

# *LAT Flight Software*

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## LIM Package Design

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A description of the design of the LAT Instrument Manager (LIM).

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# 0 Introduction

The LAT Instrument Manager (LIM) package contains functions and command handlers that manage the operating mode of the LAT flight software. These operating modes define the various states in which the LAT instrument operates and the types of high-level actions allowed within those states. LIM is responsible for transitioning between the operating modes and ensuring that the flight software performs only the actions appropriate for the current mode.

The LIM package does not autonomously determine when the LAT operating mode should change. Instead, all mode transitions are initiated by telecommands sent to LIM from the ground, the spacecraft, and other flight software packages. When LIM receives one of these commands, it performs any actions necessary to transition to the new mode, such as applying power to various parts of the instrument or notifying other flight software components that a mode change has occurred.

LIM intercepts telecommands intended for certain other flight software packages to ensure that only allowable actions are performed. If LIM determines that a telecommand is valid for the current mode, it forwards the command to the appropriate handler. By filtering commands in this manner, other flight software does not have to be aware of the current LAT operating mode.

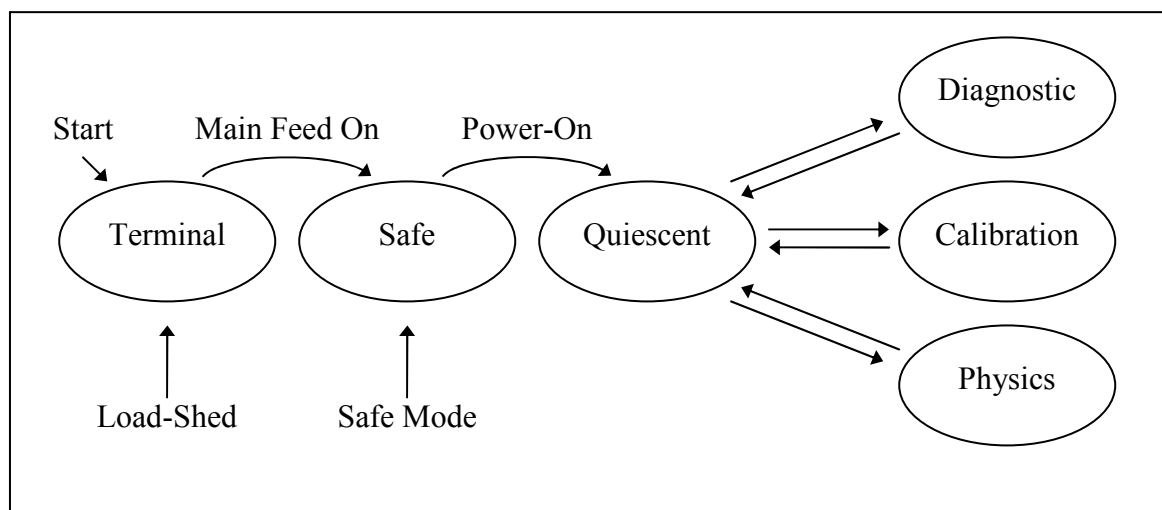
# 1 Operating Modes

The LIM software runs on the SIU CPU and operates in one of six modes – TERMINAL, SAFE, QUIESCENT, DIAGNOSTIC, CALIBRATION, and PHYSICS – as described in Table 1. Transitions between LIM modes are initiated by telecommands, as shown in Figure 1.

Table 1 – LIM Operating Modes

Name	Description
Terminal	Initial LIM mode.
Safe	Power applied to GASU/DAQ, PDU, and front-end electronics.
Quiescent	Ready for physics observations, calibration, or diagnostics.
Diagnostic	Diagnostic functions are active.
Calibration	Charge injection calibration functions are active.
Physics	Sky survey, pointed, or repointed observation activity is in progress.

Figure 1 – LIM Mode Transition Diagram



The spacecraft, LAT instrument, and LAT flight software also operate within their own sets of states and modes – some of which are determined by the LIM operating modes. Table 2 shows the correlation between the LIM and some of these external states and modes.

