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Casey Seyb – November 12, 2019

National Aeronautics and Space Administration

D-27905

Earth Observing System (EOS)
Tropospheric Emission Spectrometer (TES)

TES Processing Plan
(Early Post-Launch Processing)

Version 1.2

Rob Toaz

September 8, 2004

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Approved by:

Tom Glavich TES Project Manager	Reinhard Beer TES Principal Investogator

Andrew Griffin
SIPS Lead Engineer

September 8, 2004

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Document Change Notes

Version	Date	Page no.	Change description
1.1	9-2-04	30-31	Add description of method used to execute visualization PGEs at SIPS (time-based vs. association with Macro ID #)
1.1	9-2-04	32	In Table 4-3, change Macro ID for Closed Filter macro from 250 to 90
1.1	9-2-04	33	In Table 4-4 add nested macro ID #12 to TES_SUPER_CAL macro
1.1	9-2-04	33-40	In Tables 4-4 and 4-5 remove specification of those visualization PGEs whose execution method is time-based
1.1	9-2-04	35	In Table 4-4 add nested macro ID #11 to TES_SUPER_GS macro
1.1	9-2-04	36-40	In Table 4-5 omit the L1A Geo-location PGE from the PGE processing sequence for the Spatial Cal and OBRCS Target Search macros
1.1	9-2-04	36-40	In Table 4-5 add APID 1681 as an input for the Radiometric Assessment and Spatial Cal macros
1.1	9-2-04	45	Add description of sampling rate and content of low-rate data stream used to supply run info. to SIPS
1.2	9-8-04	1	Changed D # of document from D-22371 to D-27905

1 Introduction

1.1 Identification and Scope

This document describes the early Post-Launch portion of the processing plan for the TES Ground Data System. The planning description covers processing to be performed at both the Production SIPS at Raytheon and the Science Computing Facility (and Science SIPS) at JPL.

This plan focuses on those processing activities planned between Launch and Launch plus six months. Several teams have been defined to support data receipt, processing, and analysis, as well as instrument operations planning. Descriptions of these teams (personnel, responsibilities, functions, and work products) are included in this plan. Six TES internal JPL/Raytheon Mission rehearsals occurred during the three months preceding Launch to exercise the interactions between these teams with the goal of demonstrating whether this team structure would be effective in accomplishing the processing objectives. These mission rehearsals are described in this document.

The scope of this plan includes all mission functions supported by the TES GDS, including instrument operations, SIPS operations, Science software development, and science product generation and distribution.

1.2 Purpose

The primary purpose of this document is to provide a comprehensive reference describing all processing activities nominally planned for the first six months after Launch. Activity elements include the following GDS components:

- Production SIPS processing at Raytheon
- Science data analysis at the SCF (including the Science SIPS) for instrument Calibration & Validation
- Instrument Operations Team (IOT) support at EDOS and the Instrument Support Terminal (IST)
- At-Launch processing teams to provide SIPS status, science data analysis and assessment, and Management functions
- Initial Product generation and delivery to the ASDC DAAC

The information in this plan will provide a management guideline for the critical post-launch activities conducted by the various sub-teams within the TES Ground Data System.

A critical component of this document that has been recently defined is a set of tables which provide specific information needed by the SIPS team to plan ahead for the PGE processing sequences that will be required as a function of the macros that are executed by the TES instrument. These tables can be found in Section 4.3.

1.3 Reference Documents

1. [redacted]
2. [redacted]
3. [redacted]
4. [redacted]
5. [redacted]
6. [redacted]
7. JPL D-11294, TES Scientific Objectives & Approach, Goals & Requirements Document, Revision 6.0, April 14, 1999
8. [redacted]
9. [redacted]
10. [redacted]
11. [redacted]
12. [redacted]

2 Facility Descriptions

Key components and immediate interfaces within the TES Ground Data System will be described in the following paragraphs. The facilities described are the NASA Langley Atmospheric Science Data Center (ASDC) DAAC, the Raytheon Production SIPS, and the JPL Science Computing Facility (SCF).

2.1 ASDC DAAC

The primary responsibilities of the Atmospheric Science Data Center (ASDC) DAAC are to 1) Deliver L0 ESDT, GMAO, and DPREP data to the TES SIPS and 2) Receive TES Standard Products from the TES Production SIPS and provide archive and distribution services.

The operational interface between the SIPS and the ASDC DAAC is documented in the TES-ASDC DAAC Operations Agreement, which is developed by the DAAC with support from the SIPS (ref. [5]). The technical details of the interface, including data transfers between the SIPS and the DAAC as well as DAAC subscription services, will be documented in the ECS to SIPS ICD, which is also developed by the DAAC with the assistance of the SIPS (ref. [4]).

The ASDC DAAC provides archival services for Level 0, Level 1B and Level 2 Standard Data Products for the life of the mission.

2.2 Production SIPS

The Production SIPS facility is the data processing center that will be used for routine Production processing. The primary interfaces of the Production SIPS will be through the TES SCF at JPL and the NASA Langley Atmospheric Science Data Center (ASDC) DAAC. The SIPS is connected to the TES SCF via fiber optic networks provided by Raytheon which are within the JPL network. This interface supports delivery and installation of science software at the SIPS, transmission of data products and QA data to/from the SCF, production planning and scheduling, and operational support activities.

The Production SIPS is responsible for the accumulation and life-of-mission storage of external data sets, short-term storage of Science software output files, the processing of TES global survey data, and the control and synchronization of the processing entities within the data processing system.

The Production SIPS provides the complete set of computing resources to support standard data processing operations plus a reprocessing capability as described in ref. [12]. Product file ESDTs will be passed to the ASDC DAAC for distribution and storage.

All processing priorities at the Production SIPS will be controlled by the TES Management Team/CCB as defined in Section 3.

2.3 Science Computing Facility (SCF)

The TES SCF supports the development of the TES science algorithms and the software required for standard and Special products processing, data quality operations, and scientific research. During the first six months after Launch, the SCF will provide the science data analysis required to complete instrument calibration and validation. All Level 1A, Level 1B Performance, and standard L1B Target and Calibration processing will be run at the Production SIPS. All PGE outputs will be accessible from a rolling storage at the SCF for further science analysis. Experimental Level 1B Target and Calibration PGE runs will be made at the SCF using a Science SIPS cluster.

The SCF provides physical resources for the development of science algorithms and software. Algorithm development requires the installation of analysis and prototyping tools such as IDL, third-party codes such as LBLRTM, and visualization software. In addition to the software requirements, algorithm development requires sufficient CPU and disk resources to run prototype codes, test Production code, and store associated data files.

Software development requires the installation of computer-aided software engineering (CASE) tools, compilers, debuggers, and other development tools as well as sufficient CPU and disk space to support the development team. The ClearCase configuration management (CM) system will also be installed.

The primary responsibilities of the SCF for standard processing are the development of software products, data quality monitoring and production of operational support products.

The SCF provides resources for the processing of special observation data, special calibration data, quality information and expedited data from the instrument.

SIPS-based automated PGE processing will be available at the SCF using a version of the Production SIPS called the Science SIPS, a 20-node cluster physically installed at the SCF site which will provide the same processing architecture as the Production SIPS. The Science SIPS facility will be managed by the SIPS PEM and Science SIPS operations will be managed by the SIPS Operations Lead.

The Instrument Support Terminal (IST) facility is an annex to the SCF and provides a set of workstations for the Instrument Operations Team (IOT) to monitor EDOS operations activities and to support the scheduling of re-planned instrument commands. Low-rate data from the instrument will be routinely monitored by the IOT using the IST.

3 Processing Support Teams, Activities, and Personnel Assignments

This section identifies the GDS teams that will be active during Post-Launch processing, including the team leaders, members, and work products. Also described are the JPL/Raytheon pre-Launch internal Mission Rehearsals that have been planned.

3.1 Processing Support Teams

The L1A, L1B, and L2 Process Teams provide detailed data analysis of SIPS processing output. Each process team uses a checklist and a reporting form to ensure that the team covers all required analysis items and provides a complete summary of their findings.

The Management Team will hold daily status meetings during the first four months after Launch. The Management Team will review summary reports provided by the Science Assessment Team and provide a set of observation requests to the Science Planning Team. The Management Team will also generate anomaly reports as needed and provide them to the CCB.

The Science Team will submit to the IOT a plan with a list of macros to be run and a set of targets of interest that are in the instrument FOV.

Table 3-1. At-Launch Processing Teams and Data Flows

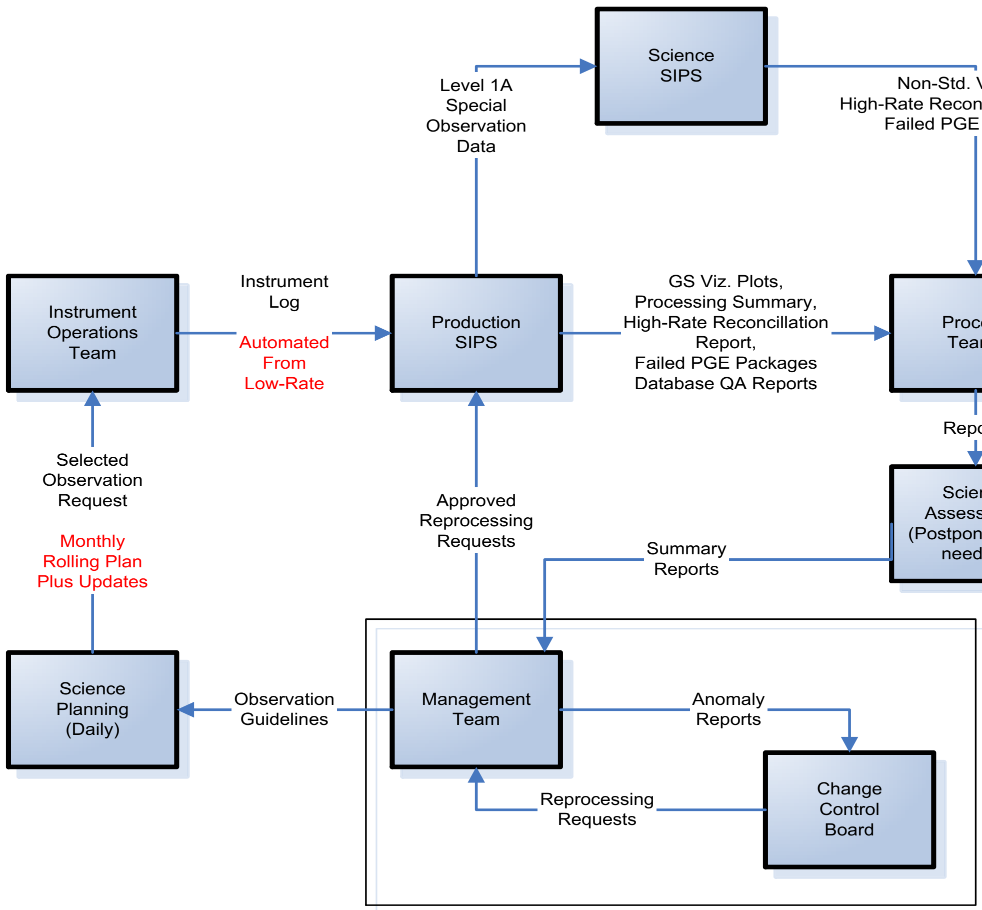

Table 3-1 illustrates the flow of data and information between each of the processing teams. (Not shown on the diagram are the High Rate data interface from the ASDC DAAC and the Low Rate data interface from the EOC.) The Science Planning team provides monthly rolling plans and observation requests to the Instrument Operations Team (IOT) which in turn converts these into macros that are scheduled using the IST and then transmitted to EDOS for uplink to the TES instrument. The IOT also receives Low Rate data at the IST that is downlinked from the TES instrument through the EOC. The IOT uses the Low Rate data to construct an Instrument Log which is automatically delivered to the Production SIPS website and provides the list of expected Level 0 data for processing.

