

*HST Scheduling System*

*Two-Gyro Science Mode*

*Phase I Requirements Document*

**December 17, 2003**

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Two-Gyro Science Mode  
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# Document Control

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## **Preface**

The requirements contained within this document will be put into the Dynamic Object Oriented Requirements System (DOORS), where final requirement numbering and traceability back to system-level requirements will be added. Once baselined, the requirements for this project will be tracked and maintained within DOORS.

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## **1.0 Introduction**

### **1.1 Purpose and Objective**

The HST Project has tasked the Two-Gyro Science Operations Working Group (TGSOWG) to develop a Two-Gyro Science Mode. A Two-Gyro Science Mode is a means to provide spacecraft attitude control and slew capability, in the condition of only two remaining operational gyros, with sufficient accuracy in order to continue science-gathering operations. It is also considered a degraded mode in that science operations will be capable of being performed but with less efficiency and flexibility compared to normal operations with three gyros.

The TGSOWG has produced system level functional requirements that task the HST Scheduling System with a number of high-level requirements to support the overall Two-Gyro Science Mode.

This document was prepared to define the functional requirements for the HST Scheduling System as part of the HST Two-Gyro Science Mode.

### **1.2 Scope**

This document is intended to provide the Phase 1 functional requirements for the Scheduling System that are derived from and necessary to support the system level functional requirements for the HST Two-Gyro Science Mode (Reference 1). This document also provides a description of changes to the Scheduling System interfaces and concept of operation, and a discussion of the system verification process.

### **1.3 Applicable Documents**

Two Gyro Science Mode System Requirements	LMMS/P563372
HST Science Scheduling to Mission Scheduling ICD:	ST-ICD-11
PASS to Project Data Base ICD:	ST-ICD-26, Part 2
HST CCS to P&S ICD:	HST-ICD-T1

## **2.0 Background/Overview**

The HST Scheduling System is comprised of operational software and personnel that gather proposals submitted by the astronomical community, generate a long-range observation plan, create detailed schedules of scientific instrument events and activities necessary to execute the observations, and convert the schedules into commanding that is uplinked to the HST to be executed. The Scheduling System consists of the following major applications: Astronomer Proposal Tool (APT), Transformation (TRANS), Science Planning Interactive Knowledge Environment (SPIKE), Science Planning and Scheduling System/Science Commanding System (SPSS/SCS), and POCC Applications Software Support (PASS).

The HST's normal operational mode utilizes three gyros out of the six onboard the spacecraft to provide a highly accurate attitude reference as part of the pointing control system (PCS). Over time these gyros eventually fail leaving the spacecraft with less redundancy and, eventually, with less than the number of gyros required (3) for the PCS to operate normally. The Two-Gyro Science (TGS) mode is a means of providing spacecraft attitude control and slew capability, in the case of only two operational gyros, with sufficient accuracy to continue science operations. TGS is a contingency mode targeted for use in the event that the HST is in a two-gyro condition prior to Servicing Mission 4 and/or at HST end-of-life. It is also a degraded mode in the sense that science operations can continue, but with higher jitter and less efficiency and flexibility than with normal operations using three gyros. Certain classes of current science operations will likely be heavily constrained or not possible.

### **2.1 Operational Concept**

There are three submodes in the TGS mode configuration. The first submode is the MSS/Two-Gyro mode (M2G). This mode shall be used for attitude hold when all the Trackers are occulted and while not guiding on FGS. This mode shall also be used for large maneuvers. In this mode, the nominal attitude error is expected to be 2 degrees, but can be higher. The rate error is nominally 0.01 degrees/second and can be as high as 0.03 degrees/second while under M2G control. The requirement is that the attitude error be below the capability of the autonomous attitude determination being developed.

The second submode is the Tracker/Two-Gyro mode (T2G). This mode shall be used for attitude determination and correction. The requirement for this mode is that the attitude error be brought well within the 90-arcsecond search radius of the FGS. One FHST is sufficient for attitude hold and a second FHST is required for star maps for attitude determination. An autonomous on-board star map and attitude determination capability is being developed. Preliminary analysis shows that even with 12-degree attitude errors, attitude determinations are successful. The attitude determination shall be followed by a slew to correct any attitude errors. A second map and attitude correction slew shall be performed to bring the final attitude error below the 90 arcsecond search limitation for FGS guide stars.