Table 2 – Operating Mode Correlations

External Mode/State	LIM Mode
Primary Boot	LIM not running
Secondary Boot	LIM not running
Load Shed	Terminal
Safe	Safe
GASU/PDU Power	Safe
SAA Transit	Supported in all LIM modes
Engineering	Quiescent, Diagnostic, Calibration
Sky Survey	Physics
Pointed Observation	Physics
Repointed Observation: ToO	Physics
Repointed Observation: ARR	Physics

## 1.0 TERMINAL Mode

The LIM software starts in the TERMINAL mode. In this mode, only the SIU is powered and all non-physics flight software is active.

From the TERMINAL mode, LIM transitions to the SAFE mode when it receives the Main-Feed-On command. LIM returns to this mode from any other mode when it receives the Load-Shed command.

While in this mode, LIM accepts the following commands:

- Main Feed On (Causes transition to SAFE mode)
- SAA Enter
- SAA Exit
- Safe Mode
- Load Shed

### 1.1 SAFE Mode

The SAFE mode is similar to TERMINAL mode, with the exception that the GASU/DAQ, PDU, and front-end electronics are powered. Since these devices are powered, the LCB service is also available in this mode.

LIM remains in the SAFE mode until it receives either a Power-On command (causing a transition to the QUIESCENT mode) or a Load-Shed command (causing a transition back to the TERMINAL mode). LIM returns to the SAFE mode from any mode (other than TERMINAL mode) when it receives the Safe-Mode command.

While in this mode, LIM accepts the following commands:

- Power On (Causes transition to QUIESCENT mode)
- SAA Enter
- SAA Exit
- Safe Mode
- Load Shed (Causes transition to TERMINAL mode)

## 1.2 QUIESCENT Mode

The QUIESCENT mode serves as a synchronization point between the spacecraft and the LAT, in that transitions between operational modes must pass through QUIESCENT mode. In this mode, the LAT is ready to perform observations, charge injection calibrations, and diagnostic functions. It is the first mode in which the EPU's are powered and CPU-to-CPU communication is active.

While in this mode, LIM accepts the following commands:

- Power Change
- Diagnostic Enter (Causes transition to DIAGNOSTIC mode)
- Calibration Enter (Causes transition to CALIBRATION mode)
- Physics Enter (Causes transition to PHYSICS mode)
- SAA Enter
- SAA Exit
- Safe Mode (Causes transition to SAFE mode)
- Load Shed (Causes transition to TERMINAL mode)

## 1.3 DIAGNOSTIC Mode

When in DIAGNOSTIC mode, LIM allows the LDF task to perform testing and troubleshooting procedures that cannot be performed in TERMINAL or SAFE mode. LIM transitions to this mode from the QUIESCENT mode when it receives the Diagnostic-Enter command. It remains in this mode until it receives the Diagnostic-Exit command, at which point it returns to the QUIESCENT mode.

While in this mode, LIM accepts the following commands:

- LDF Commands (Forwarded to LDF)
- Diagnostic Exit (Causes transition to QUIESCENT mode)
- SAA Enter
- SAA Exit
- Safe Mode (Causes transition to SAFE mode)
- Load Shed (Causes transition to TERMINAL mode)

## 1.4 CALIBRATION Mode

The CALIBRATION mode is a specialized form of the DIAGNOSTIC mode. When in this mode, LIM allows Charge Injection Calibration operations by the LCI task. LIM transitions to this mode from the QUIESCENT mode when it receives the Calibration-Enter command. It remains in this

mode until it receives the Calibration-Exit command, at which point it returns to the QUIESCENT mode.

While in this mode, LIM accepts the following commands:

- LCI Commands (Forwarded to LCI)
- Calibration Exit (Causes transition to QUIESCENT mode)
- SAA Enter
- SAA Exit
- Safe Mode (Causes transition to SAFE mode)
- Load Shed (Causes transition to TERMINAL mode)

## 1.5 PHYSICS Mode

When in PHYSICS mode, LIM allows the LPA task to perform Physics Observation operations. This mode encompasses the three LAT observation modes – Sky Survey, Pointed Observation, and Repointed Observation. From the perspective of LIM, these three LAT observation modes are identical and it is the responsibility of the LPA task to respond to changes between them.

