downlinks OFF at AOS + 8 Min. (Activity No. 30).
2. Payloads OFF (766).
3. CMD USB OFF (Activity No. 54).

6.44 ORBIT 42 (TOTAL COMPOSITE TIME, 20 MIN.)

6.44.1 INTERROGATION 42 ALASKA (9 MIN., 17°)

1. Verify S/C status.
2. Turn ON REC NBTR No. 1 (Activity No. 55).

3. P/B NBTR No. 2 (Activity No. 51, No. 52).

4. Turn MSS ON (Activity No. 28) at AOS + 6 Min.

5. Turn RBV ON (Activity No. 26) at AOS + 6 Min. 10 Sec.

6. Turn Wideband Links ON (Activity No. 22, No. 23) at AOS + 6 Min. 20 Sec.

6.44.2 INTERROGATION 42 GOLDSTONE (15 MIN., 50^{o})

1. Payloads OFF at AOS + 7 Min. (766).

2. Wideband Links OFF at AOS + 7 Min. 10 Sec. (Activity No. 30).

3. Store USB ON for 43 ALASKA AOS - 1 Min. (Activity No. 53).

4. Store Wideband Links ON for 43 ALASKA AOS (Activity No. 22, No. 23).

6.45 <u>ORBIT 43</u>

6.45.1 INTERROGATION 43 ALASKA (10 MIN., 52^{o})

1. Verify S/C status.

2. Turn ON REC NBTR No. 2 (Activity No. 50.

3. P/B NBTR No. 1 (Activity No. 56, No. 57).

4. Send Stored Payload configuration (Activity No. 45, No. 38) Downlinks ON (Stored Commands).

5. P/B both WBVTR AOS + 2 Min. (Activity No. 43, No. 39).

6. Store USB ON for 44 ALASKA AOS - 1 Min. (Activity No. 53).

7. Store Wideband Links ON for 44 ALASKA AOS (Activity No. 22, No. 23).

8. Stop WBVTR P/B at AOS + 7 Min. (Activities No. 9, No. 19).

9. Wideband Links OFF at AOS + 7 Min. 10 Sec. (Activity No. 30).

10. CMD USB OFF (Activity No. 54).

6.46 ORBIT 44

6.46.1 INTERROGATION 44 ALASKA (12 MIN., 58°)

1. Verify S/C status.
2. Downlinks ON (Stored Commands).
3. P/B both WBVTR AOS + 2 Min. (Activity No. 43, No. 39).
4. Store USB ON for 45 ALASKA AOS - 1 Min. (Activity No. 53).
5. Store Wideband Links ON for 45 ALASKA AOS (Activity No. 22, No. 23).
6. Stop WBVTR P/B at AOS + 9 Min. 10 Sec. (Activity No. 30).
7. Wideband Links OFF at END OF P/B + 10 Sec. (Activity No. 30).
8. CMD USB OFF (Activity No. 54).

6.47 ORBIT 45

6.47.1 INTERROGATION 45 ALASKA (11 MIN., 27°)

1. Verify status of S/C.
2. Turn ON REC NBTR No. 1 (Activity No. 55).
3. P/B NBTR No. 2 (Activity No. 51, No. 52).
4. Downlinks ON (Stored Commands).
5. P/B both WBVTR AOS + 2 Min. (Activity No. 43, No. 39).
6. Stop WBVTR P/B at END OF TAPE (Activity No. 9, No. 19).
7. Wideband Links OFF at END OF P/B + 10 Sec. (Activity No. 30).
8. CMD USB OFF (Activity No. 54).

6.48 ORBIT 46

6.48.1 INTERROGATION 46 GREENBELT (11 MIN., 16°) ALASKA (9 MIN., 18°)

1. Verify status of S/C.
2. Turn ON REC NBTR No. 2 (Activity No. 50).
3. P/B NBTR No. 1 (Activity No. 56, No. 57).
4. Rewind both WBVTR to BOT (Activity No. 41, No. 37).
5. Turn OFF WBVTR after BOT (Activity No. 9, No. 19).

6.49 ORBIT 409

6.49.1 INTERROGATION 409 GREENBELT MSS BAND 5 ACTIVATION

1. Verify status of S/C.
2. Commence outgassing of MSS cooler door.

APPENDIX A
SOLAR ARRAY DRIVE
EMERGENCY
PROCEDURES

APPENDIX A

SOLAR ARRAY DRIVE EMERGENCY PROCEDURE

APPENDIX A

SOLAR ARRAY DRIVE EMERGENCY PROCEDURE

A.1 CRITERIA FOR STOPPING PADDLES

1. General

Solar Array Drives will require emergency procedures in case of sudden stoppage of shaft rotations and/or because of degradation which leads to imminent stoppage. The following procedures will be used:

2. Procedure for Sudden Stop of Shaft Rotation

If the RSAD or LSAD stops suddenly without previous degradation (no previous motor voltage, temperature or cosine pot anomalies) the following steps will be taken:

a. Check fused mode (Loss of all TLM signal)

b. Command unfused mode. If SAD does not rotate -

c. Command high rate - continue at high rate. If SAD does not rotate -

d. Command SAD OFF

e. Wait until cosine pot position such that RSAD SS preamp less 2.3 volts or LSAD SS preamp greater than 3.9 volts.

f. Command SAD on (shaft should rotate in reverse direction).

g. Continue evaluation of stoppage/rotation and await further direction from Landsat controls.

3. Procedure for Gradual Degradation (Motor Voltage and Temperature Increasing)

If the RSAD or LSAD has degraded to an orbital average motor volts of 18 volts or an orbital average motor winding temperature of 70 $^{\circ}$C, the following steps will be taken:

a. Command SAD OFF at High Noon (Cosine pot reading less than 0.10 volt)

b. Await further evaluation and direction from Landsat controls.

A. 2 ANALYSIS OF SOLAR ARRAY OUTPUT VERSUS PADDLE POSITION

The following analysis was performed by the Stabilization and Control Branch, Code 732, in support of the Landsat mission.

The output from a solar array is directly proportional to the cosine of the angle between the sun line and the normal to the array surface. This cosine, denoted S_{xp}, is found from the relation

$$S_{xp} = \cos_k \cos B \cos (\theta - a) - \text{sine } k \text{ sine } B$$

where:

- k is the cant angle of the array (= -33 deg)
- B is the true angle of the sun line to the orbit plane
- θ is the orbit angle, increasing with time and equal to zero when the sun line lies forward in the S/C roll-pitch (xy) plane, which is assumed coincident with the local horizontal.
- a is the position angle of the solar paddle, equal to zero when the normal to the array surface points forward in the xy plane of the spacecraft; positive rotation defined by right hand rule on the spacecraft +y axis.

With spacecraft attitude error near zero, the solar array drives will make the position angle (a) of each paddle essentially equal to orbit angle(θ). This results in maximum S_{xp} for the existing B angle. The ideal condition occurs when B = 33 deg and the sun line is normal to the array (S_{xp} = 1. 0).

In addition to affecting the level of power output by its influence on the angle at which solar radiation strikes the paddles, the B angle changes the length of satellite day. The orbit angle for umbra exit, θ N/D is found from

$$\sin \theta N/D = \frac{\text{sine } n}{\cos B}$$

where:

$$n = \cos^{-1} \frac{R_e}{R_e + h} = 29.2 \text{ deg (nom. orbit)}$$

R_e = mean earth radius

h = orbit altitude

Thus the time in sunlight increases with B until B = 90 -n = 60.8 deg and the orbit remains entirely out of the umbra.

The B angle itself varies according to the relation

$$\text{sine } B = \text{sine } i \ \ \text{sine } B \ \ \cos \delta + \cos i \ \ \text{sine } \delta$$

where:

i = is the inclination of the orbit (99.09° nom.)

δ = is the declination of the apparent sun

B = is the Local Hour Angle (LHA) of the apparent sun referred to the ascending node of the spacecraft orbit.

The LHA of the mean sun is to be maintained constant by sun-synchronous precession, at 142.9 degrees in the nominal orbit in which the descending node occurs about 9:30 A.M. local time. This is the orbit expected if lift off occurs at the beginning of the launch window. The booster guidance program is fixed in geographic coordinates, however, and lift off one-half hour later at the end of the window will increase the mean sun LHA to 150.4 degrees.

The angle B is related to the mean sun LHA by the "equation of time", which corrects for the non-uniform orbital rate of the earth. The effect is such that B is greater than the mean sun LHA by about 4 degrees in mid-autumn and less by about 3.5 degrees in mid-winter. The specific values of B chosen for this analysis of paddle performance are 20, 33 and 45 degrees.

As long as the solar array drives keep θ-a near zero, the instantaneous sunlit paddle output will vary directly with

$$S_{xp} = \cos (B + k) = \cos (B - 33^{\circ})$$

The time integral of output power per orbit will be proportioned to the product of this essentially constant direction cosine and the angular width of the daylight sector of the orbit. (See Table A-1.)

Table A-1. Per-Orbit Power Integral: Normal SAD Operation

B Deg	S_{xp}	(Δ θ) DAY Radians	Radians	$\int_{DAY} S_{xp}\, d\theta$	Normalized
20	.9744	4.2325	4.1241	1.000 .941	.904
33	1.0000	4.3823	4.3823	1.063 1.000	.961
45	.9781	4.6631	4.5612	1.106 1.041	1.000

If a SAD malfunctions and a paddle becomes fixed in position at an angle a, the instantaneous available output, being proportional to S_{xp} where $S_{xp} \geq 0$, varies sinusoidally with the paddle pointing error, θ -a, as shown in Figure A-1. (The function S_{xp} is defined to exclude negative values of S_{xp}.) Note that the sun remains on the array side of the paddle (i.e., $S_{xp} > 0$) for more than 180 degrees of pointing error because of the term sine 33° sine B in the expression for S_{xp}: that is, because the sun is out of the orbit plane and the arrays are canted appropriately. For certain a, however, this will occur in the umbra and not be useful. Another point of interest is that the range of θ -a over which $S_{xp} > 0$ increases with B, and that S_{xp} ($B > 33^{\circ}$) is greater than S_{xp} ($B = 33^{\circ}$) except in a narrow band of pointing error near zero.

The more significant measure of stopped paddle performance is the time integral of output over an orbit. The integral to be evaluated is:

$$\int_{DAY} S_{xp}\, d\theta$$

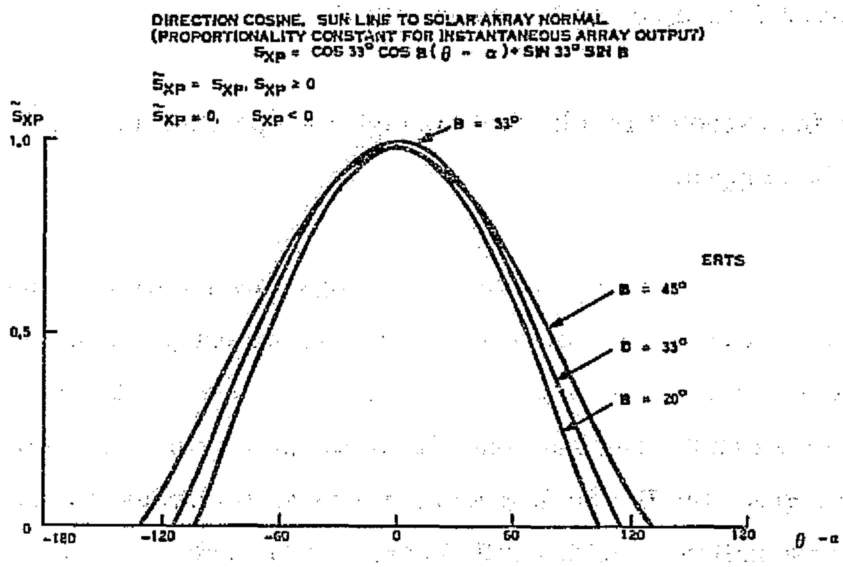

Figure A-1. Difference Between Paddle Angle & Orbit Angle, Deg.

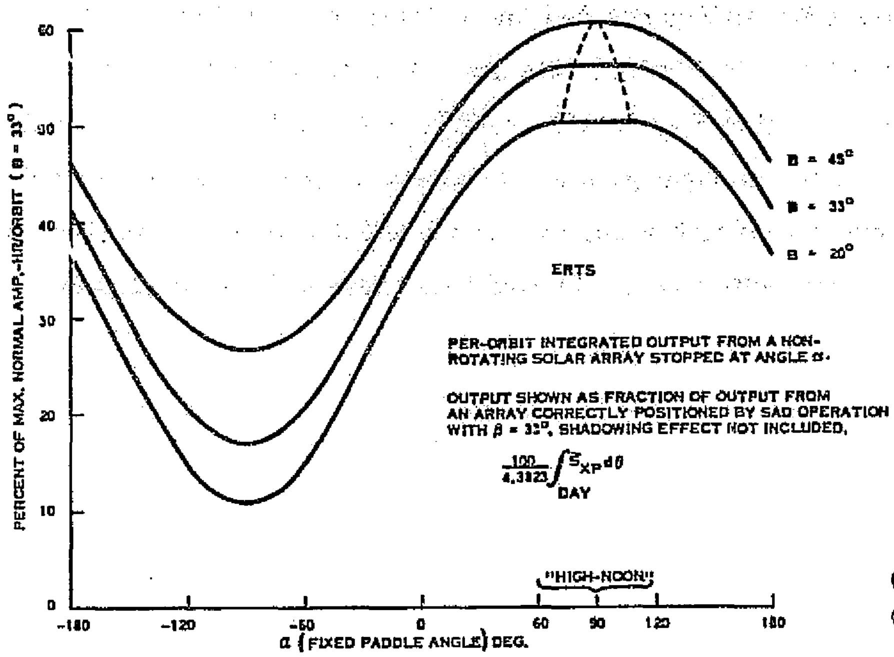

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Figure A-2. Per-Orbit Integrated Output From A Non-Rotating Solar Array Stopped at Angle α which is simply the integral of S_{xp} between $\theta_{N/D} \rightarrow \pi - \theta_{N/D}$, with the condition that the integrand is zero where $S_{xp} < 0$ to exclude the situations where the sun lights the back of the paddle. Values for all a and the three levels of B are plotted in Figure A-2 as fractions of the integrated output from a normally driven with $B = 33^{o}$.

The curves show the expected result, that the high noon position ($a = 90^{o}$) is always preferred if a paddle must be stopped.

For the selected levels of B, a paddle fixed at the high noon position exits the umbra with its back to the sun, and turns it back to the sun before umbra entry. Because of the symmetry of the situation, the output integral remains constant at maximum value for a in a high-noon-centered band over which the sun sees the edge of the array twice in the orbit. The width of the band ($\pm$ 17.6 degrees for B = 20 degrees) narrows as B increases to about 46 degrees, when edgewise presentation coincides with umbra exit and entry. At this point and larger B, maximum integrated output is available only if the paddle is fixed exactly in the high-noon position.

If the results presented in Figures A-1 and A-2 are to be applied in scheduling spacecraft electrical loads after a SAD failure, the user is cautioned that the effect of shadows from the Sensory Ring and other Spacecraft structure have not been included in the results. Reduction in output from the right paddle may exceed 15 percent at certain values of θ -a and may be more severe with high B angles. Solar cell degradation with time, and the seasonal variation in solar intensity (about $\pm$ 3) would also have to be accounted for.

APPENDIX B

BATTERY MANAGEMENT PROCEDURE

B.1 GENERAL

The Power Subsystem was designed to operate under an isothermal or near isothermal situation. The voltate/temperature circuits were designed to allow some overcharge in order to assure a "fully charged" system. When the system is allowed to operate in the "automatic power management mode," a strong tendency exists for any battery module mismatch to be greatly compounded, especially when the batteries have aged. If the batteries are mismatched and allowed to operate in a high overcharge mode for an extended period of time, the adversely affected battery module(s) will heat up. The higher battery module temperature will result in lower cell voltages and a higher charge rate in comparison to the other battery modules. The higher temperature also affects the charge controller resulting in higher charge rates. The resulting effect is that the affected battery module is taking more charge, supplying less load (load sharing) and may result in the remaining batteries not reaching full charge.

B.2 MISMATCH INDICATION

An indication of battery mismatch is when a battery shows a divergence between the percent load sharing and percent charge sharing from its nominal (nominal will vary based on the number of batteries on-line). This divergence from nominal may continue or the battery may stabilize at a new percent level.

In addition to the divergence of the load and charge sharing percentages will be a corresponding increase in charge/discharge ratios and battery module temperature.

B.3 PROCEDURE

B.3.1 TURN OFF

The following procedure will be used to determine when to turn a battery module off:

1. Ascertain that a battery can be turned off. This determination can be made using power management calculations. Table B-1 gives the approximate continuous load and the corresponding number of battery modules required together with the excess charge from the array. These values are based on an 103 minute orbit (73 minutes of day and 30 minutes of night), an array of 15 amperes, and a maximum battery charge of 1.1 amperes.

Table B-1. Battery Loads

Number of Batteries	Maximum Load or Charge to BATT	Excess Charge
1	80	1015
2	161	934
3	241	854
4	321	774
5	402	693
6	482	613
7	562	533
8	642	453

2. The battery should be turned OFF at either of the following times to prevent burning of the relay contacts:

- The first 10 minutes of Satellite Night. The battery is hot, the cell voltages are lower than the cooler batteries, and the discharge current will be either zero or fairly low at the beginning of the discharge period.

- During Satellite Day with sufficient loads ON to reduce charge current to near zero (0 to 300 ma).

3. When a battery module reaches a charge/discharge ratio of 1.75:1 AND the temperature is $4^{o}C$ above the average of all modules, turn if OFF and permit it to discharge to -27.0 to -25.5 VDC.

B.3.2 TURN ON

When the battery module has discharged to -27.0 to -25.5 VDC, command the module back ON. The battery should be turned ON at either of the following times:

1. Commanding the battery ON anywhere in Satellite Day will result in taking all the charge available up to 1.1 amperes. Therefore, sufficient loads must be used to cause a slight discharge in Satellite DAY at turn on.

2. Command the battery ON anywhere in Satellite Night since the discharged battery will not supply any current.

B.4 EVALUATION

Evaluate the battery module 3 or 4 orbits after turn-on. Check the load and charge sharing percentages for the following:

1. If the load and charge sharing percentages are close or the charge sharing percentage is lower than the load sharing, the procedure corrected the problem and the module will operate properly until it is overcharged again.

2. If the load and charge sharing percentages are more than approximately 2 percent apart and the charge sharing percentage is the highest, the problems still exist. Do not allow the module to overcharge long before commanding it OFF and repeating the process.

3. If several attempts at the procedure prove unsuccessful, the battery probably has a shorted or partially shorted cell or cells. The battery can then be used only for emergency use if kept near full charge.

B.5 DOCUMENTATION

Plot the module terminal voltage and average module temperature for each orbit that the module is off-line. This documentation will provide data as to why and when the module corrects itself and keep personnel aware of its state.