The Production SIPS ingests and stores all Level 0 data and provides all L1A and L1B Performance PGE processing, and also the associated Visualization PGE processing, creating visualization plots and posting them on the SIPS website. The Production SIPS also provides high-rate reconciliation and database QA reports, and generates failed PGE packages for analysis at the SCF. For Special Observation processing, the Production SIPS transmits Level 1A and L1B

Performance PGE output to the SCF for processing using the Science SIPS cluster.

Process Teams associated with each subsystem analyze a checklist of data coming from both SIPS and provide reports to the Science Assessment team. Summaries of these reports will then go to the Management Team. The Management Team will decide whether reprocessing is necessary in the case of failed PGEs.

These activities span across the functional areas that make up the TES GDS, including the TES Production SIPS, the SCF, and the ASDC DAAC. How these activities map to those functional areas and the requirements are described in the following sections.

3.1.1 Management Team

A Management Team will provide the authority to direct all Post-Launch processing activities. The Management Team is comprised of the following members:

Reinhard Beer[1]	Principal Investigator
Mike Gunson[1]	Deputy Principal Investigator
Tom Glavich	Project Manager
Kirk Seaman	Deputy Project Manager
Rob Toaz[1]	GDS Manager
Emily Greene[1]	Raytheon Manager
Helen Worden[1]	Algorithm Development Lead
Doug Shepard[1]	GDS System Engineer
Susan Paradise[1]	Science Software PEM
Andy Griffin	SIPS Operational Lead
Padma Varanasi	Instrument Operations Lead
Dave Rider	Instrument Scientist, Calibration

The Management Team will:

1) Receive summary reports from the L1A and L1B Process teams.
2) Generate anomaly reports for review by the CCB.

[1] CCB Members

3) Generate a report of approved updates to the 2-week and 6-month operating plans and submit the report to the Science Planning team.
4) Generate a set of proposed observation guidelines to the Science Planning Team.
5) Create any CRs/ARs needed to clarify and/or update science software requirements.

3.1.2 CCB

A Change Control Board will meet daily as a follow-on to the Management Team meeting. The CCB has the following membership:

Reinhard Beer	Principal Investigator
Mike Gunson	Deputy Principal Investigator
Rob Toaz	GDS Manager
Emily Greene	Raytheon Manager
Helen Worden	Algorithm Development Lead
Doug Shepard	GDS System Engineer
Susan Paradise	Science Software Lead

The CCB will:

1) Approve and prioritize changes (functionality upgrades, bug fixes) required for new Science software executables.
2) Review and take action on all CRs and ARs submitted, including anomaly reports generated by the Management Team.
3) Generate reprocessing requests for review by the Management Team.
4) Approve the delivery of new Science software PGEs to the SIPS Operational Environment.

3.1.3 Process Teams

Process teams will be formed to routinely analyze PGE output data and provide reports to the Management Team. Immediately after Launch there will be two process teams in place: L1A and L1B. The L2 process team will begin meeting when mini-Global Survey processing begins.

The L1A Process Team will examine visualization plots, database entries, and other L1A processing results to monitor instrument functionality and L1A processing status. A summary report will be generated and submitted daily to the Science Assessment team. Appendix A shows the Process Team Checklist Template.

3.1.3.1 L1A Process Team

The L1A Process Team will be responsible for providing data analysis for all L1A PGE processing results.

The L1A Process Team definition is as follows:

Team Leader:	B. Fisher
Team members:	H. Worden, M. Luo, D. Shepard, K. Fry, J. Zong
Function:	Examines Visualization plots, database entries, and other L1A processing results to monitor instrument functionality and L1A processing status. Provides report to the Science Planning team.

L1A Visualization PGEs include:

L1A Engineering/State Vis.

L1A ICS Performance Vis.

L1A PCS Performance Vis.

The L1A Process team checklist to be followed at each meeting consists of the following items:

1) Examine standard visualization plots (see below) for anomalies. If any found determine
severity, and recommended follow-up. May require non-standard analysis and/or plots in some cases.

2) Check status reports (see below) for anomalies, problems, etc.
Determine severity of anything found and formulate recommended actions, if any. May require consultation with wider TES team to track down some problems.

3) Respond to any requests for information from the Science Planning Team

4) Create summary report

The following summary plots are required to support L1A Process Team reporting:

L1A Temperature Vis.
L1A ICS State Vis.
L1A ICS Performance Vis.
L1A PCS Performance Vis.
L1A Geolocation Vis
Interferometer Alignment Status (from SCS)

L1A Status reports needed for inclusion in report to Science Planning team (and Responsible Parties):

L1A Main, SIPS L1A processing status -- Data completeness, processing failures, etc (Kent)

Channel shifts status (Helen)

Test pattern data (Ming)

L1A Quality flags & Database Issues (Doug)

Disk Space management (hard to exercise in the rehearsal) (Doug)

L1A Geolocation Status (Jia)

3.1.3.2 L1B Process Team

The L1B Process Team will be responsible for providing data analysis for all L1B PGE processing results.

The L1B Process Team definition is as follows:

Team Leader:	H. Worden
Team members:	K. Bowman, E. Sarkissian, D. Tremblay, S. Gluck
Function:	Examines Vis. Plots, database entries, and other L1B processing results to monitor interferogram quality, instrument performance, and L1B processing status. Provides report to the Science Planning team.

L1B Visualization PGEs include:

L1B Performance Viz. (temporal)

L1B Performance Viz. (spatial)

L1B Performance Viz. (magnitude spectra)

L1B Product Viz.

L1B Performance Plots:
1) Temporal Shear Plots DB values (micron/pixel)
2) Temporal Shear Plots fractional change over 16 orbits
3) Temporal Integrated Magnitude Plots DB values (DN)
4) Temporal Integrated Magnitude Plots fractional change over 16 orbits
5) Spectral Magnitude Plots
6) Spatial Shear Plots
7) Spatial Integrated Magnitude Plots

L1B Product Plots:
1) Temporal Nadir NESR Plots - DB values, pixel avg.
2) Temporal Nadir NESR Plots fract. change, pixel avg.
3) Nadir NESR Plots - DB values, each pixel
4) Temporal Nadir NESR Plots fract. change, each pixel
5) Spatial Nadir NESR Maps DB values, pixel avg.
6) Spatial Nadir BT10 & BT11 Maps DB pixel averages (K)
7) Spatial BT10 & BT11 interpixel variability Maps DB values (K2)
8) Temporal Spike Ratio Plots DB pixel average values
9) Temporal Spike Ratio Plots pixel avg. fractional change
10) Spatial Spike Ratio Maps DB pixel averages
11) Temporal Limb NESR, pix 0, DB values
12) Temporal Limb NESR, pix 0, fract. Change
13) Temporal Limb NESR, pix 8, DB values
14) Temporal Limb NESR, pix 8, fract. Change
15) Spatial Limb NESR Maps, DB values, pixel 0

3.1.3.3 L2 Process Team

The L2A Process Team will be responsible for providing data analysis for all L2 Retrieval and L2 Product processing results.

The L2 Process Team definition is as follows:

Team Leader: J. Worden

Team members: A. Eldering, M. Lampel, S. Akopyan, S. Poosti, R. Monarrez, S. Kulawik, K. Croft, K. Bowman, H. Worden, G. Osterman

Function: Examines Vis. Plots, database entries, and other L2 processing results to monitor retrieval quality and all L2 processing status. Provides report to the Science Planning team.

L2 visualization tools TBD.

3.1.4 Science Planning Team

The Science Planning Team will review proposed observation requests developed by the Management Team and work with the IOT to select a specific observation request and plan the request in conjunction with the IOT.

The Science Planning Team definition is as follows:

Team Leader: R. Beer

Team members: M. Gunson, A. Eldering, M. Lampel, S. Kulawik, K. Bowman, H. Worden, J. Worden, M. Luo, G. Osterman, T. Clough, C. Rinsland, C. Rodgers, F. Murcray, A. Goldman, D. Jacobs, J. Logan

Planning products include maintaining a ground track file and orbital event file for the upcoming seven-week period. The Ground track file contains GMT and orbit numbers. A planning tool provided by Ming Luo will takes as input the planning products and allow the Science Team to map TES targets of interest as a function of GMT and orbit number.

The Science Planning Team will perform the following tasks:

1) Review the weekly planning reports generated by the Management Team.
2) Review the set of proposed observation guidelines from the Management Team and select one or more observation requests for submittal to the IOT.

3.1.5 Instrument Operations Team (IOT)

The IOT definition is as follows:

Team Leader: P. Varanasi

Team members: R. Murdock, O. Sanchez

Function: Monitor all low-rate data and generate a low-rate reconciliation report. Use the IST to:

a) monitor EDOS activities

b) plan and schedule TES observations

The IOT functions include the following activities which are performed at the IST:

- Monitor real-time spacecraft/instrument telemetry via plots and pages
- Display ground-generated information (Real-Time Log)
- Provide TES real-time commanding conducted in EOC by FOT
- Define and schedule Instrument activities (Derive from Scientific Objectives & Approach, Goals & Requirements Document, Revision 6.0, April 14, 1999)
  - Weekly, special, or baseline activities
- Build microprocessor loads
- Monitor command transmission from EOC
- Display and analyze TES Instrument telemetry
- Process housekeeping (H/K) data
- Provide a complete list of the macros actually executed to the SIPS Team and Science Team (the Science Team will use this list to maintain an accurate log of ICS motion)

The Instrument Operations Team (IOT) needs to continuously maintain a current schedule of what macros are planned to be run. The IOT will maintain both long-term (1 year) and short-term (1 week) plans. The long term plan will be updated quarterly and the 2-week plan will be used to decide the next set of processing requests, including special observations, to be submitted to EDOS.

3.1.6 Science Assessment Team

The Science Assessment Team will provide a rollup analysis of the reports submitted by the Process Teams and generate a summary report for the Management Team.

The Science Assessment Team definition is as follows:

Team Leader: R. Beer

Team members: M. Gunson, A. Eldering, M. Lampel, S. Kulawik, K. Bowman, H. Worden, J. Worden, M. Luo, G. Osterman, T. Clough, C. Rinsland, C. Rodgers, F. Murcray, A. Goldman, D. Jacobs, J. Logan

Based upon Mission Rehearsal experience, the Science Assessment Team will not be active during the first two months after Launch. Once the calibration effort is underway, the need for having a Science Assessment Team will be re-evaluated.

3.1.7 SIPS Team

The SIPS Team definition is as follows:

Team Leader: A. Griffin

Team members: J. Ericson, M. Harata

The SIPS team will be responsible for managing all science data processing at the Production SIPS and the Science SIPS. This team is also responsible for updating the Production SIPS website with data availability, data processing status, PGE status, and visualization plot updates.

