PERSI-ALICE FLIGHT RULES

JANUARY 2006

SwRI® Project 05310

Document No. 05310.02-FLTRULES-01
Revision 1
Contract NASW-02008

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REVISION NOTICE

Document Revision History		
Revision	**Date**	**Changes**
Initial Release	1/16/03	
Update (Revision 1)	12/21/2005	• Adjusted operational temperature ranges • Added Vent Valve Operation • Adjusted some operating constraints to match commissioning plan specification • Defined hibernation • Added instrument shutdown criteria based on instrument and spacecraft telemetry • Added nominal HVPS operating parameters and related shutdown criteria • Added nominal power figures and related shutdown criteria • Corrected temperature ranges • Added Instrument scientist to the signature list

ABBREVIATIONS AND ACRONYMS

AD	Aperture Door
AGA	Air Glow Aperture
Alice	Just a name, not an abbreviation
APL	Applied Physics Lab
AU	Astronomical Unit
BRT	Bright Object Avoidance
CAS	Canned Segment (command sequence building block)
DD	Detector Door
EEPROM	Electrical Erasable Programmable Read Only Memory
EMP	EEPROM Memory Patch
Frag	Fragment (command sequence building block)
FSD	Fail-Safe Door
HIB	Hibernation
HOP	High Output Paraffin (actuator)
HV	High Voltage
LV	Low Voltage
MOC	Mission Operations Center
OAP	Off Axis Parabolic (instrument telescope mirror)
PERSI	Pluto Exploration Remote Sensing Investigation
PLU	Parameter List Update
PI	(Instrument) Principal Investigator
PM	(Instrument) Project Manager
SOC	Solar Occultation Channel (second Alice aperture)
STOL	Systems Test and Operations Language
SwRI	Southwest Research Institute
TBD	To Be Defined
TBR	To Be Reviewed
VV	Vent Valve

1. SCOPE

This document defines the flight rules for the PERSI-Alice flight instrument. The rules as listed in this document will ultimately be captured at a higher level in the APL document, "The New Horizons Flight Rules" which documents all of the flight rules across the mission. The APL document requires sign off approval by the Alice PM to ensure that all of the Alice flight rules have been incorporated into the mission level document. When the APL document is released, it will supersede this document. The purpose of this document is to supply early information to the spacecraft and mission operations teams to allow early planning to more easily accommodate instrument flight rules later in the mission.

2. VERIFICATION

The requirements as specified in this document (and subsequently in "The New Horizons Flight Rules Document") will be verified by the APL Mission Operations team using several different methods. The Flight Rules that pertain to commanding will be written into Mission Ops software (Seqgen and StateSim) as "rules". All command sequences will be evaluated against these rule sets. No instrument command sequences will be uploaded to or executed on the observatory without verification and approval (sign-off) by the instrument point of contact. If the instrument point of contact is not on site at APL, then a signed FAX on the appropriate form listing the procedures (STOL) or CASs (sequence upload) to be executed or uploaded will be acceptable. APL New Horizons Mission Operations has an established procedure for verification of CASs and Fragments and real-time STOL procedures or procs which includes sign-off/approval by the instrument point of contact(s). Once these CASs, Fragments, and real-time procedures have been signed off/approved by the instrument point of contact, mission ops representative, and the mission ops manager, they go into the production directories on the Mission Operations Center (MOC). There is yet another form that needs to be signed off by the instrument point of contact before the CAS, Frag, or real-time procedure is actually uploaded or executed on the observatory. This process was used successfully on NEAR, CONTOUR and MESSENGER.

3. BRIGHT OBJECT AVOIDANCE (BRT)

3.1 BRT.1 Thermal Protection

In order to prevent thermal damage, the PERSI-ALICE Air Glow Aperture (AGA) shall never be pointed within 11 deg of the Sun with either the aperture door or the fail-safe door open. The airglow aperture (AGA) can be pointed at the Sun indefinitely, even at 1 AU when the aperture door and fail-safe door are closed.

3.2 BRT.2 Excessive Count Rates

In order to prevent excessive detector count rate backgrounds, when detector high voltage (HV) is >250 V, the PERSI-ALICE AGA shall never be pointed within 20 deg of the Sun with the aperture door or failsafe door open or closed.

