Program Control on the Tropical Rainfall Measuring Mission

by Dorothy J. Pennington and Walter Majerowicz

The Tropical Rainfall Measuring Mission (TRMM), an integral part of NASA's Mission to Planet Earth, is the first satellite dedicated to measuring tropical rainfall. TRMM will contribute to an understanding of the mechanisms through which tropical rainfall influences global circulation and climate. Goddard Space Flight Center's (GSFC) Flight Projects Directorate is responsible for establishing a Project Office for the TRMM to manage, coordinate and integrate the various organizations involved in the development and operation of this complex satellite.

The TRMM observatory, the largest ever developed and built inhouse at GSFC, includes state-of-the-art hardware. It will carry five scientific instruments designed to determine the rate of rainfall and the total rainfall occurring between the north and south latitudes of 35 degrees. As a secondary science objective, TRMM will also measure the Earth's radiant energy budget and lightning.

The complexities of managing an inhouse project are magnified by many non-GSFC interfaces, as shown in Table 1. The TRMM Project Office is responsible for managing the integration of all segments of this complex activity and providing a cohesive team that will deliver a fully functioning observatory within budget and schedule constraints. These interfaces require careful management and coordination of technical, schedule and budget elements. While the project office provides overall program planning, direction and control, the subsystem managers and instrument suppliers

Table 1. TRMM Organization Responsibilities

Component	*Responsible Organization*
Project Management	TRMM Project
Observatory Subsystems	Engineering Directorate/numerous aerospace companies
Precipitation Radar (PR)	Japan/ NASDA/Toshiba
TRMM Microwave Imager (TMI)	TRMM Project/Hughes
Visible Infrared Scanner (VIRS)	TRMM Project/Santa Barbara Research Center
Clouds and Earth's Radiant Energy System (CERES)	EOS/Langley Research Center/TRW
Lightning Imaging Sensor (LIS)	TRMM Project/Marshall Space Flight Center
TRMM Science Data and Information System (TSDIS)	Earth Sciences Directorate/General Sciences Corporation
Mission Operations	Mission Operations and Data System Directorate
H-II Launch Vehicle and Launch Services	Japan/NASDA
Science Team	Earth Science Directorate, U.S. Universities, JPL, NOAA, Japan, Australia, Israel, France, Taiwan, Great Britain

implement project requirements at a detailed level. One immediate challenge to securing a successful TRMM mission is implementing program control systems that will ensure an August 1997 launch from Tanegashima Space Center, Japan. The August 1997 launch is critical; if TRMM is not launched on time, high levels of solar activity forecast for the late 1990s would result in a reduced mission life. This constraint, along with the limitation of biannual launch windows at the Tanegashima Space Center, places top priority on schedule performance, but not at the expense of technical excellence, safety or cost.

Program Control Overview

The TRMM Program Control staff has established a comprehensive Program Control System that includes schedule management, financial management, configuration management and risk management. The Program Control System is not simply a computer program. Rather, it consists of a series of checks and balances in each of these areas that are designed to keep the entire management system integrated, as shown in Figure 1. Four monthly reports reflecting analyses in the areas of schedule, finance, general business and risk management are generated by the TRMM program control staff. These reports, called the Program Control Monthly Status Reports (PCMSR), are distributed to TRMM technical and resources management and provide a current, complete analysis of all business issues and concerns. TRMM also conducts monthly status reviews with each of the subsystem, instrument and element managers. During these reviews, each manager is allocated approximately 30 minutes to present technical, cost, schedule and manpower issues and concerns to the TRMM Project Manager. The importance placed on communication, whether through these reviews or in the PCMSR, is one of the key reasons behind the success of the Program Control System.

A major element of the Program Control System is the logic network. Using the project work breakdown structure, the project planners developed an end-to-end network that was baselined shortly after the TRMM System Concept Review.

