

SANTA BARBARA
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A HUGHES ELECTRONICS COMPANY

**MODERATE RESOLUTION IMAGING
SPECTRORADIOMETER
(MODIS) PROGRAM**

**UPDATED WBS DIAGRAM AND
TASK DESCRIPTION**

(REVISION 8)

PREPARED FOR
NATIONAL AERONAUTICS & SPACE ADMINISTRATION
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MODIS

WORK BREAKDOWN STRUCTURE (WBS) DICTIONARY

Revision 8

(Changes from WBS Dictionary Revision 7
are noted with paragraph change bars.)

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WBS DICTIONARY
Moderate Resolution Imaging Spectroradiometer (MODIS)

AXXX SYSTEM STUDY

This element includes efforts required to refine derived requirements on the instrument system and subsystems, to conduct tradeoffs and refine the instrument design, and to prepare and present the System Study Review (SSR). It includes the initial effort to plan the MODIS program and initiate the Performance Measurement System (PMS) and the training associated with the preparation for the implementation of the PMS.

AAXX System Study

1XXX PROGRAM MANAGEMENT

This element includes all efforts required to provide program management. It includes planning, technical direction, schedules, budgets, formal and informal reviews, documentation, and control of all program efforts including program management functions for the major subcontractors.

11XX Program Office

This element includes program technical integration and management: to direct performing functional groups, management/integration of customer interface, and liaison meetings. It specifically includes the efforts of the program manager's staff and contract administrative support. This element includes the preparation and maintenance of a project plan, a Project Organization Chart, and other program management CDRL items not separately priced and included in 14XX. This element includes the effort, if required, to prepare estimates for added scope tasks.

This element includes the management of major subcontractors. It covers planning, technical direction, schedules, budgets, integration, measurement, and control of all program effort associated with major subcontractors. It coordinates government approval of major subcontracts. This task includes subcontract administration (procurement) specifically assigned to support any major subcontract technical officers. Engineering assigned to the subcontract should be covered in the appropriate WBS element where the subcontract appears. MPA is included in this WBS element.

This element includes all efforts associated with the procurement of high reliability parts and materials which are generally not specifically designed by the SBRC for MODIS.

12XX Financial and Schedule Controls and Reporting

This element includes all effort to develop and maintain a program control section, prepare and maintain a master program schedule, prepare and maintain schedules and reporting in conformance with the PMS. This task does not include the efforts of technical and functional management to prepare, analyze and control their internal schedules or their contribution to the maintenance of program schedules and status. These efforts are considered to be a part of tasks defined elsewhere in the WBS.

This element also includes integration, preparation, and maintenance of program budgets and the assessment of progress against them, including reporting in conformance with the PMS. It also includes financial evaluation of changes on the program; the preparation of management and customer financial reports including CDRL items 003 (Performance Measurement System Implementation Plan & System Description - completed with the proposal), 015 (Updated WBS Diagram and Task Description), 523 (Performance Measurement Status Report (PMSR)) and implementation of cost control procedures. CDRL items 036 (Schedule Management Plan), 534 (Monthly and Quarterly Financial Management Reports), 538 (Intermediate Logic Network Diagrams), 541 (Work Packages/Scheduling System Cross Reference Guide), and 542 (End Item Float Report and Analysis) are priced separately in 141X.

13XX Configuration Management and Data Management

This element includes configuration control to the component level for hardware and to the line of code level for software. It includes the preparation and maintenance of a Hardware System Configuration Management Plan (CDRL 005) and the preparation, maintenance, and control of performance and interface requirements and other related documentation. This element includes the effort to administer the tracking, compilation, reproduction, and submittal (through Contracts) of CDRL items 104 (Engineering Analysis Reports), 105 (Contractor-Generated Internal Technical Memoranda), 203 (Configuration Management Status Report), 220 (Other Technical Reports and Reissued Reports), 304 (Engineering Drawings, for Materials Applications), 401 (Standard Practices and Procedures), 509 (Approved or Controlled Drawings), 510 (Material Review Board (MRB) Waiver/Deviation Requests), 511 (Safety Waiver Requests), 512 (Configuration Change Requests (CCR) Class I), 513 (Configuration Change Requests (CCR) Class II), 515 (Drawing Tree), 517 (Drawing Books), and 518 (Indentured Drawing List). It includes status accounting and verification auditing. This element includes the effort to administer the tracking, reproduction, and submittal (through Contracts) of the data items prepared under element 14XX.

14XX Documentation

This element includes the preparation and maintenance of the overall MODIS program documentation as specified in the contract. This item includes the effort to organize and outline any documentation preparatory to its generation. Only documentation separately priced in the proposal is included in this WBS element. All documentation included in this item shall be individually identified (e.g., Design Report, Interface Specification Document, Operation and Maintenance Manuals, etc.). The effort to administer the tracking, reproduction, and submittal (through Contracts) of these data items is included in element 13XX of this WBS.

15XX Manufacturing Management

This element includes manufacturing support labor not directly related to a hardware or touch labor task. It includes the efforts of PC/MC, the history (1992-1995) of the Manufacturing Manager (who was the Responsible Manufacturing Authority (RMA)), and history (1992-1995) for Cost Analysis. This cost account includes the effort to prepare the CDRL items: 010 (Make or Buy Plan-completed prior to

contract award) and 414 (Standard Repair Procedures). The history (1992-1995) of the effort to manage all Manufacturing cost accounts is included in this WBS element. In the December 1995/January 1996 timeframe, managing the manufacturing cost accounts shifts to the Cost Account Managers who have responsibility for hardware.

1LXX Engineering Document Control Center (EDCC) and Labor Pools

This element includes the allocated costs for EDCC services and labor pooling allocations. EDCC releases and maintains records and files of engineering documents. Labor Pooling charges for managers and secretaries in the labor pool system are automatically allocated across the accounts charged by the personnel that they support. In 1996, labor pooling charges will no longer be collected in 1LXX. All labor pooling charges will be planned and accrued across the accounts charged by the personnel that they support.

2XXX SYSTEM ENGINEERING AND ANALYSES

This element includes the effort required to generate the overall system requirements, which include the instrument and its test equipment. It includes definition of system requirements and interfaces so that the individual subsystem designs may advance in a unified manner. The system engineering task will include all advisory efforts involved in the design, integration, test and evaluation of the MODIS as an individual system and as a part of a spacecraft system. This will be a continuing effort starting with system definition and following through to final performance tests and calibrations. This task will include the oversight of all system software development, including flight software, algorithms for data reduction, algorithms for calibration, and GSE software, to ensure that the system requirements are met. This WBS element includes all system engineering CDRL items that were not separately priced and included in 142X. These include CDRL items: 022 (Performance Verification Plan), 102 (Structural Math Model), 103 (Thermal Math Model), 201 (Previously Designed, Fabricated or Flown Hardware Data), 207 (Engineering Test Reports), 219 (Instrument Output Data Records Required in Special Data Requirements Section of the MODIS Specification), 223 (New Technology Reports), 301 (Specifications on Parts, Materials, Subassemblies/Subsystems), 302 (Instrument Functional Logic Diagrams), 303 (Command List and Description), 308 (Performance Verification Specification), 408 (Control of Unscheduled Activities (Integration/Verification Testing)), 409 (Detailed Test Procedures), 410 (Detailed Ground Calibration Procedures), 412 (Performance Verification Procedures), and 503 (Weight and Power Budgets).

21XX Administration

This element includes the effort required to support the Program Office in communications with GSFC and SBRC Management regarding the technical status of the MODIS program. It includes management of the total system engineering effort and system engineering support provided in preparation of program schedules and implementation of the PMS.

This element includes all System Engineering efforts associated with the preparation, organization, and presentation of all required internal design reviews. It includes all System Engineering efforts associated with the preparation, organization, and presentation of the formal design reviews, including the Quarterly Management Review, Preliminary Design Review, the Critical Design Review, Pre-Environmental Testing Reviews, Post-Environmental Testing Reviews, and Preshipment

(Acceptance) Reviews. It shall include travel costs, manpower, and all special documentation needed to conduct these formal and informal reviews. The cost of producing and reproducing CDRL items associated with these reviews is included in WBS-element 14XX. This WBS element includes the effort to prepare CDRL 223 (New Technology Reports).

22XX Requirements

This element includes all system engineering to define system and subsystem requirements as design inputs for an instrument which will meet the specifications. This element includes system engineering oversight in the definition and control of all internal instrument interfaces.

This element includes definition of all test and calibration requirements to assure that the test and calibration program demonstrates compliance with the specifications. It includes the generation of top-level GSE requirements and test specification requirements which will ensure the verification of the instrument performance requirements.