LIM transitions to this mode from the QUIESCENT mode when it receives the Physics-Enter command. It remains in this mode until it receives the Physics-Exit command, at which point it returns to the QUIESCENT mode.

While in this mode, LIM accepts the following commands:

- LPA Commands (Forwarded to LPA)
- Physics Exit (Causes transition to QUIESCENT mode)
- SAA Enter
- SAA Exit
- Safe Mode (Causes transition to SAFE mode)
- Load Shed (Causes transition to TERMINAL mode)

## 1.6 SAA

When LIM receives the SAA-Enter command, it does not change its operating mode. Instead, LIM alters the ACD/CAL configuration to place it in a state that is safe for SAA transit. It also updates its internal state to indicate that a transit is in progress. LIM holds the ACD/CAL in this safe state until it receives the SAA-exit command, at which point it restores them to their expected configuration.

During SAA transit, LIM does not change the ACD/CAL configuration in ways that would remove them from the safe state. LIM does, however, update the expected ACD/CAL configuration so that requested changes can be made when the SAA-Exit command is received.

If the current mode is DIAGNOSTIC, CALIBRATION, or PHYSICS when the SAA-Enter command is received, LIM forwards the command to the LDF, LCI, or LPA task, respectively. These tasks can then decide whether to continue, suspend, or abort their current operation. If LIM transitions from QUIESCENT to one of these modes during SAA transit, it sends an SAA-Enter command to the appropriate task immediately after sending the Diagnostic-Enter, Calibration-Enter, or Physics-Enter command.

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? ? Should LDF, LCI, and LPA keep track of the SAA state? If so, LIM would forward SAA-Enter and SAA-Exit to these tasks as soon as they were received – regardless of the current mode.  
? ? Then when DIAGNOSTIC, CALIBRATION, or PHYSICS mode is entered, the appropriate task would already know that an SAA transit is in progress.

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If the current mode is TERMINAL, SAFE, or QUIESCENT when LIM receives the SAA-Enter command, it operates normally – with the restriction that it must hold the ACD/CAL in a safe state.

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? ?  
? ? How does LIM determine if SAA transit is in progress when the SIU boots and LIM starts?

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## 2 Telecommands

The LIM package responds to certain telecommands by changing its operating mode, applying power to LAT components, and notifying other tasks of mode and state changes. LIM also intercepts telecommands intended for other packages, determines if they are valid for the current operating mode, and forwards them to the target task if appropriate.

### 2.0 LCI Calibration Enter (LCIENTERCAL)

LIM intercepts the LCI Calibration Enter (LCIENTERCAL) telecommand, which is used to enter the CALIBRATION mode.

When LIM is in the QUIESCENT mode, it accepts this telecommand and performs the following actions:

- Forwards the command to the LCI task.
- Sends an SAA-Enter command to the LCI task if an SAA transit is in progress.
- Transitions to the CALIBRATION mode.

LIM rejects this command if it is in any mode other than QUIESCENT.

### 2.1 LCI Calibration Exit (LCIEXITCAL)

LIM intercepts the Calibration Exit (LCIEXITCAL) telecommand, which is used to exit the CALIBRATION mode. This command may be sent from an external source (e.g. the ground or the spacecraft) or from an internal source (e.g. the LCI task or LIM itself). For example, the LCI task might send this command to LIM to signal the completion of a pre-defined charge injection calibration procedure.

When LIM is in the CALIBRATION mode, it accepts this telecommand and performs the following actions:

- Forwards the command to the LCI task.
- Transitions to the QUIESCENT mode.

LIM rejects this command if it is in any mode other than CALIBRATION.

## 2.2 LDF Diagnostic Enter (LDFENTERDIAG)

LIM intercepts the LDF Diagnostic Enter (LDFENTERDIAG) telecommand, which is used to enter the DIAGNOSTIC mode.

When LIM is in the QUIESCENT mode, it accepts this telecommand and performs the following actions:

- Forwards the command to the LDF task.
- Sends an SAA-Enter command to the LDF task if an SAA transit is in progress.
- Transitions to the DIAGNOSTIC mode.