The third and final submode is the FGS/Two-Gyro mode (F2G). Science is performed in this mode after FGS guide star acquisition and fine lock. T2G directly precedes this mode to ensure that the guide stars are within a 90-arcsecond search radius of their expected position.

The challenge for the Scheduling System, in TGS mode, is to schedule the sequence of FHST and FGS events required for transitioning from M2G mode to F2G mode. The Scheduling System must ensure that the appropriate combination of sensors has clear visibility of the sky during this process. To achieve the required attitude accuracy to be used for science, two onboard FHST map/attitude corrections are needed each time a new FHST/FGS visibility period is entered from M2G mode. In addition, an FHST must be available to provide rate control during the map/attitude correction period until FGS fine lock is obtained. Figure 2-1 illustrates this scheduling scenario for TGS.

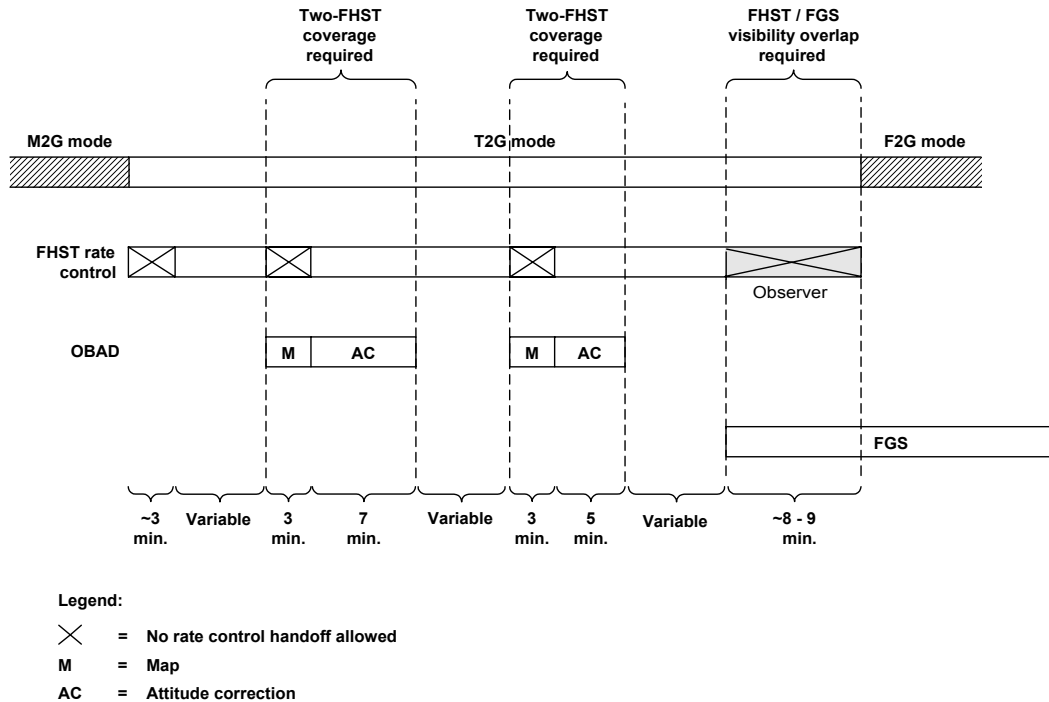


Figure 2-1. TGS Scheduling Scenario

SPIKE will ensure that visits only become candidates for scheduling during calendar periods when the alignment of FHST and FGS visibility periods will allow the transition from M2G through T2G to F2G.

SPSS/SCS will schedule an observation during these visibility periods with all required transition activities in the proper sequence and timing, so that the spacecraft transitions from M2G through T2G and into F2G control, allowing the science requirements of the observation to occur.

PASS will verify all visibility windows, and ensure the correct ordering of T2G to F2G activities including the FHST map/attitude correction sequences. Additionally, PASS will generate FHST commanding to allow flight software to perform autonomous rate-hold activities.

## **2.2 Interfaces**

### **2.2.1 Science Scheduling to Mission Scheduling (ST-ICD-11)**

The FHST statement is modified for two-gyro mode. Two new FHST statement modes have been added to provide two-gyro capabilities. The OAD and GOB modes are used to specify the onboard map/attitude correction and FHST two-gyro observer, respectively.