This element includes the preparation and updating of system-level instrument test and calibration procedures. It includes the preparation, review and updating of the subsystem procedures to ensure they are compatible with and responsive to the overall system test plans.

This element includes definition of data system requirements from within the instrument to the GSE, via the spacecraft (when present) and EOSDIS (when present). The purpose of the requirements is to assure that the instrument data is available for engineering evaluation when the instrument is at the SBRC facility, at the spacecraft integrator's facility, on an EOS spacecraft at the spacecraft integrator's facility, or in orbit.

This task will include the oversight of all system software development, including flight software, algorithms for data reduction, and GSE software, to ensure that the system requirements are met.

This WBS element includes the coordination of the efforts to prepare and compile the following CDRL items: 022 (Performance Verification Plan), 201 (Previously Designed, Fabricated or Flown Hardware Data), 301 (Specifications on Parts, Materials, Subassemblies/Subsystems), 302 (Instrument Functional Logic Diagrams), 303 (Command List and Description), 308 (Performance Verification Specification), 409 (Detailed Test Procedures), 410 (Detailed Ground Calibration Procedures), 412 (Performance Verification Procedures), and 503 (Weight and Power Budgets).

23XX System Analyses

This element includes all analytical studies carried out as inputs to the design of the instrument, which are necessary to assure that the instrument will satisfy the specifications, or which are required for delivery to the spacecraft contractor.

This element includes systems engineering oversight and participation in engineering analyses of the data resulting from test and calibration of the instrument models. It includes analysis of all performance data to verify compliance with the specifications, or to identify areas where the trade-offs and/or improvements may be necessary.

This element includes generation and maintenance of all radiometric analyses necessary to assure that the instrument will satisfy the specifications, both during ground testing and in orbit. It includes the radiometric math models identified in the specification.

This element includes system engineering oversight of all optical analyses necessary to assure that the instrument will satisfy the specifications.

This element includes system engineering oversight of all polarization analyses necessary to assure that the instrument will satisfy the specifications.

This element includes system engineering oversight of all stray light analyses necessary to assure that the instrument will satisfy the specifications.

This element includes system engineering oversight of all electrical/electronic analyses necessary to assure that the instrument will satisfy the specifications.

This element includes generation and maintenance of all structural analyses necessary to assure that the instrument will satisfy the specifications, or to provide to the spacecraft contractor.

This element includes generation and maintenance of all system-level thermal analyses necessary to assure that the instrument will satisfy the specifications, or to provide to the spacecraft contractor. The system thermal analyses include both the instrument assembly and any radiative coolers. This element includes system engineering oversight of all thermal analyses performed at the component or assembly level.

This element includes generation and maintenance of all contamination analyses necessary to assure that the instrument will satisfy the specifications.

This element includes generation and maintenance of all analyses of the impact of temperature changes upon instrument performance which are necessary to assure that the instrument will satisfy the specifications. It includes thermal sensitivities of the optics, spectral definition, focal plane, structure, mechanisms, and electronics.

This element includes the following CDRL items: 102 (Structural Math Model), 103 (Thermal Math Model), and 207 (Engineering Test Reports).

24XX AM Spacecraft Interfaces

This element includes specification and control of all interfaces between the instrument and the AM spacecraft.

25XX Instrument Integration and Test Support

This element includes the system engineering support during the integration and test phases of the program to assess, on a day-to-day basis, the validity of the data and test results (both during alignment and test) so as to anticipate and prevent serious problems later on. This element includes preparation and maintenance of the instrument command list and description and general instrument operating procedures. This element includes CDRL Items 408 (Control of Unscheduled Activities (Integration/Verification Testing)), and 219 (Instrument Output Data Records Required in Special Data Requirements Section).

26XX Algorithm Development

This element includes all algorithm development necessary to support instrument testing, calibration and performance evaluation in any instrument operating environment (Ref: GSFC WBS 3.10).

27XX PM Spacecraft Interfaces

This element includes all design costs associated with the EOS-PM Spacecraft interface and accommodation studies.

4XXX INSTRUMENT DESIGN & DEVELOPMENT

This element includes all the design activity, in coordination with the system engineering and system analyses, necessary to assure that the instrument will satisfy the specifications. Interface design activity, pertinent both to interfaces within the instrument and to interfaces between the instrument and the spacecraft, is included within the appropriate elements listed below. These elements shall be performed in coordination with the system engineering and system analyses performed under WBS element 2XXX, to assure that the instrument will satisfy the specifications. This element includes the generation of engineering drawings and other design documents, and maintenance of these documents during the design period. It includes breadboarding and subsystem design analyses, subsystem project management and subsystem cost and schedule planning and control.

41XX Optical Assemblies and Mounts Design

This element includes all design activity associated with the Afocal Telescope Assembly, and the aft-optics objective assemblies (VIS Objective, NIR Objective, SWIR/MWIR Objective, and LWIR Objective), the dichroic beamsplitters (Dichroic #1, Dichroic #2, and Dichroic #3) and their mounts, and the spectral filters for the VIS, NIR, SWIR/MWIR, and LWIR focal planes. The design of the Aft Optics Platform and Afocal Telescope Bench are included in this element. The design of the filter mounting hardware is included in element 42XX. This element includes interface design activity, pertinent to interfaces between these optical assemblies and other components of the instrument. It includes the generation of engineering drawings and other design documents for these optical assemblies and mounts, and maintenance of these documents during the design period. It includes breadboarding, risk reduction activities, and optical design analyses related to these elements of the design. Design analyses include optical ray traces, stray light analyses, polarization analyses, thermal and structural analyses. It includes support of the contamination analyses performed by System Engineering. This element

includes the effort to provide Opto-Mech project management for the Design and Development period. It includes cost and schedule planning, control, and statusing for 41XX cost accounts for the design and development period . This element includes all efforts associated with the preparation, organization, and presentation of all required internal design reviews regarding hardware or software items included in this WBS element. It includes all preparation and organization of materials in support of the MODIS system Preliminary Design Review and the Critical Design Review. Data package preparation and participation in these formal system-level reviews are included elsewhere in the WBS.

42XX FPA Design

This element includes all focal plane design and breadboard activity, except for the design of the spectral filters which is included in 41XX and the design of the Cold Focal Plane Assembly (CFPA) platform, which is included in 45XX. It includes the design of the VIS, NIR, SWIR/MWIR, and LWIR focal planes. It includes the efforts associated with the design, fabrication, and testing of any proof-of-concept parts for design evaluation or life testing of the FPAs. The Focal Plane design includes the sensor chip assembly (SCA) design, detector design, readout design, mechanical packaging design, and cable and connector design. It includes interface design activity, pertinent to interfaces between the focal planes and other components of the instrument and between the focal plane subassemblies. This element includes the generation of engineering drawings and other design documents for the Focal Planes, and maintenance of these documents during the design period through Critical Design Review. It includes breadboarding and risk reduction activities, and Focal Plane design analyses. Design analyses include detector and readout performance analyses, stray light analyses, thermal and structural analyses. It includes support of the contamination analyses performed by System Engineering, and the design and development of focal plane packaging tooling, critical process development, and SCA/FPA test equipment. This element includes the effort to provide Focal Plane project management for the Design and Development period ending at the Critical Design Review. It includes cost and schedule planning, control, and statusing for all 42XX cost accounts for the design and development period ending at the Critical Design Review. It includes the effort associated with interfacing with HTC and coordinating the design and development of the VIS and NIR SCAs and the infrared focal plane readout circuits. This element includes the design and fabrication of a breadboard readout drive electronics assembly for use in SCA testing and as a design aid for interface electronics incorporated in the Analog Electronics Modules (AEMs) (47XX). This element includes all efforts associated with the preparation, organization, and presentation of all required internal design reviews regarding hardware or software items included in this WBS element. It includes all preparation and organization of materials relative to the activities of this WBS element in support of the MODIS system Preliminary Design Review and the Critical Design Review. Data package preparation and participation in these formal system-level reviews are included elsewhere in the WBS.

43XX Mainframe Structure and Door Design

This element includes the design of the mainframe structure and anti-contamination doors. This includes the design of the nadir aperture, solar diffuser , and space-view anti-contamination door assemblies. The design of actuators to control these doors is

also included in this element. This element also includes the design of the multi-layer insulation (MLI) thermal blankets. This cost account includes mechanical, thermal, and structural interface design activity, pertinent to interfaces between the Mainframe, doors, and door actuators and other assemblies of the instrument. It includes the generation of engineering drawings and other design documents for the mechanical parts, mechanisms, and subassemblies of the Mainframe Assembly and door assemblies, and maintenance of these documents during the design period. It includes breadboarding, risk reduction activities, and mechanical, thermal, and structural design analyses related to these elements of the design. It includes support of the contamination analyses performed by System Engineering. It includes cost and schedule planning, control, and statusing for all 43XX cost accounts for the design and development period. This element includes all efforts associated with the preparation, organization, and presentation of all required internal design reviews regarding hardware or software items included in this WBS element. It includes all preparation and organization of materials relative to the activities of this WBS element in support of the MODIS system Preliminary Design Review and the Critical Design Review. Data package preparation and participation in these formal system-level reviews are included elsewhere in the WBS.