3.3 BRT.3 Excessive Count Rates.

In order to prevent excessive detector count rate backgrounds, when HV>250 V, and with the aperture door or fail safe door open, no portion of the PERSI-ALICE slit as viewed through the AGA shall ever be pointed within 0.1 deg surrounding the entrance slit field-of-view of any source in the PERSI-ALICE Bright Star Avoidance List (05310.02-KeepOut_BadStars-01, Rev. 0).

3.4 BRT.4 Excessive Count Rates.

In order to prevent excessive detector count rate backgrounds, when HV>250 V, the PERSI-ALICE Solar Occultation Channel (SOC) shall never be pointed within 11 deg of the Sun with the SOC door open or closed at heliocentric distances between 1 and 21 AU. At distances greater than 21 AU, it is safe to point the SOC directly at the Sun with HV>250 V. (See table 1 for a summary of Alice viewing Keep Out zones).

TABLE 1. SUMMARY PERSI-ALICE VIEWING KEEP-OUT ZONES

APERTURE	HELIOCENTRIC DISTANCE	APERTURE STATE	DETECTOR HVPSs (>250 Volt)	SOLAR VIEWING KEEP-OUT ZONE	STELLAR VIEWING KEEP-OUT ZONE	CONCERN
Airglow	ALL DISTANCES	CLOSED	OFF	NONE	NONE	
		OPEN	OFF	± 11° w.r.t. airglow boresight	NONE	Thermal (1-3 AU); photopolymerization
		CLOSED	ON	± 20° w.r.t. airglow boresight	NONE	Excessive detector count rate
		OPEN	ON	± 20° w.r.t. airglow boresight	>0.1° outside slit FOV	Excessive detector count rate
SOC*	1-5 AU	CLOSED	OFF	NONE	NONE	
	>5 AU	OPEN	OFF	NONE	NONE	
	1-21 AU	OPEN/CLOSED	ON	± 11° w.r.t. SOC boresight	NONE	Excessive detector count rate
	>21 AU	OPEN	ON	NONE	NONE	

TABLE 1. SUMMARY PERSI-ALICE VIEWING KEEP-OUT ZONES						
APERTURE	**HELIOCENTRIC DISTANCE**	**APERTURE STATE**	**DETECTOR HVPSs (>250 Volt)**	**SOLAR VIEWING KEEP-OUT ZONE**	**STELLAR VIEWING KEEP-OUT ZONE**	**CONCERN**
Failsafe**	ALL DISTANCES	CLOSED	OFF	NONE	NONE	
		OPEN	OFF	± 11° w.r.t. airglow boresight	NONE	Thermal (1-3 AU); photopolymerization
		CLOSED	ON	± 20° w.r.t. airglow boresight	NONE	Excessive detector count rate
		OPEN	ON	± 20° w.r.t. airglow boresight	>0.1° outside slit FOV	Excessive detector count rate
* SOC door is planned to open once at 5 AU ** With failsafe door open, airglow aperture door is assumed closed.						

4. INITIAL START UP (INIT)

4.1 INIT.1 Thermal Protection.

The temperature reference point temperature shall be between –10<T<+40ºC.

5. INSTRUMENT SHUTDOWN (IS)

Instrument operations shall be shutdown when anomalous conditions are detected. After this point instrument operations may only be continued after PM authorization.

5.1 IS.1 Unexpected housekeeping telemetry

(i) Any unexpected telemetry limit violations are considered anomalous conditions

(ii) After anomalous conditions instrument operations may only be continued after PM authorization

5.2 IS.2 Unexpected instrument current

(i) Unexpected over or under power conditions on the instrument bus are considered anomalous conditions, whenever the expected power deviates by more than 10%. The expected instrument bus currents depend on the power configuration of the instrument and change when either a single or both power supplies are active as listed in the table below:

Instrument Power Configuration	Expected basic instrument power (no HV or Heaters)	Instrument power HV active
Single supply operation	3.7 Watt	3.9 Watt
Double supply operation	4.2 Watt	4.5 Watt

(ii) After anomalous currents were observed instrument operations may only be resumed after PM authorization

6. HV OPERATIONS (HV)

6.1 HV.1 Initial High Voltage Turn-On Requirements

(i) At least 30 days shall have elapsed since launch.

(ii) The aperture door shall be open. Note: If the aperture door is failed closed, a failsafe door open turn on may be considered (see section 11).

(iii) The detector door shall be open. Note: If the detector door is failed closed, opening the valve may be considered (see section 12) as a backup to evacuate the detector housing and a vent valve based HV activation may be used (see 6.4).