LIM rejects this command if it is in any mode other than QUIESCENT.

## 2.3 LDF Diagnostic Exit (LDFEXITDIAG)

LIM intercepts the LDF Diagnostic Exit (LIMEXITDIAG) telecommand, which is used to exit the DIAGNOSTIC mode. This command may be sent from an external source (e.g. the ground or the spacecraft) or from an internal source (e.g. the LDF task or LIM itself). For example, the LDF task might send this command to LIM to signal the completion of a special-purpose diagnostic procedure.

When LIM is in the DIAGNOSTIC mode, it accepts this telecommand and performs the following actions:

- Forwards the command to the LDF task.
- Transitions to the QUIESCENT mode.

LIM rejects this command if it is in any mode other than DIAGNOSTIC.

## 2.4 LPA Physics Enter (LPAENTERPHYS)

LIM intercepts the LPA Physics Enter (LPAENTERPHYS) telecommand, which is used to enter the PHYSICS mode.

When LIM is in the QUIESCENT mode, it accepts this telecommand and performs the following actions:

- Forwards the command to the LPA task.
- Sends an SAA-Enter command to the LPA task if an SAA transit is in progress.
- Transitions to the PHYSICS mode.

LIM rejects this command if it is in any mode other than QUIESCENT.

## 2.5 LPA Physics Exit (LPAEXITPHYS)

LIM intercepts the LPA Physics Exit (LPAEXITPHYS) telecommand, which is used to exit the PHYSICS mode. This command may be sent from an external source (e.g. the ground or the spacecraft) or from an internal source (e.g. the LDF task or LIM itself). For example, the LPA task might send this command to LIM to signal the completion of an observation run.

When LIM is in the PHYSICS mode, it accepts this telecommand and performs the following actions:

- Forwards the command to the LPA task.
- Transitions to the QUIESCENT mode.

LIM rejects this command if it is in any mode other than PHYSICS.

## 2.6 Load Shed (LIMLOADSHED)

The Load Shed (LIMLOADSHED) telecommand is used to remove all power from the LAT instrument. When LIM receives this command, it provides a five-second warning to other active tasks before removing power and transitioning to the TERMINAL mode.

When LIM is already in the TERMINAL mode, it accepts this command and performs the following actions:

- Sends an alert indicating that LAT power has already been removed.
- Sends a Load-Shed command to the LTC task.

When LIM is in the SAFE or QUIESCENT mode, it accepts this telecommand and performs the following actions:

- Sends an alert indicating that all LAT power is about to be removed.
- Sends a Load-Shed command to the LTC task.
- Waits five seconds.
- Removes power from all LAT components using the PIG\_shed() function.
- Sends an alert indicating that all LAT power has been removed.
- Transitions to the TERMINAL mode.

When LIM is in the DIAGNOSTIC, CALIBRATION, or PHYSICS mode, it accepts this telecommand and performs the following actions:

- Sends an alert indicating that all LAT power is about to be removed.
- Sends a Load-Shed command to the LTC task.
- Sends a Diagnostic-Exit, Calibration-Exit, or Physics-Exit command to the active LDF, LCI, or LPA task.
- Waits five seconds.
- Removes power from all LAT components using the PIG\_shed() function.
- Sends an alert indicating that all LAT power has been removed.
- Transitions to the TERMINAL mode.

## 2.7 Main Feed On (LIMMAINFEEDON)

The Main Feed On (LIMMAINFEEDON) telecommand is used to apply power to the GASU/DAQ, PDU, and front-end electronics. This command also causes LIM to transition from the TERMINAL mode to the SAFE mode.

When LIM is in the TERMINAL mode, it accepts this telecommand and performs the following actions:

- Applies power to the GASU/DAQ, PDU, and front-end electronics using the PIG\_switch(), PIG\_lcb\_start(), and PIG\_links() functions.
- Transitions to the SAFE mode.

LIM rejects this command if it is in any mode other than TERMINAL.