3.2 JPL/Raytheon Internal Mission Rehearsals

TES will run internal JPL/Raytheon Mission Rehearsals prior to Launch to exercise the data interfaces and work product exchanges between each of the teams:

Instrument Operations Team

SIPS Team

L1A/L1B/L2 Process Teams

Management Team/CCB

Science Planning Team

The first Mission rehearsal ran from May 3-6 and exercised the processing teams using a 4-sequence back-produced L0 dataset that SIPS processed through Level 1A and 1B.

A set of daily meetings were established to analyze SIPS processing outputs, summarize findings, and practice problem identification. The nominal meeting schedule was as follows:

L1A Process Team 9:00am
Agenda: work off checklist

L1B Process Team 9:30am
Agenda: work off checklist

Science Assessment 10:00am
Agenda: review process team summary reports, prepare rollup report for Mgmt. team

Management Team 1:00pm
Agenda: review Science Assessment report
assess meeting structure (ordering, duration), convene CCB at end of meeting

Science Planning/IOT 2:00pm
Agenda: review near-term plan for macro commanding
propose next observation requests

A second Mission Rehearsal was held May 24-27. The Science Assessment Team was removed and the L2 Process Team was added.

The SCF rolling archive area was exercised in both MR1 and MR2 to familiarize the processing teams with the directory structure and file access. A more detailed description of the Rolling archive can be found in Section 6.2.1.

A total of five Mission Rehearsals were completed prior to Launch.

3.3 Launch + 6 Months Objectives and Tasks for TES Science Team

The previous sections provided personnel assignments for Post-Launch processing team activities across the entire TES Ground Data System.

Individual members of the TES Science Team will also be given specific assignments to review data early in the Post-Launch calibration/validation period. A draft assignment list has been prepared by the Science Team defining the Science Team objectives and tasks to be accomplished in the first six months after Launch. Table 3-3 shows a prioritized list of preliminary Science Team tasks and the designated leader for each task.

The fundamental objectives in the first six months after Launch are to develop Global maps of O_3, CO, H_2O for clear/ocean nadir scenes with preliminary validation.

Table 3-3. TES External Science Team Tasks for Post-Launch Processing

TES External Science Team Tasks Launch – Launch + 6 months				
Priority	Activity or Analysis	At JPL ?	ST Lead	Notes, e.g. datasets required
1	Support day-to-day Instr. operations and performance evaluation	X	D. Rider	
2	Maintain data flow	X		
3	Shear/co-boresight optimization and trending	X	D. Rider	
4	Ice-buildup trending	X	M. Luo	
5	mid/long term mission ops planning	X	R. Beer	Special Observations: ARM & O3 sonde sites + volcanos & biomass burning
6	Coordination with INTEX campaign		D. Jacob M. Gunson	
7	PCS/ICS performance	X	B. Fisher	
8	Rad. Calibration dependence on latitude	X	H. Worden	
9	Radiance comparison w/AIRS	X	J. Worden S. Clough	
10	L1A/L1B updates	X	H. Worden	
11	Improve vis/ops tools	X	A. Eldering	
12	PCS/geolocation cal/val	X	B. Fisher	
13	Clear sky ident.		A. Eldering S. Clough C. Rodgers	
14	SST comparisons			Buoy data & models Can it be done?
15	Model Radiance comparison based on ECMWF		S. Clough C. Rodgers	
16	NESR trending	X	R. Beer	
17	L2 updates	X	J. Worden C. Rinsland	microwindow updates included
18	OSP refinements	X	G. Osterman	
19	Ozonesonde comparisons		J. Logan C. Rinsland K. Bowman	Includes evaluation of apriori climatologies
20	Residual analysis		C. Rinsland S. Sander	Retrieval diagnostic + unmodeled species
21	Radiosonde comp.		S. Clough J. Logan	

TES External Science Team Tasks Launch – Launch + 6 months				
Priority	Activity or Analysis	At JPL ?	ST Lead	Notes, e.g. datasets required
22	Comp. T, H2O w/AIRS	X	S. Clough	
23	CH4, N2O control checks			
24	Comparison with GEOS-Chem model		D. Jacob	
25	Update & maintain ODT for regression testing	X	M. Lampel	
26	Linelist updates		S. Clough	

4 Processing Overview

Planning the sequence of events in data processing must make certain assumptions regarding the timeframe required to correct processing anomalies. The ability to successfully complete Level 1A Main processing is a prerequisite for all subsequent processing steps.

L1A Main processing was performed extensively during instrument system testing at JPL, and Aura engineering testing (MT, SCIF, and CPT tests) at NGST and Vandenberg.

The Aura Long Term Plan (LTP) has been developed by each Instrument Operations Team and covers processing details during the first ninety days after Launch. The TES portion of the Aura LTP can be found on the TES internal website. The LTP identifies the timeline for both individual instrument commands and run-level macros as a function of Mission-Elapsed Time (MET).

The TES Master Macro List (Appendix B) provides a complete listing of all approved instrument macros and standalone realtime commands that can be uploaded to the instrument during on-orbit operations. Each macro has a numeric macro ID that serves as a unique identifier.

The following top-level decisions have been made regarding all TES science data processing performed by the GDS:

1) All L0 data will be ingested and stored at the TES Production SIPS.

2) All L1A processing without exception will be done at the TES Production SIPS.

3) All L1B Performance PGE processing (and associated visualization PGE processing) will be done at the TES Production SIPS.

4) The operational environment at the Production SIPS is reserved for operational processing only and will be available on a 24 X 7 basis, but staffed 8 X 5.

5) The Science SIPS will be used for runs of L1B Cal/Target and L2 Retrieval PGEs as defined by the Science Team. Andy Griffin will be the Operational Lead of the Science SIPS, and Eugene Chu will be the Facilities Lead.

6) Nominal operational processing will occur at the Raytheon Production SIPS.

The TES GDS performs two basic types of processing: Standard Product processing and Special Product processing. The next two sections describe these two types of processing.

4.1 Standard Product Processing

Standard Product processing consists of 16-orbit Global surveys performed routinely in 48-hour periods. Each Global Survey is preceded by 2 orbits of 'calibration-only' data collection known as a 'pre-cal' run, and followed by 2 orbits of 'calibration-only' data collection known as a 'post-cal' run. Each Global Survey orbit has 72 sequences, each containing the following:

- One (1) Cold space calibration view
- One (1) Internal blackbody view
- Two (2) nadir views
- Three (3) limb views

Standard Products are produced and stored at the Production SIPS.

During routine operations, all Standard Product processing will be performed at the Production SIPS, and Standard Products will be sent to the ASDC DAAC where they will be archived.

4.2 Special Product Processing

Special processing covers any other type of measurement, i.e., all non-Global Survey data collection, including special tests and calibration, validation campaigns, and targeted observations of localized phenomena such as volcanoes and biomass burning. Measurements are made in between Global Surveys and can consist of either short or long scans. Special Products are produced at the SCF and stored at the Production SIPS.

Before reaching the point where the TES GDS can routinely run Standard processing, a set of early Mission phases has been defined to complete instrument activation, assess interferometer performance, and complete preliminary instrument calibration, including the verification of all fundamental instrument functions. Most of the processing needed to accomplish this work falls in the category of Special processing.

During TES post-Launch operations, the Production SIPS at Raytheon will perform all L1A processing for special products without exception. The following L1A PGEs are included in SIPS Special Product processing:

1) L1A Main
2) L1A Geolocation
3) L1A Engineering (Temperature/State) Visualization
4) L1A ICS/PCS Performance Visualization

In addition to L1A, the following L1B PGEs are included in SIPS Special Observation processing:

1) L1B Performance
2) L1B Performance Visualization (temporal)
3) L1B Performance Visualization (magnitude spectra)
4) L1B Performance Visualization (spatial)

The L1B Calibration, L1B Target, L1B Reformat, and L2 Retrieval PGEs will be processed at the SCF to produce Special Products. Special Products all fall into one of the following categories:

1) Special tests and calibrations
2) Validation campaigns (generally transects)
3) Targeted observations of localized phenomena such as volcanoes and biomass burning

It is possible to generate Special Products from Global Survey data from L1B and L2 processing at the SCF. For example, runs will be made using different microwindows, species, and residual calculations.

4.3 SIPS Processing Instructions

A subset of the complete list of TES Flight macros (the full set of TES Flight Macros and their macro IDs can be found in the Master Macro List in Appendix B) is used to support planned runs for standard or special product processing. These macros will hereafter be referred to as ‘run-level’ macros. The SIPS processing instructions for what APIDs to expect and which PGEs to run are based on run-level Macro IDs.

The observation type specified in the macros is what forces the generation of APIDs by the Flight software. Appendix C lists all of the different TES Observation Types, and Table 4-1 is used by the L1A Main PGE to sort data into directories as a function of Observation type.

The different types of APIDs that can be generated by the TES instrument are listed in Appendix D.

A record of all ICS motion needs to be carefully logged as a means of tracking translator usage. Table 4-2 shows the number of short and long scans associated with each run-level macro. Refer to the Notes section for an explanation of how the scans are calculated based on the number of calls to the macro and the number of orbits covered during the execution of all macro calls associated with a run-level macro.

Table 4-1. L1A Observation Types Lookup Table

Observation Type Mnemonic	Observation Type #	Directory	Res	Obs View
GS_CS_PRECAL_PC	1	CAL	Low	SPACE
GS_BLACKBODY_PC	2	CAL	Low	BBODY
GS_CS_VIEW	3	CAL	Low	SPACE
GS_BLACKBODY_VI	4	CAL	Low	BBODY
GS_NADIR_VIEW	5	TGT	Low	NADIR
GS_LIMB_VIEW	6	TGT	High	LIMB
GS_CS_POSTCAL	7	CAL	Low	SPACE
GS_BLACKBODY_POS	8	CAL	Low	BBODY

Observation Type Mnemonic	Observation Type #	Directory	Res	Obs View
SO_SHORT_SCI	9	TGT	Low	LIMB
SO_LONG_SCI	10	TGT	High	NADIR
SO_REG_POLL	11	TGT	Low	NADIR
SO_ACID_RAIN	12	TGT	Low	NADIR
SO_BIOMASS_BURN	13	TGT	Low	NADIR
SO_VOLCANO	14	TGT	Low	NADIR
SO_INDUS_CATAS	15	TGT	Low	NADIR
SO_OBS_STARE	16	TGT	Low	NADIR
SO_TRANSECT	17	TGT	Low	NADIR
SO_LS_LIMB_CORR	18	TGT	High	LIMB
SO_SHORT_NADIR	19	TGT	Low	NADIR
SO_SHORT_BLACK	20	CAL	Low	BBODY
SO_SHORT_COLD_SP	21	CAL	Low	SPACE
SO_LONG_LIMB	22	TGT	High	LIMB
SO_SHORT_GIMBAL	23	CAL	Low	OTHER
SO_COLD_PRECAL	24	CAL	Low	SPACE
SO_BLACK_PRECAL	25	CAL	Low	BBODY
SO_COLD_POSTCAL	26	CAL	Low	SPACE
SO_BLACK_POSTCAL	27	CAL	Low	BBODY
SO_VAR_TEMP_BLT	28	CAL	Low	OTHER
SO_VAR_TEMP_CSLT	29	CAL	Low	OTHER
SO_LONG_COLD_SC	30	CAL	High	SPACE
SO_LONG_BLACK_CA	31	CAL	High	BBODY
SO_SHORT_COLD_SC	32	CAL	Low	SPACE
SO_SHORT_BC	33	CAL	Low	BBODY
SO_SPATIAL_CAL	34	CAL	Low	SPATIAL
SO_COLD_SVTGC	35	CAL	Low	SPACE
SO_BLACK_VTGC	36	CAL	Low	BBODY
SO_TEST_PATTERN	37	TPT	Low	TESTP
SO_LONG_NADIR	38	TGT	High	NADIR