The FHST statement MAN, DEL, and OBS modes are restricted to the three-gyro vehicle control mode. Also restricted to three-gyro mode is the REACQ form of the GSACQ statement and SLEW statements that specify the SLEWRATE parameter.

The FHST statement MAP mode will be supported in two-gyro vehicle control mode as a map-only OAD of fixed duration. In three-gyro vehicle control mode, the map is open-ended.

The AUTO statement is expanded to include an optional event identifier. This allows control of a subset of the command groups associated with a particular orbital event.

The list of orbital event mnemonics is expanded to include new events defining the start and end of visibility for each FHST. These new orbital events will be used to trigger the FHST shutter open and close commands and the FHST availability commanding.

### **2.2.2 PASS to Project Data Base (ST-ICD-26, Part 2)**

Several files in the PDB have been modified to support two-gyro mode.

The Spacecraft Characteristics file (SCHF) – Parameters have been added to define which mode is in operation and to specify the minimum times required for specific two-gyro activities.

The Constraint and Restriction Parameter Value file (CRPF) – Constraint parameters have been expanded to account for the multiple levels of attitude uncertainty.

The HST486 Scenario Data file (DFSC) and the Group Expansion file (GREX) – New command templates and command group names have been added to support the new FHST commanding required in two-gyro mode.

The Auto-Group Command Data file (AGCF) – The format has been modified to add optional offset times and event identifiers. These additions support the new capabilities needed for FHST shutter and availability commanding in two-gyro mode.

### **2.2.3 CCS to P&S (HST-ICD-T1)**

The SKYMAP star catalog definition has been added to HST-ICD-T1. This star catalog will be the basis of the onboard catalog used to perform autonomous flight software FHST map/attitude determination.

### **3.0 Requirements**

#### **3.1 APT Requirements**

There are no Phase 1 two-gyro requirements for APT.

#### **3.2 TRANS Requirements**

There are no Phase 1 two-gyro requirements for TRANS.

#### **3.3 SPIKE Requirements**

##### **3.3.1 FHST Visibility and TGS Constraints**

SPIKE shall model FHST visibility at 2 levels of attitude uncertainty. *(SPIKE 1.1)*

SPIKE shall implement two-gyro constraints based on FHST visibility overlaps. *(SPIKE 1.2)*

SPIKE shall integrate two-gyro constraints with the existing constraint infrastructure and visualization tools. *(SPIKE 1.3)*

SPIKE shall model FHST and SAA impacts. *(SPIKE 1.4)*

SPIKE shall integrate FHST roll restrictions with the existing roll constraints. *(SPIKE 1.5)*

#### **3.4 SPSS/SCS Requirements**

##### **3.4.1 SPSS Database and C&C List Requirements**

SPSS shall query the PMDB for all parameters relevant to the scheduling of FHST activities for two-gyro mode operation and store these database parameters in a modified version of the C&C List Data Structure. These parameters are used later by SPSS for the scheduling of two-gyro mode FHST activities. *(SPSS 1.1)*

Upon creating a new C&C List, SPSS shall designate the C&C List as being either a 2-gyro or a non-2-gyro C&C List, based upon a database field that indicates which mode is currently being used for the HST. *(SPSS 1.2)*

SPSS shall issue an error message if the addition of 2-gyro scheduling units to a non-2-gyro C&C List is attempted, and vice versa. *(SPSS 1.3)*

For the initial implementation of the two-gyro mode, SPSS shall issue an error, during validation of observational data in the PMDB, if a moving-target observation is set to use a two-gyro PCS scenario. *(SPSS 1.4)*

For the initial implementation of the two-gyro mode, SPSS shall issue an error, when attempting to add a moving-target observation to a C&C List, if the observation is set to use a two-gyro PCS scenario. *(SPSS 1.5)*

### **3.4.2 SPSS Scheduling Requirements for GYRO PCS Mode**

SPSS shall schedule scheduling units using GYRO PCS mode only in M2G mode. *(SPSS 2.1)*

SPSS shall not schedule any FHST activities for scheduling units using GYRO PCS mode. *(SPSS 2.2)*

### **3.4.3 SPSS Scheduling Requirements for FGS PCS Mode**

After scheduling the current targeted alignment, SPSS shall examine the previously scheduled activities on the calendar, as well as FHST visibility windows, to determine whether the HST is currently in M2G or T2G mode at the start of the current targeted alignment. *(SPSS 3.1)*