(iv) >24 hours of decontamination heating of the OAP/SOC mirrors and grating shall have been performed.

(v) PERSI-ALICE shall be pointed to a safe attitude;

(vi) PERSI-ALICE shall have all measured temperatures within their nominal operating range and acceptable to the Project Manager.

(vii) HV turn on shall be a critical command.

(viii) Initial turn on shall require a real time (light-delayed) link and a slow HV ramp up.

6.2 HV.2 General Turn-On Requirements

(i) All instrument-read thermistors must be within the range from -10 to +40 ºC for instrument operations to proceed.

(ii) PERSI-ALICE shall be pointed in a safe direction whether or not the AGA or Failsafe doors are open or closed.

(iii) HV turn on shall be a critical command.

6.3 HV.3 Shutdown Conditions.

Instrument internal checking will deactivate the HV operations whenever defined limit values are exceeded. These limit checking values are based on the nominal operating voltage.

In addition to this internal checking additional checking will be performed during initial HV rampup. This checking will be based on nominal operating parameters. If more then a 20 % deviation from the expected current values (possibly corrected for the actual operating temperature) is observed the HV will be deactivated. The nominal values for a 22 ºC operating temperature are listed in the table below:

Hv Setpoint (counts)	HV Setpoint (Volt)	McpVoltage (Volt)	Strip Current[1)] (µA)	AnodeV (Volt)
23	996	1012	0.0	319
37	1493	1531	0.0	507
57	1993	2015	3.1	593
77	2493	2528	4.3	596

Hv Setpoint (counts)	HV Setpoint (Volt)	McpVoltage (Volt)	Strip Current[1)] (μA)	AnodeV (Volt)
97	2993	3012	5.5	596
117	3493	3524	6.7	596
137	3993	4009	7.9	599
141	4093	4122	8.2	599
145	4193	4208	8.5	599
149	4293	4322	8.7	599
153	4393	4407	8.9	599
157	4493	4521	9.3	599

1) When the Alice instrument is operating using both power supplies and both HVPSs are active (flyby configuration), the telemetry field: MAX_STRIP_CURR should be used as the measurement for the Strip Current. When only a single HVPS is active the Strip Current telemetry field corresponding to the active HVPS should be used: STRIP1_CURR respectively STRIP2_CURR.

6.4 HV.4 Vent Valve Based HV Activation

(i) At least 60 (TBR) days shall have elapsed since vent valve opening.

(ii) The aperture door shall be open. Note: If the aperture door is failed closed, a failsafe door open turn on may be considered (see section 11).

(iii) >24 hours of decontamination heating of the OAP/SOC mirrors and grating shall have been performed.

(iv) PERSI-ALICE shall be pointed to a safe attitude;

(v) PERSI-ALICE shall have all measured temperatures within their nominal operating range and acceptable to the Project Manager.

(vi) HV turn on shall be a critical command.

(vii) Initial turn on shall require a real time (light-delayed) link and a slow HV ramp up.

7. LAUNCH LATCH OPERATION (LATCH)

7.1 LATCH.1 Opening

(i) PERSI-ALICE shall be in a safe attitude.

(ii) HV shall be off.

(iii) (iii) PERSI-ALICE shall have all measured temperatures within their nominal operating range, i.e**.,** -10 to +40 ºC at the temperature reference point.

8. APERTURE DOOR OPERATIONS (AD)

8.1 AD.1 Opening

(i) The Aperture Door open command shall be a critical command;

(ii) PERSI-ALICE shall be in a safe attitude.

(iii) PERSI-ALICE shall have all predicted temperatures within their nominal operating range, i.e., -10 to +40 ºC at the temperature reference point.

(iv) At least 30 days shall have elapsed since launch

8.2 AD.2 Maintenance

(i) The motor of the aperture door shall be cycled a minimum of 20 times (10 cycles) per flight year.

8.3 AD.3 Total Cycles

(i) The planned number of door cycles after launch will not exceed 10,000 (for a safety factor of 2). Door cycles must be rationed and tracked accordingly.

9. DETECTOR DOOR OPERATION (DD)

9.1 DD.1 Detector Door Opening

(i) PERSI-ALICE shall have all measured temperatures within their nominal operating range, i.e., -10 to +40 ºC at the temperature reference point.

(ii) >24 hours of optics decontamination heating of the OAP/SOC mirrors and grating shall have been performed

(iii) Near-real time contact is strongly desired.

(iv) HV shall be off.

(v) The aperture door or fail-safe door shall be open.