Table 4-2. Number of ICS Scans Associated with Run-Level Macros

Macro Name	Run-level Macro ID	Notes	# Scans (with ICS movement)		
			Short	Long	Transition
Spatial Cal (TES_FLT_SPAL_CAL)	226	3 calls, 120 short scans/call	360	0	0
Radiometric Assessment (TES_RAD_ASSESS)	240	2 filter sets, 40 scans/set	80	0	0
OBRCS Target Search (TES_OBRCS_SEARCH)	443	9 x 9 grid, 2 short scans/grid pt.	162	0	0
Pre/Post Calibration (TES_SUPER_CAL)	15	2 orbits, 72 seq/orbit, 14 short scans/orbit	2016	0	0
16-Orbit Global Survey (TES_SUPER_GS)	10	4 calls (16 orbits), 72 seq/orbit, 4 short + 3 long/seq	4608	3456	2304
4-Orbit Global Survey (TES_GS)	10	1 call (4 orbits), 72 seq/orbit, 4 short + 3 long/seq	1152	864	576
PCS Quick Performance (TES_PCS_QUICK_PERF)	323	No scans	0	0	0
ICS Quick Performance (TES_ICS_QUICK_PERF)	321	7 GS scans, 4 short, 3 long	28	21	14
Quick Test Pattern (TES_TP_QUICK)	390	No ICS movement	0	0	0
Closed Filter (TES_CLOSED_FILTER)	250	Has ICS movement	0	1000	8
Closed Filter (TES_CLOSED_FILTER)	90	No ICS movement, Uses SIM clock	0	0	0
ARM Site Stare	444		32	0	0
ARM Site Stare Cal	104		20	0	0
INTEX Transect	225		68	0	0
INTEX Transect Cal	221		20	0	0
Volcano Stare	132		32	0	0
Volcano Stare Cal	220		16	0	0
HIRDLS Intercomparison	136		0	56	2
HIRDLS Intercomparison Cal	227		80	0	0

The execution of any run-level macro results in the generation of one of eight APID groups, broken into Standard processing, Special processing, and Engineering categories as follows:

Standard processing APID groups:

- Pre and Post-Global Survey Calibration
  APIDs 1672-1675, 1680, 1701-1702
- Global Survey
  APIDs 1664-1667, 1680, 1701-1702

Special processing APID groups:

- Special Calibration
  APIDs 1676-1679, 1703-1704
- Special Observation Calibration
  APIDs 1676-1679, 1681, 1703-1704
- Special Observations
  APIDs 1668-1671, 1681, 1703-1704

Engineering APID groups:

- ICS Performance
  APIDs 1688
- PCS Performance
  APIDs 1689, 1705-1706
- Test Pattern
  APIDs 1682-1685
- Memory Dump
  APID 1686
- Sequence (Macro) Dump
  APID 1687
- Table Dump
  APID 1698

Table 4-3 shows the different macro categories and associated APID groups.

Tables 4-4 through 4-6 shows the APIDs and PGE sequences to run as a function of the run-level macro ID for Standard Processing macros, Special processing macros, and Engineering macros, respectively.

The execution of the following visualization plots will be based on association with their corresponding PGEs (in parenthesis) as part of SIPS macro-based execution:

1) L1A Geo-location Plot (L1A Geo-location)
2) L1B Product Plot (L1B Cal/Target)

3) L1A PCS Performance Plot (L1A Main)
4) L1A ICS Performance Plot (L1A Main)

The execution of the following visualization PGEs will be time-based; execution will be twice daily, at 7am and 3pm PST, with the plot outputs posted on the TES SIPS website:

1) L1A Temperature ICS State Plot
2) L1B Perf Viz Mag Shear Temp
3) L1B Perf Viz Spec Mag
4) L1B Perf Viz Mag Shear Spatial

Table 4-7 shows the APIDs and PGE sequences to run as a function of the run-level macro ID for realtime commands generating high-rate APIDs.

Table 4-3. Macro Categories and Associated APID Groups

Standard Processing		
Macro Name	Macro ID	APID Group
Pre/Post Calibration (TES_SUPER_CAL)	15	Pre and Post-Global Survey Calibration 1672-1675, 1680, 1701-1702
4-Orbit Global Survey (TES_GS)	11	Global Survey 1664-1667, 1680, 1701-1702
16-Orbit Global Survey (TES_SUPER_GS)	10	Global Survey 1664-1667, 1680, 1701-1702
Special Processing		
Spatial Cal (TES_FLT_SPAL_CAL)	226	Special Calibration 1676-1679, 1703-1704
Radiometric Assessment (TES_RAD_ASSESS)	240	Special Calibration 1676-1679, 1703-1704
OBRCS Target Search TES_OBRCS_SEARCH)	443	Special Calibration 1676-1679, 1703-1704
Closed Filter (TES_CLOSED_FILTER)	90	Special Calibration 1676-1679, 1703-1704
Volcano Cal (TES_VOL_CAL)	220	Special Observation Calibration 1676-1679, 1681, 1703-1704
Volcano Measurement (TES_VOL_MEAS) (STARE)	132	Special Observation 1668-1671, 1681, 1703-1704
ARM Site Cal (TES_ARMSITE_CAL)	106	Special Observation Calibration 1676-1679, 1681, 1703-1704
ARM Site Measurement (TES_ARMSITE_MEAS) (STARE)	104	Special Observation 1668-1671, 1681, 1703-1704
INTEX Cal (TES_INTEX_CAL)	221	Special Observation Calibration 1676-1679, 1681, 1703-1704
INTEX Measurement (TES_INTEX_MEAS) (TRANSECT)	225	Special Observation 1668-1671, 1681, 1703-1704
Engineering		
PCS Quick Performance (TES_PCS_QUICK_PERF)	323	Engineering – PCS
ICS Quick Performance (TES_ICS_QUICK_PERF)	321	Engineering – ICS
Quick Test Pattern (TES_TP_QUICK)	390	Engineering – Test Pattern

Table 4-4. PGE Processing sequences for Standard Processing Macros

At-Launch Processing Run-level Standard Processing Macros, High-rate APIDs, PGE Processing and Data Outputs					
Macro Name[2]	Run-level Macro ID	Inputs[3]	PGE sequence	Processing Location	Output Description
Pre/Post Calibration (TES_SUPER_CAL)	15, 12	APIDs 1672-1675 1680 1701-1702	L1A Main	Production SIPS	Diagnostic files
		OBRCS data database	L1B Performance	Production SIPS	magnitude spectra Database
		L1A PCS output file, DPREP (ephemeris/attitude)	L1A Geolocation	Production SIPS	Database
		Database	L1A Geolocation Plot	Production SIPS	Plot files (2 nadir, 1 limb)

[2] These are Run-level macros, i.e., they execute command sets associated with instrument Runs
[3] More input detail is provided in the PGE specs.

At-Launch Processing Run-level Standard Processing Macros, High-rate APIDs, PGE Processing and Data Outputs					
Macro Name	Run-Level Macro ID	Inputs	PGE Sequence	Processing Location	Output Description
4-Orbit Global Survey (TES_GS)	11	APIDs 1664-1667 1680 1701-1702	L1A Main	Production SIPS	diagnostic files
		OBRCS data, database	L1B Performance	Production SIPS	Magnitude spectra, database
		L1A PCS output file, DPREP (ephemeris/attitude)	L1A Geolocation	Production SIPS	Database
		Database	L1A Geolocation Plot	Production SIPS	Plot files (2 nadir, 1 limb)
		L1A Cal. files, L1A Target files	L1B Cal/Target	Production SIPS	NESR, spectra
		Database	L1B Product Plot	Production SIPS	plot files
		Database	L1B Reformat	Production SIPS	L1B Product file
		NESR, spectra files	L2 Retrieval	SCF (specialized processing)	Profiles, database
		Database	L2 Products	SCF (specialized processing)	L2 Product file

At-Launch Processing Run-level Standard Processing Macros, High-rate APIDs, PGE Processing and Data Outputs					
Macro Name	Run-Level Macro ID	Inputs	PGE Sequence	Processing Location	Output Descripiton
16-Orbit Global Survey (TES_SUPER_GS)	10, 11	APIDs 1664-1667 1680 1701-1702	L1A Main	Production SIPS	diagnostic files
		OBRCS data, database	L1B Performance	Production SIPS	magnitude spectra Database
		L1A PCS output file, DPREP (ephemeris/attitude)	L1A Geolocation	Production SIPS	Database
		Database	L1A Geolocation Plot	Production SIPS	Plot files (2 nadir, 1 limb)
		L1A Cal. files, L1A Target files	L1B Cal/Target	Production SIPS	NESR, spectra
		Database	L1B Product Plot	Production SIPS	plot files
		Database	L1B Reformat	Production SIPS	L1B Product files
		NESR, spectra files	L2 Retrieval	Production SIPS	Profiles, database
		Database	L2 Products	Production SIPS	L2 Product files

Table 4-5. PGE Processing sequences for Special Processing Macros

At-Launch Processing Run-level Special Processing Macros, High-rate APIDs, PGE Processing and Data Outputs					
Macro Name	Run-level Macro ID	Inputs	PGE sequence	Processing Location	Output Description
Spatial Cal (TES_FLT_SPAL_CAL)	226	APIDs 1676-1679 1681 1703-1704	L1A Main	Production SIPS	Diagnostic files
Radiometric Assessment (TES_RAD_ASSESS)	240	APIDs 1676-1679 1681 1703-1704	L1A Main	Production SIPS	Diagnostic files
		OBRCS data database	L1B Performance	Production SIPS	Magnitude spectra Database
		L1A PCS output file, DPREP (ephemeris/attitude)	L1A Geolocation	Production SIPS	Database
		L1A Cal. Files	L1B Cal/Target (using cal input only)	SCF (specialized processing)	NESR, spectra

At-Launch Processing Run-level Special Processing Macros, High-rate APIDs, PGE Processing and Data Outputs					
Macro Name	Run-level Macro ID	Inputs	PGE sequence	Processing Location	Output Description
OBRCS Target Search (TES_OBRCS_SEARCH)	443	APIDs 1676-1679 1703-1704	L1A Main	Production SIPS	Diagnostic files
Closed Filter (TES_CLOSED_FILTER) (no ICS motion)	90	APIDs 1676-1679 1703-1704	L1A Main	Production SIPS	diagnostic files
		L1A PCS output file, DPREP (ephemeris/attitude)	L1A Geolocation	Production SIPS	Database