44XX Scan Mirror Assembly Design

This element includes all design and breadboard activity associated with the scan mirror subsystem, except for the control electronics which are included in element 46XX. This element includes the design of the two-sided scan mirror, low distortion mirror mount, and the scan mirror and coatings, and the motor mount assembly. It includes the generation of engineering drawings and other design documents for the optical and mechanical parts, mechanisms, and subassemblies of the Scan Mirror Assembly, and maintenance of these documents during the design period. This element includes all breadboarding, risk reduction activities, and optical design, thermal, and structural design analyses related to the scan mirror design. It includes support of the contamination analyses performed by System Engineering. It includes cost and schedule planning, control, and statusing for all 44XX cost accounts for the design and development period. This element includes all efforts associated with the preparation, organization, and presentation of all required internal design reviews regarding hardware or software items included in this WBS element. It includes all preparation and organization of materials relative to the activities of this WBS element in support of the MODIS system Preliminary Design Review and the Critical Design Review. Data package preparation and participation in these formal system-level reviews are included elsewhere in the WBS.

45XX Radiative Cooler Design

This element includes all design and breadboard activity associated with the Radiative Cooler. It does not include the radiative cooler anti-contamination door assembly which is included in WBS element 43XX. This element includes all structural and thermal analyses of the Radiative Cooler at the assembly level and below. It includes support of the contamination analyses performed by System Engineering. It includes the generation of engineering drawings and other design documents for the Radiative Cooler Assembly and maintenance of these documents during the design period. It includes cost and schedule planning, control, and statusing for all 45XX cost accounts for the design and development period. This element includes all efforts

associated with the preparation, organization, and presentation of all required internal design reviews regarding hardware or software items included in this WBS element. It includes all preparation and organization of materials relative to the activities of this WBS element in support of the MODIS system Preliminary Design Review and the Critical Design Review. Data package preparation and participation in these formal system-level reviews are included elsewhere in the WBS.

46XX Main Electronics Module (MEM) Design

This element includes all design of the MEM including electronics circuit design and electronics packaging design. The effort associated with the on-board calibrator electronics, generally packaged within the MEM, is included in this element. This element includes the design and mockup of any harnesses that may be necessary to interconnect the MEM with the AEMs, the On-Board Calibrators, and other elements of the electrical subsystem. It includes the efforts associated with the design, fabrication, and testing of any proof-of-concept parts for design evaluation or life testing of hybrid circuits used in the MEM. It includes the generation of engineering drawings and other design documents for the MEM and maintenance of these documents during the design period. This WBS element includes liaison with vendors and coordination with Materiel during the design and development period. This element includes all electronic, structural and thermal analyses of the MEM at the component level and below. This element includes the effort to provide Electronics project management for the design and development period. It includes cost and schedule planning, control, and statusing for all 46XX cost accounts during this period. This element includes all efforts associated with the preparation, organization, and presentation of all required internal design reviews regarding hardware or software items included in this WBS element. It includes all preparation and organization of materials relative to the activities of this WBS element in support of the MODIS system Preliminary Design Review and the Critical Design Review. Data package preparation and participation in these formal system-level reviews are included elsewhere in the WBS.

47XX AEMs Design

This element includes all design and breadboarding activity associated with the AEMs. It includes electronics circuit and packaging design. (The design and fabrication of a brassboard readout drive electronics assembly will be provided under WBS-element 42XX.) It includes the efforts associated with the design, fabrication, and testing of any proof-of-concept parts for design evaluation or life testing of hybrid circuits used in the AEMs. It includes the generation of schematic drawings and other circuit design documents for the AEMs and maintenance of these documents during the design period. This element includes all electronics, structural and thermal analyses of the AEMs at the component level. It includes cost and schedule planning, control, and statusing for all 47XX cost accounts for the design and development period. This WBS element includes liaison with vendors and coordination with Materiel regarding the AEMs during the design and development period. This element includes all efforts associated with the preparation, organization, and presentation of all required internal design reviews regarding hardware or software items included in this WBS element. It includes all preparation and organization of materials relative to the activities of this WBS element in support of the MODIS system Preliminary Design Review and the Critical Design Review.

Data package preparation and participation in these formal system-level reviews are included elsewhere in the WBS.

48XX On-Board Calibrators Design

This element includes the on-board calibrator Optical and Mechanical design activity, in coordination with system engineering and system analyses performed under element 2XXX, which is necessary to assure that the instrument will satisfy the specifications. This element includes the design activity associated with the on-board Blackbody, the Solar Diffuser, the Solar Diffuser Stability Monitor, and the Spectroradiometric Calibrator. It includes the generation of engineering drawings and other design documents for the on-board calibrators and maintenance of these documents during the design period. It includes all optical, structural, and thermal analyses of these assemblies performed at the assembly level. It includes support of the contamination analyses performed by System Engineering. It includes cost and schedule planning, control, and statusing for all 48XX cost accounts for the design and development period. This element includes all efforts associated with the preparation, organization, and presentation of all required internal design reviews regarding hardware or software items included in this WBS element. It includes all preparation and organization of materials relative to the activities of this WBS element in support of the MODIS system Preliminary Design Review and the Critical Design Review. Data package preparation and participation in these formal system-level reviews are included elsewhere in the WBS.

4AXX On-Board Software Development

This WBS element includes all development, flow charting, coding, documentation, etc., of instrument-based software/firmware necessary to assure that the instrument will satisfy the specification. It includes command and data handling functions within the instrument and between the instrument and the spacecraft. It includes cost and schedule planning, control, and statusing for all 4AXX cost accounts for the design and development period. This element includes all efforts associated with the preparation, organization, and presentation of all required internal design reviews regarding hardware or software items included in this WBS element. It includes all preparation and organization of materials relative to the activities of this WBS element in support of the MODIS system Software Preliminary Design Review, the Software Test Readiness Review, and the Software Critical Design Review. Data package preparation and participation in these formal system-level reviews are included elsewhere in the WBS.

5XXX TEST MODELS AND TEST COMPONENTS

51XX Test Models and Components

This element includes the fabrication and testing of the MODIS Structural Model required for instrument development and to fulfill requirements in the GIIS, as documented on the Performance Verification Plan/Performance Verification Specification (151800). This element includes the costs associated with the design, fabrication, and test of all life test assemblies and parts. It includes cost and schedule planning, control, and statusing for all 514X and 515X cost accounts. This element includes all efforts associated with the preparation, organization, and presentation of all required internal design reviews regarding hardware or software items included in

this WBS element. It includes all preparation and organization of materials relative to the activities of this WBS element in support of the MODIS system Preliminary Design Review and the Critical Design Review. Data package preparation and participation in these formal system-level reviews are included elsewhere in the WBS.

6XXX ENGINEERING MODEL

This element includes the effort, equipment, material, tests and calibrations to develop, fabricate, integrate and test the MODIS engineering model. It also includes the generation and updating of the required engineering drawings, assembly planning and support, vendor surveillance, preparation of test procedures, testing during fabrication and alignment, conduct of integration and performance tests, test data reduction and analysis, and preparation of reports and special analyses. This element includes the cost of materials and subcontracts as well as the generation of special test procedures and the purchase and/or fabrication of special fixtures and test equipment related to each element within this task.

61XX Optical Assemblies and Mounts

This element includes the development, fabrication, and verification of the engineering model Afocal Telescope Assembly, and the aft-optics objective assemblies (VIS Objective, NIR Objective, SWIR/MWIR Objective, and LWIR Objective), the dichroic beamsplitters (Dichroic #1, Dichroic #2, and Dichroic #3) and their mounts, and the spectral filters for the VIS, NIR, SWIR/MWIR, and LWIR focal planes. The fabrication of the Aft Optics Platform and Afocal Telescope Bench are included in this element. The fabrication of the filter mounting hardware is included in element 62XX. This element includes the generation and the maintenance of required engineering drawings, assembly planning and support, manufacturing assembly, technical vendor surveillance and procurement support, preparation of test procedures, testing during fabrication and alignment, conduct of component integration and performance tests, test data reduction and analysis, and preparation of reports and special analyses for these optical assemblies and mounts. This element includes the cost of materials and subcontracts as well as the generation of special test procedures and the purchase and/or fabrication of special fixtures and test equipment related to this task. The Manufacturing effort to install the radiative Cooler onto the Aft-Optics Platform is also included in this task. It includes cost and schedule planning, control, and statusing for 61XX cost accounts.