(vi) Both the mirror and grating heaters shall be turned on. Detector door opening shall not be commanded until the corresponding measured temperatures indicate an increase of at least 10 degrees.

(vii) The detector door wax pellet actuator shall be commanded to be powered on for no longer than 200 seconds. The PM must authorize any longer power on duration in writing. The new power on duration shall be recorded in the PERSI-ALICE Flight Operations Log.

(viii) Heliocentric distance shall be >2 AU

10. SOC DOOR OPERATION (SOC)

10.1 SOC.1 SOC Opening

(i) PERSI-ALICE shall have all measured temperatures within their nominal operating range, i.e., -10 to +40 ºC at the temperature reference point.

(ii) HV shall be off.

(iii) Heliocentric distance shall be >4.5 AU.

11. FAIL SAFE DOOR OPERATION (FSD)

11.1 FSD.1 Approval for Opening

(i) Because the fail-safe door cannot be closed after opening, the aperture door shall be certified as permanently inoperable prior to FSD opening.

(ii) The PI and PM must both provide written approval prior to FSD opening.

11.2 FSD.2 Opening

(i) PERSI-ALICE shall be in a safe attitude.

(ii) PERSI-ALICE shall have all measured temperatures within their nominal operating range, i.e., -10 to +40 ºC at the temperature reference point.

(iii) HV shall be off.

(iv) Heliocentric distance shall be >3 (TBR) AU.

12. VENT VALVE OPENING (VV)

12.1 VV.1 Approval for Opening

(i) The PI and PM must both provide written approval prior to VV opening.

12.2 VV.2 Opening

(i) PERSI-ALICE shall be in a safe attitude.

(ii) PERSI-ALICE shall have all measured temperatures within their nominal operating range, i.e., -10 to +40 ºC at the temperature reference point.

(iii) HV shall be off.

13. HEATER OPERATIONS (HOP)

13.1 HOP.1 Operations

There does not exist a maximum decontamination heater (OAP/SOC mirrors and grating) operation time.

14. PERMANENT PARAMETER LIST UPDATE (PLU)

14.1 PLU.1 Certification

(i) The PM must authorize any update of the permanent parameter list (when saved in the PERSI-ALICE EEPROM) in writing.

(ii) Such authorization, including the revised Parameter List and the reason for each change, shall be recorded in the PERSI-ALICE Flight Operations Log.

15. SAFETY MASK UPDATES (SMU)

15.1 SMU.1 Certification

(i) The PM must authorize any update of the Safety Mask (saved in the PERSI-ALICE parameter file) in writing.

(ii) Such authorization, including the revised Safety Mask and the reason for each change, shall be recorded in the PERSI-ALICE Flight Operations Log.

16. EEPROM MEMORY PATCH (EMP)

16.1 EMP.1 Certification

(i) The PM must authorize any EEPROM memory patch in writing.

(ii) Such authorization, including the reason for each memory patch shall be recorded in the PERSI-ALICE Flight Operations Log.

16.2 EMP.2 Total Cycles

(i) The total number of EEPROM memory patch cycles since launch should not exceed 10,000 per EEPROM page (for a safety factor of 2), and should be rationed accordingly. Further:

(ii) Load new EEPROM beginning on modulo 128 byte (page) boundaries and write all 128 bytes at one time. (can do this 10,000 times in each 128 byte block).

(iii) Maintain a single counter for each of the four 32 kbyte pages; do not maintain a counter for each 128 byte block.

(iv) When uploading new code, write to one of the four pages, verify the load as accurate, and then repeat for the other duplicate images.

17. HIBERNATION (HIB)

Hibernation is considered any period of time when the instrument is not planned to be activated for a period of 3 (TBR) months.

17.1 HIB.1 Prerequisites

(i) Hibernation operations shall be preceded by the PM's written certification that the EEPROM memory and Parameter List are all suitable for post-hibernation power up.

(ii) A 16-hr heater decontamination cycle shall have been completed <16 hours before entering hibernation.

(iii) The Aperture Door shall be successfully closed and verified.

(iv) The HV set-point (for use during normal acquisition operations) should be changed to a low (i.e., safe) value before entering hibernation or the HVPS activation should be disabled by clearing the selection bits (both are settings included in the instrument parameter list).

17.2 HIB.2 Configuration

PERSI-ALICE shall be configured as follows:

(i) HV off.

(ii) Aperture door closed.

(iii) LV off.