At-Launch Processing Run-level Special Processing Macros, High-rate APIDs, PGE Processing and Data Outputs					
Macro Name	Run-level Macro ID	Inputs	PGE sequence	Processing Location	Output Description
Volcano Calibration (TES_VOL_CAL)	220	APIDs 1676-1679 1681 1703-1704	L1A Main	Production SIPS	Diagnostic files
		OBRCS data database	L1B Performance	Production SIPS	magnitude spectra Database
		L1A PCS output file, DPREP (ephemeris/attitude)	L1A Geolocation	Production SIPS	Database
Volcano Measurement (TES_VOL_MEAS) (Stare)	132	APIDs 1668-1671 1681 1703-1704	L1A Main	Production SIPS	Diagnostic files
		L1A PCS output file, DPREP (ephemeris/attitude)	L1A Geolocation	Production SIPS	Database

At-Launch Processing Run-level Special Processing Macros, High-rate APIDs, PGE Processing and Data Outputs					
Macro Name	Run-level Macro ID	Inputs	PGE sequence	Processing Location	Output Description
ARM Site Calibration (TES_ARMSITE_CAL)	106	APIDs 1676-1679 1681 1703-1704	L1A Main	Production SIPS	Diagnostic files
		OBRCS data database	L1B Performance	Production SIPS	magnitude spectra Database
		L1A PCS output file, DPREP (ephemeris/attitude)	L1A Geolocation	Production SIPS	Database
		L1A Cal. files	L1B Cal/Target (using cal input only)	SCF (specialized processing)	NESR, spectra
		Database	L1B Reformat	SCF (specialized processing)	L1B Product files
		NESR, spectra files	L2 Retrieval	SCF (specialized processing)	Profiles, database
ARM Site Measurement (TES_ARMSITE_MEAS) (Stare)	104	APIDs 1668-1671 1681 1703-1704	L1A Main	Production SIPS	Diagnostic files
		L1A PCS output file, DPREP (ephemeris/attitude)	L1A Geolocation	Production SIPS	Database
		L1A Target files	L1B Cal/Target (using target input only)	SCF (specialized processing)	NESR, spectra
		Database	L1B Reformat	SCF (specialized processing)	L1B Product files
		NESR, spectra files	L2 Retrieval	SCF (specialized processing)	Profiles, database

At-Launch Processing Run-level Special Processing Macros, High-rate APIDs, PGE Processing and Data Outputs					
Macro Name	Run-level Macro ID	Inputs	PGE sequence	Processing Location	Output Description
INTEX Calibration (TES_INTEX_CAL)	221	APIDs 1676-1679 1681 1703-1704	L1A Main	Production SIPS	Diagnostic files
		OBRCS data database	L1B Performance	Production SIPS	magnitude spectra Database
		L1A PCS output file, DPREP (ephemeris/attitude)	L1A Geolocation	Production SIPS	Database
		L1A Cal. files	L1B Cal/Target (using cal input only)	SCF (specialized processing)	NESR, spectra
		Database	L1B Reformat	SCF (specialized processing)	L1B Product files
		NESR, spectra files	L2 Retrieval	SCF (specialized processing)	Profiles, database
INTEX Measurement (TES_INTEX_MEAS) (Transect)	225	APIDs 1668-1671 1681 1703-1704	L1A Main	Production SIPS	Diagnostic files
		L1A PCS output file, DPREP (ephemeris/attitude)	L1A Geolocation	Production SIPS	Database
		L1A Target files	L1B Cal/Target (using target input only)	SCF (specialized processing)	NESR, spectra
		Database	L1B Reformat	SCF (specialized processing)	L1B Product files
		NESR, spectra files	L2 Retrieval	SCF (specialized processing)	Profiles, database

Table 4-6. PGE Processing sequences for Engineering Macros

At-Launch Processing Run-level Engineering Macros, High-rate APIDs, PGE Processing and Data Outputs					
Macro Name	Run-level Macro ID	Inputs	PGE sequence	Processing Location	Output Description
PCS Quick Performance (TES_PCS_QUICK_PERF)	323	APIDs 1689 1705-1706	L1A Main	Production SIPS	diagnostic files
		Database, L1A PCS files	L1A PCS Performance Plot	Production SIPS	plot files
ICS Quick Performance (TES_ICS_QUICK_PERF)	321	APIDs 1688	L1A Main	Production SIPS	diagnostic files
		Database, L1A ICS files	L1A ICS Performance Plot	Production SIPS	plot files
Quick Test Pattern (TES_TP_QUICK)	390	APIDS 1682-1685	L1A Main	Production SIPS	diagnostic files

Table 4-7. PGE Processing sequences for Realtime Commands Generating High-rate APIDs

At-Launch Processing Realtime Commands[4], High-rate APIDs, PGE Processing, and Data Outputs						
Realtime Command Name	Command Type	Inputs	PGE sequence	Processing Location	Output Description	Comments
Sequence (Macro) Dump TES_5DUMP_SEQ	Immediate	APIDs 1687	L1A Main	Production SIPS	Diagnostic files	Generated when a macro dump is requested to be downlinked to the ground.
Table Dump TES_5DUMP_TABLE	Immediate	APIDs 1698	L1A Main	Production SIPS	Diagnostic files	Generated when a table (e.g., MPT, Fault Threshold,…) dump is requested to be downlinked to the ground. Fault Threshold Table dumped in fault protection macros.
Memory Dump TES_5DUMP_MEM	Immediate	APIDs 1686	L1A Main	Production SIPS	Diagnostic files	Generated when a memory dump is requested to be downlinked to the ground.

[4] These dumps are typically issued as realtime commands. One exception in the fault threshold tables, which are dumped within the fault protection macros.

4.4 Production Data Set (PDS) processing versus Expedited Data Set (EDS) processing

PDS and EDS file processing is similar in the sense that both will process the same set of APID groups as described above; however, the SIPS will use different Production rules and PGE sequence stopping points for Expedited datasets.

For Expedited datasets, SIPS operational processing will always stop after L1A Main processing is complete. All output files will be made available in the Rolling archive at the SCF. The Science Team will inspect individual values using IDL.

For Special Observation processing, SIPS operational processing will stop after L1A Main, L1A Geolocation, and L1B Performance PGE processing is complete. All output files will be made available in the rolling Science Access area at the SCF.

4.5 Websites

There are two GDS websites which support At-Launch processing. The TES SIPS website (Section 4.2.1) provides a centralized location to access the latest status of SIPS processing. The TES Internal website will document Mission Operations status with daily status reports and run logs.

The Process Teams described in Section 3.1 will use the SIPS website on a daily basis to determine the status of PGE processing by RunID/sequence/scan.

4.5.1 Production SIPS Website

The SIPS website is maintained by the SIPS team and provides automated, near-realtime SIPS status that is easily accessible by all GDS teams.

The SIPS website will have online help.

The Data Availability page of the TES SIPS website will be updated at 20 and 50 minutes after the hour. The PGE Status page of the TES SIPS website will be updated at 25 and 55 minutes after the hour.

The TES SIPS website will contain a link to the TES Internal website.

4.5.2 TES Internal Website

The TES internal website provides detailed macro descriptions.

The TES Internal website will contain a link to the TES SIPS website.

5 Production SIPS Processing

The SIPS Production Facility described in Section 5.2 will ingest and archive all L0 data received from the ASDC DAAC.

The Production SIPS will also provide L1A Main PGE processing for all L0 data received from the ASDC DAAC.

The Production SIPS processing status will be maintained through automated updates on the SIPS website 'tessipsweb', described in Section 4.5.1. The 'Data Processing' page of tessipsweb will provide reconciliation reports listing 'actual vs. received' telemetry and 'actual vs. processed' L0 data. The 'Instrument Ops' page of tessipsweb will provide a reconciliation reports of commanded vs. actual low-rate engineering data.

All L0 data arrives at the TES Production SIPS and is ingested by the SIPS software. Every L0 file is permanently archived at the TES Production SIPS for the life of the TES mission.

For every macro that is scheduled, the IOT will supply the following information to the SIPS team in advance of sending the macro:

1) Run ID #

2) Start time (± 5 sec.)

3) Stop time (± 5 sec.)

4) Orbit #

5) Macro ID #

6) Realtime command ID # (if needed)

The above information will be updated to the tessipsweb website.

The Run ID # is critical to SIPS processing. A failure to increment the Run ID # will lead to data overwrites; therefore, it is essential that the run-level macros increment the Run ID #, and that the Instrument Operations Team communicate the Run ID # and Macro ID # to the SIPS team.

The SIPS team needs to be provided with the above information as actual data representing what was downlinked from the Spacecraft. A reconciliation of the low rate data received vs. the macros commanded will be completed before the RunID is sent to the SIPS team. A record is extracted from the low-rate data stream with macro run information. The low-rate stream provides a 4Hz sampling of what macro is being executed on the instrument. Earlier predictions of the Run ID # and Macro ID # are useless to the SIPS team if the resulting runs are not guaranteed.

The above information, combined with Tables 4-3 through 4-5, tells the SIPS processing team what APIDs to expect and what PGE sequences to run.

All Visualization PGE output goes to the rolling archive at the SCF and eventually to permanent archive. All output from the visualization PGEs will be posted to the TES SIPS website.

5.1 Production SIPS Databases

The Production SIPS will generate and maintain two separate databases.

A Production Database will be used exclusively for Operational processing.

A History database will be created from the Production Database. SCF processing and SCF users will have access to the History database.

5.1.1 Production Database (Operational)

The Production database will be a 60-day rolling storage of all database entries that result from Production SIPS operational processing. The 60-day rolling period was determined assuming a 30-day GMAO latency. The Production database will be protected from any access external to the SIPS team.

5.1.2 History Database (Non-Operational)

The History database will provide a complete archive of all database entries for the life of the mission. All data in the History database is derived from data originally located in the SIPS Production database. SCF access to the History database will be provided for the life of the mission.

The History database will have a user account setup with read-only privilege.

5.2 Production SIPS Data Storage Areas

The Production SIPS will use three different storage areas categorized by the time required to access the data.

5.2.1 Online Data Storage Area

The Online Data storage area contains a 90-day rolling archive of all data generated by Production SIPS processing of all PGEs. The Online Storage Area consists entirely of online disks providing the user with immediate data access. Data placed in the online area will remain there for 90 days.

5.2.2 Nearline Data Storage Area

The Nearline Data storage area contains a 180-day rolling archive of all data generated by Production SIPS processing of all PGEs. The Nearline Storage Area consists entirely of tape cartridges stored in the tape robot device that do not require human intervention to retrieve and mount in the tape robot devices.

5.2.3 Offline Data Storage Area

The Offline Data storage area contains a permanent archive of all data generated by Production SIPS processing of all PGEs for the life of the mission. The Offline Storage Area consists entirely of tape cartridges stored on shelves that do require human intervention to retrieve and mount in the tape robot devices.

6 SCF Processing

While the L1A and L1B Performance PGEs (and their associated visualization PGEs) will be processed at the Production SIPS during the early misison phase, the first L1B Target and L1B Cal PGE processing will be done at the SCF. The method by which the Science Team will run PGEs at the SCF is still under evaluation. In addition to using the SIPS capability at the SCF, there is an alternative method to run PGEs using a tool call CASPER (Cluster-Automated System for Processing Experimental Retrievals).