To determine that the HST is in T2G mode, SPSS shall verify that visibility windows exist, on at least one FHST, from the loss of FGS usability after the previous targeted alignment through the start of F2G mode for the current alignment, using a database-derived small attitude uncertainty (SAU). The HST is in M2G mode if it is not in T2G mode. *(SPSS 3.2)*

When the HST is in M2G mode, SPSS shall calculate visibility windows for all three FHSTs from the end of the slew to the current alignment and the start of F2G mode, using a database-derived large attitude uncertainty (LAU). This corresponds to the pointing uncertainty of the HST during M2G guiding mode. *(SPSS 3.3)*

To bring the HST out of M2G mode, SPSS shall schedule an initial FHST rate control activity, using a database-derived duration, to achieve T2G mode during the visibility of the earliest FHST that is continuously available for the initial rate control period. T2G mode commences at the start of this FHST activity. *(SPSS 3.4)*

SPSS shall calculate FHST visibility windows using a large attitude uncertainty of the HST (LAU) after the initial rate control period, to determine where two FHSTs are simultaneously visible for the duration required to complete an initial FHST map and attitude correction. The window for this calculation extends from the end of the initial rate control period to the start of F2G mode. *(SPSS 3.5)*

SPSS shall schedule initial FHST map and attitude correction activities, using a database-derived duration, at the earliest time when two FHSTs are simultaneously visible and at least one FHST is visible since the initial rate control activity. *(SPSS 3.6)*

SPSS shall permit no FHST handoffs during a map activity. *(SPSS 3.7)*

SPSS shall, optionally, calculate FHST visibility windows using a medium attitude uncertainty of the HST (MAU) after the first attitude correction, to determine where two FHSTs are simultaneously visible for the duration required to complete a second FHST map and attitude correction. The window for this calculation extends from the end of the first attitude correction to the start of F2G mode. *(SPSS 3.8)*

SPSS shall, optionally, schedule a second FHST map and attitude correction, using a database-derived duration, ending as close as possible to the start of the FGS PCS acquisition. *(SPSS 3.9)*

SPSS shall calculate FHST visibility windows using a small attitude uncertainty of the HST (SAU), to determine when one FHST is continuously visible, for a database-derived duration that ends partway through the FGS PCS acquisition. *(SPSS 3.10)*

SPSS shall schedule an FHST observer mode activity that ends partway through the FGS PCS acquisition, when F2G mode is established, using database-derived durations for the observer mode activity as well as for the amount of overlap with the FGS PCS acquisition. *(SPSS 3.11)*

SPSS shall permit no FHST handoffs during the observer mode activity. *(SPSS 3.12)*

If an observation cannot be scheduled, as is, under 2-gyro mode, SPSS shall remove all FHST activities relevant to the observation from the calendar. *(SPSS 3.13)*

When more targeted alignments need to be scheduled after loss of FGS usability, SPSS shall schedule a full FGS PCS acquisition (not a reacquisition) as long as one FHST remains visible throughout loss of FGS usability. If there is a gap in FHST coverage, HST is assumed to revert back to M2G mode and an entire set of FHST map and attitude correction activities must be scheduled along with the FGS PCS acquisition. *(SPSS 3.14)*

#### **3.4.4 SPSS Utility Function Requirements**

SPSS shall be able to display the new FHST activity types on a calendar, as well as to display FHST visibility windows on a calendar using any of the HST pointing uncertainties associated with 2-gyro scheduling. *(SPSS 4.1)*

#### **3.4.5 SCS Requirements**

The SCS msg generation process shall recognize the new FHST activity types. *(SCS 5.1)*

SCS shall, optionally, provide to commanding FHST tracker identification for FHST and GSACQ activities. Where practicable, existing pseudo-instructions will be enhanced to provide this additional information. *(SCS 5.2)*

SCS shall, optionally, provide to commanding FHST mode information for FHST activities. Where practicable, existing pseudo-instructions will be enhanced to provide this additional information. *(SCS 5.3)*

SCS shall indicate in the data processing support schedule whether an observation was scheduled using two-gyro mode or the nominal three-gyro mode. *(SCS 5.4)*

## **3.5 PASS Requirements**

### **3.5.1 Vehicle Control Determination**

PASS shall determine whether an SMS is in Three-Gyro Vehicle Control (nominal), or Two-Gyro Vehicle Control (degraded) based on a database value. (*PASS 1.1*)