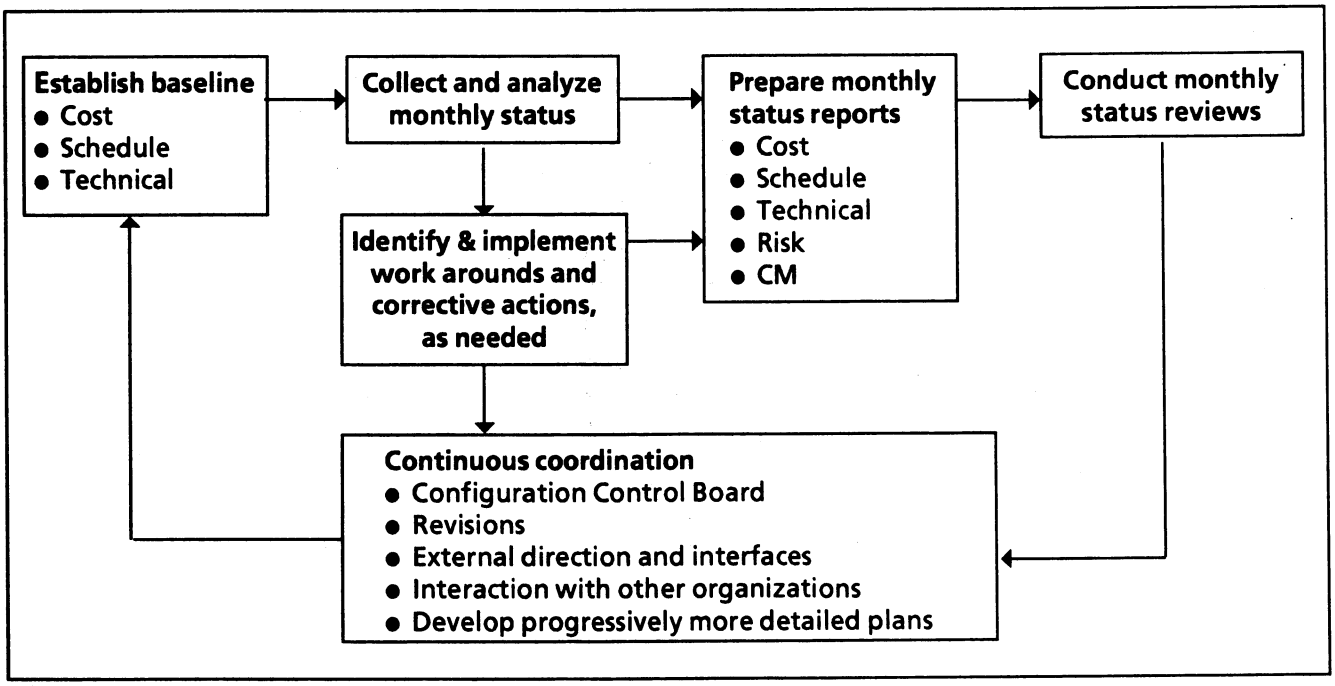

Figure 1. Program Control Process

This network, in conjunction with the mission specifications and agreements, provided the foundation for project management to focus on the preparation of the budget estimates. Careful consideration was given to technical and schedule risks and tradeoffs while attempting to determine annual funding requirements. After the technical, schedule and cost baselines were established, the TRMM Configuration Control Board (CCB) was set up to systematically consider all changes to the baselines. Finally, the risk management report was initiated by the Program Control staff to provide project management with an ongoing early warning system. Using this mechanism, actions to resolve cost, manpower, schedule and technical problems can be quickly identified and implemented. Frequent communication between project managers, subsystem managers, instrument suppliers and the program control staff is the key to maintaining these effective management systems.

Schedule Management

The scheduling function is centralized at the project level. The scheduling staff is assigned to the project office and coordinates with both GSFC and outside organizations responsible for the development of the TRMM spacecraft, instrument, and ground segments as well as overall system integration and test (I&T).

The TRMM Program Control staff has developed a comprehensive logic network for TRMM that integrates key work tasks and milestones from all elements within the TRMM system. For work being performed at GSFC, the schedulers prepare the subnetworks in coordination with the responsible subsystem and element technical managers. For work being performed outside of GSFC, schedule data is received from the contractors' scheduling systems and incorporated into the TRMM schedule database.

A sample portion of the logic network is contained in Figure 2. The information contained in the activity boxes or "nodes" identifies the task description, activity duration in work days, and total slack (the amount of time an activity or event can be delayed before it impacts launch readiness). With the use of TRMM's automated scheduling system for developing and maintaining the logic network, bar charts are easily generated. The bar chart corresponding to the logic network sample presented in Figure 2 is shown in Figure 3. These detailed schedules are "rolled up" to an intermediate level in order to summarize the schedule information for management. Figure 4 depicts how the Thruster detailed schedule is summarized within the Reaction Control Subsystem (RCS) Intermediate Schedule. This "roll-up" or schedule summarization capability, combined with the precedence relationships among the activities in the logic network, provide the framework to properly manage the vertical and horizontal schedule integration and traceability on TRMM.

For effective Program Control of TRMM, maintaining a schedule baseline is as important as maintaining a technical and cost baseline. Moreover, proper configuration management of the TRMM schedule is vital in order to accurately assess the impact of changes. TRMM's formal schedule baseline is identified in the TRMM Project Schedule Baseline Document (PSBD). The PSBD consists of three parts: major project milestones, project control milestones and the Observatory integration and test schedule. The schedule for these milestones can only be changed with the approval of the TRMM Configuration Control Board.