The CASPER system serves two primary purposes: (1) to provide an automated system for weekly builds and tests, and (2) to provide the primary general-purpose processing of selected on-orbit TES data at the SCF. A website interface is used to display processing status.

CASPER automated weekly builds and tests include unit tests, PGE regression tests, and chained PGE tests, using pre-defined inputs with expected results. Automating these processes reduces the load on the development teams, ensures consistency between subsystems and completeness in testing, and provides ease of visibility into the success or failure of each of these operations.

CASPER will provide a means for a) prototyping and testing new PGEs and OSPs and b) processing on-orbit data at the SCF. CASPER has access to the most recent PGE and OSP versions as well as the capability to experiment with the PGEs and OSPs in an informal environment.

The CASPER website displays details of the following:
- ClearCase merges for each weekly build (i.e., the config spec used along with each ClearCase branch contributing to the build for the week)
- Compiler options and compilation messages
- Unit test results
- Regression test results
- Chained PGE test results
- Delivery package creation results

Activity for the builds and tests are displayed with color codes to indicate success or failure. Some operations may be skipped or pardoned, depending on the PGE or subsystem and its state of readiness. Accessibility to the details is provided by a simple click onto the "pass" or "fail" in each status.

6.1 Science SIPS Database (tesscft)

L1A and L1B Performance data will be copied from the SIPS Production database to the Science SIPS database. The Science SIPS database will be a 60-day rolling storage of all database entries that result from Production SIPS operational processing.

During instrument calibration/validation, the Science SIPS database will be updated to include the L1A and L1B Performance PGE updates made at the Production SIPS database.

6.2 Development database (tes9i)

The development database supports user-created databases with read/write privilege within one instance of Oracle.

6.3 SCF Science Data Access Areas

Four Science Data Access Areas will be resident at the SCF. The SIPS will have the ability to write to all four Areas. The Rolling, On Demand, and Long-Term Reference Areas will be read-only for any users other than the SIPS. (In addition to these four Science Access Areas, data in the database at the SIPS will be available at all times). The database will never have interferograms, NESR, spectra or Production History information.

The initial sizes of these data storage areas are determined based on an assumption of the size of a Global Survey (approximately 50 GB), the equivalent number of copies of the data, and its duration in the storage area.

In addition to the four Science Access Areas defined above, the SCF will provide managed areas containing Operational Support Product (OSP) inputs, Special

Calibration products, and Special Observation products. The SCF will also provide data storage areas that will be used and managed by the SCF-SIPS for its regular operations.

6.3.1 Rolling

This area will be automatically populated by SIPS via subscription with data file packages. During the early Mission phases (Activation, Interferometer Tuning and Calibration/Validation), subscriptions will be activated for the output of all PGEs run at the SIPS, as they are brought on-line. As TES gets closer to Routine processing, subscriptions for certain PGEs (such as the L1A PGEs) will be deactivated. Output from the Visualization PGEs will also be sent to this area.

For PGE outputs, a data file package is defined as all of the files that have been tar'ed together. Each file package will be placed in a directory structure based on PGE outputs created in this area.

Certain selected PGE inputs may also be subscribed to and sent to this area, such as DPREP (ephemeris and attitude) and GMAO (met) files. L0 data will not be subscribed to, since L1A will always process 100% of the L0 data at the SIPS.

SIPS will automatically remove data files from this area after sixty days. Data files required for periods longer than sixty days should be copied into the Science Analysis area described below.

Initial size of this area will be nine (9) TB.

The Rolling Archive directory structure uses the first subdirectory to sort by RunID (or date, for those data not associated with a RunID). The next tier is sorted by PGE name and date. An additional suffix is added to indicate failed PGEs. This directory structure may be modified slightly as the automated file delivery capability matures.

6.3.2 On-Demand

This area will be populated only with data file packages requested using an ordering GUI. If data files are in the 90-day on-line SIPS cache storage system, they can be delivered immediately. If data files are in the storage tape robot, delivery will take a few hours. If data files are no longer on-line and must be retrieved from offline tape storage, delivery will be completed by the next business day.

Only those files requested via the ordering GUI will appear in this area. The requestor will be notified via TBD when a request has been fulfilled. The ordering GUI allows data file packages (including L0 data files) to be requested by Data Type, Run, & Time.

For PGE outputs, a data file package is defined as all of the files that have been tar'ed together.

This area serves as a short-term holding area for requested data files.

SIPS will automatically remove data files from this area after seven days. Data files required for periods longer than seven days should be copied into the Science Analysis area described below.

Initial size of this area will be three (3) TB.

6.3.3 Long-term Reference

This area will be populated only with data files that have been identified as Reference or Static files. These may include certain Calibration data files and PGE outputs that have been identified as reference "Global Orbits" for testing. This area will also contain data files from the One-Day Test (ODT), ST-5, and HITRAN activities that are needed as reference.

During post-launch processing, the CCB will serve as the authority to approve additional data to be stored in the long-term reference area. Data files will only be removed from this area by CCB-approved requests.

Initial size of this area will be three (3) TB.

As an example, the field-of-view response (a file containing the result of analyzing the calibration data) would be a candidate to store in the long-term reference area. Files related to translator life that are derived from the ICS performance data will also be candidates to store in the long-term reference area.

6.3.4 Science Analysis

This area serves as a Science Team "Sandbox" used for algorithm testing and analysis. It is incumbent on Science Team members to copy the data files they require to this area. Members of the Science Team will use this area to store data generated by their test and analysis activities.

Data files in this area will be managed by the Science Team. Data in this area will not be routinely backed up, but can be backed up or archived by the SCF on request.

The Initial size of this area will be 9 TB.

Certain items will be created in this area that will need to be be moved to the long-term reference area.

6.4 Failed PGE packages

When SIPS processing results in a non-zero, i.e., failure return status on PGE completion, the Production SIPS will

a) cancel subsequent PGE jobs that directly depend on the failed PGE

b) run the PGE database purge script

c) produce a failed PGE package

d) cleanup files produced by the PGE prior to failure

Each Failed PGE package will go into a unique subdirectory (named by PGE, date, and process ID, if applicable) in the Rolling archive.

7 Post-Launch Processing Phases

During the first 6 months after Launch, three distinct early-mission phases have been defined preceding the point where routine Standard processing operations can be performed at the Production SIPS.

An Instrument Commissioning Plan has been developed and approved by the Aura Project Scientist.

All Aura data will be categorized using a common set of data release type definitions as follows:

Beta release – Data to the algorithm teams to tune algorithms. SIPS is operational and data is sent to the DAAC but is not accessible except by anyone except the algorithm team.

Provisional release – Data is available to the Science Team (those funded under the Aura NRA) and validation teams as appropriate. Images, pictures, for PAO purposes may be released to the general public. Users should work with the PI and algorithm teams.

Validated data release – Data has been validated and is available to the general public.

Not all data products will be available initially since some of the more difficult to produce products will require more validation and algorithm work.

7.1 Instrument Commissioning Plan

The early activation and calibration plan requirements for TES have been embedded into the Long Term Plan for the first 60 days of Aura mission operations. This point after launch coincides with the time when normal or routine operations begin, albeit with a short period where emphasis will be placed on acquiring some ground target observations for system calibration (e.g., pointing). TES will focus in the first two months on ensuring that L1A and L1B algorithms and software are verified so that operational processing to these levels can begin with good reliability at L+ 180 days. These products will then be available at the LaRC ASDC. Routine L2 production products will be made available through the LaRC ASDC beginning no later than L+ 1 year.

Based on experience with TES in system test, gradual ice build-up on the detectors will occur, leading to a progressively increasing signal loss. This ice build-up will require one or more “de-icing” or decontamination cycles early in the mission. The frequency or need for such cycles will diminish with time on orbit and the steady outgassing of the instrument and platform.

Cycles of calibration and mini-global survey observations will be performed after cooldown to establish the alignment and performance of the instrument and to assess changes which may have occurred following launch. Based on ST-5 and TV observations, this is expected to be no longer than three weeks and allows for any corrective action that may be required.

For validation purposes, and to support early mission “show and tell”, cloud-free scenes are a priority. By the end of the first year, TES expects to have completed comparisons with ozonesondes, radiance comparisons with AIRS, model atmospheric state comparisons, and one or more closure experiments with coupled aircraft and ground-based observations. Any level of data, primarily L2 products, will be made available through the AVDC for the validation teams as soon as is feasible.

TES will use one full global survey (16 orbits) as the “golden” day of data to verify and test end-to-end data processing. However, for “show and tell’ in the early mission, a more compete set of cloud-free scenes will be required from multiple global surveys over a month.

Sixteen days will be employed to conduct approximately twenty transects over the region surrounding Ascension Island in order to obtain enough data for early public releases of science results.

Table 7-2 lists the high-level activity timeline during the first year after Launch.

Table 7-2. TES Instrument and Processing Activities Through L + 1year

Timeline	Activity
L+ 0	Aura Launch.
L+ 8 days	TES Power On (noisy bus) and start instrument activation. Unlatch translator and execute test pattern macro.
L+ 11 days	Perform hot quick performance tests.
L+ 22 days	Deploy Earthshade, turn on decontamination heaters.
L+ 29 days	Turn off decontamination heaters, start instrument cool down.
L+ 31 days	Exit decontamination mode and activate cryocooler for detector cooldown.
L+ 33 days	Begin interferometer tuning phase with calibration and mini-global survey measurement cycles. Periodically assess ice buildup. (Note: reduced number of scans to conserve lifetime of instrument)
L+ 58 days	Begin formal calibration and initial validation. Priority for specific target ground sites. Transition to full 16 orbit global surveys.
L+ 3 months	On-orbit calibration assessment complete. Products transferred to ASDC DAAC.
L+ 6 months	Transition L1B operational processing to Production SIPS.
L+ 1 year	Transition L2 operational processing to Production SIPS.

The four early mission phase timelines are nominally planned, and the duration of each phase is contingent on the data processing results as described below.

7.2 Activation Phase (Day 1 – Day 33)

The Activation phase begins immediately after Launch and includes all instrument commands required to power-on the instrument, deploy the Earthshade, and cool the focal planes. The Long-Term Plan provides a detailed chronology of the TES macros and commands that are executed during the Activation phase. There will be no Special Observations processed during the Activation phase.

The L1A Main, L1A Geo-location, and L1A Visualization PGEs will be executed regularly during the Activation phase.

The focal planes will be cooled starting on Day 32.

The Quick performance macro is first executed on Day 8. This is the first time that L1A processing is required.

7.3 Interferometer Tuning Phase (Day 34 - Day 57)

Interferogram tuning will begin immediately after Activation completes. The first macro executed in this phase is the closed filter measurement macro, run after Activation completes at Day 34. This phase will be devoted to assessing the beamsplitter drift and adjusting the interferogram to maximize signal strength. A set of macros will be repeated in periodic measurement cycles as described at the end of the Long Term Plan.

The S&R macro pattern runs spatial calibration for 2 orbits followed by radiometric assessment macros every 2 orbits, repeated 7 times over 14 orbits, for a total of 16 orbits.

The GS&R macro pattern runs spatial calibration for 2 orbits followed by pre-GS calibration for 2 orbits followed by a 4-orbit mini-GS followed by radiometric assessment macros every 2 orbits, repeated 4 times over 8 orbits, for a total of 16 orbits.