When under two-gyro vehicle control, PASS shall use SMS statements and database values to determine which two-gyro mode is in effect. (*PASS 1.2*)

- MSS control (M2G) mode is in effect by default.
- FHST control (T2G) mode starts with the first FHST visibility following a type 2 slew or the first FHST visibility following loss of FGS usability. T2G control ends at the earlier of:
  1. A database specified time after the start of a subsequent GSACQ
  2. The start of any subsequent type 2 slew.
  3. The end of systemic FHST visibility.
- FGS Control (F2G) mode starts at a database specified time after a GSACQ statement, and ends at a calculated loss of FGS usability.

### **3.5.2 Two-Gyro SMS Statements**

PASS shall accept the following FHST statements to support two-gyro mode: (*PASS 2.1*)

- FHST OAD to perform onboard attitude determination and attitude correction
- FHST GOB to perform two-gyro FHST observer control

When in Two-Gyro Mode, PASS shall verify that the following SMS statements are not present: (*PASS 2.2*)

- FHST maneuver update - FHST(MAN)
- FHST delay update - FHST(DEL)
- FHST observer - FHST(OBS)
- Guide Star reacquisition - GSACQ,CPNAME(REACQ)
- Vehicle slews that specify the rate parameter - SLEW,SLEWRATE

### **3.5.3 Attitude Uncertainty**

When under Two-Gyro vehicle control, PASS shall use SMS statements, database values, and knowledge of which two-gyro mode is in effect to determine the level of attitude uncertainty that exists at any given time. (*PASS 3.1*)

- A large attitude uncertainty (LAU) exists during M2G mode and into T2G mode until the first FHST OAD is complete.

- If a second FHST OAD is present in the SMS, a medium attitude uncertainty (MAU) exists following the first FHST OAD until the second FHST OAD is complete.
- A small attitude uncertainty (SAU) exists at all other times.

PASS shall verify FHST constraints for sun, earth, and moon based on the expected attitude and the attitude uncertainty as calculated throughout the SMS. *(PASS 3.2)*

PASS shall verify V1-axis constraints for sun, earth, and moon based on the expected attitude and the attitude uncertainty as calculated throughout the SMS. *(PASS 3.3)*

PASS shall verify Solar Array position based on the expected attitude and attitude uncertainty as calculated throughout the SMS. *(PASS 3.4)*

PASS shall verify antenna constraints and antenna field-of-view calculations based solely on the expected attitude without consideration for attitude uncertainty. *(PASS 3.5)*

#### **3.5.4 FHST Initial Rate Control**

PASS shall verify that an Initial Rate Control period exists, lasting at least a database specified time. An Initial Rate Control period is a period when a single FHST has continuous visibility prior to the first FHST OAD statement following a period of M2G Control. *(PASS 4.1)*

#### **3.5.5 Systemic FHST Visibility Coverage**

PASS shall calculate individual FHST visibility windows based on calculated FHST constraints. FHST visibility windows will be trimmed to not overlap Type 2 vehicle slews. FHST visibility windows shorter than a given database value will not be available for use. *(PASS 5.1)*

PASS shall calculate systemic FHST visibility as the entire time period comprising a collection of individual FHST visibility windows that overlap by a database specified time. *(PASS 5.2)*

PASS shall verify that systemic FHST visibility exists as required for FHST OAD and GSACQ activities. *(PASS 5.3)*

#### **3.5.6 FHST Map/Attitude Correction**

PASS shall determine whether an FHST OAD SMS statement request is an initial, or a second Onboard Map/Attitude Correction. An initial Onboard Map/Attitude Correction is the first FHST/OAD statement following a period of M2G control. *(PASS 6.1)*

PASS shall verify that an optional second FHST OAD SMS statement follows the initial FHST OAD SMS statement by at least a database-specified period of time. *(PASS 6.2)*

PASS shall verify that systemic FHST visibility exists from the start of an Initial Rate Control period to a database-specified time after the start of any FHST OAD. *(PASS 6.3)*

PASS shall process the FHST/OAD SMS statement, verify FHST visibility and issue commanding as follows: *(PASS 6.4)*