APPENDIX C

COMMAND ACTIVITIES

Item	Acronym		Activity	Time
1	W1FF			
		607	WBVTR1 On (Prim)	T_o -7 sec
		464	RBV Standby 1	T_o -5 sec
		504	WBVTR1 Fast Forward	T_o +1 sec
2	W2FF			
		650	WBVTR2 On (Prim)	T_o -14 sec
		572	MSS Standby 2	T_o -12 sec
		571	WBVTR2 Fast Forward	T_o
3	W1RI			
		607	WBVTR1 On (Prim)	T_o -28 sec
		464	RBV Standby 1	T_o -26 sec
		426	Record	T_o -20 sec
4	W2RI			
		650	WBVTR2 On (Prim)	T_o -28 sec
		551	RBV Standby 2	T_o -26 sec
		513	Record	T_o -20 sec
5	W1RS			
		426	WBVTR1 Record	T_o -20 sec
6	W2RS			
		513	WBVTR2 Record	T_o -20 sec
7	W1SR			
		464	RBV Standby 1	T_o +13 sec
8	W2SR			
		551	RBV Standby 2	T_o +13 sec
9	W1FR			
		464	RBV Standby 1	T_o +13 sec
		651	WBVTR1 Off	T_o +15 sec
10	W2FR			
		551	RBV Standby 2	T_o +13 sec
		712	WBVTR2 Off	T_o +15 sec

Item	Acronym		Activity	Time
11	PYDF			
		766	Payloads Off	T_o +25 sec
12	W1MI			
		607	WBVTR1 On (Prim)	T_o −35 sec
		505	MSS Standby 1	T_o −33 sec
		426	Record	T_o −28 sec
13	W2MI			
		650	WBVTR2 On (Prim)	T_o −35 sec
		572	MSS Standby 2	T_o −33 sec
		513	Record	T_o −28 sec
14	W1MS			
		426	WBVTR1 Record	T_o −29 sec
15	W2MS			
		513	WBVTR2 Record	T_o −28 sec
16	W1SM			
		505	MSS Standby 1	T_o +29 sec
17	W2SM			
		572	MSS Standby 2	T_o +28 sec
18	W1FM			
		505	MSS Standby 1	T_o +28 sec
		651	WBVTR1 Off	T_o +30 sec
19	W2FM			
		572	MSS Standby 2	T_o +28 sec
		712	WBVTR2 Off	T_o +30 sec
20	RTM2			
		703	INH Data/RBV Filter A	T_o −32 sec
		741	INH Data/MSS Filter A	T_o −30 sec
		514	RT1 Data/MSS Filter A	T_o −28 sec
21	RTM3			
		722	INH Data/RBV Filter B	T_o −32 sec
		760	INH Data/MSS Filter B	T_o −30 sec
		475	RT1 Data/MSS Filter B	T_o −28 sec

Item	Acronym		Activity	Time
22	DLK2			
		540	WPA Power On 1	T_o -180 sec
		525	WFM Inv A Power On	T_o -176 sec
23	DLK3			
		46	WPA Power On 2	T_o -178 sec
		525	WFM Inv A Power On	T_o -174 sec
24	RTR2			
		741	INH Data/MSS Filter A	T_o -24 sec
		703	INH Data/RBV Filter A	T_o -22 sec
		515	RT Data/RBV Filter A	T_o -20 sec
25	RTR3			
		760	INH Data/MSS Filter B	T_o -24 sec
		722	INH Data/RBV Filter B	T_o -22 sec
		476	RT Data/RBV Filter B	T_o -20 sec
26	RBVN			
		667	RBV On	T_o -72 sec
27	RBVF			
		731	RBV Off	T_o +15 sec
28	MSSN			
		53	MSS System On	T_o -187 sec
		112	MSS Hi-Voltage On	T_o -185 sec
29	MSSF			
		73	MSS System Off	T_o +28 sec
30	WBDF			
		566	WFM Inv A Power Off	T_o +32 sec
		561	WPA Power Off 1	T_o +30 sec
		67	WPA Power Off 2	T_o +28 sec
31	PYDN			
		053	MSS System On	T_o -187 sec
		112	MSS Hi-Voltage On	T_o -185 sec
		667	RBV On (Prim)	T_o -72 sec
32	W1RM			
		607	WBVTR1 On (Prim)	T_o -7 sec
		505	MSS Standby 1	T_o -5 sec
		465	Rewind WB1	T_o

Item	Acronym		Activity	Time
33	W1M3			
		722	INH Data/RBV Filter B	T_o -8 sec
		760	INH Data/MSS Filter B	T_o -6 sec
		537	WB1 Data/MSS Filter B	T_o -4 sec
34	W1PM			
		607	WBVTR1 On (Prim)	T_o -7 sec
		505	MSS Standby 1	T_o -5 sec
		447	WBR Playback 1	T_o
35	P1FM			
		505	MSS Standby 1	T_o
		651	WBVTR1 Off	T_o +2 sec
36	W1M2			
		703	INH Data/RBV Filter A	T_o -8 sec
		741	INH Data/MSS Filter A	T_o -6 sec
		556	WB1 Data/MSS Filter A	T_o -4 sec
37	W2RM			
		650	WBVTR2 On (Prim)	T_o -14 sec
		572	MSS Standby 2	T_o -12 sec
		552	Rewind WB2	T_o
38	W2M3			
		722	INH Data/RBV Filter B	T_o -9 sec
		760	INH Data/MSS Filter B	T_o -7 sec
		570	WB2 Data/MSS Filter B	T_o -5 sec
39	W2PM			
		650	WBVTR2 On (Prim)	T_o -14 sec
		572	MSS Standby 2	T_o -12 sec
		534	WBR Playback 2	T_o
40	W2M2			
		703	INH Data/RBV Filter A	T_o -12 sec
		741	INH Data/MSS Filter A	T_o -10 sec
		577	WB2 Data/MSS Filter A	T_o -8 sec
41	W1RR			
		607	WBVTR1 On (Prim)	T_o -7 sec
		464	RBV Standby 1	T_o -5 sec
		465	Rewind WB1	T_o

Item	Acronym		Activity	Time
42	W1R3			
		760	INH Data/MSS Filter B	T_o -8 sec
		722	INH Data/RBV Filter B	T_o -6 sec
		517	WB1 Data/RBV Filter B	T_o -4 sec
43	W1PR			
		607	WBVTR1 On (Prim)	T_o -10 sec
		464	RBV Standby 1	T_o -8 sec
		447	WBR Playback 1	T_o
44	P1FR			
		464	RBV Standby 1	T_o
		651	WBVTR1 Off	T_o +3 sec
45	W1R2			
		741	INH Data/MSS Filter A	T_o -8 sec
		703	INH Data/RBV Filter A	T_o -6 sec
		536	WB1 Data/RBV Filter A	T_o -4 sec
46	W2RR			
		650	WBVTR2 On (Prim)	T_o -14 sec
		551	RBV Standby 2	T_o -12 sec
		552	Rewind WB2	T_o
47	W2R3			
		760	INH Data/MSS Filter B	T_o -12 sec
		722	INH Data/RBV Filter B	T_o -10 sec
		531	WB2 Data/RBV Filter B	T_o -8 sec
48	W2PR			
		650	WBVTR2 On (Prim)	T_o -14 sec
		551	RBV Standby 2	T_o -12 sec
		534	WBR Playback 2	T_o
49	W2R2			
		741	INH Data/MSS Filter A	T_o -12 sec
		703	INH Data/RBV Filter A	T_o -10 sec
		557	WB2 Data/RBV Filter A	T_o -8 sec
50	NBR2			
		601	NBR2 Record	T_o
51	NBS2			
		620	NBR2 Record Stop	T_o

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Item	Acronym		Activity	Time
52	NBP2			
		604	Select NBTR2	T_o -1 sec
		542	Playback NBTR2	T_o
53	USBN			
		605	Modulator A On	T_o -2 sec
		775	Enable USB Transmitter	T_o
54	USBF			
		626	Modulator A Off	T_o
		757	Disable USB Transmitters	T_o +2 sec
55	NBR1			
		543	NBR1 Record	T_o
56	NBS1			
		562	NBR1 Record Stop	T_o
57	NBP1			
		646	Select NBTR1	T_o -1 sec
		621	Playback NBTR1	T_o
58	MSGL			
		174	Band 2 Low Gain (MSS)	T_o -1 sec
		175	Band 1 Low Gain (MSS)	T_o
59	MSGH			
		154	Band 1 High Gain (MSS)	T_o -1 sec
		155	Band 2 High Gain (MSS)	T_o
60	ESSA			
		636	Enable Scan Select A	T_o
61	ESSB			
		734	Enable Scan Select B	T_o
62	RANN			
		127	Ranging On	T_o
63	RANF			
		146	Ranging Off	T_o
64	AUX1			
		356	Aux Load 1 On	T_o

Item	Acronym		Activity	Time
65	AUX2			
		357	Aux Load 2 On	T_o
66	AUX3			
		435	Aux Load 3 On	T_o
67	AUX4			
		436	Aux Load 4 On	T_o
68	AUX5			
		455	Aux Load 5 On	T_o
69	AUXf			
		374	All Aux Loads Off	T_o
70	MSLN			
		333	MSS Linear	T_o
71	MSCM			
		315	MSS Compress	T_o
72	EXP1			
		450	Exposure 1	T_o
73	EXP2			
		451	Exposure 2	T_o
74	EXP3			
		453	Exposure 3	T_o
75	EXP4			
		454	Exposure 4	T_o
76	EXP5			
		452	Exposure 5	T_o
77	RCAL			
		472	RBV Start Cal	T_o -5 sec
78	DISS			
		613	Disable Selected Scanner	T_o
79	PA2F			
		561	WBPA #1 Off	T_o +30 sec

Item	Acronym		Activity	Time
80	PA3F			
		067	WBPA #2 Off	T_o +28 sec
81	P1SM			
		505	Rec'r 1 Standby MSS	T_o
82	P2SM			
		572	Rec'r 2 Standby MSS	T_o

APPENDIX D

DECISION TREES

SEPARATION SWITCH DECISION TREE (FIGURE D-2)

Both separation switches are mechanically controlled by the S/C to Flight Adapter interface. As the spacecraft leaves the flight adapter, the switches are closed, the solar array unfold sequence is started, and command matrix A drivers are powered, (Switch #1 to prime and Switch #2 to redundant), thus enabling command capability (see Figure D-1). One of these switches must close in order to continue with the mission. The following decision tree shows how to close the other switch once either one has been closed. The spacecraft is to be launched with the prime matrix A drivers enabled. Verify CIU/COMDEC configuration with CIU/COMDEC Decision Tree before entering Separation Switch Decision Tree. (See Figure D-2.)

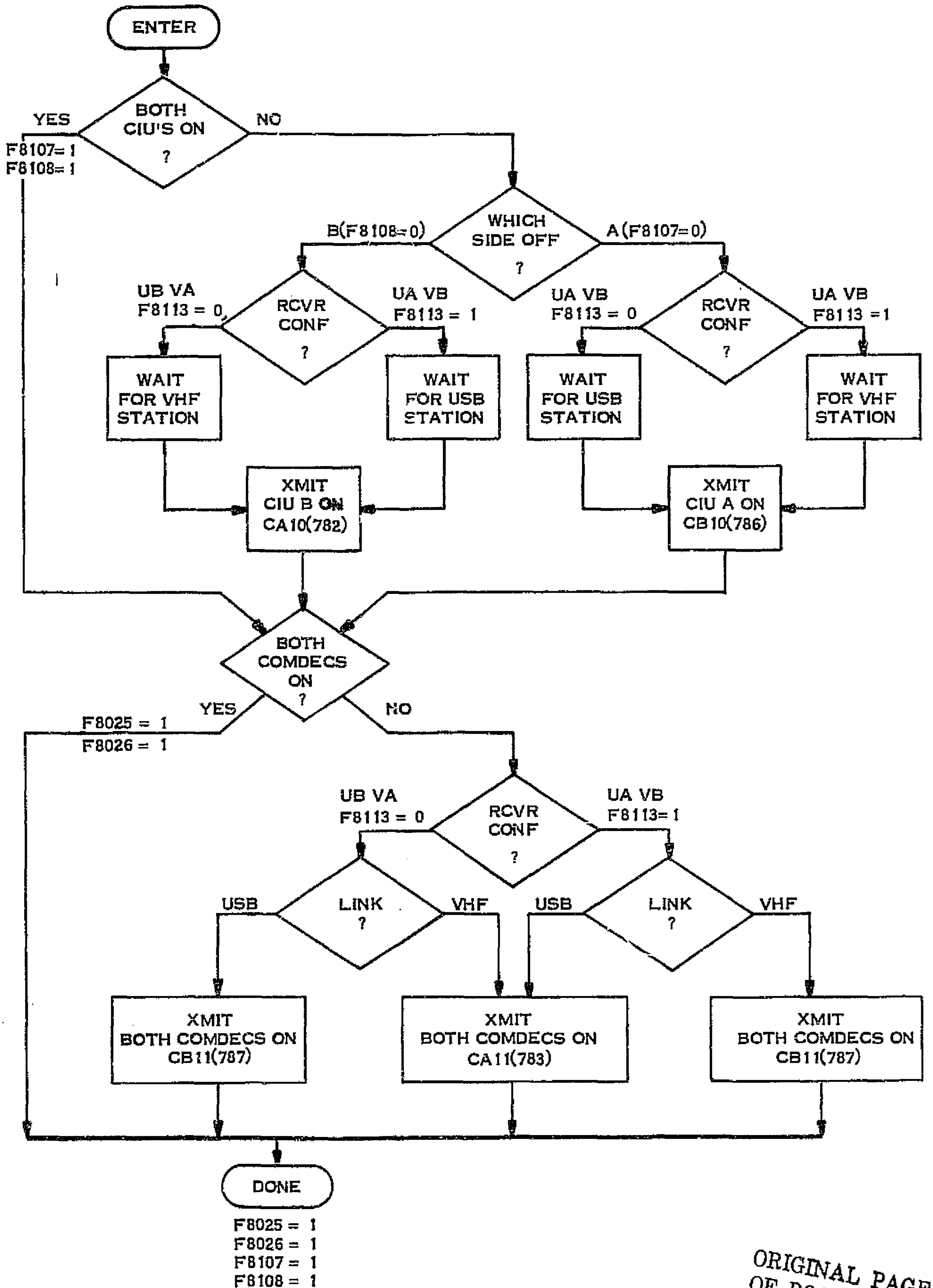


Figure D-1. CIU/COMDEC Decision Tree

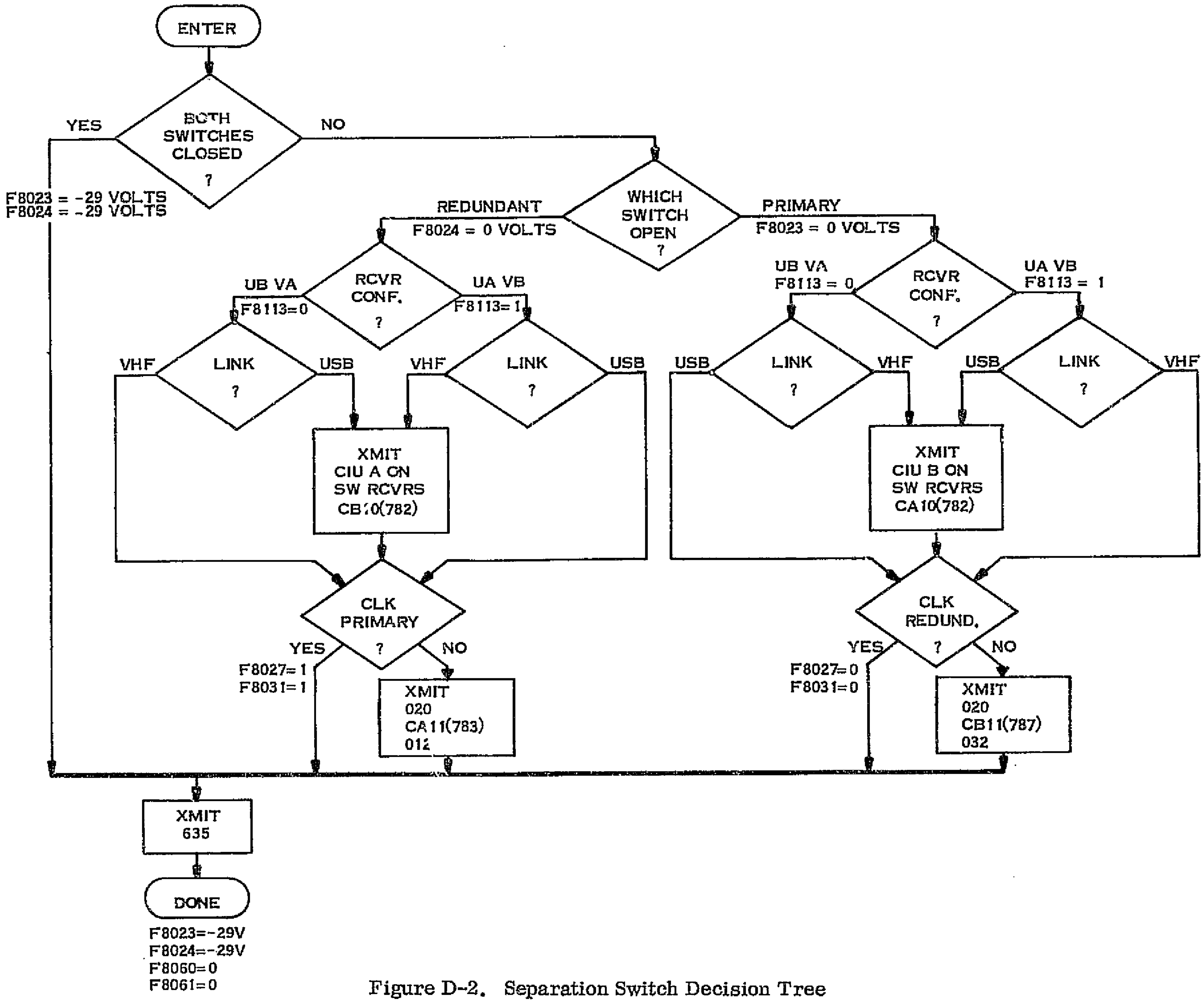


Figure D-2. Separation Switch Decision Tree

EARTH ACQUISITION DECISION TREE (Figure D-3)

First Pass Decision Tree - Alaska Thru Hawaii

1. The objective of the decision tree is to mechanize the decision to command Yaw Normal Mode and Pneumatics Disable during the first Alaska/Hawaii pass.

2. The decision tree is prepared assuming that ACS performance is nominal or that failures if present are among those which we can do something about.

3. Should the data take us through the tree and terminate in the statement "other action," it indicates that a malfunction of grievous proportions has occurred and will be too complex to be treated in a manner as automatic as a decision tree.

4. The initiation of the decision tree process is contingent upon Madrid, and/or Winkfield data verification of Launch Mode following spacecraft separation.

5. Should the Launch Mode be altered for any reason the ACS should be placed in the Launch Mode by command immediately upon reaching Alaska.

6. Execution of the decision tree must be performed in parallel with the activities involving stabilization of the solar array drives.