## 2.8 Power On (LIMPOWERON)

The Power On (LIMPOWERON) telecommand is used to apply power to the EPU's and transition from the SAFE mode to the QUIESCENT mode.

When LIM is in the SAFE mode, it accepts this telecommand and performs the following actions:

- Applies power to the EPU's using the PIG\_epu\_on() function.
- Transitions to the QUIESCENT mode.

LIM rejects this command if it is in any mode other than SAFE.

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Do any other tasks need to be notified when EPU power is applied, for example, to start CPU-to-CPU communication between master and slave tasks?

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## 2.9 Power Change (LIMPOWERCHANGE)

The Power Change (LIMPOWERCHANGE) telecommand is used to apply and remove power for the remaining LAT components.

When LIM is in the QUIESCENT mode, it accepts this telecommand and performs the following actions:

- Applies power to the specified TEM components using the PIG\_tem\_on() and PIG\_tem\_off() functions.
- If not in SAA transit, applies power to the specified ACD/CAL components using the PIG\_cal\_on(), PIG\_cal\_off(), PIG\_tkr\_on(), PIG\_tkr\_off(), PIG\_acd\_off(), and PIG\_acd\_on() functions.
- Updates the expected ACD/CAL configuration (whether in SAA transit or not).

LIM rejects this command if it is in any mode other than QUIESCENT.

## 2.10 SAA Enter (LIMSAAENTER)

The SAA Enter (LIMSAAENTER) telecommand is used to inform the LAT instrument that the spacecraft has entered the South Atlantic Anomaly (SAA). To safely transit the SAA, LIM must reconfigure the ACD/CAL to remove its high-voltage power.

When LIM is in the TERMINAL or SAFE mode, it accepts this telecommand and performs the following actions:

- Updates its internal state to indicate that an SAA transit is in progress.
- Since power is not applied to the ACD/CAL in this mode, LIM does not alter the ACD/CAL configuration.

When LIM is in the QUIESCENT mode, it accepts this telecommand and performs the following actions:

- Configures the ACD/CAL for safe SAA transit using the PIG\_enter\_SAA() function.
- Updates its internal state to indicate that an SAA transit is in progress.

When LIM is in the DIAGNOSTIC, CALIBRATION, or PHYSICS mode, it accepts this telecommand and performs the following actions:

- Forwards an SAA-Enter command to the active LDF, LCI, or LPA task.
- Configures the ACD/CAL for safe SAA transit using the PIG\_enter\_SAA() function.
- Updates its internal state to indicate that an SAA transit is in progress.

## 2.11 SAA Exit (LIMSAAEXIT)

The SAA Exit (LIMSAAEXIT) telecommand is used to inform the LAT instrument that an SAA transit has completed.

When LIM is in the TERMINAL or SAFE mode, it accepts this telecommand and performs the following actions:

- Updates its internal state to indicate that an SAA transit is not in progress.
- Since power is not applied to the ACD/CAL in this mode, LIM does not alter the ACD/CAL configuration.

When LIM is in the QUIESCENT mode, it accepts this telecommand and performs the following actions:

- Restores the ACD/CAL to its expected configuration using the PIG\_exit\_SAA() function.
- Updates its internal state to indicate that an SAA transit is not in progress.

When LIM is in the DIAGNOSTIC, CALIBRATION, or PHYSICS mode, it accepts this telecommand and performs the following actions:

- Restores the ACD/CAL to its expected configuration using the PIG\_exit\_SAA() function.
- Forwards an SAA-Exit command to the appropriate LDF, LCI, or LPA task.
- Updates its internal state to indicate that an SAA transit is not in progress.

## 2.12 Safe Mode (LIMSAFE)

The Safe Mode (LIMSAFE) telecommand is used to place the LAT instrument in a safe configuration. When LIM receives this command, it provides a five-second warning to other active tasks before removing power and transitioning to the SAFE mode.

When LIM is in the TERMINAL or SAFE mode, it sends an alert indicating that the LAT is already in a configuration that satisfies the safe mode requirements.