62XX FPAs

This element includes the development, fabrication, and verification of the engineering model FPAs. It includes the complete fabrication of the VIS, NIR, and CFPAs (SWIR/MWIR and LWIR bands). This element includes the generation and the maintenance of required engineering drawings, manufacture planning and scheduling, manufacturing assembly, technical vendor surveillance and procurement support, preparation of test procedures, testing during fabrication and alignment, conduct of part and subassembly integration and performance tests, test data reduction and analysis, and preparation of reports and special analyses for these FPAs. This element includes the cost of materials and subcontracts as well as the generation of special test procedures and the purchase and/or fabrication of special

fixtures and test equipment related to this task. It includes the effort associated with providing technical and programmatic direction to the HTC and coordinating the fabrication and delivery of the VIS and NIR SCAs and all focal plane readout circuits. It includes cost and schedule planning, control, and statusing for 62XX cost accounts.

63XX Mainframe Structure and Doors

This element includes the fabrication and testing of the mainframe structure. This element includes the generation and the maintenance of required engineering drawings, assembly planning and support, manufacturing assembly, technical vendor surveillance and procurement support, preparation of test procedures, testing during fabrication and alignment, conduct of part and subassembly integration and performance tests, test data reduction and analysis, and preparation of reports and special analyses for the mainframe structure. This element includes the cost of materials and subcontracts as well as the generation of special test procedures and the purchase and/or fabrication of special fixtures and test equipment related to this task. It includes cost and schedule planning, control, and statusing for the 634X cost account.

64XX Scan Mirror Assembly

This element includes the fabrication and testing of the Scan Mirror Assembly, except for the control electronics which are included in element 66XX. This element includes the fabrication and testing of the two-sided scan mirror, low distortion mirror mount, and the scan mirror and coatings, and the motor mount assembly. This element includes the generation and the maintenance of required engineering drawings, assembly planning and support, manufacturing assembly, technical vendor surveillance and procurement support, preparation of test procedures, testing during fabrication and alignment, conduct of part integration and performance tests, test data reduction and analysis, and preparation of reports and special analyses for the two-sided scan mirror, low distortion mirror mount, the scan mirror and coatings, and the motor mount assembly. This element includes the cost of materials and subcontracts as well as the generation of special test procedures and the purchase and/or fabrication of special fixtures and test equipment related to this task. It includes cost and schedule planning, control, and statusing for all 644X and 645X cost accounts.

65XX Radiative Cooler Assembly

This element includes the fabrication and testing of the Radiative Cooler. It does not include the fabrication and testing of the radiative cooler anti-contamination door assembly that is included in WBS element 63XX or the CFPA that is part of 628X. This element does not include the fabrication and testing of the CFPA, but does include the fabrication of dewar stem that is incorporated as part of the CFPA prior to installation of the CFPA into the Radiative Cooler. This element includes the generation and the maintenance of required engineering drawings, assembly planning and support, manufacturing assembly, technical vendor surveillance and procurement support, preparation of test procedures, testing during fabrication and alignment, conduct of component integration and performance tests, test data reduction and analysis, and preparation of reports and special analyses for the Radiative Cooler. This element includes the cost of materials and subcontracts as well as the generation

of special test procedures and the purchase and/or fabrication of special fixtures and test equipment related to this task. It includes cost and schedule planning, control, and statusing for the 654X cost account.

66XX MEM

This element includes the fabrication and testing of the MEM, including the fabrication of any harnesses that may be necessary to interconnect the MEM with the AEMs, the On-Board Calibrators, and other elements of the electrical subsystem. This element includes the procurement of electronic parts fabrication and testing of the on-board calibrator control electronics that are generally packaged within the MEM. The procurement, fabrication and testing of electronics packaged within the On-board Calibrators, including detectors, are also included in this WBS element. This element includes the generation and the maintenance of required circuit design schematics, technical vendor surveillance and procurement support, assembly support, preparation of test procedures, testing during fabrication, conduct of part and subassembly integration and performance tests, test data reduction and analysis, and preparation of reports and special analyses for the MEM. This element includes the cost of electronics parts and subcontracts as well as the generation of special test procedures and the purchase and/or fabrication of special fixtures and test equipment related to this task. It includes cost and schedule planning, control, and statusing for all 666X, 66GX and 66HX cost accounts.

67XX AEMs

This element includes the fabrication and testing of the PFM Analog Electronics Modules, including the Space Viewing Analog Module (SAM), Forward Viewing Analog Module (FAM), and the Cooler Located Analog Module (CLAM). This element includes the generation and the maintenance of required engineering drawings, assembly planning and support, technical vendor surveillance and procurement support, preparation of test procedures, testing during fabrication and alignment, conduct of component and assembly integration and performance tests, test data reduction and analysis, and preparation of reports and special analyses for the AEMs. This element includes the cost of materials and subcontracts as well as the generation of special test procedures and the purchase and/or fabrication of special fixtures and test equipment related to this task. It includes cost and schedule planning, control, and statusing for all 676X and 67HX cost accounts.

68XX On-Board Calibrators

This element includes the fabrication and testing of the On-Board Blackbody Assembly, the Solar Diffuser Assembly, the Solar Diffuser Stability Monitor Assembly, and the Spectroradiometric Calibrator Assembly. The Solar Diffuser Assembly, the Solar Diffuser Stability Monitor Assembly, and the Spectroradiometric Calibrator Assembly will not be built as functional assemblies for the Engineering Model, however, this element includes efforts to fabricate low cost surrogates (similar to the representations used in the MODIS Full Scale Model and with external form and finishes similar to the flight configuration) to represent these on-board calibrators in the Engineering Model. It includes the generation and the maintenance of required engineering drawings, assembly planning and support, technical vendor surveillance and procurement support, preparation of test procedures, testing during fabrication and alignment, conduct of part and

subassembly integration and performance tests, test data reduction and analysis, and preparation of reports and special analyses for the On-Board Calibrators. This element includes the cost of materials and subcontracts as well as the generation of special test procedures and the purchase and/or fabrication of special fixtures and test equipment related to this task. It includes cost and schedule planning, control, and statusing for all 68XX cost accounts.

69XX Integration, Test & Calibration

This element includes the integration of all assemblies into a complete MODIS engineering model and its test and calibration. It includes integration, final assembly, system-level alignment, inspection check lists, conduct of performance and environmental tests, instrument calibration, mass property measurement, compatibility tests, test data collection, reduction and analyses and issuance of test reports. This element includes the generation and the maintenance of required engineering drawings, assembly planning and support, technical vendor surveillance and procurement support. This element includes all expendables to be used during the MODIS system integration and test activity, such as liquid nitrogen, magnetic tapes, special films or papers for images, etc., and the cost of other materials and subcontracts required to support the System Integration, Test, & Calibration activity that are not covered elsewhere in the WBS. This account also includes the Manufacturing effort to support the installation of the Radiative Cooler onto the Aft Optics Assembly and the integration of the Afocal Telescope Assembly and the Aft Optics Assembly to form the Optical Bench Assembly. It includes cost and schedule planning, control, and statusing for the 69EX cost account.

6AXX On-Board Software Maintenance

This element includes the maintenance of all on-board software for the Engineering Model.

7XXX PROTOFLIGHT MODEL (PFM)

This element includes the effort, equipment, materials, and tests required to develop, fabricate, integrate, qualify, test (and refurbish, if necessary) the MODIS PFM. Efforts to disassemble the Engineering Model and upgrade parts or assemblies used on the Engineering Model to flight configuration are included in this element. It also includes updating engineering drawings and assembly planning and support, vendor surveillance, preparation of qualification and test procedures, testing during fabrication and alignment, conduct of integration, qualification and performance tests, test data reduction and analyses and preparation of reports and special analyses. This element includes the cost of materials and subcontracts as well as the generation of special test procedures and the purchase and/or fabrication of special fixtures and test equipment related to each element within this task.

71XX Optical Assemblies and Mounts

This element includes the development, fabrication, and verification of the PFM Afocal Telescope Assembly, and the aft-optics objective assemblies (VIS Objective, NIR Objective, SWIR/MWIR Objective, and LWIR Objective), the dichroic beamsplitters (Dichroic #1, Dichroic #2, and Dichroic #3) and their mounts, and the spectral filters for the VIS, NIR, SWIR/MWIR, and LWIR focal planes. The

fabrication of the Aft Optics Platform and Afocal Telescope Bench is included in this element. The fabrication of the filter mounting hardware is included in element 72XX. The installation of the spectral filters in the filter bezel is included in this element. The procurement and installation of VIS, NIR, SWIR/MWIR, and LWIR spectral filters on the focal plane filter bezels are included in this element. This element includes the generation and the maintenance of required engineering drawings, manufacture planning and scheduling, manufacturing assembly, technical vendor surveillance and procurement support, preparation of test procedures, testing during fabrication and alignment, conduct of component integration and performance tests, test data reduction and analysis, and preparation of reports and special analyses for these optical assemblies and mounts. This element includes the cost of materials and subcontracts as well as the generation of special test procedures and the purchase and/or fabrication of special fixtures and test equipment related to this task. It includes cost and schedule planning, control, and statusing for 714X and 715X cost accounts.