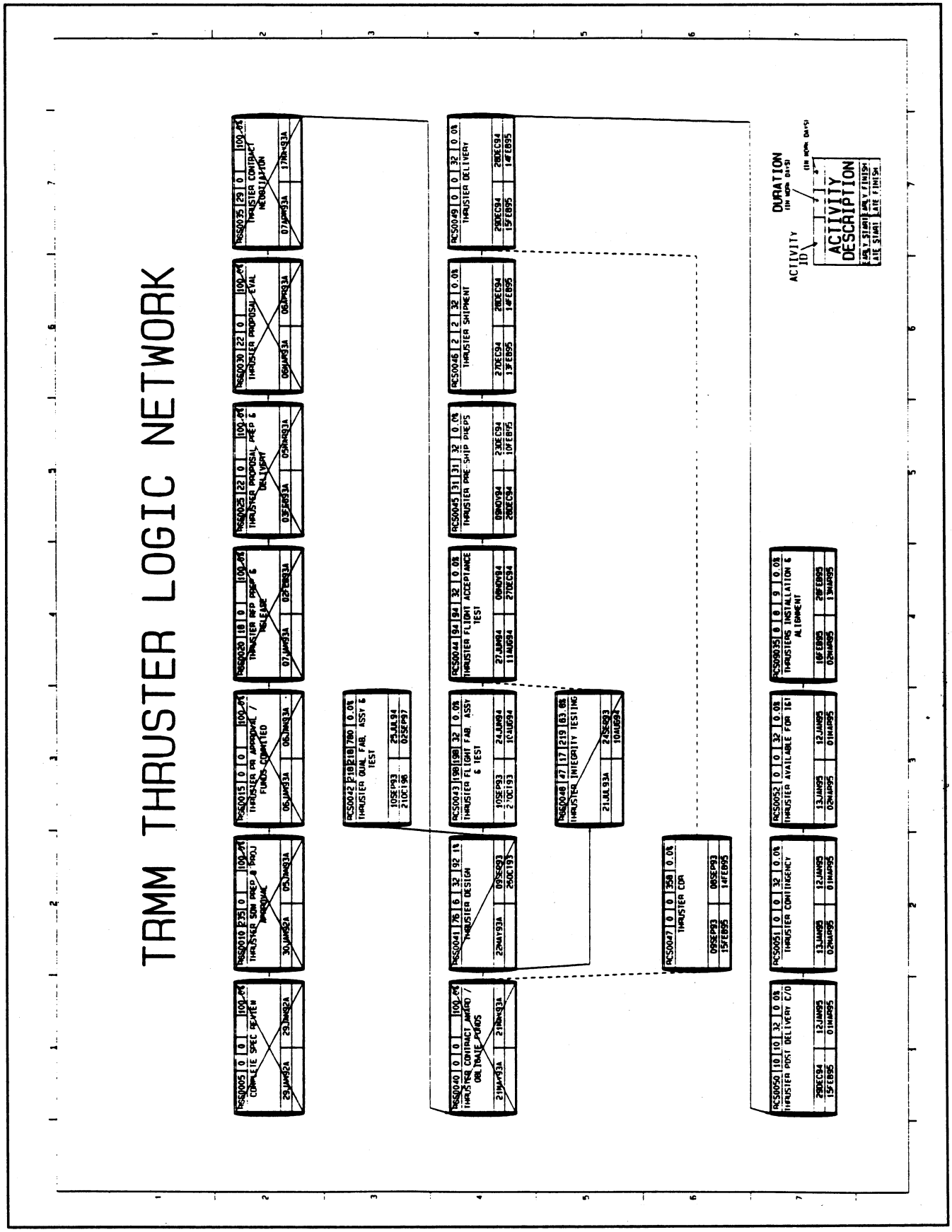

Figure 2. RCS Thruster Logic Network Diagram

ACTIVITY ID	EARLY START	EARLY FINISH	TOTL FLT
			THRUSTERS
RCS0010	30JAN92A	5JAN93A	THRUSTER SOW PREP & PROJ APPROVAL
RCS0015	6JAN93A	6JAN93A	◆ THRUSTER PR APPROVAL / FUNDS COMMITED
RCS0020	7JAN93A	2FEB93A	THRUSTER RFP PREP & RELEASE
RCS0025	3FEB93A	5MAR93A	THRUSTER PROPOSAL PREP & DELIVERY
RCS0030	6MAR93A	6APR93A	THRUSTER PROPOSAL EVAL
RCS0035	7APR93A	17MAY93A	THRUSTER CONTRACT NEGOTIATION
RCS0040	21MAY93A	21MAY93A	◆ THRUSTER CONTRACT AWARD / OBLIGATE FUNDS
RCS0041	22MAY93A	9SEP93	32 THRUSTER DESIGN
RCS0048	21JUL93A	24SEP93	219 THRUSTER INTEGRITY TESTING
RCS0047	9SEP93	8SEP93	358 ◇ THRUSTER CDR
RCS0042	10SEP93	25JUL94	780 THRUSTER QUAL FAB, ASSY & TEST
RCS0043	10SEP93	24JUN94	32 THRUSTER FLIGHT FAB, ASSY & TEST
RCS0044	27JUN94	8NOV94	32 THRUSTER FLIGHT ACCEPTANCE TEST
RCS0045	9NOV94	23DEC94	32 THRUSTER PRE-SHIP PREPS
RCS0046	27DEC94	28DEC94	32 THRUSTER SHIPMENT I
RCS0049	29DEC94	28DEC94	32 THRUSTER DELIVERY ◇
RCS0050	29DEC94	12JAN95	32 THRUSTER POST DELIVERY C/O □
RCS0051	13JAN95	12JAN95	32 THRUSTER CONTINGENCY ◇
RCS0052	13JAN95	12JAN95	32 THRUSTER AVAILABLE FOR I&T ◇

FY92 FY93 FY94 FY95

J F M A M J J A S O N D J F M A M J J A S O N D J F M A M J

Target Date 1SEP93
Plot Date 27SEP93
Data Date 1SEP93
Project Start 1JAN91
Project Finish 2SEP97
(c) Primavera Systems, Inc.