1. If the FHST/OAD SMS statement does not specify the MAP FHST ID, PASS shall verify that at least 2 FHSTs have continuous simultaneous visibility throughout the time of the FHST/OAD MAP portion, using a database-derived value. *(PASS 6.4.1)*
2. If the FHST/OAD SMS statement specifies the MAP FHST ID, PASS shall verify that the specified FHST and at least one other FHST have continuous simultaneous visibility throughout the time of the FHST/OAD map portion, using a database-derived value. *(PASS 6.4.2)*
3. If the FHST/OAD SMS statement specifies two FHST IDs, PASS shall verify that the specified FHSTs have continuous simultaneous visibility throughout the time of the FHST/OAD map portion, using a database-derived value. *(PASS 6.4.3)*
4. PASS shall verify that at least 2 FHSTs have simultaneous visibility throughout the attitude correction portion, using a database-derived value. *(PASS 6.4.4)*
5. If the FHST/OAD SMS statement does not specify an FHST ID, PASS shall optionally populate, based on a database parameter, the FHST/OAD command with the mapping FHST ID selected as the best FHST, using the following criteria: *(PASS 6.4.5)*
  - Determine which FHST field-of-view contains the greatest number of stars
  - Determine which FHST boresight points to the lowest galactic latitude
  - Determine which FHST has the latest-ending visibility window
6. If the FHST/OAD SMS statement specifies the MAP FHST ID, PASS shall populate the FHST/OAD command with the mapping FHST specified in the SMS. *(PASS 6.4.6)*

### **3.5.7 FHST Observer Commanding to Support FGS Acquisition**

PASS shall process the FHST/GOB SMS statement, verify FHST availability and issue commanding as follows: *(PASS 7.1)*

1. PASS shall verify that the FHST/GOB SMS statement start time is a database specified time offset from an associated SMS GSACQ statement. *(PASS 7.1.1)*
2. If the FHST/GOB SMS statement specifies an FHST ID, PASS shall verify that the specified FHST has continuous visibility throughout the time from start of FHST/GOB until the SMS specified end time. *(PASS 7.1.2)*
3. If the FHST/GOB SMS statement does not specify an FHST ID, PASS shall verify that an FHST has continuous visibility throughout the time from start of FHST/GOB until the SMS specified end time. *(PASS 7.1.3)*

4. If the FHST/GOB SMS statement specifies an FHST ID, PASS shall populate the FHST/GOB command with the SMS specified FHST ID. (*PASS 7.1.4*)
5. If the FHST/GOB SMS statement does not specify an FHST ID, PASS shall select an FHST and populate the FHST/GOB command with the selected FHST. (*PASS 7.1.5*)

### **3.5.8 FGS Acquisition Commanding**

PASS shall verify that Systemic FHST visibility exists throughout the time period that begins with the Initial Rate Control Period and ends a database specified time after the start of the subsequent Guide Star Acquisition request. (*PASS 8.1*)

If a GSACQ SMS statement is followed by a GSACQ statement with no intervening FHST/OAD statement, PASS shall verify that Systemic FHST visibility exists throughout the time between the 2 GSACQ statements as follows: (*PASS 8.2*)

- Beginning a database specified period prior to the end of the FGS visibility that starts with the first GSACQ.
- Ending a database-specified period of time after the beginning of the second GSACQ statement.

PASS shall process the GSACQ SMS statement and issue requested commanding. (*PASS 8.3*)

PASS shall verify that every GSACQ SMS statement has an associated FHST/GOB SMS statement. (*PASS 8.4*)

PASS shall verify that no FHST statements intervene between associated GSACQ and FHST/GOB statements. (*PASS 8.5*)

### **3.5.9 FHST Maps**

PASS shall, optionally, generate FHST map-only OAD commands on a single FHST, and only when that FHST and at least one other FHST have visibility. These PASS-generated FHST maps, called AUTOMAPs, will be scheduled to begin as soon as possible after the first GSACQ following a vehicle type 2 slew. Additional AUTOMAPs will be scheduled following the subsequent database specified number of GSACQs. (*PASS 9.1*)

For SMS-specified FHST maps, PASS shall verify that FHST visibility exists for two or more FHSTs and generate a map-only OAD. (*PASS 9.2*)

PASS shall verify that FHST map-only OAD commands do not overlap FHST OAD SMS statements or FHST GOB SMS statements. (*PASS 9.3*)

FHST maps, whether SMS-specified or PASS-generated, shall have a database specified duration. (*PASS 9.4*)