72XX FPA's

This element includes the development, fabrication, and verification of the PFM FPA's. It includes the complete fabrication of the VIS FPA, NIR FPA, and the CFPA, except for the spectral filters which will be provided under WBS-element 71XX and the CFPA platform (dewar stem) which will be provided under WBS-element 75XX. This element includes the generation and the maintenance of required engineering drawings, manufacture planning and scheduling, manufacturing assembly, technical vendor surveillance and procurement support, preparation of test procedures, testing during fabrication and alignment, conduct of component integration and performance tests, test data reduction and analysis, and preparation of reports and special analyses for these FPA's. This element includes the cost of materials and subcontracts as well as the generation of special test procedures and the purchase and/or fabrication of special fixtures and test equipment related to this task. It includes the effort associated with providing technical and programmatic direction to the HTC and coordinating the fabrication and delivery of the VIS and NIR SCAs and the infrared focal plane readout circuits. It includes cost and schedule planning, control, and statusing for 72XX cost accounts.

73XX Mainframe Structure and Doors

This cost account includes the effort to disassemble the Engineering Model to retrieve assemblies which will be refurbished for use on the Protoflight Model. It includes the effort to refurbish the Engineering Model Mainframe for flight use and the fabrication and testing of the nadir-aperture, solar diffuser, and space-view anti-contamination door assemblies. The fabrication of actuators to control these doors and fabrication of the MLI thermal blankets are also included in this element. This element includes the generation and the maintenance of required engineering drawings, manufacture planning and scheduling, manufacturing assembly, technical vendor surveillance and procurement support, preparation of test procedures, testing during fabrication and alignment, conduct of component integration and performance tests, test data reduction and analysis, and preparation of reports and special analyses for the mainframe structure, doors, and MLI thermal blankets. This element includes the cost of materials and subcontracts as well as the generation of special test procedures and the purchase and/or fabrication of special fixtures and test equipment related to

this task. It includes cost and schedule planning, control, and statusing for the 734X cost account.

74XX Scan Mirror Assembly

This element includes the fabrication and testing of the PFM Scan Mirror subsystem, except for the control electronics which are included in element 76XX. This element includes the refurbishment and testing of the Engineering Model two-sided scan mirror, and fabrication and testing of a scan motor encoder assembly. This element includes the generation and the maintenance of required engineering drawings, manufacturing planning, scheduling and assembly, technical vendor surveillance and procurement support, preparation of test procedures, testing during fabrication and alignment, conduct of part integration and performance tests, test data reduction and analysis, preparation of reports, and special analyses for the two-sided scan mirror, low distortion mirror mount, the scan mirror and coatings, and the scan motor encoder assembly. This element includes the cost of materials and subcontracts as well as the generation of special test procedures and the purchase and/or fabrication of special fixtures and test equipment related to this task. It includes cost and schedule planning, control, and statusing for all 74XX cost accounts.

75XX Radiative Cooler Assembly

This element includes the effort and parts associated with the refurbishment and upgrading of the Engineering Model Radiative Cooler for use on the Protoflight Model. It does not include the fabrication and testing of the space-view anti-contamination door assembly which are included in WBS element 73XX. This element does not include the fabrication and testing of the CFPA, but does include the fabrication of the dewar stem that is incorporated as part of the CFPA prior to installation of the CFPA into the Radiative Cooler. This element includes the generation and the maintenance of required engineering drawings, manufacture planning and scheduling, manufacturing assembly, technical vendor surveillance and procurement support, preparation of test procedures, testing during fabrication and alignment, conduct of component integration and performance tests, test data reduction and analysis, and preparation of reports and special analyses for the Radiative Cooler. This element includes the cost of materials and subcontracts as well as the generation of special test procedures and the purchase and/or fabrication of special fixtures and test equipment related to this task. It includes cost and schedule planning, control, and statusing for all 75XX cost accounts.

76XX MEM

This element includes the fabrication and testing of the PFM MEM, including the fabrication of any harnesses that may be necessary to interconnect the MEM with the AEMs, the On-Board Calibrators, and other elements of the electrical subsystem. This element includes the fabrication and testing of the on-board calibrator electronics that are generally packaged within the MEM. The procurement, fabrication and testing of electronics packaged within the On-board Calibrators, including detectors, are also included in this WBS element. This element includes the generation and the maintenance of required engineering drawings, manufacture planning and scheduling, technical vendor surveillance and procurement support, manufacturing assembly, preparation of test procedures, testing during fabrication and alignment, conduct of component and assembly integration and performance tests, test data

reduction and analysis, and preparation of reports and special analyses for the MEM. This element includes the cost of materials and subcontracts as well as the generation of special test procedures and the purchase and/or fabrication of special fixtures and test equipment related to this task. It includes cost and schedule planning, control, and statusing for all 76XX cost accounts.

77XX AEMs

This element includes the fabrication and testing of the PFM Analog Electronics Modules, including the Space Viewing Analog Module (SAM), Forward Viewing Analog Module (FAM), and the Cooler Located Analog Module (CLAM). This element includes the generation and the maintenance of required engineering drawings, manufacture planning and scheduling, technical vendor surveillance and procurement support, preparation of test procedures, testing during fabrication and alignment, conduct of component and assembly integration and performance tests, test data reduction and analysis, and preparation of reports and special analyses for the AEMs. This element includes the cost of materials and subcontracts as well as the generation of special test procedures and the purchase and/or fabrication of special fixtures and test equipment related to this task. It includes cost and schedule planning, control, and statusing for all 77XX cost accounts.

78XX On-Board Calibrators

This element includes the fabrication and testing of the PFM On-Board Calibrators including the Blackbody, the Solar Diffuser, the Solar Diffuser Stability Monitor (SDSM), and the Spectroradiometric Calibrator. It includes the generation and the maintenance of required engineering drawings, manufacture planning and scheduling, technical vendor surveillance and procurement support, preparation of test procedures, testing during fabrication and alignment, conduct of component and assembly integration and performance tests, test data reduction and analysis, and preparation of reports and special analyses for the On-Board Calibrators. This element includes the cost of materials and subcontracts as well as the generation of special test procedures and the purchase and/or fabrication of special fixtures and test equipment related to this task. It includes cost and schedule planning, control, and statusing for all 78XX cost accounts.

79XX Integration, Test & Calibration

This element includes the integration of all components/assemblies into a complete MODIS PFM and its test and calibration. It includes integration, final assembly, system-level alignment, inspection check lists, conduct of performance and environmental tests (including thermal balance and sine sweep), instrument calibration, mass property measurement, compatibility tests, test data collection, reduction and analyses and issuance of test reports. This element includes the generation and the maintenance of required engineering drawings, assembly planning and support, technical vendor surveillance and procurement support. This element includes all expendables to be used during the MODIS system integration and test activity, such as liquid nitrogen, magnetic tapes, special films or papers for images, etc., and the cost of other materials and subcontracts required to support the System Integration, Test, & Calibration activity that are not covered elsewhere in the WBS. This account also includes the Manufacturing effort to support the installation of the Radiative Cooler onto the Aft Optics Assembly and the integration of the Afocal

Telescope Assembly and the Aft Optics Assembly to form the Optical Bench Assembly. It includes cost and schedule planning, control, and statusing for the 79EX cost account.

7AXX On-Board Software Maintenance

This element includes the maintenance of all on-board software for the PFM.

7BXX Protoflight Refurbishment

This element includes the partial disassembly of the instrument, replacement of particular critical components and re-assembly to flight configuration. It includes the required retesting and calibration of the MODIS PFM to bring it up to flight worthiness.

7CXX Spares

This element includes all the planning, procurement, fabrication, testing, qualification, and storage of spares necessary for the maintenance of the MODIS flight models. The plan for meeting the spares needs of the MODIS Program is documented in the Spares program plan (CDRL 035). The cost of any refurbishment and repairs is allocated to other appropriate elements in the corresponding elements of this WBS.