Activity Bar/Early Dates
Critical Activity
Target Bar
Milestone/Flag Activity

GODDARD SPACE FLIGHT CENTER
TROPICAL RAINFALL MEASURING MISSION
RCS THRUSTER DETAIL SCHEDULE

Sheet 1 of 1

Date	Revision	Checked	Approved

Figure 3. RCS Thruster Detailed Schedule Bar Chart

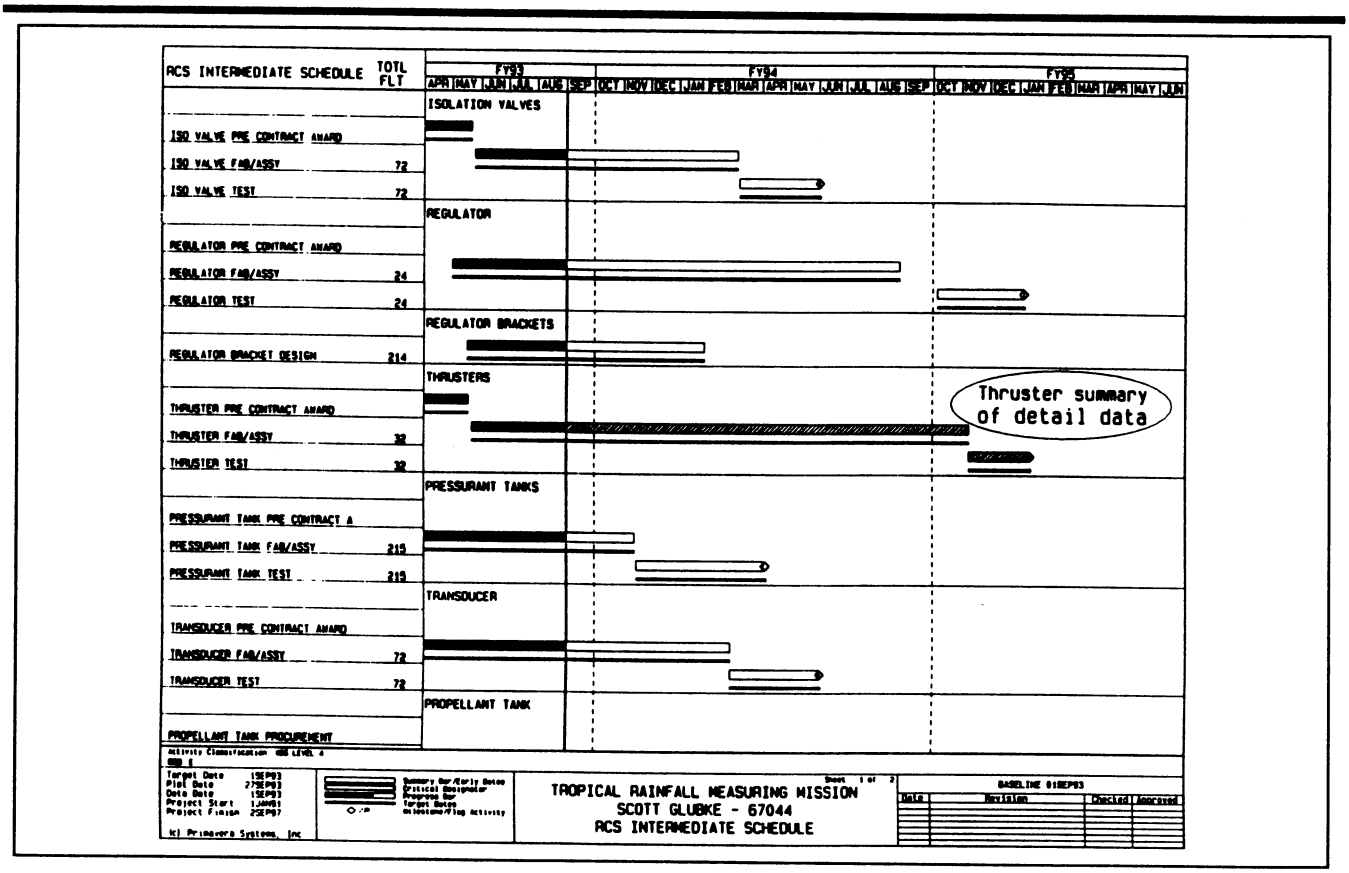

Figure 4. RCS Intermediate Schedule (1 of 2)

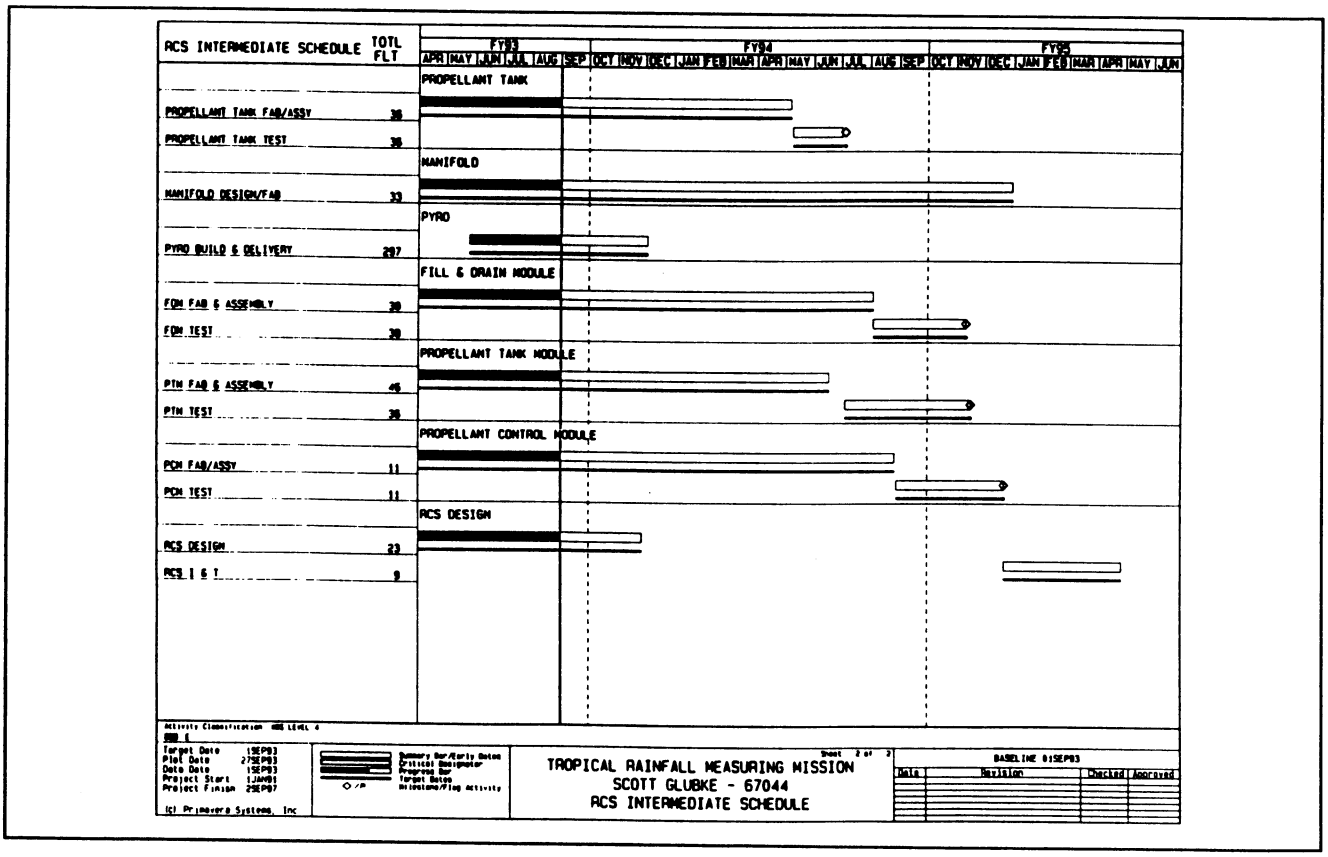

Figure 4. RCS Intermediate Schedule (2 of 2)

The major project milestones provide the framework for overall planning and scheduling for the TRMM spacecraft segment, instrument segment, and ground segment developments, system integration and test, shipping and delivery, and launch site preparations. These milestones, depicted at the top of the Master Schedule (see Figure 5) consist of the System Concept Review (SCR), Preliminary Design Review (PDR), Critical Design Review (CDR), Pre-Environmental Test Review (PER), Pre-Shipment Review (PSR), and the Launch Readiness Review.