When LIM is in the QUIESCENT mode, it accepts this telecommand and performs the following actions:

- Sends an alert indicating the LAT is starting the Safe-Mode procedure.
- Removes power from all LAT components except the GASU/DAQ, PDU, and front-end electronics, using the PIG\_safe() function.
- Sends an alert indicating the LAT has finished the Safe-Mode procedure.
- Transitions to the SAFE mode.

When LIM is in the DIAGNOSTIC, CALIBRATION, or PHYSICS mode, it accepts this telecommand and performs the following actions:

- Sends an alert indicating the LAT is starting the Safe-Mode procedure.
- Sends a Diagnostic-Exit, Calibration-Exit, or Physics-Exit command to the active LDF, LCI, or LPA task.

- Waits five seconds.
- Removes power from all LAT components except the GASU/DAQ, PDU, and front-end electronics, using the PIG\_safe() function.
- Sends an alert indicating the LAT has finished the Safe-Mode procedure.
- Transitions to the SAFE mode.

# 3 Control and Status

The LIM package provides functions that control the operation of the LIM command handlers and report their status. These functions act as the interface to the LIM package.

## 3.0 LIM\_initialize()

The LIM\_initialize() function allocates resources used by the LIM package and sets configuration values to their default state. It accepts two parameters:

- a pointer to the task description block of the task to which the LIM command handlers should be attached
- the ID of the task to which the LIM command handlers should be attached.

These parameters are redundant, in that they provide two methods for specifying the LIM command handler task. If the first parameter is non-NULL, it is used to attach the LIM command handlers to the corresponding task (and the second parameter is ignored). If, on the other hand, the first parameter is NULL, then LIM\_initialize() calls an ITC function to translate the second parameter into a task description block pointer, which it then uses to attach the LIM command handlers. Finally, if the first parameter is NULL and the second parameter is not a valid task ID (e.g. -1), then LIM\_initialize() does not attach the LIM command handlers to any task. In the latter case, it is assumed that some other application-level code has or will perform this attachment.

LIM\_initialize() returns a MSG status code.

## 3.1 LIM\_shutdown()

The LIM\_shutdown() function frees resources allocated by the LIM package. It requires no parameters, and it returns a MSG status code.

## 3.2 LIM\_getInfo()

The LIM\_getInfo() function returns information about the state of the LIM package. This state includes the current LIM operating mode, as well as an indication of whether an SAA transit is in progress. This function requires a single parameter, which is a pointer to a buffer into which the LIM information should be stored.

LIM\_getInfo() returns a MSG status code.

# 4 Requirements

The LIM package is designed to satisfy many of the mode control requirements defined in the LAT Flight Software Specification (LAT-SS-00399).

## 4.0 (5.3.11) GRB Response

*Requirement: The LAT FSW shall respond to GRB alert messages from all sources (a GRB alert message from the GBM, or an internally generated GRB alert) when in Sky Survey or Pointed Observation modes.*

LIM assumes that GRB alert messages are sent to the LPA task for handling. The fact that the LPA task is active during PHYSICS mode and that the PHYSICS mode encompasses the Sky Survey and Pointed observatory modes, ensures that the LPA task has the opportunity to respond to GRB alert messages when the spacecraft is in one of the allowed observatory modes.

## 4.1 (5.3.15) Mode Control

*Requirement: The FSW shall support the observatory modes of (1) sky survey, (2) pointed observation, and (3) repointed observation.*

LIM does not distinguish between the observatory modes of Sky Survey, Pointed Observation, and Repointed Observation. From the perspective of LIM, these observatory modes all occur within the PHYSICS mode of LIM operation. LIM assumes that the LPA task and the spacecraft handle transitions between these observatory modes and perform the actions required within them. LIM supports this activity by intercepting commands intended for the LPA task and forwarding them to LPA only if the current operating mode is PHYSICS.

## 4.2 (5.3.15.1) Ground Commanded Repointing

*Requirement: Upon command, the FSW shall support transition to repointed observation mode from sky survey and pointed observation modes.*

LIM is involved in these observatory mode transitions only to the extent that it forwards observatory mode transition commands to the LPA task during PHYSICS mode. LIM assumes that the LPA task and the spacecraft handle transitions between these observatory modes and perform the actions required within them.