7. Table D-1 is a tabulation of the effect of Sun in the Scanner FOV at sunrise on the ACS performance.

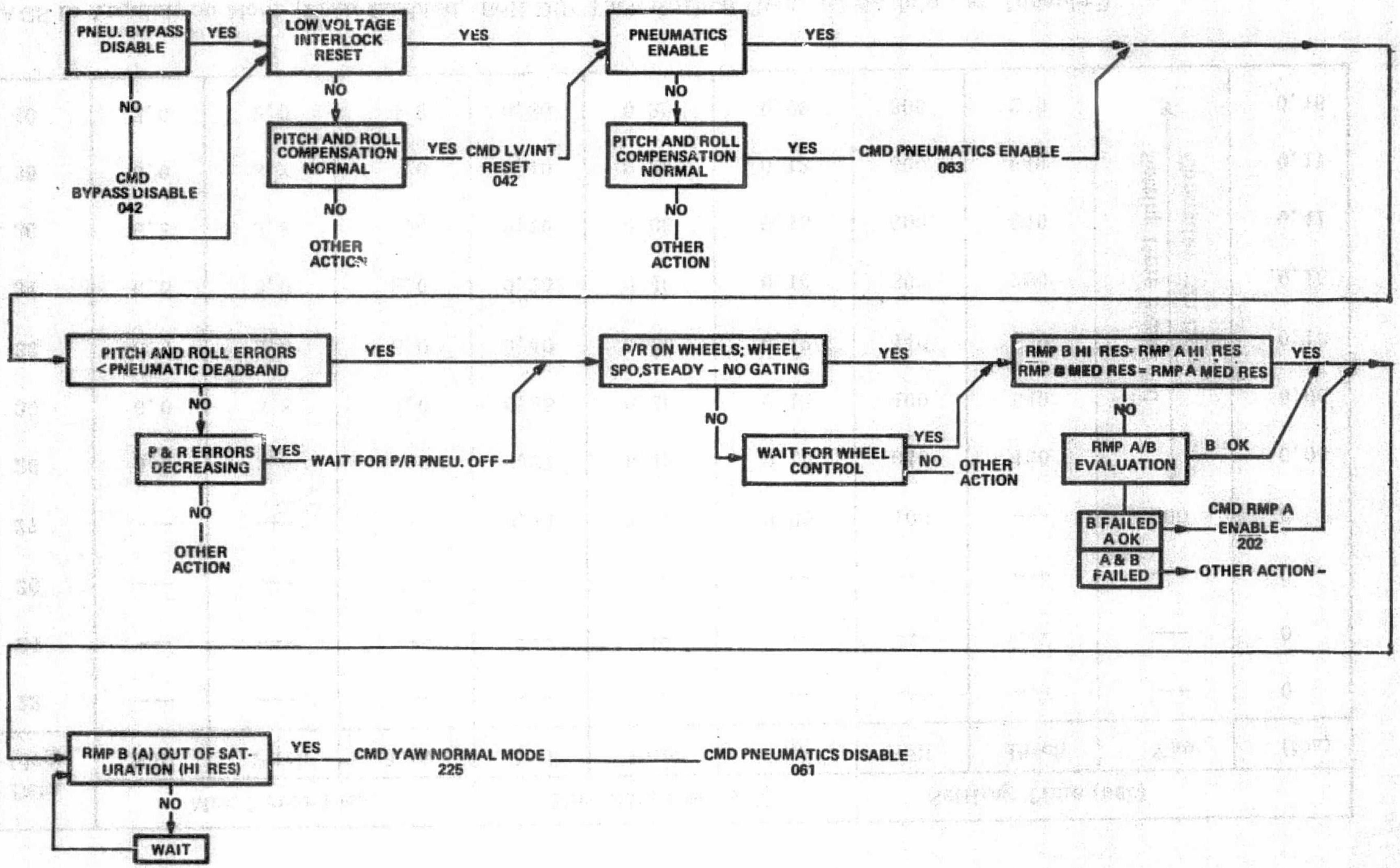
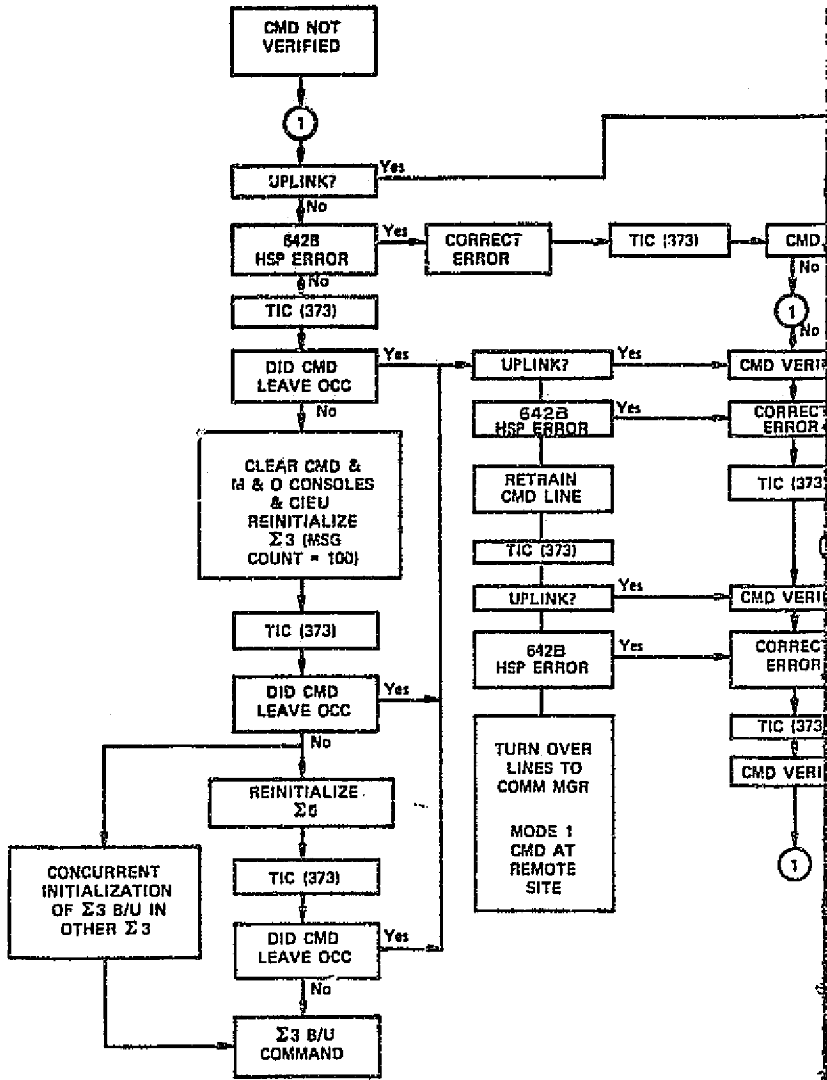


Figure D-3. Earth Acquisition Decision Tree

Table D-1. Effect of Sun in the Scanner FOV at Sunrise on ACS Performance

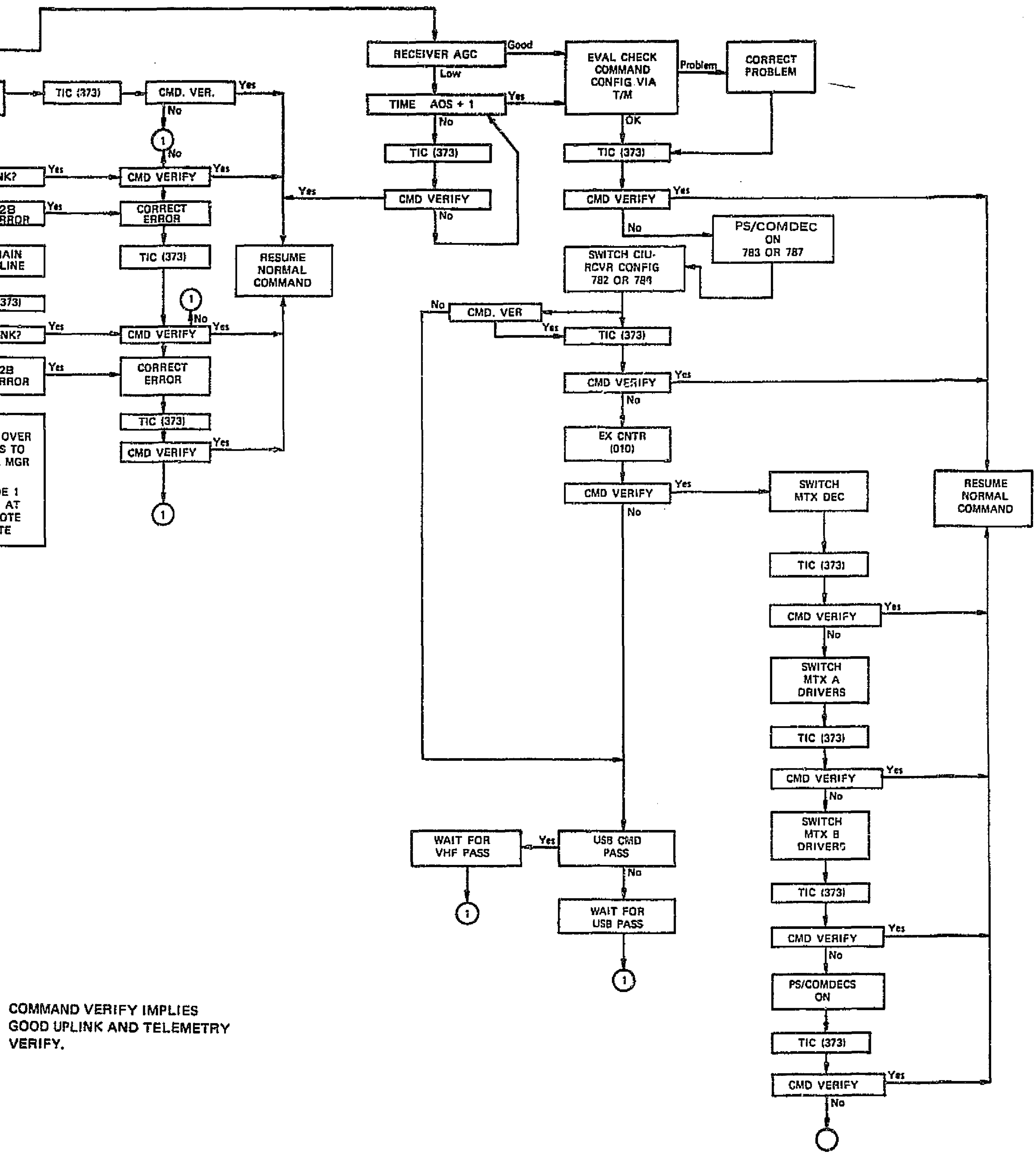
Beta (deg)	Max Error (deg)			Max Rate (deg/sec)			Settling Time (sec)			
	Roll	Pitch	Yaw	Roll	Pitch	Yaw	Roll	Pitch	Yaw	(lbs)
22	---	---	---	---	---	---	---	---	---	0
24	---	---	---	---	---	---	---	---	---	0
26	---	---	---	---	---	---	---	---	---	0
27	---	---	---	0.04	0.02	0.03	100	---	200	0
28	6.0	3.0	5.0	0.27	0.12	0.15	640	460	Setting time exceeded Computer run time	0.04
30	6.0	3.8	4.0	0.35	0.20	0.15	400	540		0.06
32	6.0	2.5	5.0	0.40	0.20	0.12	440	420		0.13
34	6.5	3.0	9.0	0.25	0.40	0.14	800	760		0.15
36	6.5	3.8	7.0	0.70	0.30	0.13	600	540		0.41
38	6.0	3.2	5.0	0.40	0.25	0.12	600	640		0.17
40	3.0	2.0	4.0	0.30	0.30	0.09	300	280		0.16

ACS in Acquisition Mode (Pneu Enabled, Roll Diff Tach Normal Gain, RLNA Into Yaw Disabled)



COMMAND VERIFY IMPLI
GOOD UPLINK AND TELE
VERIFY.

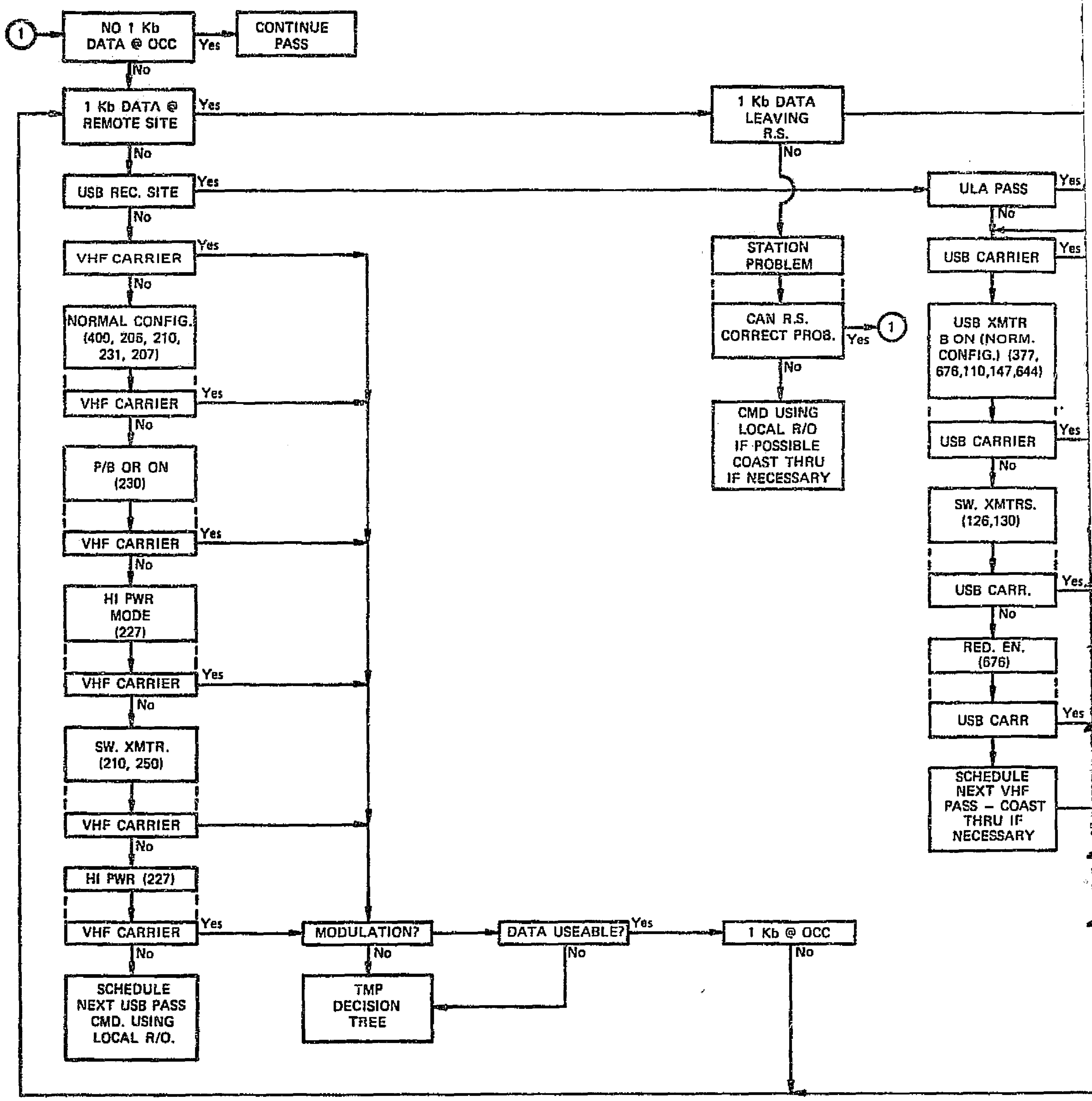
FOLDOUT FRAME 1



COMMAND VERIFY IMPLIES GOOD UPLINK AND TELEMETRY VERIFY.

Figure D-4. Command Decision Tree

FOLDOUT FRAME 2



FOLDOUT FRAME

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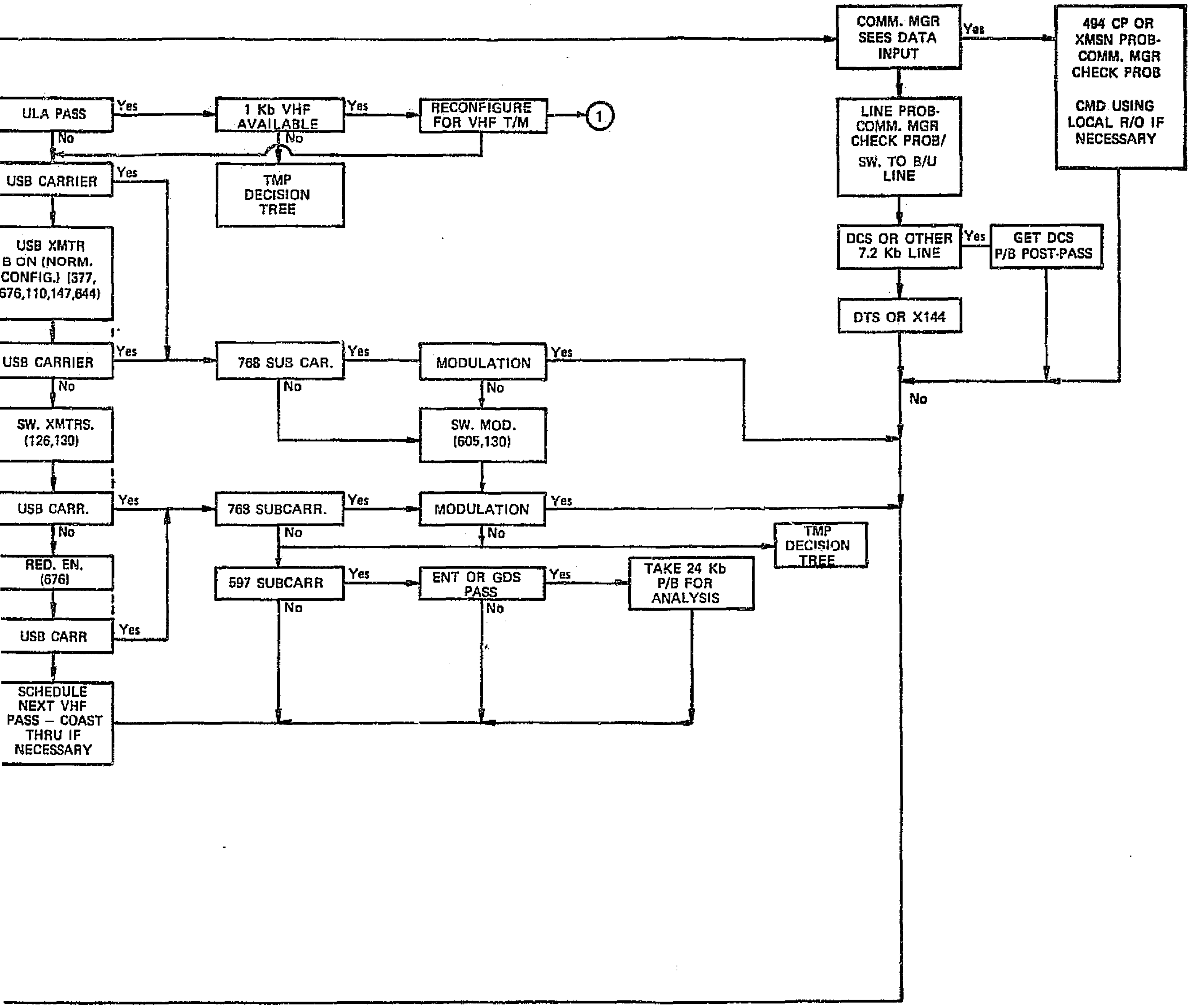
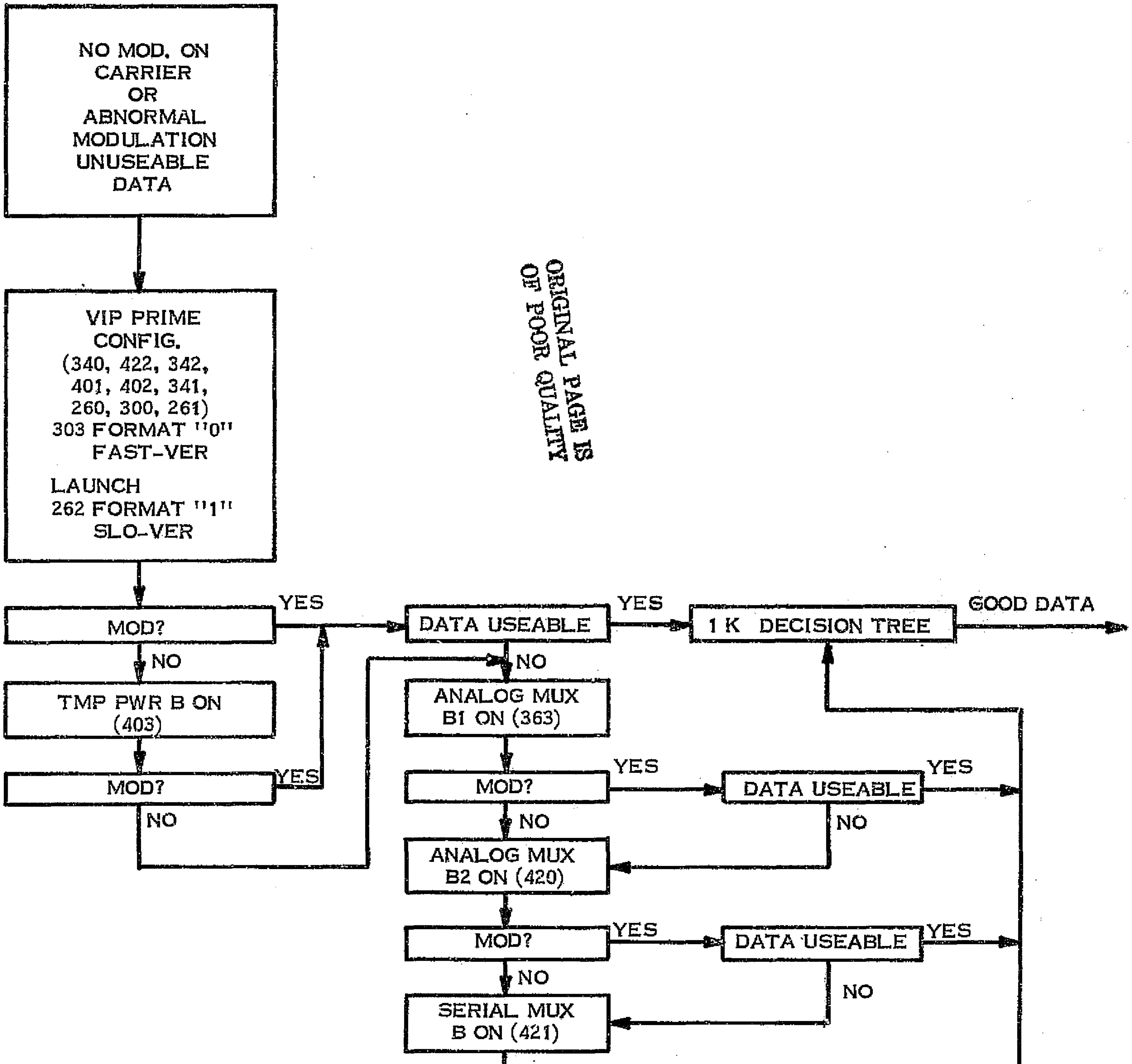