8XXX FLIGHT MODEL 1

81XX Optical Assemblies and Mounts

This element includes the development, fabrication, and verification of the Flight Model 1 Afocal Telescope Assembly, and the aft-optics objective assemblies (VIS Objective, NIR Objective, SWIR/MWIR Objective, and LWIR Objective), the dichroic beamsplitters (Dichroic #1, Dichroic #2, and Dichroic #3) and their mounts, and the spectral filters for the VIS, NIR, SWIR/MWIR, and LWIR focal planes. The refurbishment of the Engineering Model Aft Optics Platform and Afocal Telescope Bench is included in this element. The fabrication of the filter mounting hardware is included in element 82XX. This element includes the generation and the maintenance of required engineering drawings, assembly planning and support, manufacturing assembly, technical vendor surveillance and procurement support, preparation of test procedures, testing during fabrication and alignment, conduct of component integration and performance tests, test data reduction and analysis, and preparation of reports and special analyses for these optical assemblies and mounts. This element includes the cost of materials and subcontracts as well as the generation of special test procedures and the purchase and/or fabrication of special fixtures and test equipment related to this task. It includes cost and schedule planning, control, and statusing for 81XX cost accounts.

82XX FPAs

This element includes the development, fabrication, and verification of the Flight Model 1 FPAs. It includes the complete fabrication of the VIS FPA, NIR FPA, and the CFPA, except for the spectral filters which will be provided under WBS-element 81XX and the CFPA platform (dewar stem) which will be provided under WBS-

element 85XX. This element includes the generation and the maintenance of required engineering drawings, manufacture planning and scheduling, manufacturing assembly, technical vendor surveillance and procurement support, preparation of test procedures, testing during fabrication and alignment, conduct of component integration and performance tests, test data reduction and analysis, and preparation of reports and special analyses for these FPAs. This element includes the cost of materials and subcontracts as well as the generation of special test procedures and the purchase and/or fabrication of special fixtures and test equipment related to this task. It includes the effort associated with providing technical and programmatic direction to the HTC and coordinating the fabrication and delivery of the VIS and NIR SCAs and all focal plane readout circuits. It includes cost and schedule planning, control, and statusing for 82XX cost accounts.

83XX Mainframe Structure and Doors

This element includes the fabrication and testing of the Flight Model 1 mainframe structure and the nadir aperture, solar diffuser, and space-view anti-contamination door assemblies. The fabrication of actuators to control these doors and fabrication of the MLI thermal blankets are also included in this element. This element includes the generation and the maintenance of required engineering drawings, assembly planning and support, manufacturing assembly, technical vendor surveillance and procurement support, preparation of test procedures, testing during fabrication and alignment, conduct of component integration and performance tests, test data reduction and analysis, and preparation of reports and special analyses for the mainframe structure, doors, and MLI thermal blankets. This element includes the cost of materials and subcontracts as well as the generation of special test procedures and the purchase and/or fabrication of special fixtures and test equipment related to this task. It includes cost and schedule planning, control, and statusing for the 834X cost account.

84XX Scan Mirror Assembly

This element includes the fabrication and testing of the Flight Model 1 Scan Mirror Assembly; the control electronics are included in element 86XX. This element includes the fabrication and testing of the two-sided scan mirror, low distortion mirror mount, and the scan mirror and coatings, and the motor mount assembly. This element includes the generation and the maintenance of required engineering drawings, assembly planning and support, manufacturing assembly, technical vendor surveillance and procurement support, preparation of test procedures, testing during fabrication and alignment, conduct of part integration and performance tests, test data reduction and analysis, and preparation of reports and special analyses for the two-sided scan mirror, low distortion mirror mount, the scan mirror and coatings, and the motor mount assembly. This element includes the cost of materials and subcontracts as well as the generation of special test procedures and the purchase and/or fabrication of special fixtures and test equipment related to this task. It includes cost and schedule planning, control, and statusing for all 844X and 845X cost accounts.

85XX Radiative Cooler Assembly

This element includes the fabrication and testing of the Radiative Cooler. It does not include the fabrication and testing of the space-view anti-contamination door

assembly which are included in WBS element 83XX. This element does not include the fabrication and testing of the CFPA, but does include the fabrication of dewar stem which is incorporated as part of the CFPA prior to installation of the CFPA into the Radiative Cooler. This element includes the generation and the maintenance of required engineering drawings, assembly planning and support, manufacturing assembly, technical vendor surveillance and procurement support, preparation of test procedures, testing during fabrication and alignment, conduct of component integration and performance tests, test data reduction and analysis, and preparation of reports and special analyses for the Radiative Cooler. This element includes the cost of materials and subcontracts as well as the generation of special test procedures and the purchase and/or fabrication of special fixtures and test equipment related to this task. It includes cost and schedule planning, control, and statusing for the 854X cost account.

86XX MEM

This element includes the fabrication and testing of the Flight Model 1 MEM, including the fabrication of any harnesses that may be necessary to interconnect the MEM with the AEMs, the On-Board Calibrators, and other elements of the electrical subsystem. This element includes the procurement of electronic parts fabrication and testing of the on-board calibrator control electronics that are generally packaged within the MEM. The procurement, fabrication and testing of electronics packaged within the On-board Calibrators, including detectors, are also included in this WBS element. This element includes the generation and the maintenance of required engineering drawings, assembly planning and support, technical vendor surveillance and procurement support, manufacturing assembly, preparation of test procedures, testing during fabrication and alignment, conduct of component and assembly integration and performance tests, test data reduction and analysis, and preparation of reports and special analyses for the MEM. This element includes the cost of materials and subcontracts as well as the generation of special test procedures and the purchase and/or fabrication of special fixtures and test equipment related to this task. It includes cost and schedule planning, control, and statusing for all 866X, 86GX and 86HX cost accounts.

87XX AEMs

This element includes the fabrication and testing of the Flight Model 1 AEMs. This element includes the generation and the maintenance of required engineering drawings, assembly planning and support, technical vendor surveillance and procurement support, preparation of test procedures, testing during fabrication and alignment, conduct of component and assembly integration and performance tests, test data reduction and analysis, and preparation of reports and special analyses for the AEMs. This element includes the cost of materials and subcontracts as well as the generation of special test procedures and the purchase and/or fabrication of special fixtures and test equipment related to this task. It includes cost and schedule planning, control, and statusing for all 876X and 87HX cost accounts.

88XX On-Board Calibrators

This element includes the fabrication and testing of the Flight Model 1 On-Board Calibrators, including the Blackbody, the Solar Diffuser, the Solar Diffuser Stability Monitor, and the Spectroradiometric Calibrator. It includes the generation and the

maintenance of required engineering drawings, assembly planning and support, technical vendor surveillance and procurement support, preparation of test procedures, testing during fabrication and alignment, conduct of component and assembly integration and performance tests, test data reduction and analysis, and preparation of reports and special analyses for the On-Board Calibrators. This element includes the cost of materials and subcontracts as well as the generation of special test procedures and the purchase and/or fabrication of special fixtures and test equipment related to this task. It includes cost and schedule planning, control, and statusing for all 88XX.

89XX Integration, Test & Calibration

This element includes the integration of all components/assemblies into a complete MODIS Flight Model and its test and calibration. It includes integration, final assembly, system-level alignment, inspection check lists, conduct of performance and environmental tests, instrument calibration, mass property measurement, compatibility tests, test data collection, reduction and analyses and issuance of test reports. This element includes the generation and the maintenance of required engineering drawings, assembly planning and support, technical vendor surveillance and procurement support. This element includes all expendables to be used during the MODIS system integration and test activity, such as liquid nitrogen, magnetic tapes, special films or papers for images, etc., and the cost of other materials and subcontracts required to support the System Integration, Test, & Calibration activity that are not covered elsewhere in the WBS. This account also includes the Manufacturing effort to support the installation of the Radiative Cooler onto the Aft Optics Assembly and the integration of the Afocal Telescope Assembly and the Aft Optics Assembly to form the Optical Bench Assembly. It includes cost and schedule planning, control, and statusing for the 89EX cost account.

8BXX Storage & Storage Test

This element includes the effort, equipment, materials and verification necessary to store the completed Flight Model 1 until the time for integration on a spacecraft. It includes storage environment requirements, scheduled storage testing and evaluation, and a complete post-storage/pre-integration test and calibration sequence. This cost account includes all costs to prepare and pack the instrument and applicable GSE for shipment and the cost of shipment to the spacecraft contractor's facility.

9XXX GSE

This element includes the effort, materials, and subcontracts required to design, develop, fabricate and test the MODIS GSE. The GSE consists of two sets of System Test Equipment (STE), STE 1 and STE 2, test fixtures, and calibration equipment. STE 2 does not have the ability to control external calibration sources or devices and does not have a high volume archival capability, but otherwise is fully interchangeable with STE 1. This element includes all the planning, procurement, fabrication, testing, qualification, and storage of spares necessary for the maintenance of the MODIS GSE. It also includes updating of drawings, manufacture planning and scheduling, vendor surveillance, preparation of test and checkout procedures, performance of checkout tests, test data analysis and reduction, and preparation of reports, manuals, and special analyses. All the breadboarding and special testing required to design, develop, fabricate and test the major subsystems of the GSE are included in the appropriate Level 3 elements

below. The cost for all Level 3 subsystems of the task include the cost of materials and subcontracts, as well as the generation of special test procedures and purchase and/or fabrication of special test equipment related to each element within this task.