## 4.3 (5.3.15.2) Sequences of Observations

*Requirement: The FSW shall support execution of sequences of pointed and sky survey observations from on-board command storage.*

LIM is involved in these observation sequences only to the extent that it forwards observation commands to the LPA task during PHYSICS mode. LIM assumes that observation sequences are controlled by sets of scheduled commands that the spacecraft stores in its on-board storage and sends to the LPA task at the appropriate time.

## 4.4 (5.3.15.3) Automatic Resume

*Requirement: Upon completion of a repointed observation that is performed autonomously, the FSW shall support the resumption of the previously interrupted sky survey or pointed observation.*

LIM is involved in these observatory mode transitions only to the extent that it forwards the mode transition commands to the LPA task during PHYSICS mode. LIM assumes that the LPA task and the spacecraft handle transitions between these observatory modes and perform the actions required within them.

## 4.5 (5.3.15.4) Mode Reporting

*Requirement: The FSW shall report mode changes in telemetry.*

LIM reports the status of all commands via the ITC command acknowledgment mechanism. When LIM completes a command, including those that result in a mode change, ITC uses this mechanism to send a response indicating that the command succeeded. Additionally, the LHK task periodically calls the LIM\_getInfo() function to determine and report the current LIM operating mode.

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Is there a specific telemetry packet that LIM should send when it changes modes?

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## 4.6 (5.3.15.5) Responding to GRBs

*Requirement: The FSW shall respond to GRBs with filter changes or an ARR only when the GRB is detected from Sky Survey, Pointed, or Repointed modes.*

LIM assumes that the LPA task handles filter changes and Automatic Repoint Requests resulting from GRB detections. The fact that the LPA task is active only during PHYSICS mode and that the PHYSICS mode corresponds to the Sky Survey, Pointed, and Repointed observatory modes, ensures that the flight software responds to GRBs only when the spacecraft is in one of the allowed observatory modes.

## 4.7 (5.3.16.1.1) Safe Mode Notification from SC

*Requirement: The SIU FSW shall receive and process a safe-mode notification message from the SC, then execute a set of actions designed to place the LAT in a predetermined LAT Safe Mode within 15 seconds.*

LIM accepts the Safe-Mode command in all of its operating modes. When LIM receives this command, it performs the sequence of actions described in Section 2.12, which places the LAT in a safe-mode configuration. This sequence includes two steps that consume significant amounts of time – a five-second warning to active tasks, and a controlled power-down sequence. The

power-down sequence is designed to require no more than 6.2 seconds. When combined with the five second delay, the total time required to place the LAT in a safe-mode configuration is no more than 11.2 seconds from the receipt of the Safe-Mode command.

## 4.8 (5.3.16.1.2) Safe Mode Notification to Ground

*Requirement:* Assuming that power is available, the SIU FSW shall put a notification of transition to LAT Safe Mode as alert telemetry to the ground prior to entering LAT Safe Mode.

LIM sends alert telemetry to the ground before and after it places the LAT in the safe-mode configuration.

## 4.9 (5.3.16.2.1) Load Shedding Notification from SC

*Requirement:* The SIU FSW shall receive and process a load shedding notification message from the SC, then execute the necessary configuration commands within 15 seconds to power off all SIU-controlled LAT components and prepare for shutdown.

LIM accepts the Load-Shed command in all of its operating modes. When LIM receives this command, it performs the sequence of actions described in Section 2.6, which removes power from the LAT components. This sequence includes two steps that consume significant amounts of time – a five-second warning to active tasks, and a controlled power-down sequence. The power-down sequence is designed to require no more than 6.2 seconds. When combined with the five second delay, the total time required to remove power from the LAT components is no more than 11.2 seconds from the receipt of the Load-Shed command.

## 4.10 (5.3.16.2.2) Load Shedding Notification to Ground

*Requirement:* Assuming that power is maintained during the 15 seconds, the SIU FSW shall put a notification of powering off due to load shedding into the telemetry stream to the ground, prior to powering off.

LIM sends alert telemetry to the ground before and after it removes power from the LAT components.