Figure D-5. 1 KB Decision Tree

FOLDOUT FRAME 2



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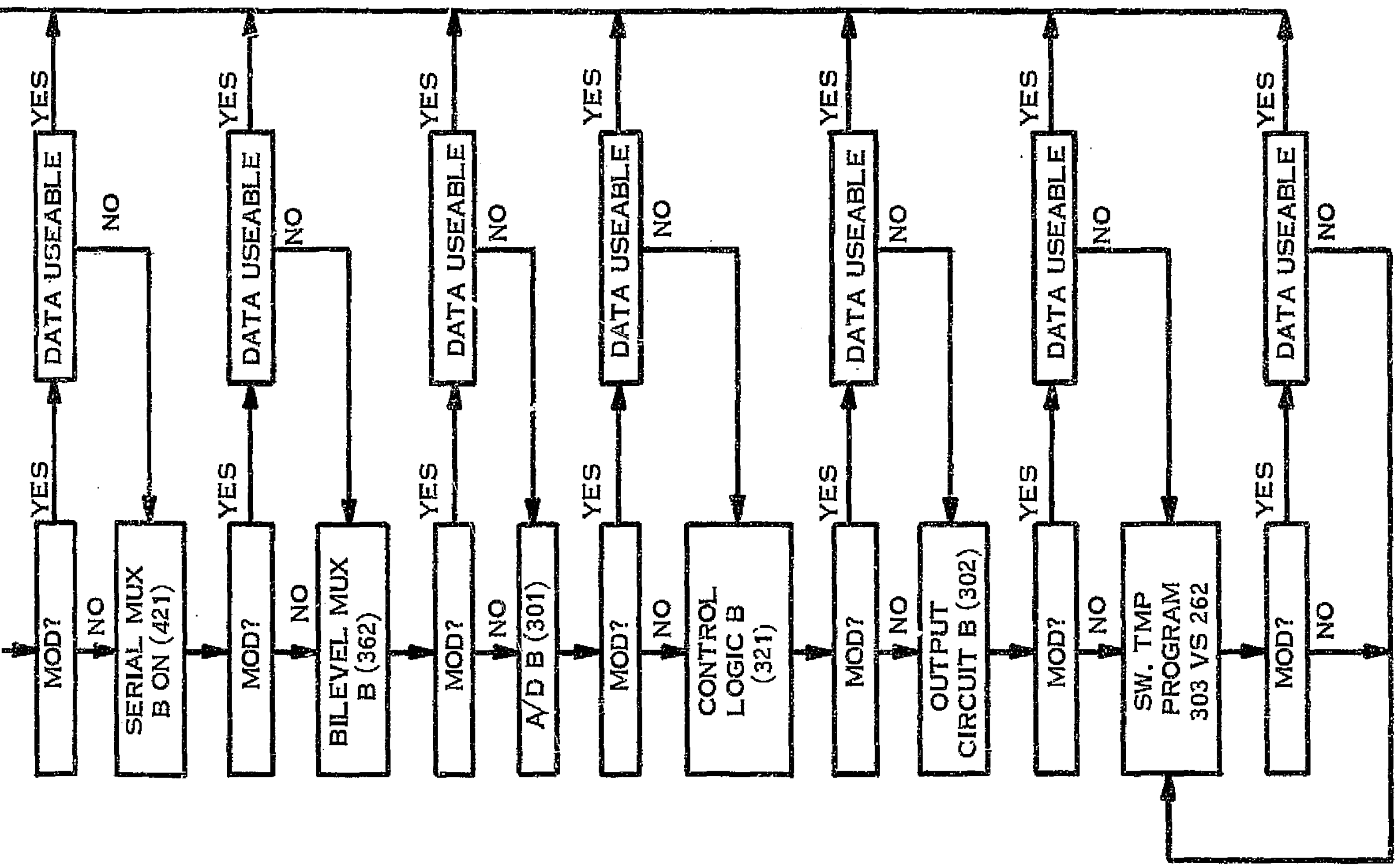


Figure D-6. TMP Decision Tree

APPENDIX D

DECISION TREES

ITEM	DESCRIPTION	PAGE
1	COMMENTARY FOR SEPARATION SWITCH DECISION TREE	D-1
2	FIGURE D-1, CIU/COMDEC DECISION TREE	D-2
3	FIGURE D-2, SEPARATION SWITCH DECISION TREE	D-3
4	COMMENTARY ON EARTH ACQUISITION DECISION TREE	D-4
5	FIGURE D-3, EARTH ACQUISITION DECISION TREE	D-5
6	TABLE D-1, EFFECTS OF SUN IN THE SCANNER FOV AT SUNRISE ON ACS PERFORMANCE	D-6
7	FIGURE D-4, COMMAND DECISION TREE	D-7
8	FIGURE D-5, KB DECISION TREE	D-8
9	FIGURE D-6, TMP DECISION TREE	D-9

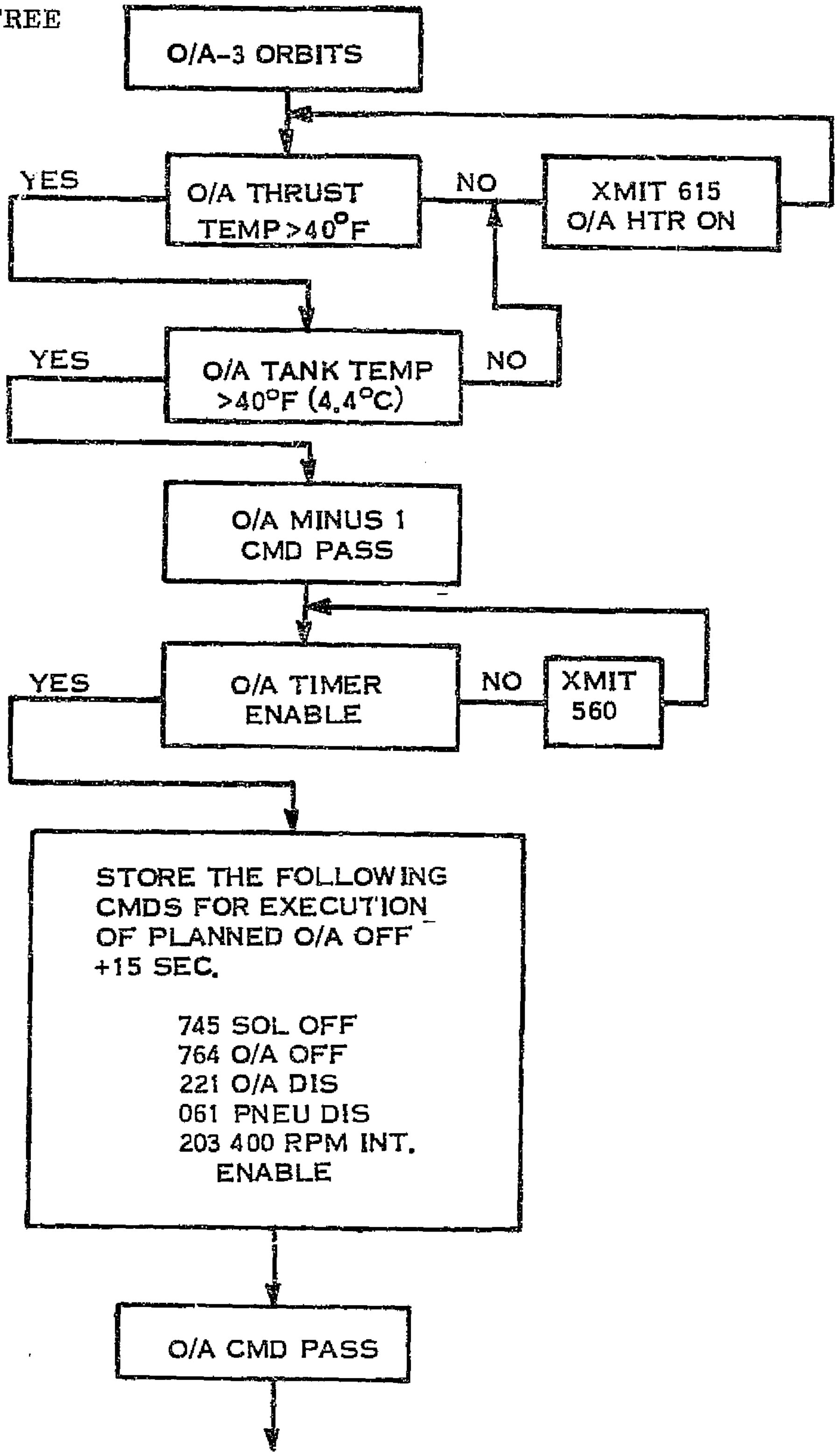
APPENDIX E

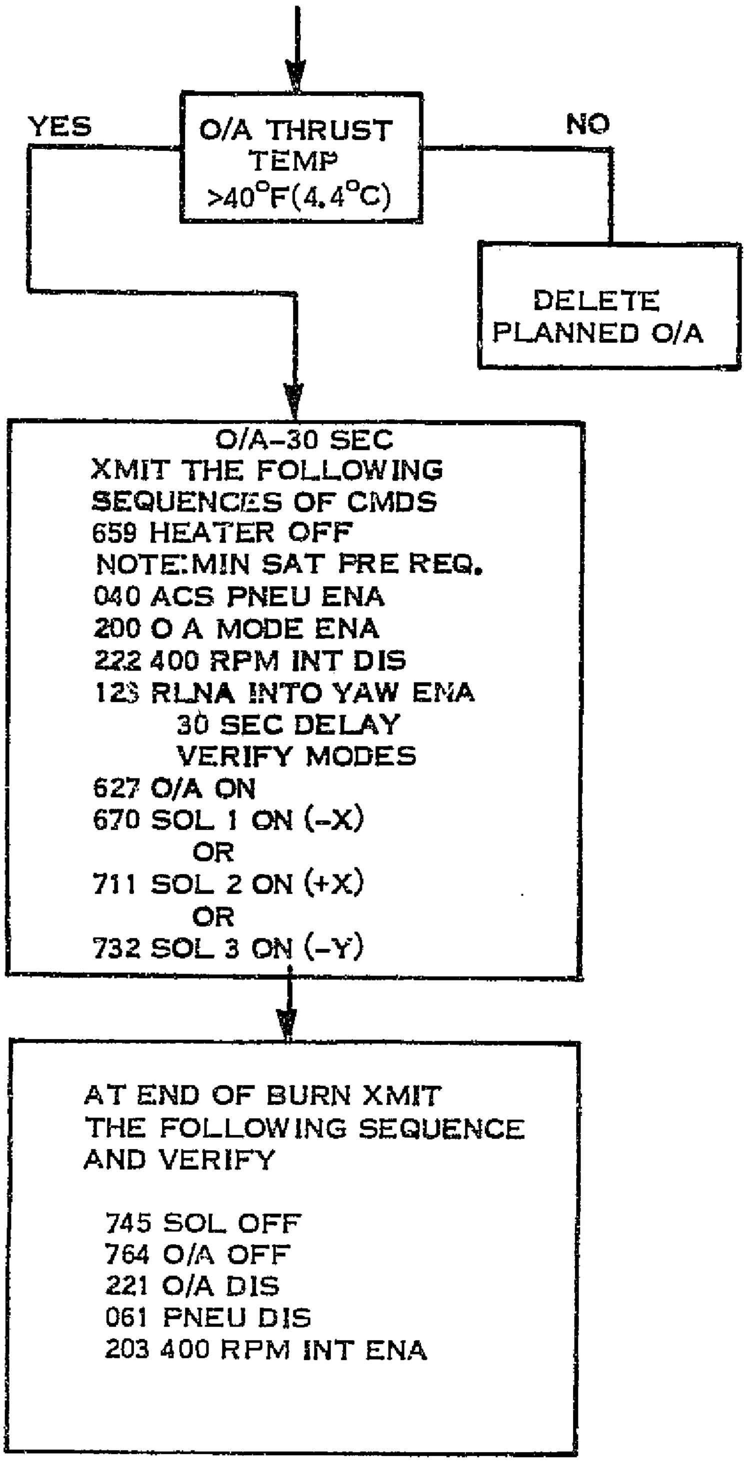
ORBIT ADJUST PROCEDURE

APPENDIX E

ORBIT ADJUST PROCEDURE

A. NOMINAL FIRING TREE




O/A THRUST TEMP >40°F(4.4°C)
YES
NO
DELETE PLANNED O/A
O/A-30 SEC
XMIT THE FOLLOWING SEQUENCES OF CMDS
659 HEATER OFF
NOTE:MIN SAT PRE REQ.
040 ACS PNEU ENA
200 O A MODE ENA
222 400 RPM INT DIS
123 RLNA INTO YAW ENA
30 SEC DELAY
VERIFY MODES
627 O/A ON
670 SOL 1 ON (-X)
OR
711 SOL 2 ON (+X)
OR
732 SOL 3 ON (-Y)
AT END OF BURN XMIT THE FOLLOWING SEQUENCE AND VERIFY
745 SOL OFF
764 O/A OFF
221 O/A DIS
061 PNEU DIS
203 400 RPM INT ENA

The following charts show the possible corrections for orbit adjust.

Enter chart from left side-apogee plus perigee.

Select a dot on the chart and ODG will provide the corrective action.

During the simulation exercises the following sample orbits were run.

B. NO SECOND BURN

Initial orbit was 92 x 482 nm

Correction was to 242 x 482 nm, utilizing 100% Fuel.

B. EXTENDED SECOND BURN

Initial orbit was 1060 x 492 nm

Correction was to 1000 x 492 nm, utilizing 40% Fuel. (18 day cycle, skip 5)

D. NON-NOMINAL

Initial orbit was 395 x 449 nm

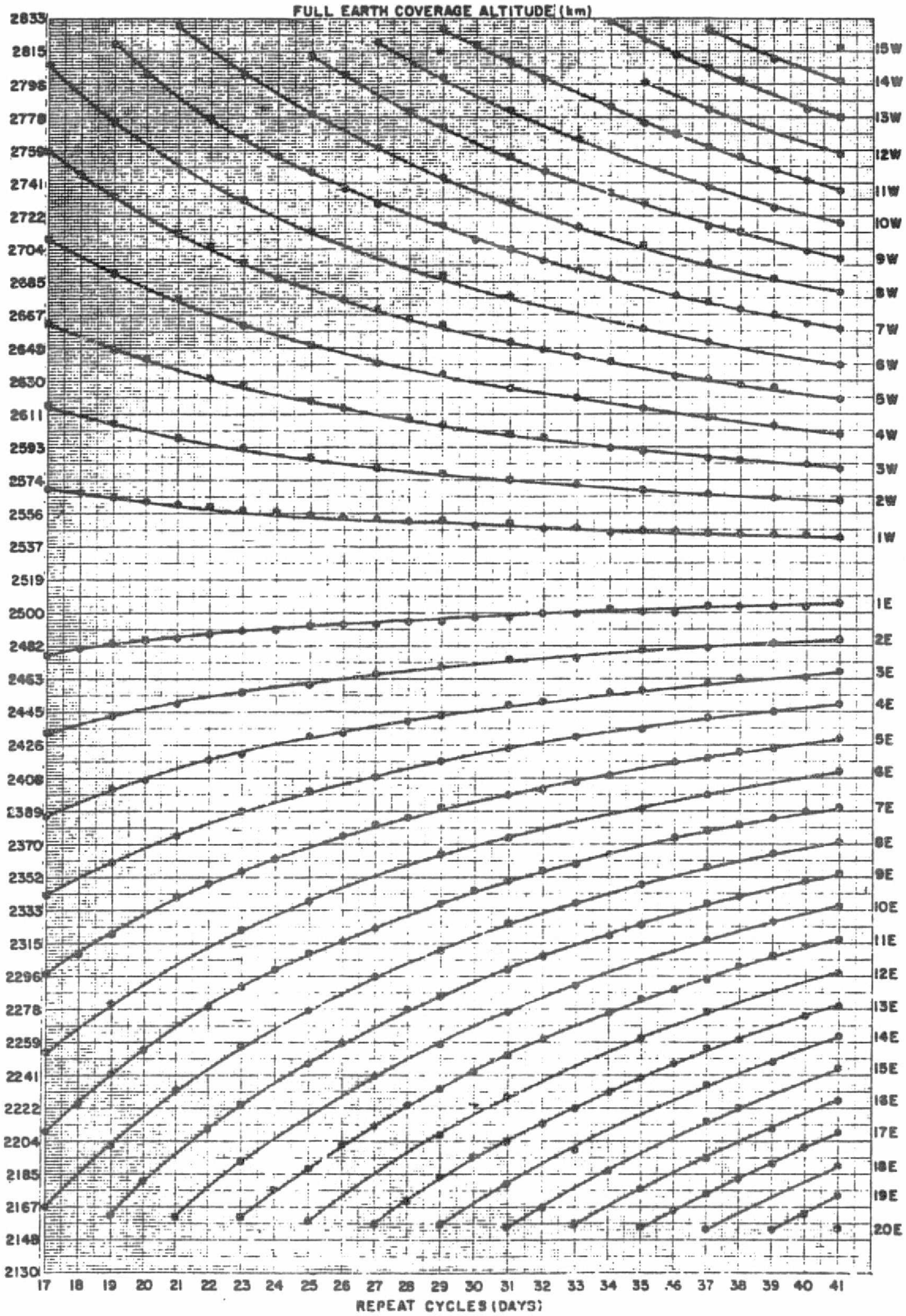
Correction was to 461 x 465 nm, utilizing 45% Fuel. (19 day cycle, skip 2)

E. NORMAL OPERATIONS & ORBIT MAINTENANCE

This section defines the products generated and the interface for the Orbit Determination Group (ODG) and the Operations Control Center (OCC) for the support of the Landsat-C Orbit Adjust and Orbit Maintenance Operations.

Figure E-1 shows the ODG/GDHS information flow.

ERTS ORBIT SELECTION GRAPH
(13 REVOLUTIONS PER DAY)