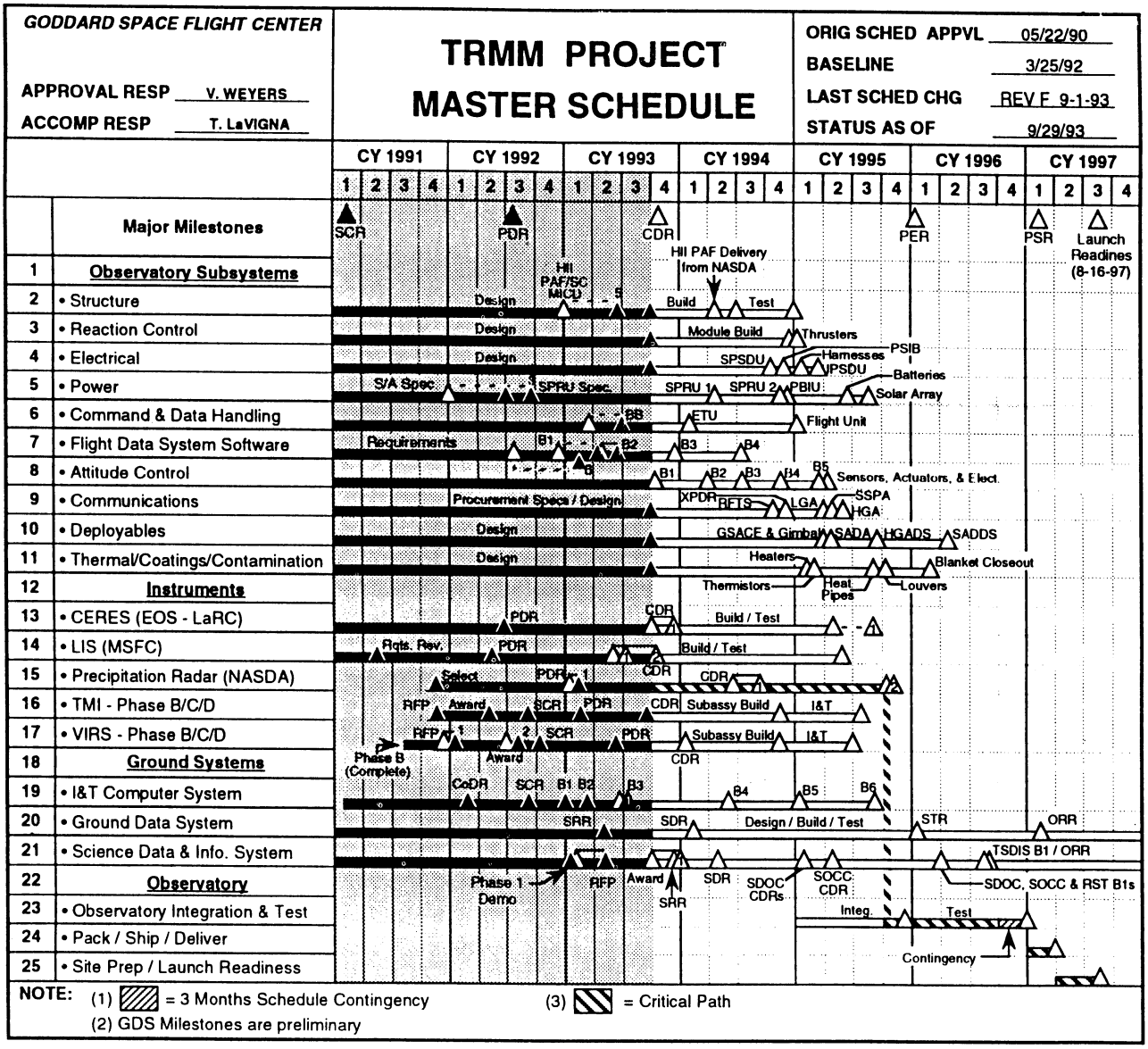

Figure 5. TRMM Project Master Schedule

The project control milestones are events which the TRMM Project Office considers critical. These include, but are not limited to, interface milestones such as the delivery of hardware or software between TRMM organizational elements. Control milestones can also represent the completion of major stages of work within a given subsystem or element. More importantly, they are commitments by the responsible organizations to the TRMM Project Office to accomplish these events as planned.

Next, the TRMM I&T schedule is included in the PSBD because it establishes the need dates for flight hardware and software. Considerable emphasis was placed on establishing the I&T schedule soon after the SCR in February 1991. Moreover, because all of the TRMM elements ultimately come together during integration and test, the I&T schedule has become the "hub" of the overall scheduling process. It is a key planning tool for all of the elements of the spacecraft, instrument and ground segments.

Since the logic network is a continuously evolving tool, it is not directly contained in the PSBD—only the project control milestones are. However, the logic network supports the schedule baseline in that a target version of the network is maintained against which the current status is compared. This concept is illustrated in the sample bar chart presented earlier (see Figure 4). The compressed black line below each activity bar or milestone represents the schedule baseline at the detailed work task level. This provides a correlation between the current schedule and the baseline. Unilateral changes to the logic network by the responsible subsystem or technical managers are permitted, provided they do not impact the project control milestones or necessitate rephasing of the budget.

Schedule status accounting on the TRMM Project occurs formally each month. Work already underway or activities that should have started or been completed since the last accounting period are statused by determining the percentage of work accomplished, the amount of time remaining to complete a task, or the new expected finish date of a task. For the work being performed at GSFC, the responsible subsystem technical managers are interviewed by the schedulers in order to obtain schedule status. In this way, the schedulers receive not only the status, but also the rationale and issues affecting the status. Once the raw status is input into the logic network data base, it is processed, analyzed and verified. This allows schedule issues to be identified, resolved or addressed before status is formally reported in the TRMM Monthly Project Review. For TRMM's scientific instruments, schedule status is received from the instrumentors each month and analyzed prior to incorporation into the logic network.

The key driver in the TRMM schedule is the August 16, 1997 launch readiness date. In addition to monitoring the actual progress of work toward launch readiness, the TRMM schedulers carefully analyze schedule slack. Total slack is a specific, quantitative and easily understood measure of schedule health. Figure 6 depicts the TRMM Total Slack Summary, which presents an overview of progress for a given month. The chart highlights the key elements for the spacecraft, instrument and ground segments. Each month the total slack for the worst case item within each element is elevated to the total slack chart. It is compared to total slack from the previous month, as well as the total slack for that item in the schedule baseline. The benefit of this chart is that TRMM project managers can see the overall health of the TRMM project schedule at a glance.