This task includes the effort to coordinate and administer the development of software management plans and other software CDRL documents, including coordinating the system engineering, flight software engineering, GSE software engineering, and software assurance and configuration management organization participation in the preparation of these plans and other software management documents.

91XX GSE Administration & Systems Engineering

This account includes the project management of the GSE effort. This element covers all the effort and analyses required to establish a firm set of requirements for the GSE designs. It covers the establishment of design specifications for the STE, required fixtures and stimuli, and information presentation devices. It also includes definition of GSE software requirements necessary to verify and calibrate the instrument. This task includes the effort to coordinate and administer the development of software management plans and other software CDRL documents, including coordinating the system engineering, flight software engineering, GSE software engineering, and software assurance and configuration management organization participation in the preparation of these plans and other software management documents.

92XX GSE Software

This element includes all the computer code, documentation and manuals required to operate, verify and calibrate the instrument, and to display the instrument output in quickly grasped formats including images. This element includes CDRL items 411 (GSE Test Procedures) and 508 (Procurement Document).

93XX STE

This element includes the STE 1 and STE 2, as required by the specification. It also includes the mechanical and electrical design, engineering and test planning, and checkout of any test sets required for the focus and alignment of the MODIS Aft Optics assemblies.

94XX System Test Fixtures & Shipping Containers

This element includes the primary test fixture and all other fixtures and equipment (such as the bench test cooler) necessary to operate and verify performance at all spectral bands of the instrument in a clean room. It includes all equipment and fixtures unique to verification and calibration in thermal vacuum chambers in order to meet the requirements of the specification. It includes the planning and fabrication of focus and alignment fixtures required for the MODIS Aft Optics assemblies. It also includes shipping containers for the instrument models, and for all GSE to be shipped to the spacecraft contractor for support of integration to the spacecraft.

95XX Optical/Thermal Stimuli

This element includes the required optical and thermal stimuli's sources to verify and calibrate the MODIS, including targets and special fixtures for these stimuli. It

includes any optical and thermal sources needed to support the focus and alignment of the MODIS Aft Optics assemblies.

96XX GSE Spares

This element includes all the planning, procurement, fabrication, testing qualification, and storage of spares necessary for the maintenance of the MODIS GSE.

BXXX PRODUCT ASSURANCE & SAFETY

This element includes all the effort and analyses required to establish a set of requirements for the MODIS reliability and quality assurance program. This includes planning for the implementation of all efforts in the areas of reliability, quality assurance, system safety and parts programs.

B1XX Reliability & Safety Program

This element includes all effort, equipment, and material necessary to implement the reliability engineering and reliability assurance activities on the program. This includes each task in the MODIS Reliability Program Plan, such as: reliability engineering support to design, reliability engineering support to test, failure and malfunction reporting, cause and corrective action, stress analysis, worst case circuit analysis, radiation effects analysis, and support of design and readiness reviews. In addition, this element includes related documentation and reports not specified as deliverable items and preparation prior to "compilation" of deliverable items. This element also includes all effort, equipment, and material necessary to plan and implement a system safety program. This element includes the following CDRL items: 013 (Safety & Health Plan), 206 (Component and Subassembly Test Reports for Subcontracted Items), 212 (Alerts), 213 (Responses to Alerts), 214 (Responses to NASA Problem Notices), 218 (Data on Non-Conventional Application of Materials), and 507 (Critical Items List (CIL)).

B2XX Quality Program

This element includes all effort, equipment, and material necessary to plan and implement the Quality Assurance program. This will include each task area delineated in the MODIS Quality Assurance Plan, such as government source inspection, quality assurance aspects of control of subcontractors, and fabrication controls. Also included in this element are related documentation and reports not specified as deliverable items and preparation prior to "compilation" of deliverable items. This element includes CDRL items: 210 (MRB Decisions on Non-Conformance), 501 (Audit Program Description), 526 (Acceptance Data Package), and 530 (Material Inspection and Receiving Report).

CXXX PRE-& POST-LAUNCH SUPPORT

C1XX Pre- & Post-Launch Support

This element includes the effort required to perform the initial test of each instrument at the spacecraft contractor's facility. In addition, this element includes supporting

the MODIS program from the integration of each MODIS instrument into an EOS spacecraft through the analysis of its integration into the spacecraft through the analysis of its initial output data, video and telemetry, during its first three months in orbit. This support is anticipated to last twenty-one months pre-launch and three months post-launch for each flyable model.

This element includes the effort associated with field engineering support, as well as support at the SBRC facility (special tests, data analysis), to integrate and test each flyable MODIS model with the spacecraft at the spacecraft contractor's facility and at the launch site. It includes support for cross calibration of instruments at the spacecraft contractor's facility.

This element covers the effort associated with the engineering and other efforts as required, to support launch operations for each flyable MODIS model.

This element includes the effort associated with supporting the required post-launch activities, including the analysis and evaluation of data and telemetry from each MODIS model during the first three months of operation in order to determine and compare its performance with the requirements of the specification.

DXXX FLIGHT MODEL 2

D1XX Optical Assemblies and Mounts

This element includes the development, fabrication, and verification of the Flight Model 2 Afocal Telescope Assembly, and the aft-optics objective assemblies (VIS Objective, NIR Objective, SWIR/MWIR Objective, and LWIR Objective), the dichroic beamsplitters (Dichroic #1, Dichroic #2, and Dichroic #3) and their mounts, and the spectral filters for the VIS, NIR, SWIR/MWIR, and LWIR focal planes. The fabrication of the Aft Optics Platform and Afocal Telescope Bench are included in this element. The fabrication of the filter mounting hardware is included in element D2XX. This element includes the generation and the maintenance of required engineering drawings, assembly planning and support, manufacturing assembly, technical vendor surveillance and procurement support, preparation of test procedures, testing during fabrication and alignment, conduct of component integration and performance tests, test data reduction and analysis, and preparation of reports and special analyses for these optical assemblies and mounts. This element includes the cost of materials and subcontracts as well as the generation of special test procedures and the purchase and/or fabrication of special fixtures and test equipment related to this task. It includes cost and schedule planning, control, and statusing for D14X and D15X cost accounts.

D2XX FPAs

This element includes the development, fabrication, and verification of the Flight Model 2 FPAs. It includes the complete fabrication of the VIS FPA, NIR FPA, and the CFPA, except for the spectral filters which will be provided under WBS-element D1XX and the CFPA platform (dewar stem) which will be provided under WBS-element D5XX. This element includes the generation and the maintenance of required engineering drawings, manufacture planning and scheduling, manufacturing assembly, technical vendor surveillance and procurement support, preparation of test

procedures, testing during fabrication and alignment, conduct of component integration and performance tests, test data reduction and analysis, and preparation of reports and special analyses for these FPAs. This element includes the cost of materials and subcontracts as well as the generation of special test procedures and the purchase and/or fabrication of special fixtures and test equipment related to this task. It includes the effort associated with providing technical and programmatic direction to the HTC and coordinating the fabrication and delivery of the VIS and NIR SCAs and all focal plane readout circuits. It includes cost and schedule planning, control, and statusing for D2XX cost accounts.

D3XX Mainframe Structure and Doors

This element includes the fabrication and testing of the Flight Model 2 mainframe structure and the nadir aperture, solar diffuser and space-view anti-contamination door assemblies. The fabrication of actuators to control these doors and fabrication of the MLI thermal blankets are also included in this element. This element includes the generation and the maintenance of required engineering drawings, assembly planning and support, manufacturing assembly, technical vendor surveillance and procurement support, preparation of test procedures, testing during fabrication and alignment, conduct of component integration and performance tests, test data reduction and analysis, and preparation of reports and special analyses for the mainframe structure, doors, and MLI thermal blankets. This element includes the cost of materials and subcontracts as well as the generation of special test procedures and the purchase and/or fabrication of special fixtures and test equipment related to this task. It includes cost and schedule planning, control, and statusing for the D34X cost account.