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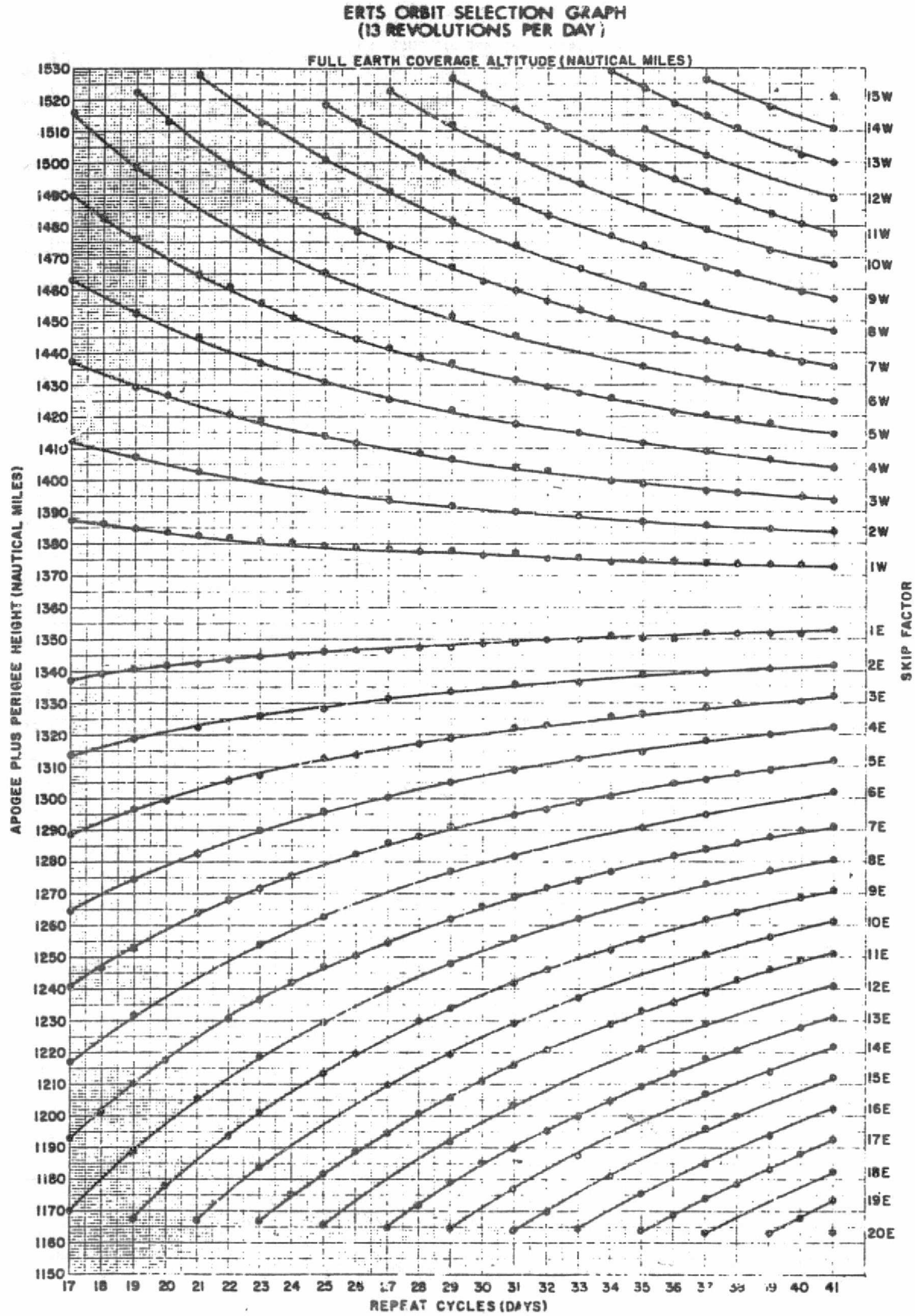
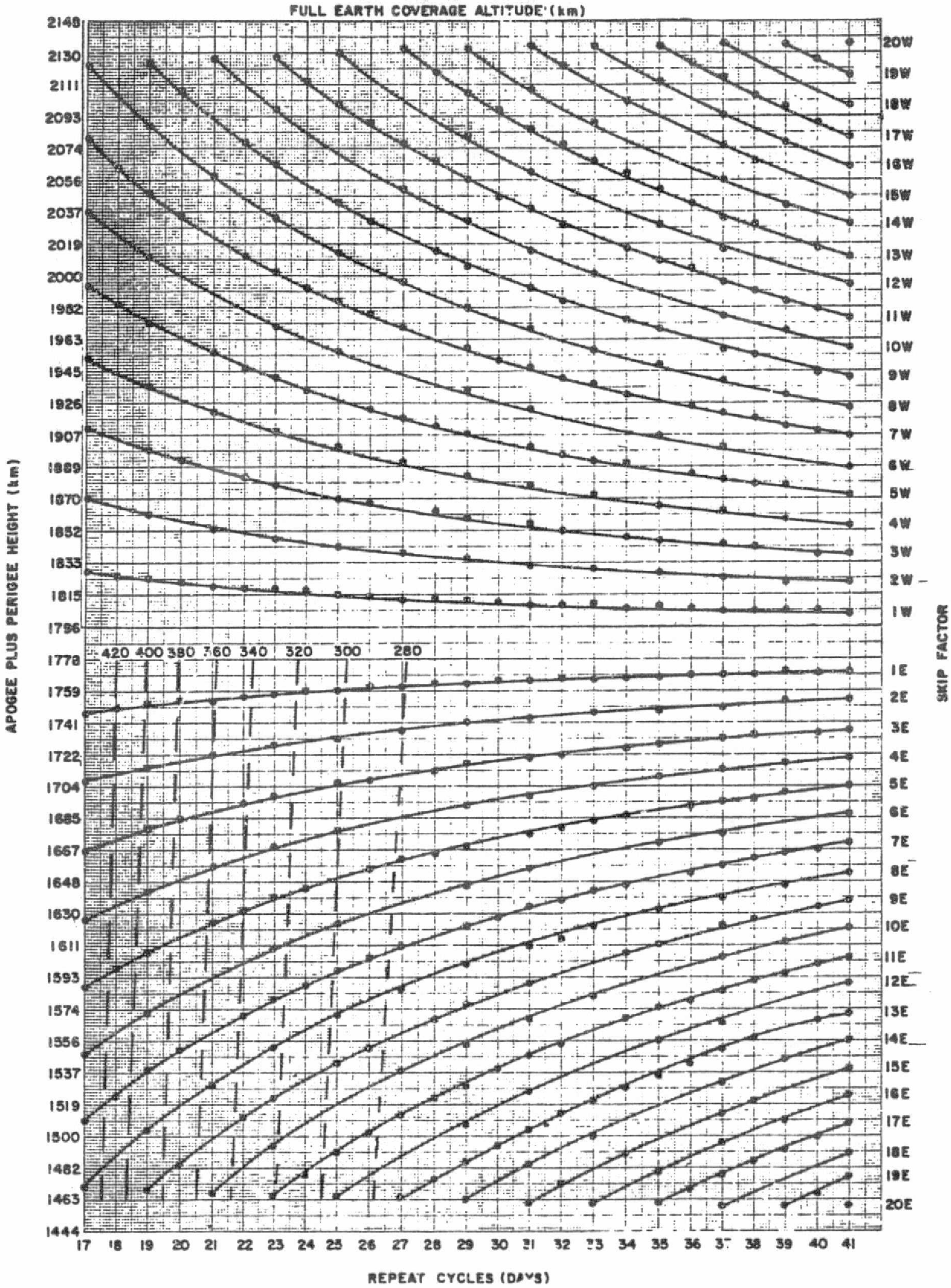


ERTS ORBIT SELECTION GRAPH
(13 REVOLUTIONS PER DAY)
FULL EARTH COVERAGE ALTITUDE (NAUTICAL MILES)
APOGEE PLUS PERIGEE HEIGHT (NAUTICAL MILES)
REPEAT CYCLES (DAYS)
SKIP FACTOR
15W 14W 13W 12W 11W 10W 9W 8W 7W 6W 5W 4W 3W 2W 1W
1E 2E 3E 4E 5E 6E 7E 8E 9E 10E 11E 12E 13E 14E 15E 16E 17E 18E 19E 20E

ERTS ORBIT SELECTION GRAPH

(14 REVOLUTIONS PER DAY)



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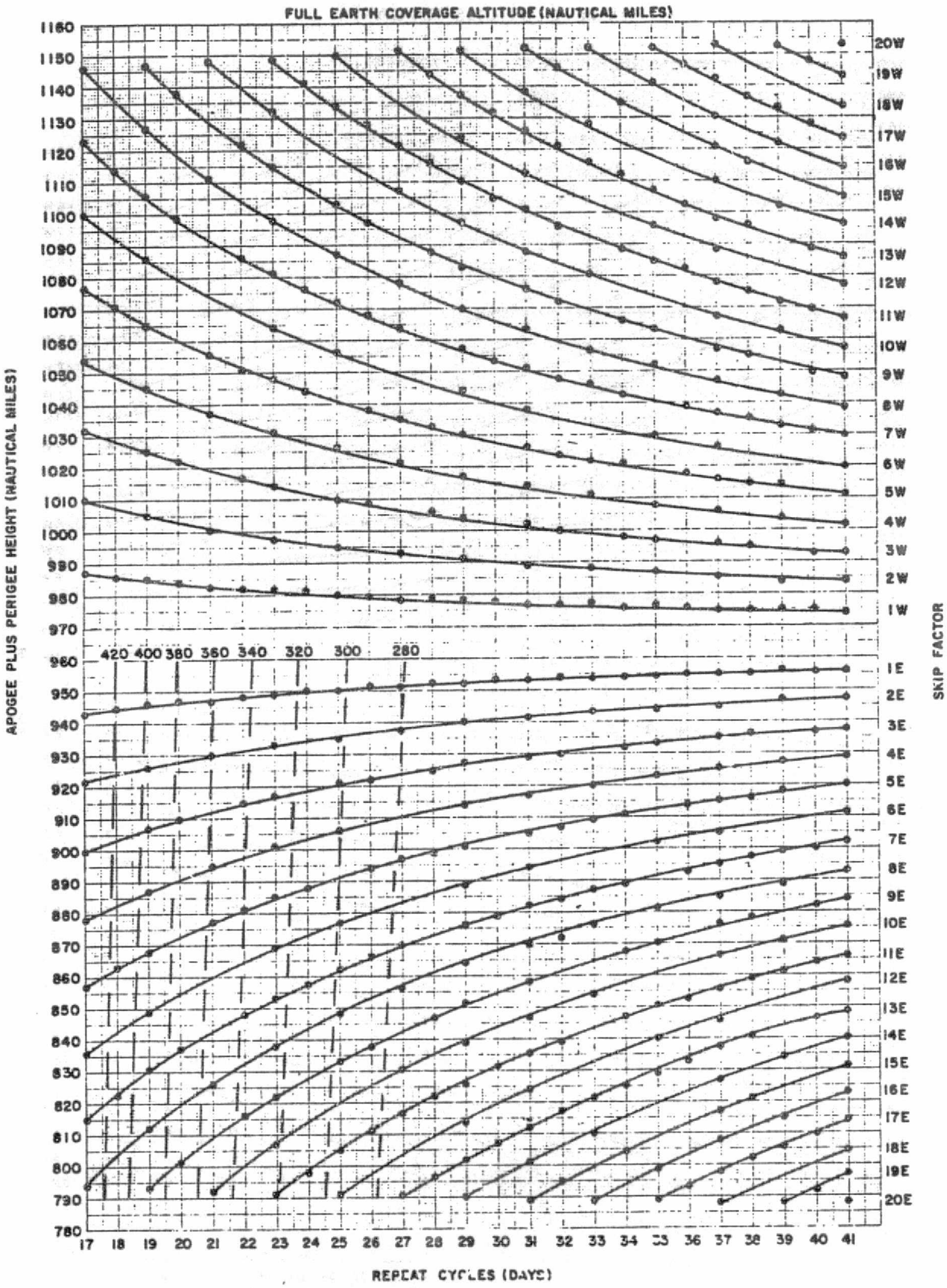
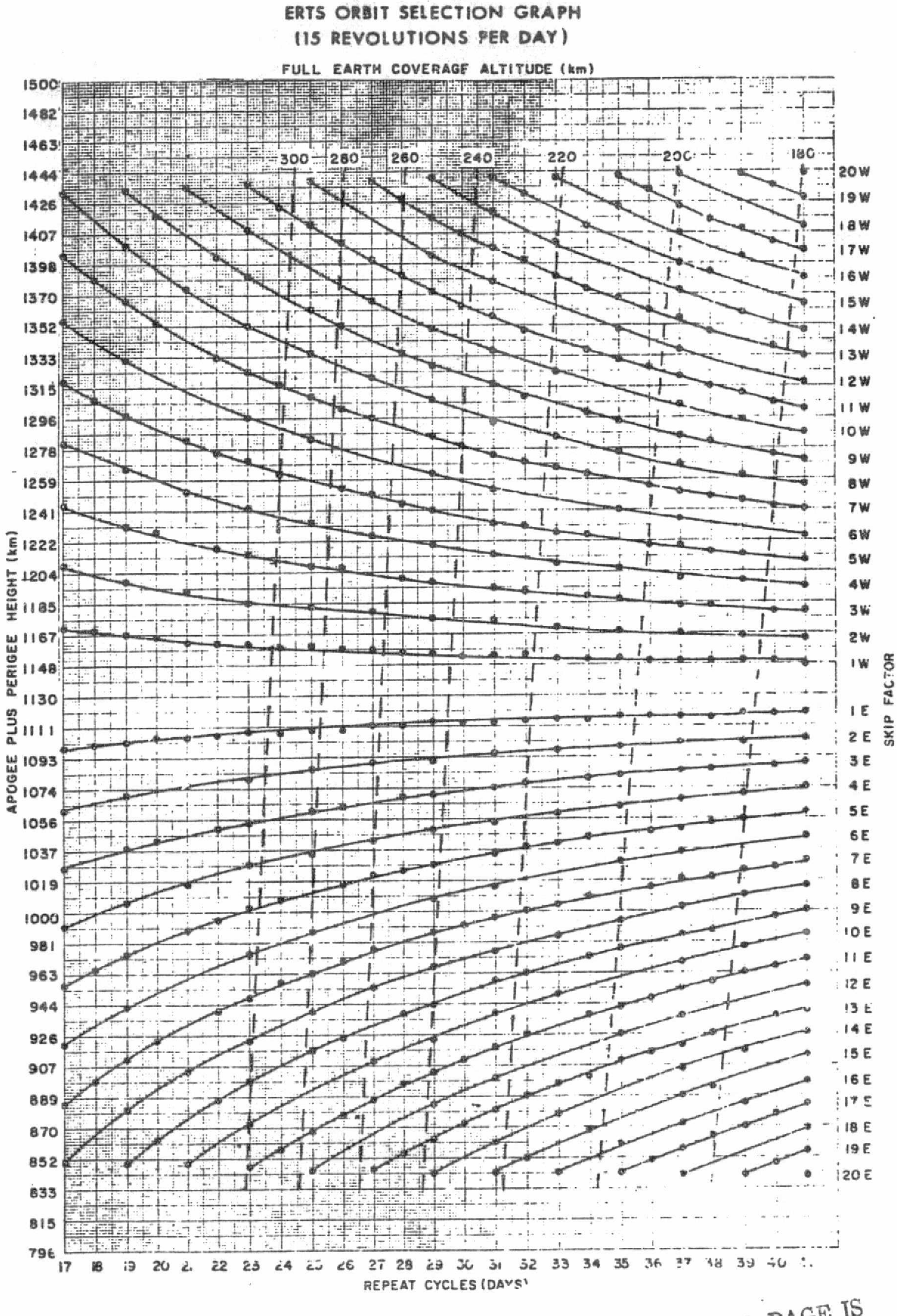
ERTS ORBIT SELECTION GRAPH
(14 REVOLUTIONS PER DAY)





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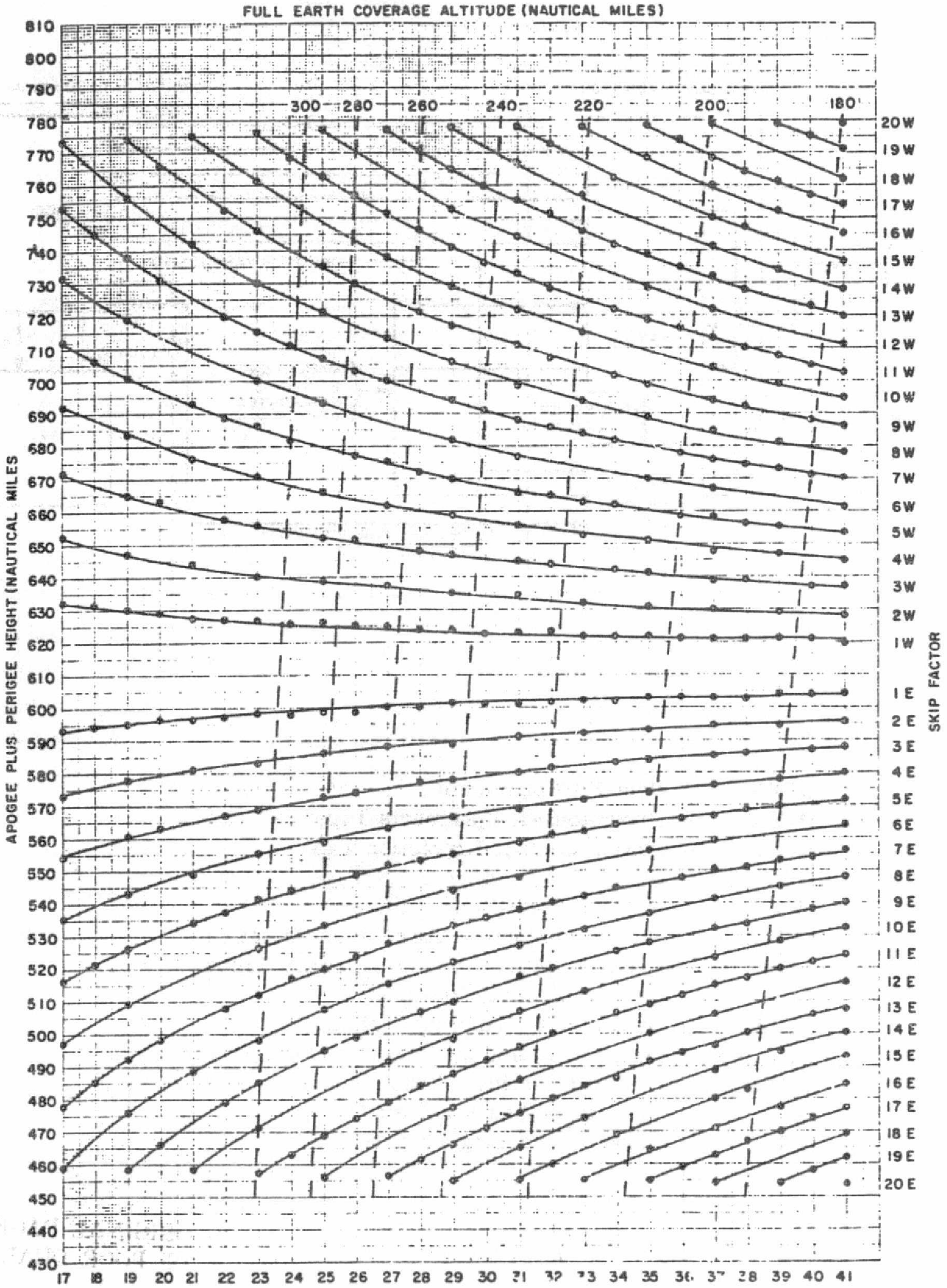
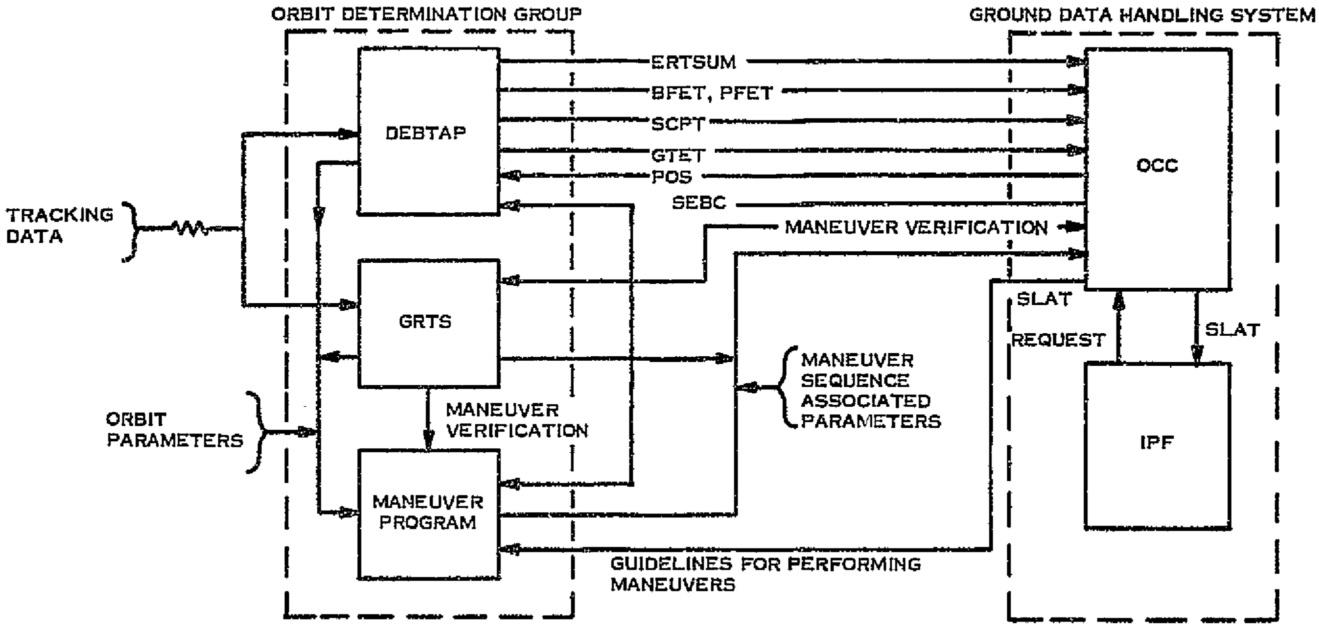
ERTS ORBIT SELECTION GRAPH
(15 REVOLUTIONS PER DAY)





Legend:

BFET	-	Best Fit Ephemeris
PFET	-	Predicted Fit Ephemeris Tape
SCPT	-	Station Contact Prediction Tape
GTET	-	Ground Trace Ephemeris Tape
POS	-	Payload Operations Summary
SEBC	-	Spacecraft Engine Burn Characteristics
ERTSUM	-	Landsat Station Contact Summary Listing
ODG	-	Orbit Determination Group
GDHS	-	Ground Data Handling System
DEBTAP	-	Data Evaluation by Trajectory Analysis Program
GRTS	-	Goddard Realtime System
OCC	-	Operations Control Center
IPF	-	Image Processing Facility

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Figure E-1. Landsat ODG/OCC Information Flow

OCC/ODG Interface

This section defines the general responsibilities of the OCC and ODG, and the specific requirements on the transfer of spacecraft ephemeris-related and spacecraft parameter data between the OCC and ODG. The OCC acts primarily as a user of ephemeris data obtained from the ODG. However, it must also perform certain key tasks in order to permit successful definitive orbit computations. These tasks are as follows:

- Provide spacecraft parameter data (mass, thruster geometry, and thruster system characteristics) in memo form.
- Provide guidelines to ODG for maneuver planning in memo form.
- Perform maneuver Command verification; assess attitude control, maneuver epoch, and maneuver duration.
- Generate on a daily basis the ACS Gating Summaries (AGS) defining the time and direction of all gates. Also Attitude Gating Prediction Data (AGPD) is required when a trend develops during normal spacecraft operation.