Element	Baseline Master Schedule - REV F [3] Delivery	Total Slack	Aug 1993 Total Slack	Sep 1993 Total Slack	Driver
Spacecraft Structure	12-30-94	+12 Days	+12 Days	+12 Days	Aft Skirt/Central Cylinder
Reaction Control	12-21-94	+14 Days	+14 Days	+14 Days	Propellant Control Module
Electrical	11-30-94	+53 Days	+53 Days	+53 Days	PSIB
Power	8-18-95	+30 Days	+30 Days	+30 Days	Solar Array Panels
C & DH	1-6-95	+83 Days	+83 Days	+83 Days	C&DH Flight Unit
FDS Software	12-15-93	+83 Days	+83 Days	+83 Days	FDS Build #3
Attitude Control	10-6-93	+32 Days	+32 Days	+32 Days	ACS S/W Build 1
Communications	5-26-95	+46 Days	+46 Days	+46 Days	High Gain Antenna
Deployables	4-24-96	+30 Days	+30 Days	+30 Days	SADDS (Flight Wings)
Thermal	2-28-95	+33 Days	N/A	+33 Days	Thermistors
LIS	6-1-95	+53 Days	+53 Days	+53 Days	Electronics Assembly
CERES	9-1-95	+29 Days	+29 Days	+29 Days	Biaxial Scan Assembly
Precipitation Radar [4]	10-25-95	+12 Days	+4 Days	+4 Days	Transmitter / Receiver
TMI	8-1-95	+32 Days	+32 Days	+32 Days	Receivers
VIRS	7-1-95	+42 Days	+42 Days	+42 Days	Electronics Module
TSDIS	8-14-96	+35 Days	+35 Days	+35 Days	Contract Award
I&T Computer System	6-9-94	+41 Days	+69 Days	+41 Days	I&TCS Build #4
Observatory I&T	10-9-96	+12 Days	+4 Days	+4 Days	Precipitation Radar

NOTE:
1) 3 months schedule contingency not counted in slack
2) Total slack calculated in working days
3) REV F = CDR baseline revision
4) Baseline PR delivery is need date for observatory I&T

= Loss in slack from last month 10 days or greater

= Growth in slack from last month 10 days or greater

Figure 6. TRMM Total Slack Summary

The schedule products such as bar charts and network diagrams are important Program Control tools for TRMM. When combined with a formal status process, they enable the TRMM Project Office to assess the progress of the TRMM schedule. As an early warning mechanism, the scheduling system provides a means to detect potential schedule problems, implement workaround plans, or take corrective action in order to mitigate problems. Scheduling products are tailored to various members of the TRMM team. Tools such as the Total Slack Chart and the Intermediate Schedules provide a way to summarize a tremendous amount of detailed schedule data for TRMM project management. With this information, management can identify key issues, critical paths and potential workarounds. At the working level, detailed schedule bar charts and logic network diagrams are excellent planning tools.

In summary, the TRMM scheduling system provides reliable information to all levels of users.

Financial Management

A key feature of the Program Control System is cost and schedule integration. As with the scheduling staff, the financial staff is centralized at the project level—although other GSFC organizations also provide financial support for TRMM subsystem managers. The main duty of the financial staff is budget formulation and execution. The logic network schedule serves as a basis for TRMM budget planning. Based on a detailed integration and test sequence, need dates for flight hardware and software have been precisely identified. Budgets were formulated against the timeframe reflected in the schedules, as illustrated in Figure 7.