### **3.5.10 FHST Shutter Commands**

PASS shall issue individual FHST shutter open commands at the start of calculated FHST visibility. PASS will use the autogroup feature, controlled by the AGCF database and the AUTO SMS statement, to coordinate the FHST shutter open command with the FHST visibility window start time. *(PASS 10.1)*

PASS shall issue individual FHST shutter close commands at the end of calculated FHST visibility. PASS will use the autogroup feature, controlled by the AGCF database and the AUTO SMS statement, to coordinate the FHST shutter close command with the FHST visibility window end time. *(PASS 10.2)*

### **3.5.11 FHST Availability Commands**

PASS shall, optionally, issue commands indicating an FHST is available. The FHST available command will be coincident with the shutter open command. The FHST available command will use the autogroup feature, controlled by the AGCF database and the AUTO SMS statement, to coordinate the FHST available command with the FHST shutter open command. *(PASS 11.1)*

PASS shall, optionally, issue commands indicating an FHST is no longer available, this command will be issued a database specified time prior to the FHST shutter close command. The FHST unavailable command will use the autogroup feature, controlled by the AGCF database and the AUTO SMS statement, to coordinate the FHST unavailable command with the FHST shutter close command. *(PASS 11.2)*

PASS shall modify autogroup processing to provide the capability to specify command time offsets from events, and to provide individual control of multiple commands triggered by the same event. *(PASS 11.3)*

### **3.5.12 PASS Two-Gyro Reporting**

PASS shall expand existing reports to include the calculated FHST visibility windows, the M2G, T2G, F2G transition times, FHST commanding, and constraint violations. *(PASS 12.1)*

PASS shall generate an error message when constraint violations occur and continue processing if possible. *(PASS 12.2)*

### **3.5.13 Star Catalog**

PASS shall provide a SKYMAP reference star catalog for use by Flight Software in support of onboard star identification and attitude determination. The provided star catalog format and generation options are defined in HST-ICD-T1. *(PASS 13.1)*

## **3.6 Commanding Requirements**

### **3.6.1 FHST Commanding**

Commanding shall maintain support for nominal FHST commanding in the Instructions. (*CMD 1.1*)

There will be a new activity type in SPSS for two-gyro mode FHST activities. Commanding shall provide a new top-level instruction to support the new activity type. (It will be invoked via `qgactinst.instr_name`.) (*CMD 1.2*)

The new 'top' instruction, and any new or existing compound instructions it calls, shall be able to output FHST blocks with correct parameters and timing to the SMS for each two-gyro mode FHST mode defined in ST-ICD-11, and shall output other statements as needed (e.g., PCPDSLOL & PCPENLOL groups). (*CMD 1.3*)

### **3.6.2 GSACQ Commanding**

Commanding shall maintain support for nominal guide star acquisition commanding in the Instructions. (*CMD 2.1*)

There will be new guide star acquisition scenarios. Commanding shall provide instructions support for the new scenarios. The new or modified instructions shall be able to output all commanding required to support the new scenarios. (*CMD 2.2*)

## **4.0 Verification**

### **4.1 Verification Methods**

Verification will be accomplished by one or more of the following verification methods:

- Test (T)
- Demonstration (D)
- Analysis (A)
- Inspection (I)

#### **4.1.1 Test**

The "Test" method is used when the requirements have to be verified by measuring system performance and function under various simulated conditions. The measurements may need the use of special equipment, instrumentation and simulation techniques. The analysis of data obtained and derived from the test is an integral part of the test.

#### **4.1.2 Demonstration**

Verification by "Demonstration" method is used when the requirements to be verified are qualitative operational and functional requirements that do not require measurement of system performance or function. The demonstration is observed and recorded.

#### **4.1.3 Analysis**

The "Analysis" method is used when verification is achieved by performing theoretical or empirical evaluation. The analytical techniques are systematic, statistical, quantitative and qualitative design analysis, modeling and computational simulation.

#### **4.1.4 Inspection**

The "Inspection" method is used when verification is achieved by visual determination of physical characteristics (such as construction features, hardware conformance to document drawing or workmanship requirements).

## Reference

1. National Aeronautics and Space Administration, Goddard Space Flight Center, LMMS/P563372, *Two Gyro Science Mode System Requirements Document (Revision 1)*, September 2, 2003