The ODG is the source of all ephemeris-related data and orbit correction information. That is, the ODG is responsible for the following tasks:

- Maintain orbit definition.
- Determine when orbit adjustment is needed.
- Compute orbit adjust data (ignition time, duration, and thruster identification) using maneuver module.
- Verify orbit adjustments from metric data using GRTS.
- Generate spacecraft ephemeris data (BFET, PFET, GTET, SCPT, and ERTSUM).
- Provide DOB (Code 833.1) with prediction vectors for scheduling and for acquisition data.

A summary of the interface data items, their transfer medium, their source, destination, and frequency of occurrence is presented in Table E-1.

Table E-1. Summary of OCC/ODG Interface Items

Data Item	Medium	Source	Destination	Frequency
BFET	Tape	ODG	OCC	As Required
PFET	Tape	ODG	OCC	Every Other
SCPT	Tape	ODG	OCC	Weekly
GTET	Tape/Hard Copy	ODG	OCC	Weekly/As Required
SEBC	Memo	OCC	ODG	As Required
Maneuver Guidelines	Memo/Verbal	OCC/ODG	ODG/OCC	As Required
AGS	Graph	OCC	ODG	Weekly
AGPD	Memo/Verbal	OCC	ODG	As Required
ERTSUM	Hard Copy (4)	ODG	OCC	Weekly
Acq. Vector/ Scheduling	Hard Copy	ODG	DOB	Weekly

Legend --

BFET	-	Best Fit Ephemeris Tape
OCC	-	Ops Control Center
PFET	-	Predicted Fit Ephemeris Tape
SCPT	-	Station Contact Prediction Tape
GTET	-	Ground Trace Ephemeris Tape
SEBC	-	Spacecraft & Engine Burn Characteristics
AGS	-	ACS Gating Summary
AGPD	-	Attitude Gating Prediction Data
ERTSUM	-	Landsat Station Contact Summary Listing
DOB	-	Data Operations Branch (Code 833.1)

Landsat Orbit Determination

The launch and injection error removal phases of the Landsat mission will be supported by the Goddard Real Time System (GRTS). Launch data from WTR will be processed in GRTS and the resulting parameters will be used to drive NOCC displays and to inform the Landsat OCC of orbital status. The launch data will also be used to derive initial conditions for the orbit determination process.

Winkfield will view the spacecraft separation. Madrid will be the first USB station to acquire the spacecraft.

The spacecraft passes directly into the eastern keyhole at Madrid and the amount of data received will be limited.

The data from Madrid will be received at GRTS in real time and processed to determine the initial orbit. The uncertainty of the orbit determined at this time (approximately 1/2 hour following separation) will be high; however, it will give a rough estimate of the orbit. GRTS will continue to receive data from ground station and process the data for orbit determination. By the completion of the second or third revolution, a reasonable estimate of the orbit should be known. The GRTS will continue real time support of the Landsat Mission for the first 7 days. The tracking data will be transmitted by the USB stations with a "DD" header in real time and a "GWWW" post-pass header. The minitrack stations will transmit with the "GDCS" and "GWWW" post-pass headers.

During the Injection Error Removal Phase of the mission (the first 7 days), the Data Evaluation by Trajectory Analysis Program (DEBTAP) will also be used for back-up orbit determination support of the mission. Tracking data will be received during this phase in DEBTAP via the GRTS or the GRTMPS.

After the first or during the second day following launch a good estimate of the state of the orbit will be available from GRTS and confirmed by DEBTAP. This state vector will be used to initiate computations in the DEBTAP maneuver module for the generation of the maneuver sequence for injection error removal. The execution of the maneuver sequence should commence approximately 2-1/2 days following launch. The maneuver sequence will be interspersed with periods of concentrated tracking of the spacecraft for approximately two revolutions. The tracking data will be used for orbit determination by GRTS for verification that the maneuvers have been executed properly. Error analysis studies indicate that with two or three revolutions of concentrated tracking data, the uncertainty in the knowledge of semi-major axis (the energy of the orbit) is approximately 45 meters (1-sigma) and the 1-sigma uncertainty in inclination (the plane of the orbit) is 0.0004 degree. A typical burn (8.5 minutes) with one of the in-plane thrusters will yield a change in semi-major axis of 2.7 km; a typical burn (8.5 minutes) with the out-of-plane thruster will yield a change in inclination of 0.01 degree. Thus the sensitivity of the orbit determination results for maneuver verification should be quite good.

Launch and Injection Error Removal Sequence. The GRTS will provide orbit determination for the early orbit and injection error removal phase of the mission. Updated acquisition messages will be transmitted to the supporting stations no later than 30 minutes prior to AOS. If GRTS does not support during this entire phase, then off-line acquisition procedures must be utilized. Acquisition messages and scheduling data will account for expected spacecraft maneuvers within their prediction interval. Computations for the injection error removal sequence will commence as soon as a good determination of the Landsat orbit is achieved. This should occur one or two days following launch. Corrections to the Landsat injection orbit will be computed by the DEBTAP-Landsat Maneuver module to satisfy the following mission requirements:

- Picture swath overlap every 18 days to within $\pm$ 18.5 kilometers (10 nautical miles) of the first cycle.
- A sun-synchronous orbit with repetitive observations at the same mean local time.

The maneuver sequence will be computed subject to a large number of ground rules delineated in the Landsat Orbit Adjust Criteria document. The most significant ground rules are:

- Inclination errors be removed first.
- The first burn for any thruster occurs totally in view of a ground station.
- All subsequent burns for any thruster terminate either in view of a ground station or with station acquisition within 5 minutes of burn termination.

Prior to the calculation of the injection error removal sequence the Landsat OCC is required to supply the ODG with the most recent tank pressure and temperature received via telemetry. This information will be used to calculate the thrust level and burn duration for an orbital correction determined by the maneuver program. At the termination of a maneuver the Landsat OCC is required to supply the ODG with verification of thruster start and stop times, spacecraft attitude, and tank pressure and temperature. Further verification of maneuvers will be attained by the ODG via orbit determination.

Each maneuver in the sequence will be specified in the following form:

- Time of Ignition (GMT)
- Duration of Burn
- Thruster
- Expected Element Change
- Station Visibility
- Subcapsule Point of Ignition and Burnout

Orbit Maintenance

The orbit maintenance phase of the mission will commence following the completion of the injection error removal sequence. It is from this point that repeatable ground tracks will be maintained. The longitude and revolution number of an ascending nodal crossing will be recorded at the initiation of the orbit maintenance phase. The logic in the orbit maintenance maneuver program will require this longitude to be repeated with ± 18.5 kilometers (± 10 nautical miles) for a 1-year period. This longitude, mean local time (MLT), and revolution number will be entered on disk of the 360/75 computer via the 2250 console. On a daily basis (every 14 revolutions), subsequent longitudes, MLT's and revolution numbers will also be recorded and stored on disk. Following every orbit determination with either DEBTAP or GRTS, the solution vector will be integrated to the next nodal crossing and the longitude and MLT of that nodal crossing will be recorded. (It will be incombent upon the monitor of that orbit determination to assign the correct revolution number to the longitude.) Information as to revolution number will be available from the ERTSUM listings and from a listing of revolution number history generated by an off-line program.

In addition to the longitudes which are available as standard output at the nodal crossings, a number of Landsat oriented parameters such as repeat cycle overlap and mean local time will be computed and printed by DEBTAP and GRTS. The operator of the orbit determination programs will be able to monitor these parameters and detect drifts in the satellite ground trace. When these errors build up significantly, the Landsat maneuver program will be utilized to compute corrections to the orbit.

The Landsat maneuver program when operating in the orbit maintenance mode will access the longitudes, MLT's and revolution numbers stored on the disk. Utilizing these parameters as a priori information on the trends in the orbit, the program will calculate corrections to the semi-major axis of the orbit to correct the orbital drift. The program will also generate the sequence of maneuvers required to achieve these corrections.

Due to the attitude control system gatings and the uncertainty in the orbit determination process of the injection error removal phase, it is anticipated that some sizable corrections (hundreds of meters) will be required 1 or 2 weeks following the injection error removal sequence. Subsequent to these corrections further small corrections (tens of meters) are anticipated every 3 or 4 weeks.

Contingency Plans

Plans are being drawn for each item in the following contingency list.

1. Launch errors exceed three sigma error values.
2. Uncoupled torques from ACS producing translational thrust.
3. Leak in Orbit Adjust Thruster.
4. Drag effect other than predicted.
5. Luni-Solar secular drift other than predicted.
6. Resonant potential effect other than predicted.
7. Non-nominal burn in one of the engines.
8. Out-of-plane thruster fails.
9. One or both in-plane thruster fail.
10. USB transponder failure.

Contingency (1). When launch errors exceed the 3-sigma error values, the Landsat maneuver program will still calculate the maneuver sequence to achieve a nominal orbit. If the fuel expenditure required in this sequence exceeds or approaches the fuel budget, another orbit may be selected by the Landsat Project Office. Data to enable the Project Office to select an orbit has been compiled in the form of graphs of the key Landsat requirements (such as repeating ground track, full earth coverage, etc.) vs. parameters from which orbital elements may be derived. After the Project Office has selected the orbit, the orbit parameters are input to the maneuver module of the Landsat software package to generate the maneuver sequence to achieve the orbit selected.

Contingencies (2) through (6). These contingencies will each result in ground traces other than what is predicted and will be handled under the orbit maintenance logic discussed in the Orbit Adjust Procedure. Briefly what will occur as a result of these contingencies is that the actual ground traces will continuously drift from the predicted ground traces and the rate of the drift will depend on the size of the error. Discounting very large leaks in the orbit adjust fuel, the drift rates will take several days to detect. Although its cause may not be known, an error can be sensed by monitoring the trends in the orbit on a day-to-day basis. Regardless of the cause of the error, the trends in the ground trace pattern can be corrected by adjusting the period of the orbit. This procedure is readily accommodated by the orbit maintenance logic of the DEBTAP maneuver module.

Contingency (7). A non-nominal burn in one of the engines can be detected via telemetry by monitoring the engine on and off times, the spacecraft attitude, and the pressure and temperature readings or via orbit determination by comparing the expected element change for a given maneuver to the actual element change. If a non-nominal burn is detected, subsequent burns in the maneuver sequence will be recomputed, thus accounting for the anomaly. The thrust level and attitude of a thruster can be varied in the maneuver program if a series of maneuvers indicates that a subsequent burn of that thruster will be non-nominal.

Contingencies (8) and (9). If a thruster repeatedly fails when trying to execute a maneuver, the maneuver program will attempt to adjust the orbit to meet the mission requirements using another available thruster. For example, if an in-plane adjustment to the orbital period is attempted to achieve the repeating ground trace pattern, and if the designated in-plane thruster fails to fire on repeated attempts, the maneuver program will compute an out-of-plane correction to adjust the ground trace pattern event though this correction is less efficient than the in-plane correction.

Contingency (10). In case of a USB transponder failure, backup tracking by the Minitrack system will be called upon at once. A normal mode of operation will then follow, although slight degradation in the orbit determination will result in larger ephemeris uncertainties for the GDHS tapes and less optimum orbit maintenance maneuvers.

APPENDIX F

OPERATION PLAN FOR THE MMCA

APPENDIX F

OPERATION PLAN FOR THE MMCA

SCOPE

The purpose of this document is to describe the necessary command sequence and charge times for the MMCA in correcting the effective magnetic dipole moment of the Landsat spacecraft.

OPERATION

The MMCA consists of three mutually perpendicular chargeable permanent magnet rods. The activation of the charging and discharging mechanism is by command and is shown on the Block Diagram in Figure F-1.

The Landsat spacecraft will be launched with each of the three magnets in the MMCA at a near-zero moment. The launch mode sequence is as follows:

704	Yaw Coil Out
702	Pitch Coil Out
761	Roll Coil Out
765	Power Off
706	Capacitor Dump
744	Capacitor High
742	Polarity Plus

The orbital performance of the reaction wheels will be studied and, from the momentum accumulation, a spacecraft constant dipole will be analytically derived. This will be performed for all three axes. The non-constant magnetic disturbances will also be determined as each payload instrument is activated. The primary function of the MMCA will be to minimize the effect of the constant spacecraft dipole on the gas consumption of the control subsystem.

Figures F-2 through F-7 show a plot of the generated dipole of each magnetic rod in the MMCA as a function of charge time starting from a near-zero moment. On each curve there

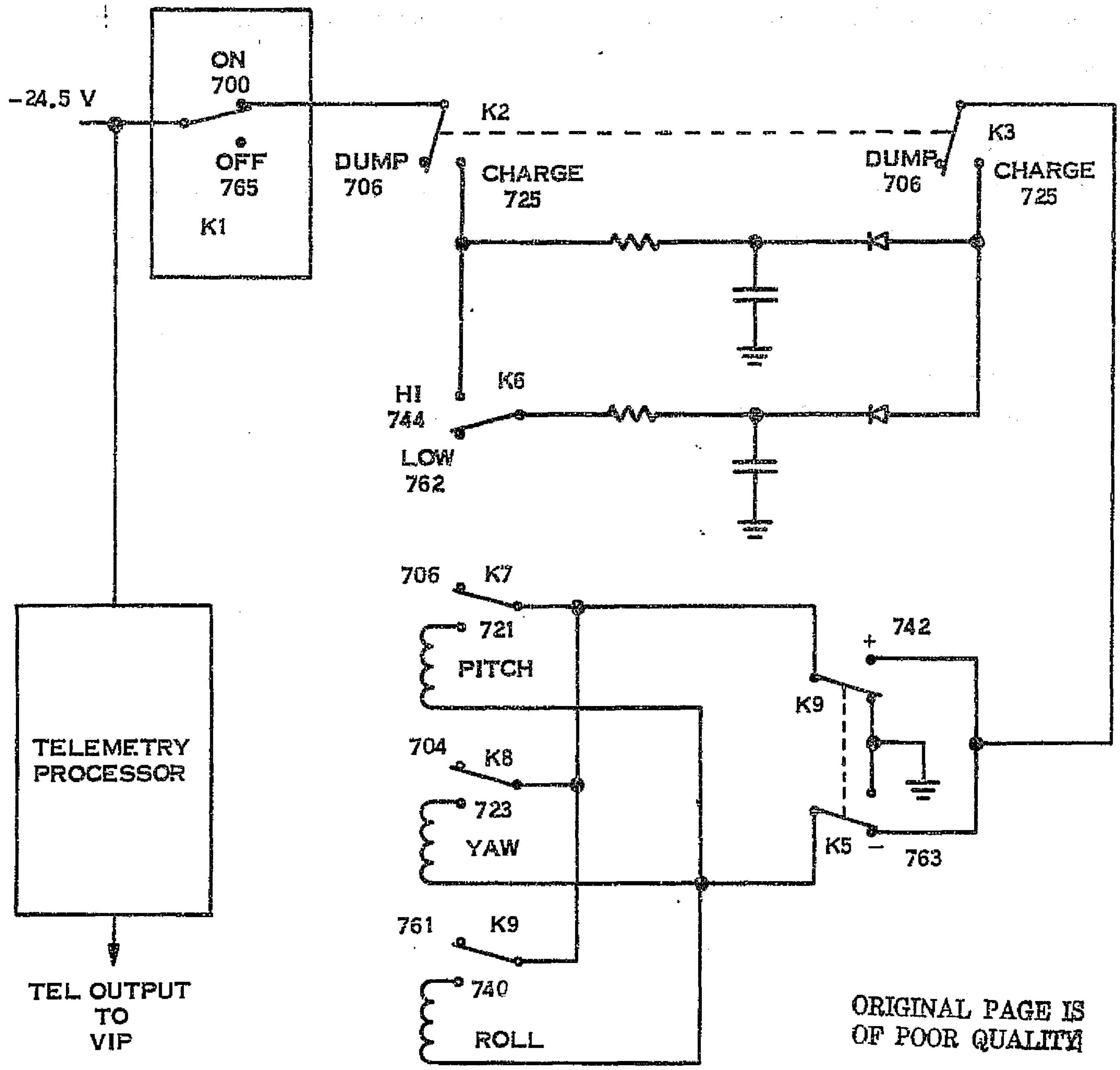

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Figure F-1. MMCA Block Diagram