The duration of the Interferogram Tuning phase will be dependent on the time it takes to stabilize the beamsplitter drift.

7.4 Calibration/Validation (Day 58 - Day 90)

The Calibration/Validation phase will focus on L1B processing. L1A processing will have been thoroughly debugged before this activity begins.

The data collection during Cal/Val will be primarily in the category of Special processing.

The completion of the Calibration/Validation phase will depend on the success of L1B PGE processing, the amount of software changes required, and the ability to achieve radiance calibration success as defined by the Science Team.

7.5 Routine Processing (Day 91 on)

The nominal plan calls for entering routine processing at Day 91. This transition is contingent on completing the Cal/Val phase.

8 Reprocessing

During the first several months after Launch full-scale reprocessing will be limited to Level 1. The nominal plan calls for no Level 2 full-scale reprocessing in the first six months. Reprocessing that occurs for Level 1 will be described in the following paragraphs.

The cause for reprocessing may include any of the following:

1) Transient errors that may occur during processing such as hardware, network or disk failure
2) Errors in staging subscribed or Operational Support or files (example: the incorrect ephemeris file is staged)
3) Failure status returned from the PGE-SIPS interface (example: numerous failed retrievals)
4) Data quality issues
5) SDPS or SIPS software failure
6) Errors in delivered files
7) Planned introduction of modified standard output file format
8) Planned algorithm or software improvement

8.1 Reprocessing Types

Reprocessing may fall into one of several categories, in order of the resources required:

8.1.1 Immediate reprocessing

Immediate reprocessing occurs when a problem is detected and the cause corrected in a short time frame, while the input data is still available on the SIPS online disk. Immediate reprocessing is confined to a limited set of Runs (or even a finer granularity if possible). An example may be correcting a strategy supplier OSP file and rerunning L2. Intermediate data to support reprocessing of an individual PGE is resident on disk and in the database. This type of reprocessing can be initiated at any PGE in the chain, but will require the database to be purged of data inserted by that PGE and intermediate file deleted. Both SIPS and the SDPS developers may have to investigate that cause of the anomaly.

8.1.2 Limited scale reprocessing

Limited scale reprocessing is restricted to some subset of data. The reprocessing is limited to only to a small set of Runs. Intermediate data has been purged and is not available on disk or in the database; therefore, limited scale reprocessing must take place from L0 forward. This type of reprocessing will require that the database be purged of data associated with that instrument Run and ESDTs replaced in the DAAC archive. It is expected that a large amount of this type of reprocessing will take place in the first year following launch.

8.1.3 Full scale reprocessing

Full scale reprocessing causes reprocessing of a large set of data. The reprocessing is caused by a major algorithm improvement or ESDT product file change. Intermediate data has been purged is not available on disk or in the database; therefore, full scale reprocessing must take place from L0 onward. This type of reprocessing will require that the database be purged of data associated with that instrument Run, and ESDTs replaced in the DAAC archive.

8.2 Reprocessing Responsibilities

8.2.1 CCB Responsibilities

The CCB will be the committee of authorization for both limited scale reprocessing and full scale reprocessing. The impact on daily processing requirements will be considered when scheduling reprocessing. The CCB will schedule and consider reprocessing impacts for algorithm and software updates. Modifications to software and controlled files will require a CCB review and follow delivery procedures. The Management Team/CCB will provide a Weekly Activity Schedule that will prioritize processing requirements, and will review the previous week's SIPS Weekly Processing Summary.

8.2.2 SIPS Responsibilities

The SIPS will be authorized to schedule immediate reprocessing when transient or minor errors occur. The SIPS will be responsible for the creation and announcement of availability of the failed PGE package. SIPS will provide a Weekly Processing Summary detailing status of processing and detected failures.

8.2.3 Science Software Team Responsibilities

The software developers will be the recipients of the failed PGE package. The analysis of the failed PGE package should take high priority in order to expedite future processing. The SDPS developers will configure and maintain software updates in response to Science Team change requests. Modifications to software and controlled files will require a CCB review and follow delivery procedures. The software product will reflect reprocessing needs, including the necessity of reporting failure through the SIPS-PGE interface and data base cleanup following failure.

Appendix A Process Team Checklist Template

Process Team: <L1A, L1B, L2> Date: <mm/dd/yy>

CHECKLIST ITEMS

TESSIPSWEB

Website checked for new data & status – yes

Summary of changes

PLOTS

All standard visualization plots checked

DATA

Expected data in /project/rolling? – still checking,

List any missing data (run/seq/scan)

failed PGEs

QA Examination

Data QA summary script ran?

Data QA summary script results per run:

(number expected targets vs. numbers processed or failed)

ACTION ITEMS

(List action items assigned and/or status from previous action items)

<Date> Action items

ANOMALIES

(List AR, CR or website feedback item #s and dates, if already reported)

Appendix B Master Macro List

Macro Name	Ver	Macro ID	MPT rows	Macro Duration	Source	High Rate APIDs	Comments
STANDARD MACROS							
TES_SUPER_GS	1.3	10	21-40	4 orbits	EEPROM	1664-1667 1680 1701-1702	TES_SUPER_GS macro TES_GS_QLSUR, TES_GS, TES_GS_RESET DeltaT = diff between TES GS orbital period (72*81.9s) and AURA S/C orbital period = 5933.2-5896.8 TES_SUPER_GS_Start MMS activity is used to schedule the 1st 4 orbit chunk so that RUNCNT is incremented. The remaining 4 orbit chunks should be scheduled using TES_SUPER_GS MMS activity so that runcnt is not incremented. Runcnt must be incremented once every 16 orbits for Global Survey.
TES_GS	1.4	11	21-40	81.9s	EEPROM		
TES_GS_RESET	1.1	16	N/A	5.7s	EEPROM		This macro is always called at the end of every science macro so that PCS is pointed to BB, and ICS in idle position. MMS activity for this

Macro Name	Ver	Macro ID	MPT rows	Macro Duration	Source	High Rate APIDs	Comments
							macro exists for contingency situations
TES_GS_QLSUR	1.3	21	21 – 40	81.9s	EEPROM		GS with expedited data for 1 scan, called by TES_SUPER_GS macro
TES_SUPER_CAL	1.5	15	1-4	2 orbits	EEPROM	1672-1675 1680 1701-1702	pre/post calibration, calls TES_SUPER_CAL macro calls TES_GS_CAL macro, TES_GS_RESET DELTA_T = 5933.2-5896.8s
TES_GS_CAL	1.5	12	1-4	5900.2s	EEPROM		Called by TES_SUPER_CAL macro
SPECIAL OBSERVATION MACROS							
TES_VOL_CAL	1.4	220	101-108	703.7s	Ground	1676-1679 1681 1703-1704	Volcano measurement
TES_VOL_MEAS	1.5	132	109-112: Colima 113-116: Erebus 117-120: Etna 121-124: Fuego 125-128: Pu OO 129-132: Lascar 133-136: Masaya 137-140: Pacaya	179.4s	Ground	1668-1671 1681 1703-1704	

Macro Name	Ver	Macro ID	MPT rows	Macro Duration	Source	High Rate APIDs	Comments
			141- 144: Sakurajima 145-148: White Island				
TES_ARMSITE_CAL	1.2	106	360-361	113.2s	Ground	1676-1679 1681 1703-1704	
TES_ARMSITE_MEAS	1.2	104	362: S. Great Plains 364: Atqasuk 366: Barrow 368:Manus Island 370: Nauru Island 372: Darwin	163.3s	Ground	1668-1671 1681 1703-1704	
TES_INTEX_CAL	1.4	221	350-351	105.9s	Ground	1676-1679 1681 1703-1704	Upload data in rows 350-351 of MPT in order to run this macro
TES_INTEX_MEAS	1.2	225	255-322	371.3s	Ground	1668-1671 1681 1703-1704	
TES_WET_GIMBAL	1.0	27	N/A	7.7s	EEPROM		
CALIBRATION							
TES_FLT_SPAL_CAL	1.6	226	1431-1551 1560-1680 1690-1810	832.5s	EEPROM	1676-1679 1703-1704	Mid Left Right
TES_CLOSED_FILTER	1.6	90	1420-1423	21014s	EEPROM	1676-1679 1703-1704	
TES_RAD_ASSESS	1.3	240	420-423	538.4s	EEPROM	1676-1679 1703-1704	
TES_OBRCS_SEARCH	1.2	443	1001-1082	1024s	EEPROM	1676-1679 1703-1704	

Macro Name	Ver	Macro ID	MPT rows	Macro Duration	Source	High Rate APIDs	Comments
FAULT PROTECTION							
TES_SHUTDOWN	0.8	360	N/A	128.5s	EEPROM		Disables all fault protection responses, idles the ICS, turns on FW mechanism background heating, Shuts down the ICS, Points the PCS at BB; Shuts down both focal plane coolers, Turns off the laser, RCS, SCS, ADCs , OB, FPOMA decon htrs, Opens all noisy bus decon htr, focal plane cooler relays, Sets submode to safe
TES_SAFE	0.7	361	N/A	0.1s	EEPROM		Enables background heating of the filter wheels, idles the ICS, PCS, points the PCS gimbal at the BB, and changes submode to SAFE.
TES_FPC_FFPS	1.0	371	N/A	50.1s	EEPROM		Disables all fault protection responses, turns on FW background heating, shuts down both focal plane coolers, opens all focal plane cooler relays, noisy bus decon heater relays, idles the ICS, shuts down the ICS, points the PCS at BB, turns off the laser, SCS, RCS, ADCs, OB decon heaters, FPOMA decon heaters,

Macro Name	Ver	Macro ID	MPT rows	Macro Duration	Source	High Rate APIDs	Comments
							and changes the submode to safe
TES_IEM_FFPS	0.9	372	N/A	7.1s	EEPROM		Disables all FP responses, re-enables FPC FP responses, Disables all LASER FP responses, turns on FW background heating, idles the ICS, PCS shuts down the ICS, PCS, turns off the laser, SCS, RCS, ADCs, OB, FPOMA decon heaters; opens all noisy bus decon heater relays, downloads the fault error log, and sets to safe submode
PERFORMANCE							
TES_ICS_QUICK_PERF	1.2	321	N/A	171.9s		1688	Collects ICS performance data by doing short and long scans
TES_PCS_QUICK_PERF	1.4	323	N/A	271.9s		1689, 1705-1706	Collects PCS perf data only without any other subsystem mechanisms moving
TES_TP_QUICK	1.1	390	N/A	87s		1682-1685	Collects high rate science test pattern data by doing short and long scans
FPCA (All cooler macros are called in real-time)							
TES_FPCA_ACT1_SETRELAY	1.1	300	N/A	214.2s	EEPROM		