## 4.11 (5.3.18.1) Configure ACD for SAA

*Requirement:* Prior to SAA transit, the FSW shall configure the ACD as described in the ACD-LAT ICD.

When LIM receives the SAA-Enter command in a mode other than TERMINAL or SAFE, it calls the PIG\_enter\_SAA() function. LIM assumes that this function configures the ACD to satisfy this requirement.

---

?	?	Does PIG keep track of the SAA transit state and reject attempts to configure the ACD in a non-safe manner during SAA transit?
?	?	

---

## 4.12 (5.3.18.2) Configure CAL for SAA

*Requirement: Prior to SAA transit, the FSW shall disable CAL-LO and CAL-HI triggering.*

When LIM receives the SAA-Enter command in a mode other than TERMINAL or SAFE, it calls the PIG\_enter\_SAA() function. LIM assumes that this function takes the actions necessary to satisfy this requirement.

---

?	?	
	?	
?		Does PIG keep track of the SAA transit state and reject attempts to enable CAL-LO and CAL-HI during SAA transit?

---

## 4.13 (5.3.18.3) Post-SAA Recovery

*Requirement: The FSW shall support recovery from SAA transits to ensure that science data collected after SAA transit is performed with the planned configuration.*

When LIM receives the SAA-Exit command in a mode other than TERMINAL or SAFE, it calls the PIG\_exit\_SAA() function. LIM assumes that this function restores the ACD/CAL to its expected configuration. If LIM is in the PHYSICS mode, it also sends an SAA-Exit command to the LPA task. LIM assumes that the LPA task resumes science data collection when it receives this notification.

---

?	?	
	?	
?		Does PIG keep track of the expected ADC/CAL configuration so that it can restore it when the the SAA transit is complete?

---

## 4.14 (5.3.19.6) TCS – Shut-Down

*Requirement: The SIU FSW shall shut down active closed loop control of the TCS, upon receipt of command from the spacecraft.*

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?	?	
	?	
?		Is LIM support needed for this action?

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## 4.15 (5.3.19.7) TCS – Thermal Constraints for Power-On

*Requirement: The FSW shall ensure that thermal constraints, as defined in [26], stored onboard and updatable by telecommand, are met prior to enabling power-on of EPUs, TEMs, and TPSs.*

---

?	?	
	?	
?		Does PIG consult TCS before enabling EPU, TEM, or TPS power, or does LIM need to consult TCS before asking PIG to enable power? In general, does TCS interact only with PIG, or does it need to interact with LIM as well?

---

## 4.16 (5.3.19.8) TCS – Load Shedding Action

*Requirement: Upon receipt of a load shedding command from the spacecraft, the SIU FSW shall stop opening the TCS watchdog switch and send a signal to the spacecraft indicating the action taken.*

When LIM receives the Load-Shed command, one of the actions it performs is to send a copy of the Load-Shed command to the LTC task. LIM assumes that the LTC task takes the appropriate actions to satisfy this requirement when it receives this command from LIM.

# 5 Questions

Here are some questions of a general nature that are not included elsewhere in the document.

1. How should LIM handle spontaneous EPU reboots? Should it simply inform the active LDF, LCI, or LPA task, or should it handle it as a Safe-Mode command?
2. Should FILE uploads be restricted or disallowed in certain modes, such as DIAGNOSTIC, CALIBRATION, or PHYSICS? Or will the ground ensure that configuration files are not uploaded in a mode that is actively using the files?
3. Should SAFE mode differ from GASU/PDU POWER mode? As originally defined, the EPU is on in SAFE mode and off in GASU/PDU POWER mode.
4. Should the EPU be on or off in SAFE mode?
5. Should a Warm-Boot command be accepted in a mode other than TERMINAL?
6. What other tasks and packages need to know the current mode – ITC, LCS, ...? What's the best way for them to get this information – callback function, directly-called function, command, ...?
7. Should DIAGNOSTIC, CALIBRATION, and PHYSICS modes be allowed during SAA transit, as described in this document?
8. Should there be a high-priority LIM task that responds to Safe-Mode and Load-Shed commands to ensure that they are handled in a timely manner?