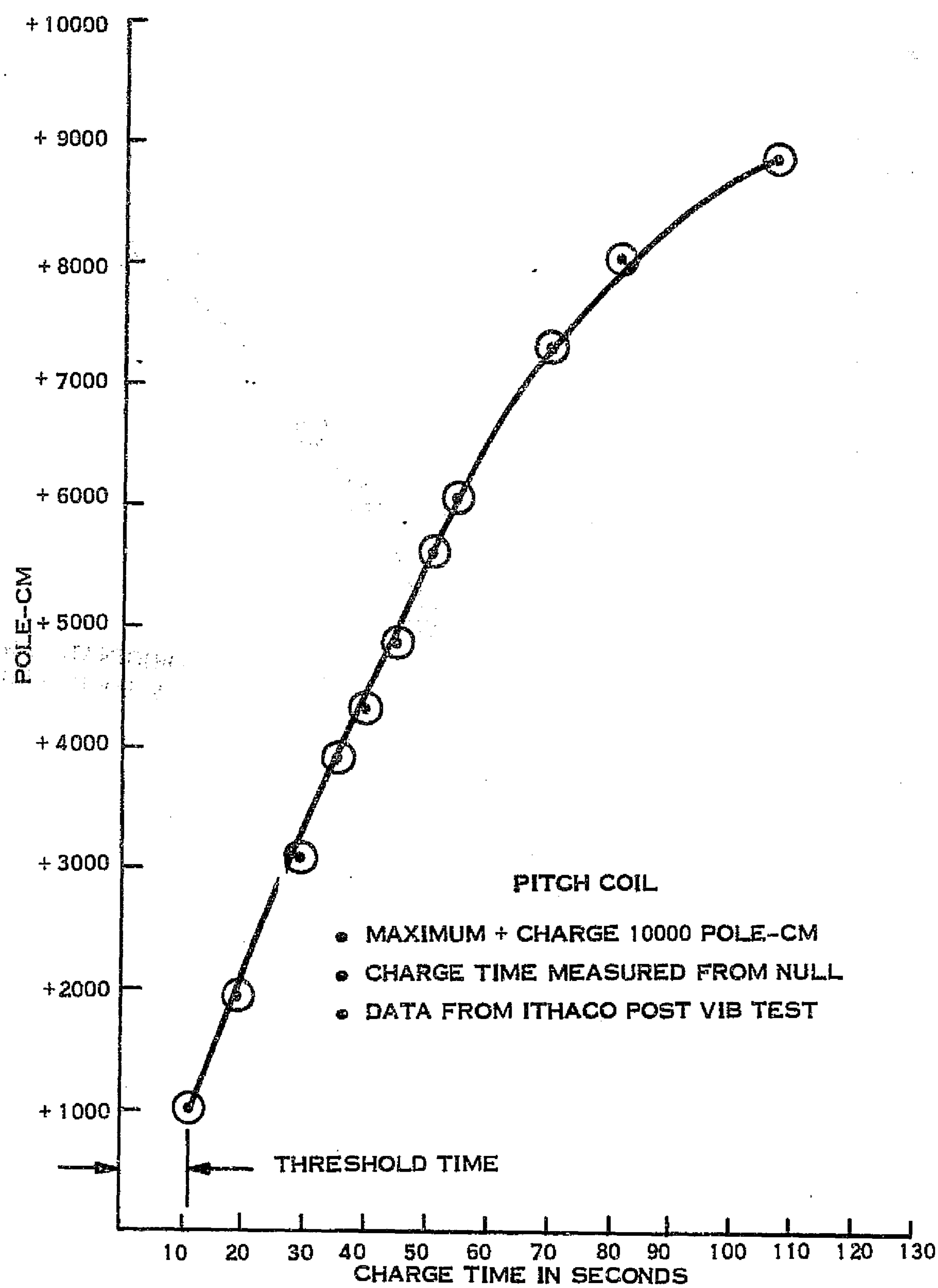

Figure F-2. Positive Pitch Dipole Transfer Curve

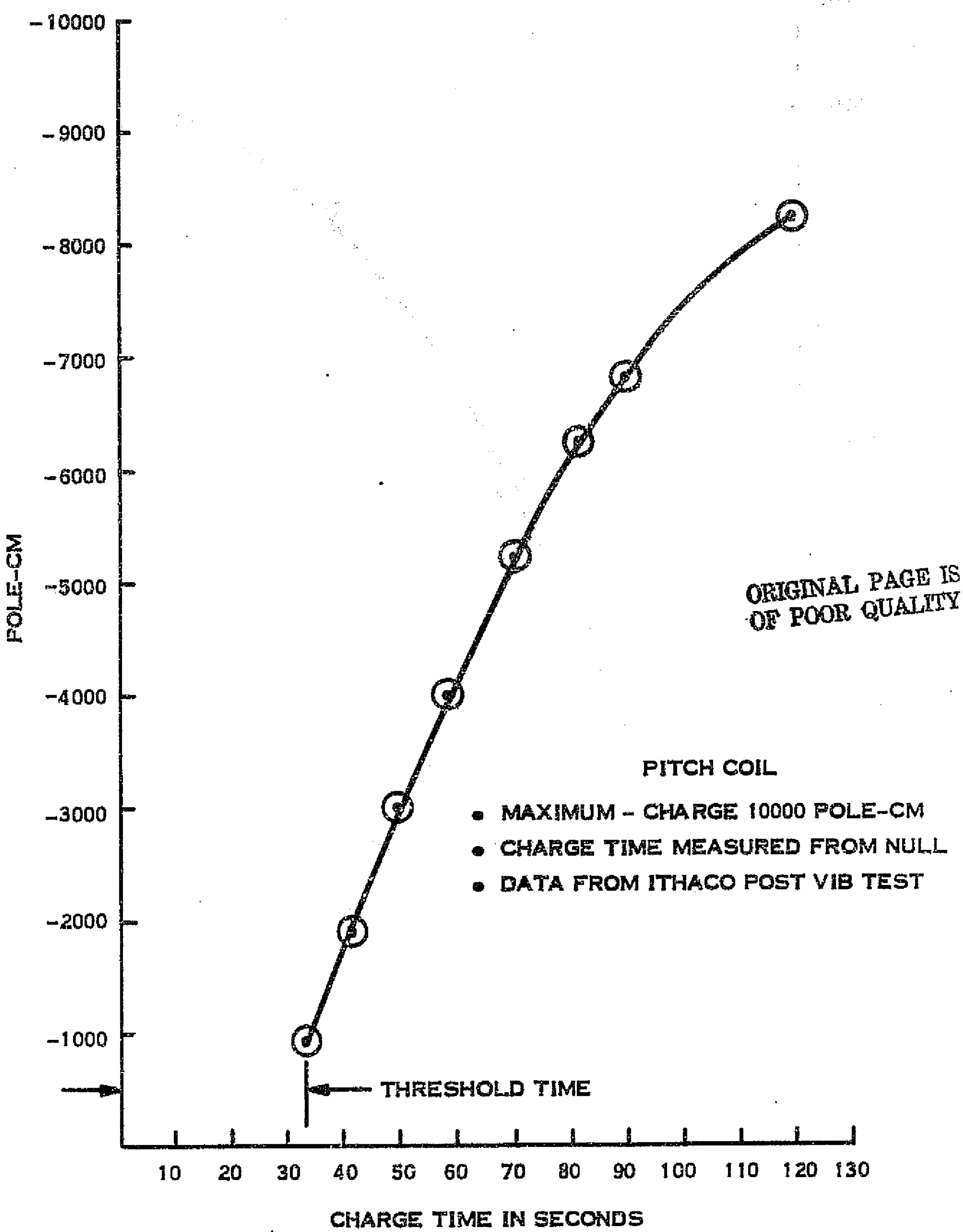

Figure F-3. Negative Pitch Dipole Transfer Curve

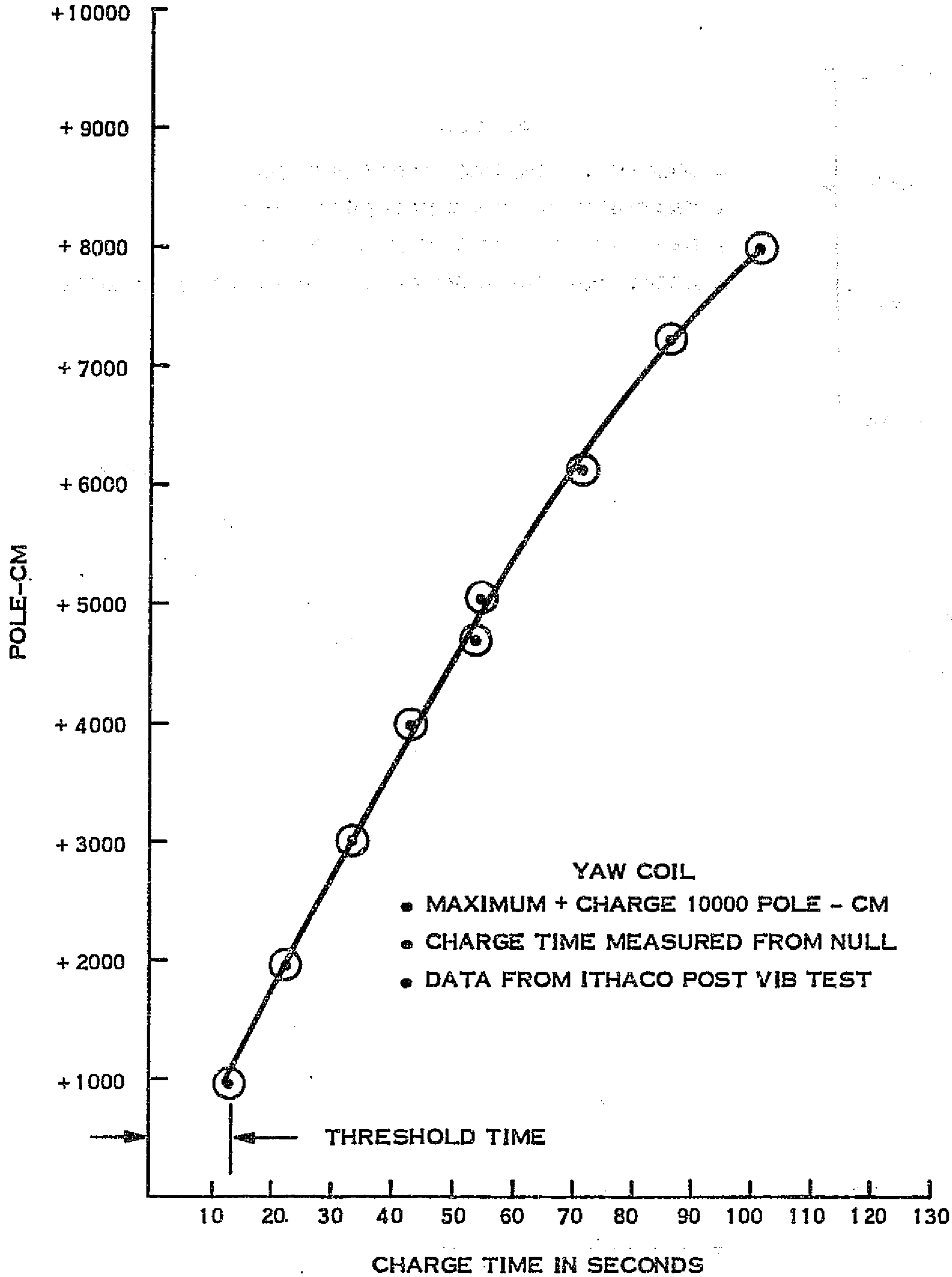

Figure F-4. Plus Yaw Dipole Transfer Curve

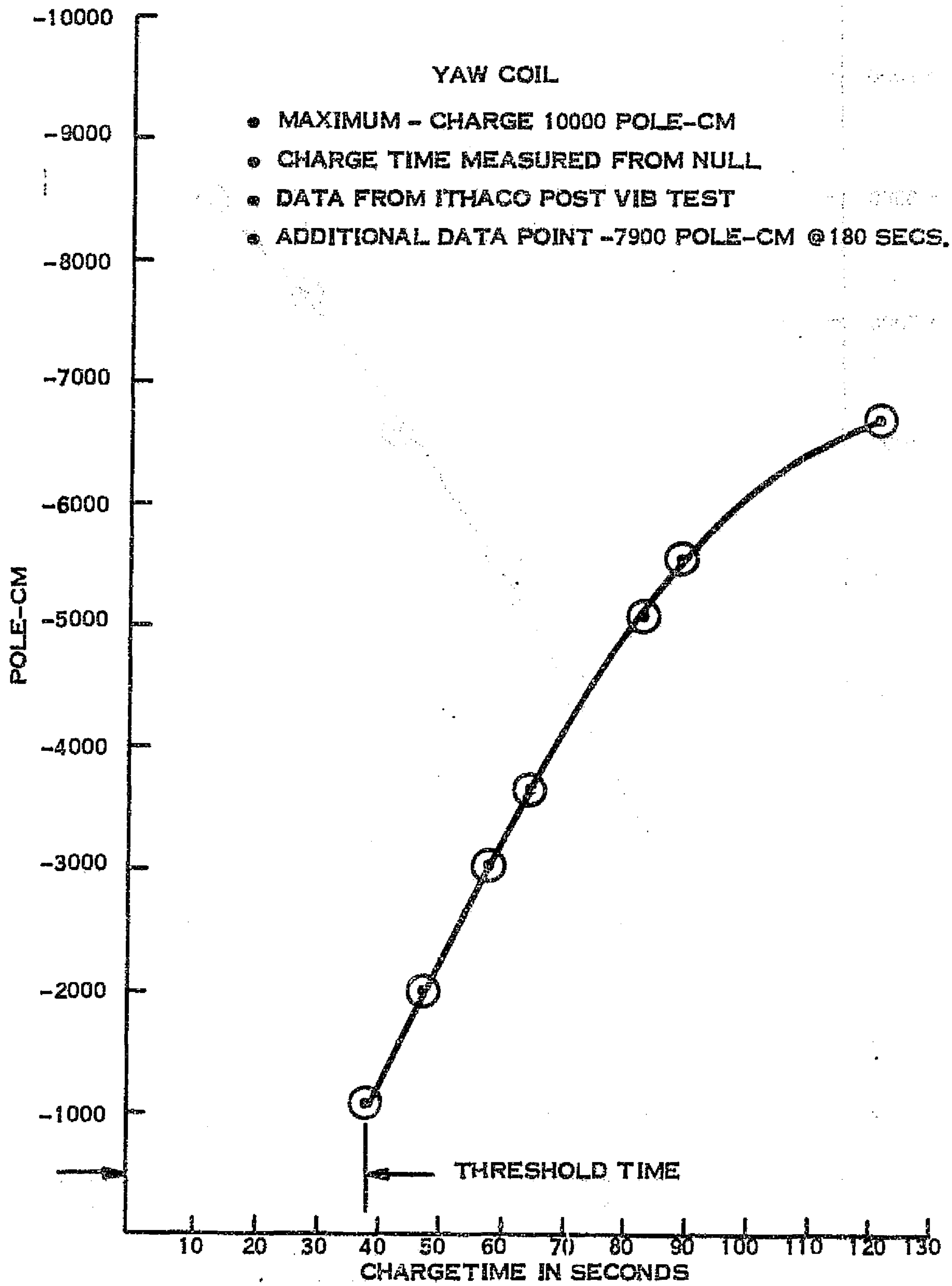

Figure F-5. Minus Yaw Dipole Transfer Curve

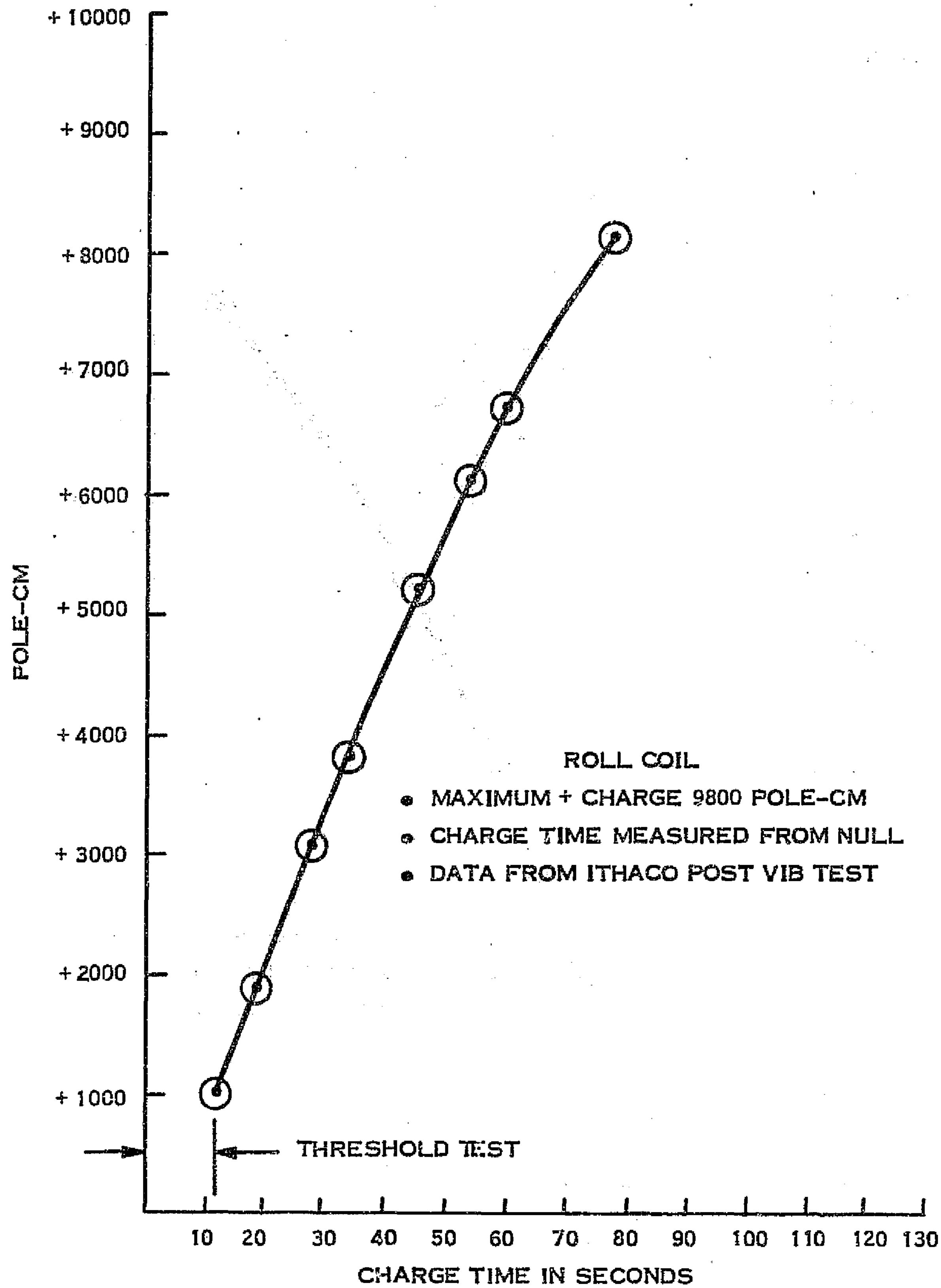

Figure F-6. Plus Roll Dipole Transfer Curve

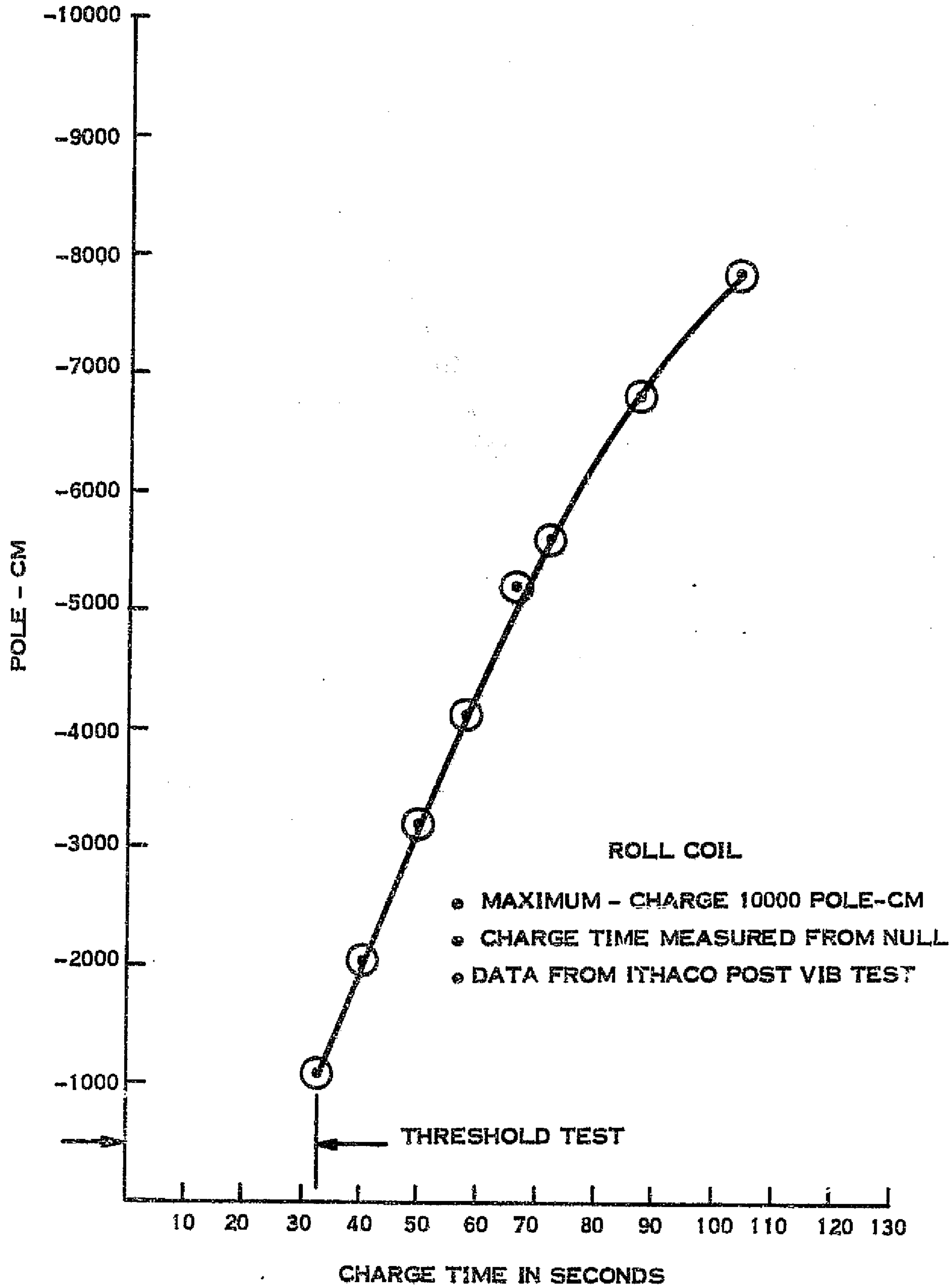

Figure F-7. Minus Roll Dipole Transfer Curve is some time of charge that must be exceeded before a dipole can be created. This time is noted on each curve as the threshold time. This is due to the fact that the B-H curve has not only one major loop but several minor loops. In Figure F-8 is a typical B-H curve illustrating the sub-loops and the effect of the threshold time, the net result will be no change in the magnetic moment. This is graphically shown in Figure F-8.