D4XX Scan Mirror Assembly

This element includes the fabrication and testing of the Flight Model 2 Scan Mirror subsystem, except for the control electronics which are included in element D6XX. This element includes the fabrication and testing of the two-sided scan mirror, low distortion mirror mount, and the scan mirror and coatings, and the motor mount assembly. This element includes the generation and the maintenance of required engineering drawings, assembly planning and support, manufacturing assembly, technical vendor surveillance and procurement support, preparation of test procedures, testing during fabrication and alignment, conduct of part integration and performance tests, test data reduction and analysis, and preparation of reports and special analyses for the two-sided scan mirror, low distortion mirror mount, the scan mirror and coatings, and the motor mount assembly. This element includes the cost of materials and subcontracts as well as the generation of special test procedures and the purchase and/or fabrication of special fixtures and test equipment related to this task. It includes cost and schedule planning, control, and statusing for all D44X and D45X cost accounts.

D5XX Radiative Cooler Assembly

This element includes the fabrication and testing of the Radiative Cooler. This element does not include the fabrication and testing of the CFPA, but does include the fabrication of the dewar stem which is incorporated as part of the CFPA prior to installation of the CFPA into the Radiative Cooler. This element includes the generation and the maintenance of required engineering drawings, assembly planning

and support, manufacturing assembly, technical vendor surveillance and procurement support, preparation of test procedures, testing during fabrication and alignment, conduct of component integration and performance tests, test data reduction and analysis, and preparation of reports and special analyses for the Radiative Cooler. This element includes the cost of materials and subcontracts as well as the generation of special test procedures and the purchase and/or fabrication of special fixtures and test equipment related to this task. It includes cost and schedule planning, control, and statusing for the D54X cost account.

D6XX MEM

This element includes the fabrication and testing of the Flight Model 2 MEM, including the fabrication of any harnesses that may be necessary to interconnect the MEM with the AEMs, the On-Board Calibrators, and other elements of the electrical subsystem. This element includes the fabrication and testing of the on-board calibrator electronics that are generally packaged within the MEM. The procurement, fabrication and testing of electronics packaged within the On-board Calibrators, including detectors, are also included in this WBS element. This element includes the generation and the maintenance of required engineering drawings, assembly planning and support, technical vendor surveillance and procurement support, manufacturing assembly, preparation of test procedures, testing during fabrication and alignment, conduct of component and assembly integration and performance tests, test data reduction and analysis, and preparation of reports and special analyses for the MEM. This element includes the cost of materials and subcontracts as well as the generation of special test procedures and the purchase and/or fabrication of special fixtures and test equipment related to this task. It includes cost and schedule planning, control, and statusing for all D66X, D6GX and the D6HX cost accounts.

D7XX AEMs

This element includes the fabrication and testing of the Flight Model 2 AEMs. This element includes the generation and the maintenance of required engineering drawings, assembly planning and support, technical vendor surveillance and procurement support, preparation of test procedures, testing during fabrication and alignment, conduct of component and assembly integration and performance tests, test data reduction and analysis, and preparation of reports and special analyses for the AEMs. This element includes the cost of materials and subcontracts as well as the generation of special test procedures and the purchase and/or fabrication of special fixtures and test equipment related to this task. It includes cost and schedule planning, control, and statusing for all D76X and D7HX cost accounts.

D8XX On-Board Calibrators

This element includes the fabrication and testing of the Flight Model 2 On-Board Calibrators, including the Blackbody, the Solar Diffuser, the Solar Diffuser Stability Monitor, and the Spectroradiometric Calibrator. It includes the generation and the maintenance of required engineering drawings, assembly planning and support, technical vendor surveillance and procurement support, preparation of test procedures, testing during fabrication and alignment, conduct of component and assembly integration and performance tests, test data reduction and analysis, and preparation of reports and special analyses for the On-Board Calibrators. This element includes the cost of materials and subcontracts as well as the generation of

special test procedures and the purchase and/or fabrication of special fixtures and test equipment related to this task. It includes cost and schedule planning, control, and statusing for the D8XX cost account.

D9XX Integration, Test & Calibration

This element includes the integration of all components/assemblies into a complete MODIS Flight Model and its test and calibration. It includes integration, final assembly, system-level alignment, inspection check lists, conduct of performance and environmental tests, instrument calibration, mass property measurement, compatibility tests, test data collection, reduction and analyses and issuance of test reports. This element includes the generation and the maintenance of required engineering drawings, assembly planning and support, technical vendor surveillance and procurement support. This element includes all expendables to be used during the MODIS system integration and test activity, such as liquid nitrogen, magnetic tapes, special films or papers for images, etc.and the cost of other materials and subcontracts required to support the System Integration, Test, & Calibration activity that are not covered elsewhere in the WBS. This account also includes the Manufacturing effort to support the installation of the Radiative Cooler onto the Aft Optics Assembly and the integration of the Afocal Telescope Assembly and the Aft Optics Assembly to form the Optical Bench Assembly. It includes cost and schedule planning, control, and statusing for the D9EX cost account.

DBXX Storage & Storage Test

This element includes the effort, equipment, materials and verification necessary to store the completed Flight Model 2 until the time for integration on a spacecraft. It includes storage environment requirements, scheduled storage testing and evaluation, and a complete post-storage/pre-integration test and calibration sequence. This cost account includes all costs to prepare and pack the instrument and applicable GSE for shipment and the cost of shipment to the spacecraft contractor's facility.

MODIS RESPONSIBILITY ASSIGNMENT MATRIX (RAM)

PL-3095
MODIS
NASA - GSFC

PROJ MANAGER	ORGANIZATION/TASK	PL-3095 MODIS NASA - GSFC					
		AXXX SYSTEM STUDY	1XXX PROGRAM MANAGEMENT	2XXX SYS ENGRG AND ANALYSES	4XXX INSTRUMENT DESIGN/DEVELOPMENT	6XXX TEST MODELS & COMPS	8XXX ENGINEERING MODEL (1 EA)
V	L. TESSMER	PROG. OFFICE	11XX PROGRAM OFFICE	21XX ADMINISTRATION	41XX OPTICAL ASSYS&MOUNTS DSN	61XX OPTICAL ASSYS & MOUNTS	81XX OPTICAL ASSYS & MOUNTS
1	L. YOUNGMAN	BUS. MGMT	12XX FINANCIAL & SCHEDULE CTL	22XX REQUIREMENTS	42XX FOCAL PLANE ASSYS DESIGN	62XX FOCAL PLANE ASSEMBLIES	82XX FOCAL PLANE ASSEMBLIES
2	T. PAGANO	SYST. ENGRG	13XX CONFIG & DATA MGMT	23XX SYSTEM ANALYSES	43XX MNRFRAME STRUCT&DOOR DSN	63XX MNRFRAME STRUCT & DOORS	83XX MNRFRAME STRUCT & DOORS
3	T. CALVIN	CDMO	14XX DOCUMENTATION	24XX SPACECRAFT INTERFACES	44XX SCAN MIRROR ASSY DESIGN	64XX SCAN MIRROR ASSEMBLY	84XX SCAN MIRROR ASSEMBLY
4	A. DEFORREST	MECHANICS/OBC	15XX MFG MANAGEMENT	25XX INST INTEG & TEST SUPPORT	45XX RADIATIVE COOLER ASSY DSN	65XX RADIATIVE COOLER ASSEMBLY	85XX RADIATIVE COOLER ASSEMBLY
5	T. KAMPE	OPTICS	16XX ENG DOC CTL & LBR POOLING	26XX ALGORITHM DEVELOPMENT	46XX MAIN ELECT MODULE DESIGN	66XX MAIN ELECTRONICS MODULE	86XX MAIN ELECTRONICS MODULE
6	E. CLEMENT	ELECTRONICS	17XX MFG MGMT	27XX PM SPACECRAFT INTERFACE	47XX ANALOG ELECT MODULES DSN	67XX ANALOG ELECT MODULES	87XX ANALOG ELECT MODULES
8	M. BALLARD	FOCAL PLANES	18XX DOCUMENTATION	28XX INST INTEG & TEST SUPPORT	48XX ON-BOARD CALIBRATORS DSN	68XX ON-BD CALIBRATORS	88XX ON-BD CALIBRATORS
A	V. ALFERD	GSE	19XX CONFIG & DATA MGMT	29XX SPACECRAFT INTERFACES	49XX ON-BD SOFTWARE DEVELOP.	69XX INTEGRATION TEST & CALIB	89XX INTEGRATION TEST & CALIB
B	VARIOUS	MANUFACTURING	20XX FINANCIAL & SCHEDULE CTL	30XX SYSTEM ANALYSES			
C	L. TRAUTWEIN	QUALITY ASSUR.					
D	E. SCHULTZ	RELIABILITY					
E	D. BATES	SYSTEM TEST					
F	M. BALLARD	HTCIRVINE					
G	E. CLEMENT	EDD					
H	E. CLEMENT	ELECTRONIC PKG					
M	R. HUDYMA	ON-BD CALIBRATORS					
P	L. TESSMER	COMPANY OPS					
			AXXX SYSTEM STUDY				

(LEVEL 4)

LEGEND: . = COST ACCOUNT