Macro Name	Ver	Macro ID	MPT rows	Macro Duration	Source	High Rate APIDs	Comments
TES_FPCA_ACT2_UPLOAD	1.1	301	N/A	197.8s	EEPROM		
TES_FPCA_ACT3_SETDRIVE	1.3	302	N/A	134.7s	EEPROM		
TES_FPCA_ACT4_SETTEMP	1.4	303	N/A	87.6s	EEPROM		
TES_FPCA_ACT5_SETVIB	1.2	304	N/A	108.7s	EEPROM		
TES_FPCA_ON	1.2	305	N/A	222.7s	EEPROM		
TES_FPCA_SHUTDN	1.1	306	N/A	90.4s	EEPROM		
TES_FPCA_SWEEP	1.3	307	N/A	322.2s	EEPROM		
TES_FPCA_MON	1.0	316	N/A	600s	EEPROM		
TES_FPCA_DEBUG	1.0	317	N/A	300s	EEPROM		
TES_FPCA_ACT1_SETRELAY	1.0	327	N/A	214.2s	EEPROM		Uses secondary relays
TES_CRYOCLRA_OFF	1.1	350	N/A	139.1s	EEPROM		
FPCB							
TES_FPCB_ACT1_SETRETRELAY	1.1	301	N/A	214.2s	EEPROM		
TES_FPCB_ACT2_UPLOAD	1.1	309	N/A	130.3s	EEPROM		
TES_FPCB_ACT3_SETDRIVE	1.3	310	N/A	134.7s	EEPROM		
TES_FPCB_ACT4_SETTEMP	1.2	311	N/A	87.6s	EEPROM		
TES_FPCB_ACT5_SETVIB	1.2	312	N/A	99.8s	EEPROM		

Macro Name	Ver	Macro ID	MPT rows	Macro Duration	Source	High Rate APIDs	Comments
TES_FPCB_ON	1.3	313	N/A	92.3s	EEPROM		
TES_FPCB_SHUTDN	1.1	314	N/A	90.4s	EEPROM		
TES_FPCB_SWEEP	1.3	315	N/A	322.2s	EEPROM		
TES_FPCB_MON	1.0	318	N/A	600s	EEPROM		
TES_FPCB_DEBUG	1.0	319	N/A	300s	EEPROM		
TES_FPCB_ACT1_SETRELAY	1.0	328	N/A	214.2s	EEPROM		Uses secondary relays
TES_CRYOCLRB_OFF	1.1	351	N/A	139.1s	EEPROM		
FSW-related							
tes_dump_eeprom_fswv20_pri_app_bc_72	1.0	72	N/A	15s	Ground	1686	Microprocessor load to RAM
tes_dump_eeprom_fswv20_pri_vxw_bc_73	1.0	73	N/A	15s	Ground	1686	Microprocessor load to RAM
tes_dump_eeprom_fswv20_seca_vxw_bc_74	1.0	74	N/A	15s	Ground	1686	Microprocessor load to RAM
tes_dump_eeprom_fswv20_secb_vxw_bc_75	1.0	75	N/A	15s	Ground	1686	Microprocessor load to RAM
tes_dump_eeprom_fswv20_seca_app_bc_76	1.0	76	N/A	15s	Ground	1686	Microprocessor load to RAM
tes_dump_eeprom_fswv20_secb_app_bc_77	1.0	77	N/A	15s	Ground	1686	Microprocessor load to RAM
tes_chksum_dram_80	1.0	80	N/A	3000s	Ground	1686	Microprocessor load to RAM
tes_chksum_dram_81	1.0	81	N/A	3000s	Ground	1686	Microprocessor load to RAM

Macro Name	Ver	Macro ID	MPT rows	Macro Duration	Source	High Rate APIDs	Comments
tes_chksum_dram_82	1.0	82	N/A	3000s	Ground	1686	Microprocessor load to RAM
tes_chksum_dram_83	1.0	83	N/A	3000s	Ground	1686	Microprocessor load to RAM
tes_chksum_dram_84	1.0	84	N/A	3000s	Ground	1686	Microprocessor load to RAM
tes_chksum_dram_85	1.0	85	N/A	3000s	Ground	1686	Microprocessor load to RAM
tes_dump_eeprom_fswv20_pri_app_44	1.0	44	N/A	305s	Ground	1686	Microprocessor load to RAM
tes_dump_eeprom_fswv20_pri_vxw_48	1.0	48	N/A	140s	Ground	1686	Microprocessor load to RAM
tes_dump_eeprom_fswv20_vxw_a_41	1.0	41	N/A	140s	Ground	1686	Microprocessor load to RAM
tes_dump_eeprom_fswv20_vxw_b_43	1.0	43	N/A	140s	Ground	1686	Microprocessor load to RAM
tes_dump_eeprom_fswv20_sec_a_app_50	1.0	50	N/A	305s	Ground	1686	Microprocessor load to RAM
tes_dump_eeprom_fswv20_sec_b_app_51	1.0	51	N/A	305s	Ground	1686	Microprocessor load to RAM
tes_crc_eeprom_fswv20_pri_vxw_53	1.0	53	N/A	30s	Ground	1686	Microprocessor load to RAM
tes_crc_eeprom_fswv20_vxw_a_54	1.0	54	N/A	30s	Ground	1686	Microprocessor load to RAM
tes_crc_eeprom_fswv20_vxw_b_55	1.0	55	N/A	30s	Ground	1686	Microprocessor load to RAM
tes_crc_eeprom_fswv20_pri_app_52	1.0	52	N/A	30s	Ground	1686	Microprocessor load to RAM
tes_crc_eeprom_fswv20_sec_a_app_56	1.0	56	N/A	30s	Ground	1686	Microprocessor load to RAM
tes_crc_eeprom_fswv20_sec_b_app_57	1.0	57	N/A	30s	Ground	1686	Microprocessor load to RAM

NOTES: Telemetry point TES_C5_SEQ_ID will show the macro ID (non zero value) to indicate the macro onboard TES is executing. TES_C5_SEQ_ID will equal zero when the macro has completed executing. No TES commands other than TES_5HALT_SEQ must be sent when TES_C5_SEQ_ID is non zero.

Appendix C Observation Types

Data Field	Hex
Glob Surv Cold Space Pre-Cal	01
Glob Surv Blackbody Pre-Cal	02
Glob Surv Cold Space View	03
Glob Surv Blackbody View	04
Glob Surv Nadir View	05
Glob Surv Limb View	06
Glob Surv Cold Space Post-Cal	07
Glob Surv Blackbody Post-Cal	08
Special Obs Short Scan Science	09
Special Obs Long Scan Science	0A
Special Obs Regional Pollution	0B
Special Obs Acid Rain	0C
Special Obs Biomass Burning	0D
Special Obs Volcano	0E
Special Obs Industrial Catastrophe	0F
Special Obs Stare	10
Special Obs Transect	11
Special Obs Long Scan Limb Correlative Measurement	12
Special Obs Short Scan Nadir	13
Special Obs Short Scan Blackbody	14
Special Obs Short Scan Cold Space	15

Special Obs Long Scan Limb	16
Special Obs Short Scan Gimbal Angle	17
Special Obs Cold Space Pre-Bracket Cal	18
Special Obs Blackbody Pre-Bracket Cal	19
Special Obs Cold Space Post-Bracket Cal	1A
Special Obs Blackbody Post-Bracket Cal	1B
Special Obs Variable Temperature Blackbody Linearity Test	1C
Special Obs Variable Temperature Cold Space Linearity Test	1D
Special Obs Long Scan Cold Space Cal	1E
Special Obs Long Scan Blackbody Cal	1F
Special Obs Short Scan Cold Space Cal	20
Special Obs Short Scan Blackbody Cal	21
Special Obs Spatial Cal	22
Special Obs Cold Space Variable Temperature Gain Cal	23
Special Obs Blackbody Variable Temperature Gain Cal	24
Special Obs Test Pattern	25
Special Obs Long Scan Nadir View	26

Appendix D TES Instrument APIDs

High Rate Telemetry Packets		
Packet Type	APID (decimal)	Size (bytes)
Global Survey Data (Focal Plane 1A)	1664	8192
Global Survey Data (Focal Plane 1B)	1665	8192
Global Survey Data (Focal Plane 2A)	1666	8192
Global Survey Data (Focal Plane 2B)	1667	8192
Special Observation Data (Focal Plane 1A)	1668	8192
Special Observation Data (Focal Plane 1B)	1669	8192
Special Observation Data (Focal Plane 2A)	1670	8192
Special Observation Data (Focal Plane 2B)	1671	8192
Pre/Post Global Survey Cal Data (Focal Plane 1A)	1672	8192
Pre/Post Global Survey Cal Data (Focal Plane 1B)	1673	8192
Pre/Post Global Survey Cal Data (Focal Plane 2A)	1674	8192
Pre/Post Global Survey Cal Data (Focal Plane 2B)	1675	8192
Special Calibration Data (Focal Plane 1A)	1676	8192
Special Calibration Data (Focal Plane 1B)	1677	8192
Special Calibration Data (Focal Plane 2A)	1678	8192
Special Calibration Data (Focal Plane 2B)	1679	8192
Global Survey Ancillary State Data	1680	8192
Special Observation Ancillary State Data	1681	8192
FPS Test Pattern Data (Focal Plane 1A)	1682	8192
FPS Test Pattern Data (Focal Plane 1B)	1683	8192
FPS Test Pattern Data (Focal Plane 2A)	1684	8192
FPS Test Pattern Data (Focal Plane 2B)	1685	8192
Memory Dump Data	1686	8192
Sequence Dump Data	1687	8192
ICS Performance Data	1688	8192
PCS Performance Data	1689	8192
Table Dump Data	1698	8192
Global Survey PCS State Data	1701	8192
Global Survey ICS State Data	1702	8192
Special Observation PCS State Data	1703	8192
Special Observation ICS State Data	1704	8192
PCS Performance Gyro Data	1705	8192
PCS Performance Ancillary Data	1706	8192

Low Rate Telemetry Packets		
Packet Name	APID (decimal)	Size (in bytes)
Low Rate Nominal Engineering Data	1690	256
Low Rate Special Cooler Engineering Data	1691	256
Low Rate Special TMR Status Data	1699	256
Low Rate Special VME Register Data	1700	256
Low Rate FPC Time Tag	1707	256
Low Rate FPC Active DB Settings	1708	256
Low Rate FPC Active Waveform Coefficients	1709	256
Low Rate FPC Active Perturbation Coefficients	1710	256
Low Rate FPC Default DB Settings	1711	256
Low Rate FPC Default Waveform Coefficients	1712	256
Low Rate FPC Default Perturbation Coefficients	1713	256
Low Rate FPC SW ID & Version Information	1714	256
Low Rate FPC Diagnostic Results	1715	256
Low Rate FPC Debug Results	1716	256
Low Rate FPC Memory Dump	1717	256

Appendix E Acronyms

Acronyms	
ASDC	Atmospheric Science Data Center
CM	Configuration Management
CPT	Comprehensive Performance Test
DAAC	Distributed Active Archive Center
DPREP	Data Pre-Processing
EDS	Expedited Data Set
ELANOR	Earth Limb And Nadir Operational Retrieval
ESDT	Earth Science Data Type
FOV	Field of View
GB	Gigabytes
GMAO	Global Modeling and Assimilation Office
KB	Kilobytes
L1A	Level 1A
L1B	Level 1B
L2	Level 2
MT	Mission Test
NESR	Noise Equivalent Spectral Radiance
ODT	One Day Test
OSP	Operational Support Product
PCF	Process Control File
PDS	Production Data Set
PGE	Product Generation Executive (Executable)
SCF	Science Computing Facility
SCIF	Spacecraft Interface Test
SIPS	Science Investigator-led Processing System
SRC	Survey Retrieval Control
TB	Terrabytes (10^{12} bytes)
TES	Tropospheric Emission Spectrometer