Assume the constant fixed dipole of the Landsat spacecraft has been calculated from the reaction wheel history in orbit and the following will have to be corrected by the MMCA:

Pitch	-2000 pole-cm
Roll	-1900 pole-cm
Yaw	+1500 pole-cm

Since the above are the effective spacecraft dipoles the MMCA magnet will have to be charged to the same magnitude, but of the opposite polarity. The operation of the MMCA shall be as following charging first the Pitch Coil then the Roll Coil and last the Yaw Coil:

Pitch Coil - (Charge to +2000 pole-cm)

721	Pitch Coil In
761	Roll Coil Out
704	Yaw Coil Out
744	Capacitor High
706	Capacitor Dump
742	Polarity Plus
700	Power On

Verify via telemetry that proper mode has been established

725	Capacitor Charge
	20 second delay (see Figure F-2)
702	Pitch Coil Out
765	Power Off

Roll Coil - (Charge to +1900 pole-cm)

740	Roll Coil In
702	Pitch Coil Out
704	Yaw Coil Out

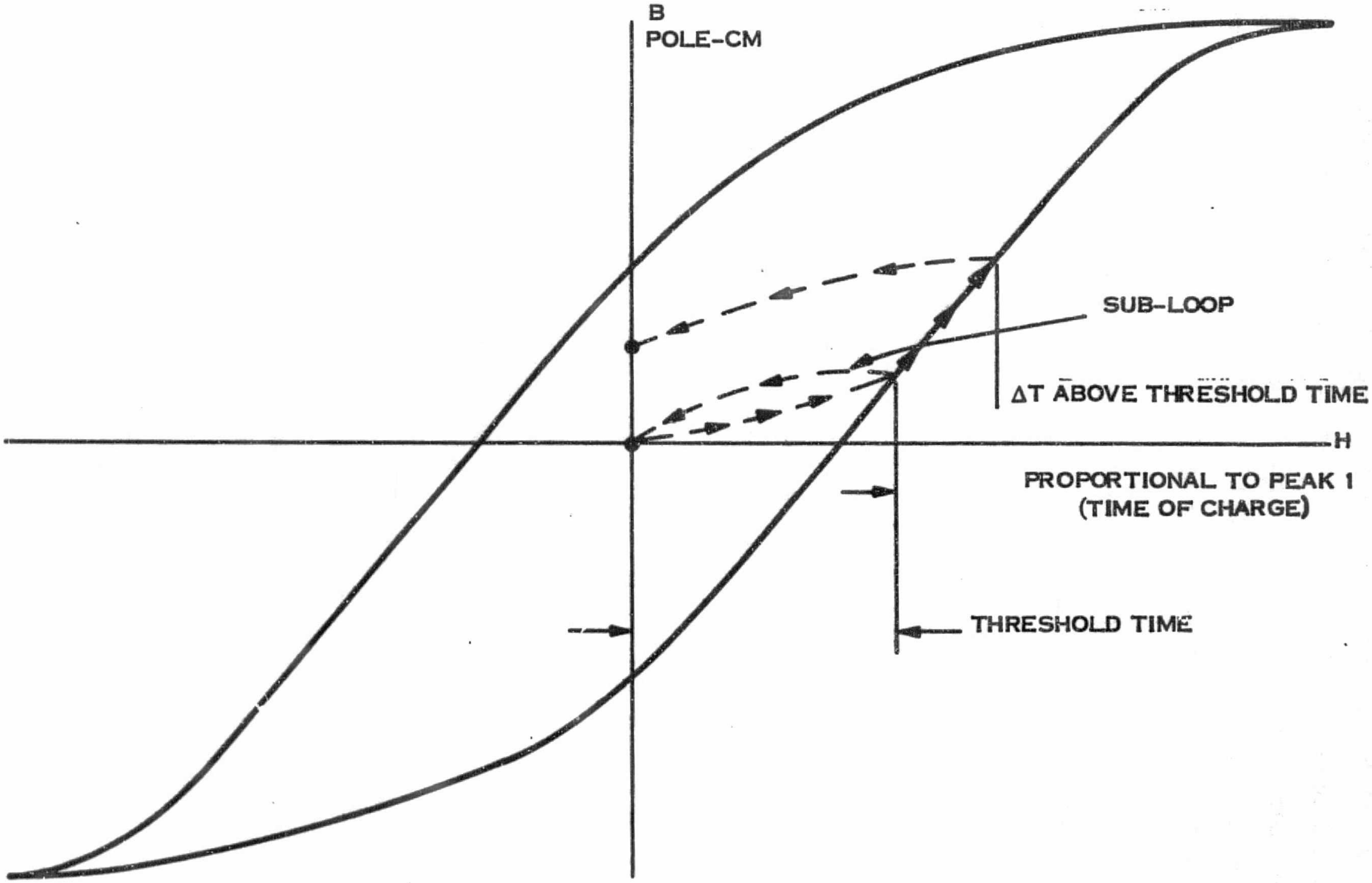

Figure F-8. Typical Magnetic Hysteresis Curve

744	Capacitor High
706	Capacitor Dump
742	Polarity Plus
700	Power On

Verify via telemetry that the proper mode has been established.

725	Capacitor Charge 19 second delay (see Figure F-6)
706	Capacitor Dump
761	Roll Coil Out
765	Power Off

Yaw Coil - (Charge to -1500 pole-cm)

761	Roll Coil Out
702	Pitch Coil Out
723	Yaw Coil In
744	Capacitor High
706	Capacitor Dump
763	Polarity Minus
700	Power On

Verify via telemetry that the proper mode has been established.

725	Capacitor Charge 43 second delay (see Figure F-5)
706	Capacitor Dump
704	Yaw Coil Out
765	Power Off

After the aforementioned sequences have been transmitted, the MMCA induced dipole can be verified via the associated coil telemetry curves.

The charge times are given starting at zero moment of each rod. If a rod is charged to a specific moment and it is found later that the moment is either too large or too small, it will be by trial and error to move to a new moment. The other alternative is to charge the rod to (+) positive saturation and then give a negative (-) charge to return to null. At this time charge the system for the proper time to reach the new desired moment.

The following are the charge times to return to null from (+) positive saturation:

Pitch	42 $\pm$ 0.5 second (-) charge
Roll	42 $\pm$ 0.5 second (-) charge
Yaw	58 $\pm$ 0.5 second (-) charge

MMCA Restraints

1. Charge only one (1) Coil at a time.

2. Before turning MMCA power on, verify that the capacitor is in the dump mode.

APPENDIX G

DEDICATED SEQUENCES

APPENDIX G

DEDICATED SEQUENCES

/SEQUENCE CRITICAL/

SEQUENCE NO. 800 COAST THRU

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	766	PAYLOADS OFF	0	
~~20~~	~~561~~	~~WPA POWER OFF 1~~	~~0~~	
30	067	WPA POWER OFF 2	0	
~~40~~	~~566~~	~~WFM INV A POWER OFF~~	~~0~~	
50	061	PNEU DISABLE	1	YES
~~60~~	~~146~~	~~USB RANGING OFF~~	~~0~~	
70	374	ALL AUX LOADS OFF A	0	
~~80~~	~~356~~	~~AUX LOAD 1 ON~~	~~0~~	
90	357	AUX LOAD 2 ON	0	
~~100~~	~~435~~	~~AUX LOAD 3 ON~~	~~0~~	
110	414	COMP LOAD 3 ON	0	

/SEQUENCE CRITICAL/

SEQUENCE NO. 801 TIME SET

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	017	LOAD TIME CODE	1	YES

SEQUENCE NO. 802 USBN

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	644	PMP MODULATOR B ON	0	
~~20~~	~~000~~			
30	000			
~~40~~	~~000~~			
50	000			
~~60~~	~~775~~	~~ENA USB XMTRS (PRI)~~	~~0~~	

SEQUENCE NO. 803 USBF

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	665	PMP MODULATOR B OFF	0	
~~20~~	~~000~~			
30	000			
~~40~~	~~000~~			
50	000			
~~60~~	~~757~~	~~DISABLE USB XMTRS~~	~~0~~	

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SEQUENCE NO. 804 RT FLT MSS L3

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	722	INH DATA/RBV FLT B	0	
~~20~~	~~000~~			
30	000			
~~40~~	~~000~~			
50	000			
~~60~~	~~760~~	~~INH DATA/MSS FLT B~~	~~0~~	
70	000			
[illegible]	~~000~~			
90	000			
~~100~~	~~000~~			
110	475	RT 1 DATA/MSS FLT B	0	

SEQUENCE NO. 805 L3 ON

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	046	WPA POWER ON 2	0	
20	000			
30	000			
40	000			
50	000			
60	000			
70	000			
80	000			
90	000			
100	000			
110	525	WFM INV A POWER ON	0	

SEQUENCE NO. 806 L2&L3 OFF

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	067	WPA POWER OFF 2	0	
~~20~~	~~000~~			
30	000			
~~40~~	~~000~~			
50	000			
~~60~~	~~561~~	~~WPA POWER OFF 1~~	~~0~~	
70	000			
~~80~~	~~000~~			
90	000			
~~100~~	~~000~~			
110	566	WFM INV A POWER OFF	0	

SEQUENCE NO. 807 RT FLT RBV L2

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	741	INH DATA/MSS FLT A	0	
20	000			
30	000			
40	000			
50	000			
60	703	INH DATA/RBV FLT A	0	
70	000			
80	000			
90	000			
100	000			
110	515	RT DATA/RBV FILTR A	0	

SEQUENCE NO. 808 NBP1

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	646	PMP SEL NBTR 1	0	
20	000			
30	000			
40	621	NBR REC 1 P/B MODE	0	

SEQUENCE NO. 809 NBP2

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	604	PMP SELECT NBTR 2	0	
20	000			
30	000			
40	542	NBR REC 2 P/B MODE	0	

SEQUENCE NO. 810 AUX 4 ON

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	374	ALL AUX LOADS OFF A	0	
20	000			
30	000			
40	000			
50	000			
60	436	AUX LOAD 4 ON	0	

SEQUENCE NO. 811 SPARE

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	000			

SEQUENCE NO. 812 WB2 FLT MSS L3

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	722	INH DATA/RBV FLT B	0	
20	000			
30	000			
40	000			
50	000			
60	766	INH DATA/MSS FLT B	0	
70	000			
80	000			
90	000			
100	000			
110	570	TR 2 DATA/MSS FLT B	0	

SEQUENCE NO. 813 WBR 2 STBY/ON/STBY

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	572	MSS STANDBY 2	0	
20	000			
30	000			
40	000			
50	000			
60	650	WBVTR 2 ON (PRIME)	0	
70	000			
80	000			
90	000			
100	000			
110	572	MSS STANDBY 2	0	

SEQUENCE NO. 814 WBR 2 REW/L2&3 OFF

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	552	FAST REWIND 2	0	
20	000			
30	000			
40	000			
50	000			
60	067	WPA POWER OFF 2	0	
70	000			
80	000			
90	000			
100	000			
110	561	WPA POWER OFF 1	0	
120	000			
130	000			
140	000			
150	000			
160	566	WFM INV A POWER OFF	0	

/SEQUENCE CRITICAL/

SEQUENCE NO. 815 NBP1 (VHF)

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	227	VHF XMT HI PWR MODE	0	
20	000			
30	000			
40	000			
50	171	VHF XMT PB OVRD OFF	0	
60	000			
70	000			
80	000			
90	251	VHF XMTR PB MODE 1	1	YES
100	000			
110	000			
120	000			
130	621	NBR REC 1 P/B MODE	0	

/SEQUENCE CRITICAL/

SEQUENCE NO. 816 NBP2 (VHF)

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	227	VHF XMT HI PWR MODE	0	
20	000			
30	000			
40	000			
50	171	VHF XMT PB OVRD OFF	0	
60	000			
70	000			
80	000			
90	166	VHF XMTR PB MODE 2	1	YES
100	000			
110	000			
120	000			
130	542	NBR REC 2 P/B MODE	0	

SEQUENCE NO. 817 R/T MODE (VHF)

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	210	VHF XMT LO PWR MODE	0	
20	000			
30	000			
40	000			
50	230	VHF XMTR PB OVRD ON	0	
60	000			
70	000			
80	000			
90	207	VHF XMTR RT MODE	0	

SEQUENCE NO. 818 MSS ON

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	053	MSS SYSTEM ON	0	
20	000			
30	000			
40	000			
50	000			
60	112	MSS HI VOLTAGE	0	

SEQUENCE NO. 819 WBR 2 ON/STBY

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	650	WBVTR 2 ON (PRIME)	0	
20	000			
30	000			
40	000			
50	000			
60	572	MSS STANDBY 2	0	

ORIGINAL PAGE IS
OF POOR QUALITY

SEQUENCE NO. 820 WB1 PB RBV L2

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	703	INH DATA/RBV FLT A	0	
20	000			
30	000			
40	607	WBVTR 1 ON (PRIM)	0	
50	000			
60	741	INH DATA/MSS FLT A	0	
70	000			
80	000			
90	464	RBV STANDBY 1	0	
100	000			
110	536	TR 1 DATA/RBV FLT A	0	
120	000			
130	000			
140	000			
150	000			
160	000			
170	000			
180	000			
190	000			
200	000			
210	447	WBR PLAYBACK 1	0	

SEQUENCE NO. 821 WBR 2 PB+14

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	650	WBVTR 2 ON (PRIME)	0	
20	000			
30	000			
40	000			
50	000			
60	572	MSS STANDBY 2	0	
70	000			
80	000			
90	000			
100	000			
110	000			
120	000			
130	000			
140	722	INH DATA/RBV FLT B	0	
150	000			
160	000			
170	000			
180	000			
190	760	INH DATA/MSS FLT B	0	
200	000			
210	000			
220	000			
230	000			
240	570	TR 2 DATA/MSS FLT B	0	
250	000			
260	000			
270	000			
280	000			
290	000			
300	000			
310	000			
320	000			
330	000			
340	000			
350	000			
360	534	WBR PLAYBACK 2	0	

SEQUENCE NO. 822	WB1 STBY/OFF			
LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	505	MSS STANDBY 1	0	
20	000			
30	000			
40	000			
50	000			
60	651	WBVTR 1 OFF	0	

SEQUENCE NO. 823	WBDN POST TIMER			
LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	561	WPA POWER OFF 1	0	
20	067	WPA POWER OFF 2	0	
30	000			
40	000			
50	000			
60	566	WFM INV A POWER OFF	0	
70	000			
80	000			
90	000			
100	776	ENABLE WBPA (PRIME)	1	YES
110	000			
120	000			
130	044	PNEU LO VOLT RESET	1	YES
140	046	WPA POWER ON 2	0	
150	000			
160	000			
170	000			
180	000			
190	000			
200	525	WFM INV A POWER ON	0	

SEQUENCE NO. 824	L2 &L3 & P/L OFF			
LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	067	WPA POWER OFF 2	0	
20	000			
30	000			
40	766	PAYLOADS OFF	0	
50	000			
60	561	WPA POWER OFF 1	0	
70	000			
80	000			
90	000			
100	000			
110	566	WFM INV A POWER OFF	0	

SEQUENCE NO. 825 L2,L3,MSS OFF

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	067	WPA POWER OFF 2	0	
20	000			
30	000			
40	000			
50	000			
60	561	WPA POWER OFF 1	0	
70	000			
80	000			
90	000			
100	000			
110	566	WFM INV A POWER OFF	0	
120	000			
130	000			
140	073	MSS SYSTEM OFF	0	

/SEQUENCE CRITICAL/

SEQUENCE NO. 826 RBV/MSS/L2/L3 OFF

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	731	RBV OFF	0	
20	000			
30	000			
40	000			
50	000			
60	067	WPA POWER OFF 2	0	
70	000			
80	000			
90	073	MSS SYSTEM OFF	0	
100	000			
110	561	WPA POWER OFF 1	0	
120	000			
130	000			
140	000			
150	000			
160	566	WFM INV A POWER OFF	0	

SEQUENCE NO. 827 WBR 2 STBY/OFF

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	572	MSS STANDBY 2	0	
20	000			
30	000			
40	000			
50	000			
60	712	WBVTR 2 OFF	0	

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SEQUENCE NO. 828 WBR 2 REC MSS

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	650	WBVTR 2 ON (PRIME)	0	
20	000			
30	000			
40	000			
50	000			
60	572	MSS STANDBY 2	0	
70	000			
80	000			
90	000			
100	000			
110	000			
120	000			
130	000			
140	000			
150	000			
160	000			
170	000			
180	000			
190	513	WBR RECORD 2	0	

SEQUENCE NO. 829 SB/OFF L3 OFF

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	505	MSS STANDBY 1	0	
20	000			
30	067	WPA POWER OFF 2	0	
40	000			
50	000			
60	566	WFM INV A POWER OFF	0	
70	000			
80	651	WBVTR 1 OFF	0	

/SEQUENCE CRITICAL/

SEQUENCE NO. 830 DOWNLINK TIMER RESET

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	561	WPA POWER OFF 1	0	
20	067	WPA POWER OFF 2	0	
30	566	WFM INV A POWER OFF	0	
40	778	ENABLE WBPA (PRIME)	1	YES
50	044	PNEU LO VOLT RESET	1	YES

SEQUENCE NO. 831 L2, L3, & MSS OFF

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	561	WPA POWER OFF 1	0	
20	067	WPA POWER OFF 2	0	
30	000			
40	073	MSS SYSTEM OFF	0	
50	000			
60	566	WFM INV A POWER OFF	0	

SEQUENCE NO. 832 WB1 FLT RBV L2				
LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	741	INH DATA/MSS FLT A	0	
20	000			
30	000			
40	000			
50	000			
60	703	INH DATA/RBV FLT A	0	
70	000			
80	000			
90	000			
100	000			
110	536	TR 1 DATA/RBV FLT A	0	

SEQUENCE NO. 833 L2 & L3 ON				
LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	540	WPA POWER 1 ON	0	
20	000			
30	000			
40	000			
50	000			
60	046	WPA POWER ON 2	0	
70	000			
80	000			
90	000			
100	000			
110	525	WFM INV A POWER ON	0	
120	000			
130	000			
140	000			
150	000			
160	525	WFM INV A POWER ON	0	

/SEQUENCE CRITICAL/

SEQUENCE NO. 834 TIC/TOC + .6 PPB DIS				
LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	373	VERIFY TICK	0	
20	000			
30	663	0.6 PPB DISABLE	1	YES
40	000			
50	457	VERIFY TOCK	0	

/SEQUENCE CRITICAL/

SEQUENCE NØ. 835 CLØCK FREQ FAILURE

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	034	SEL RED ØSCILLATØR	1	YES
20	035	SEL RED FREQ GENRTR	1	YES
30	766	PAYLØADS ØFF	0	
40	764	ØRBIT ADJUST ØFF	0	
50	061	PNEU DISABLE	1	YES
60	001	PRI CØMSTØR ØN/FILL	0	
70	021	RED CØMSTØR ØN/FILL	0	

SEQUENCE NØ. 836 AUX 1

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	374	ALL AUX LØADS ØFF A	0	
20	000			
30	000			
40	000			
50	000			
60	356	AUX LØAD 1 ØN	0	

SEQUENCE NØ. 837 AUX 2

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	374	ALL AUX LØADS ØFF A	0	
20	000			
30	000			
40	000			
50	000			
60	357	AUX LØAD 2 ØN	0	

SEQUENCE NØ. 838 AUX 3

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	374	ALL AUX LØADS ØFF A	0	
20	000			
30	000			
40	000			
50	000			
60	435	AUX LØAD 3 ØN	0	

SEQUENCE NO. 839 AUX 1 AND 2

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	374	ALL AUX LOADS OFF A	0	
20	000			
30	000			
40	000			
50	000			
60	356	AUX LOAD 1 ON	0	
70	357	AUX LOAD 2 ON	0	

SEQUENCE NO. 840 TIC/TOC SEQUENCE

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	373	VERIFY TICK	0	
20	000			
30	000			
40	000			
50	000			
60	000			
70	000			
80	457	VERIFY TOCK	0	

SEQUENCE NO. 841 AUX 1, 2, &3

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	374	ALL AUX LOADS OFF A	0	
20	000			
30	000			
40	000			
50	000			
60	357	AUX LOAD 2 ON	0	
70	356	AUX LOAD 1 ON	0	
80	435	AUX LOAD 3 ON	0	

SEQUENCE NO. 842 AUX 2 AND 3

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	374	ALL AUX LOADS OFF A	0	
20	000			
30	000			
40	000			
50	000			
60	357	AUX LOAD 2 ON	0	
70	435	AUX LOAD 3 ON	0	

SEQUENCE NO. 843 AUX 1,2,&3

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	374	ALL AUX LOADS OFF A	0	
20	000			
30	000			
40	000			
50	000			
60	435	AUX LOAD 3 ON	0	
70	357	AUX LOAD 2 ON	0	
80	356	AUX LOAD 1 ON	0	

SEQUENCE NO. 844 AUX 1 AND 4

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	374	ALL AUX LOADS OFF A	0	
20	000			
30	000			
40	000			
50	000			
60	436	AUX LOAD 4 ON	0	
70	356	AUX LOAD 1 ON	0	

SEQUENCE NO. 845 AUX 2 & 4

LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
10	374	ALL AUX LOADS OFF A	0	
20	000			
30	000			
40	000			
50	000			
60	436	AUX LOAD 4 ON	0	
70	357	AUX LOAD 2 ON	0	

/SEQUENCE CRITICAL/

SEQUENCE NO. 849 PITCH TOGGLE

	LINE	CMD	COMMAND NAME	FLAG	CRITICAL CMD
	10	642	0.6 PPB ENABLE	1	YES
	20	646	2.0 PPB ENABLE	1	YES
	30	103	2.9 PPB ENABLE	1	YES
	40	145	POS PITCH POSN BIAS	1	YES
	50	000			
	60	000			
	70	000			
	80	000			
	90	000			
	100	000			
	110	000			
	120	000			
	130	000			
	140	124	NEG PITCH POS BIAS	1	YES
	150	000			
	160	000			
	170	000			
	180	000			
	190	000			
	200	000			
	210	000			
	220	000			
	230	000			
	240	145	POS PITCH POSN BIAS	1	YES
	250	000			
	260	000			
	270	000			
	280	000			
	290	000			
	300	000			
	310	000			
	320	000			
	330	000			
	340	124	NEG PITCH POS BIAS	1	YES
	350	000			
	360	000			
	370	000			
	380	000			
	390	000			
	400	000			
	410	000			
	420	000			
12	430	000			
11	440	145	POS PITCH POSN BIAS	1	YES
	450	663	0.6 PPB DISABLE	1	YES
	460	661	2.0 PPB DISABLE	1	YES
	470	122	2.9 PPB DISABLE	1	YES