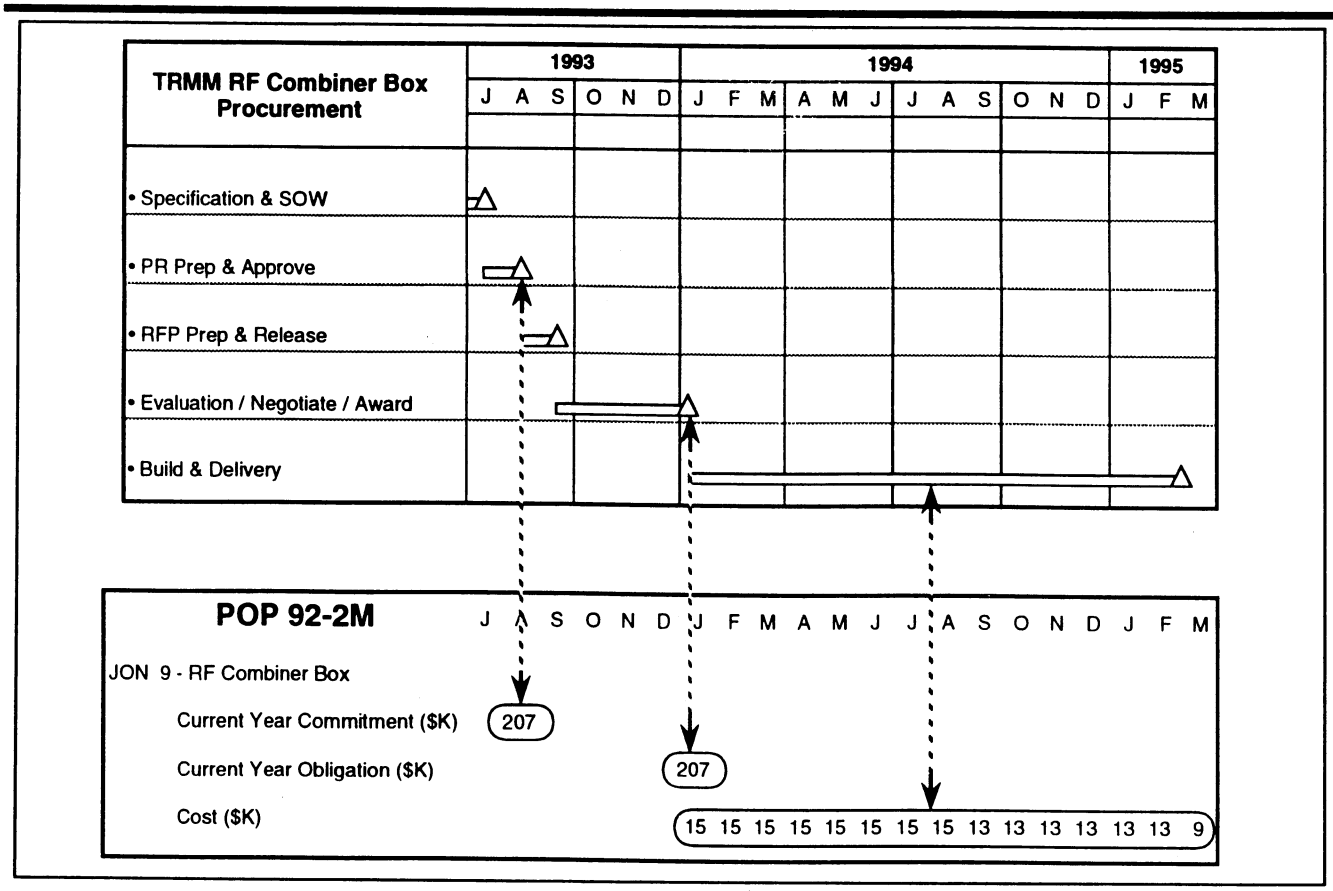

Figure 7. TRMM Cost/Schedule Integration

By integrating cost and schedule planning, the project office can perform what-if budget and schedule simulations. Civil servant manpower and travel budgets were also developed using the schedule to determine the correct phasing of requirements. In a dynamic budget environment, the TRMM Project is quickly able to isolate the impact of schedule delays, personnel shortages and travel cuts on the budget requirements. Similarly, when budgets are reduced, the integrated cost and schedule information provides a framework to quickly determine the scope of work that can be reprogrammed without having undesirable effects on launch readiness.

The TRMM Project has already used this system to identify numerous planned early year, high-cost component purchases that could be deferred to later years, thereby alleviating funding problems without risking the integration and test schedule.

Close coordination between the subsystem and element managers and the TRMM financial staff ensures timely and accurate preparation of budget estimates and procurement requests. Since TRMM is an in-house project, the procurement activities are not focused on several large prime contracts, as typically found in other GSFC projects. Instead, the financial and procurement staffs are responsible for purchasing the components, parts and instruments that will come together as a complete observatory. These extensive procurement activities require detailed planning and coordination to remain on schedule.

The budget was developed for these procurements and supporting effort as discrete items at the Job Order Number (or work package) level. The budget requirements were then "rolled-up" through the project work breakdown structure by month and fiscal year, which ensures that budget data

submitted to NASA Headquarters is based on the detailed estimates for the entire project. As part of the financial system, the TRMM financial staff has developed an extensive contingency tracking system. Details of all changes in the budget baseline are maintained in the contingency (management reserve) tracking system as shown in the summary portion of Table 2. This provides a complete audit trail of all items funded from the contingency line item.

In addition to budgeting and procurement responsibilities, the financial staff analyzes contractor financial performance and ensures that other members of the TRMM project team are kept abreast of financial issues and concerns. The TRMM Microwave Imager contract has requirements for modified Performance Measurement System (PMS) reporting. On a monthly basis, the financial staff prepares a quick-look analysis of the PMS data in the TRMM Program Control Monthly Status Report. Analyses are also prepared for other contracts and for fiscal activity.

Configuration Management

TRMM's integrated program control approach also closely aligns cost and schedule management with configuration management (CM) activities. TRMM's configuration management system provides a disciplined approach for controlling the changes to the requirements in hardware, software, performance, schedule and cost. Budget, schedule and technical requirements were established as integrated baselines early in the project's life. As changes to the established baselines occur, they are formally presented to the TRMM CCB.

The CCB, composed of technical and administrative representatives from each project discipline, evaluates the positive or negative impact of each change on the budget, schedule, and technical baselines. With this integrated, accurate approach to cost and schedule assessment, the impact of engineering changes can be quickly and thoroughly evaluated across the project. The TRMM Project Office has a goal to evaluate all changes within 45 days of the initial change request. A work progress indicator for the CM process has been incorporated into the Risk Management System.

Risk Management

Risk management is another key element of TRMM's integrated program control process. The Risk Management System emphasizes detection and resolution of problems in areas identified as having risk potential. The system allows managers to identify program risks and to implement alternate plans to mitigate the impact of unresolved problems, as shown in Figure 8. Cost, schedule and technical risk parameters have been identified for TRMM to quantitatively measure program health and ultimately program risk.

Figure 9 shows the elements of the project that are tracked in the monthly Risk Assessment Report. Technical indicators include power, mass, data rate and mission life. Management indicators include finance, schedule, configuration management, manpower and procurement. These risk indicators have been identified to provide a quantifiable goal against which progress is measured. Each indicator has three tolerance levels or alert zones used to indicate the level of risk.

First, risk is classified as a major impact if the indicator's performance reflects the existence or imminent threat of major problems, concerns or similar severe impacts upon accomplishment of project requirements.

TRMM PROJECT -- CONTINGENCY TRACKING SYSTEM

28-Sep-93

ENCUMBRANCE SUMMARY:

CAT	DESCRIPTION				POP	FY 91	FY 92	FY 93	FY 94	FY 95	FY 96	FY 97	TOTAL
1	REPHASE/RELOCATE				ALL	0	455	387	1559	-3936	-193	1728	0
2	ADJ TO PROPOSAL/NEGOTIATED/LATEST ESTIMATE				ALL	60	1546	-2543	2913	-945	-1719	-562	-1250
3	MINOR/MISC (EACH ACTION < $100K)				ALL	201	-180	1129	-109	326	-47	149	1469
4	ITEMIZED												
	4 POP	05/28/93	MSSN OPS	SIMULATOR SPPT (CEAS/NMOS)	93-1					103	162	210	475
	4 POP	05/28/93	S/W MGMT	IV&V TASK	93-1				1050	375	250	125	1800
	4 POP	05/28/93	TEST	ILLM DUPL OF SUBSYS COMPONENTS	93-1			-6	-734	-207	48	-247	-1146
	4 POP	05/28/93	PROD ASSUR	PARAMAX (INCREASE REQ)	93-1			137	229	166			532
	4 OB-0035	06/30/92	POWER	PSE TECH CHG	92-2M			-100	75	-650			-675
	4 MEMO	01/14/93	POWER	SOLAR ARRAY	93-1			576	-2635	-1444	-44	-47	-3594
	4 OB-0001	06/13/91	POWER	GaAs SA	92-1			100	967	966	866		2899
	4 POP	10/26/92	POWER	PSE DECREASE	92-2M			-100	-95				-195
	4 OB-0066	12/18/92	RCS	THRUSTER CHANGE/ISO ADDTN	93-1			230					230
	4 POP	05/28/93	ELEC	WIRE HARNESS PARTS (CCR & INCREASE)	93-1			346	-115	-24			207
	4 OB-0035	06/30/92	ELEC	PSE TECH CHG	92-2M		195	462	638	68			1363
	4 POP	10/26/92	ELEC	S/W CM	92-2M			66	75	105	137	80	463
	4 OB-0035	06/30/92	C&DH	PSE TECH CHG	92-2M			-489	-200				-689
	4 OB-0013	04/28/92	C&DH	REMOVE 5 SIRTS	92-2			-583	-623				-1206
	4 POP	05/28/93	FLIGHT S/W	FDS S/W SPPT	93-1			10	140	143	215	118	626
	4 MEMO	03/01/93	GRND SYS	GS PROJ SPPT	93-1			354					354
	4 MEMO	01/22/93	GRND SYS	GS H/W & S/W PURCHASE	93-1			285					285
	4 GN-0030	06/09/92	SPT GRND	PROTOTYPE BUDGET INCREASE	92-2M		160						160
	4 POP	05/28/93	GRND SYS	EOS/DIS SPPT/LEROY	93-1			25	36	48	60	73	242
	4 IN-0106	03/22/93	TMI	ANGULAR MOMENTUM COMPENSATION	93-1			-120	-160	-120			-400
	4 POP	05/28/93	VIRS	COOLER (INCREASE)	93-1				418				418
	4 POP	05/28/93	MPS	ROS TRANSFER W/O G/L	93-1						132	374	506
	4 POP	05/28/93	MPS	MPS TAX CHANGE	93-1				1670	510	1220	-62	3338
SUBT 4						0	355	1193	736	39	3046	624	5993
TOTAL						261	2176	167	5098	-4516	1087	1939	6212

Table 2. Contingency Tracking System

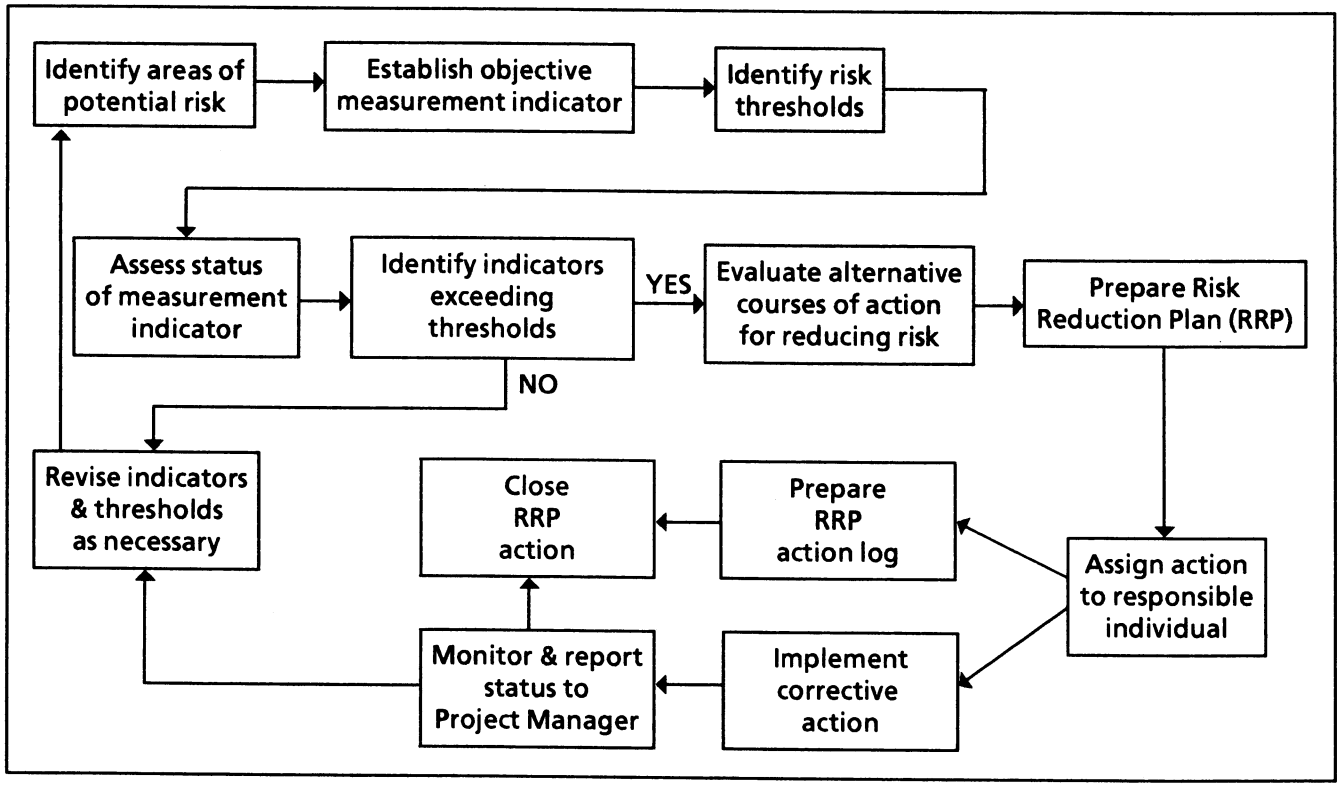

Figure 8. TRMM Risk Management Process

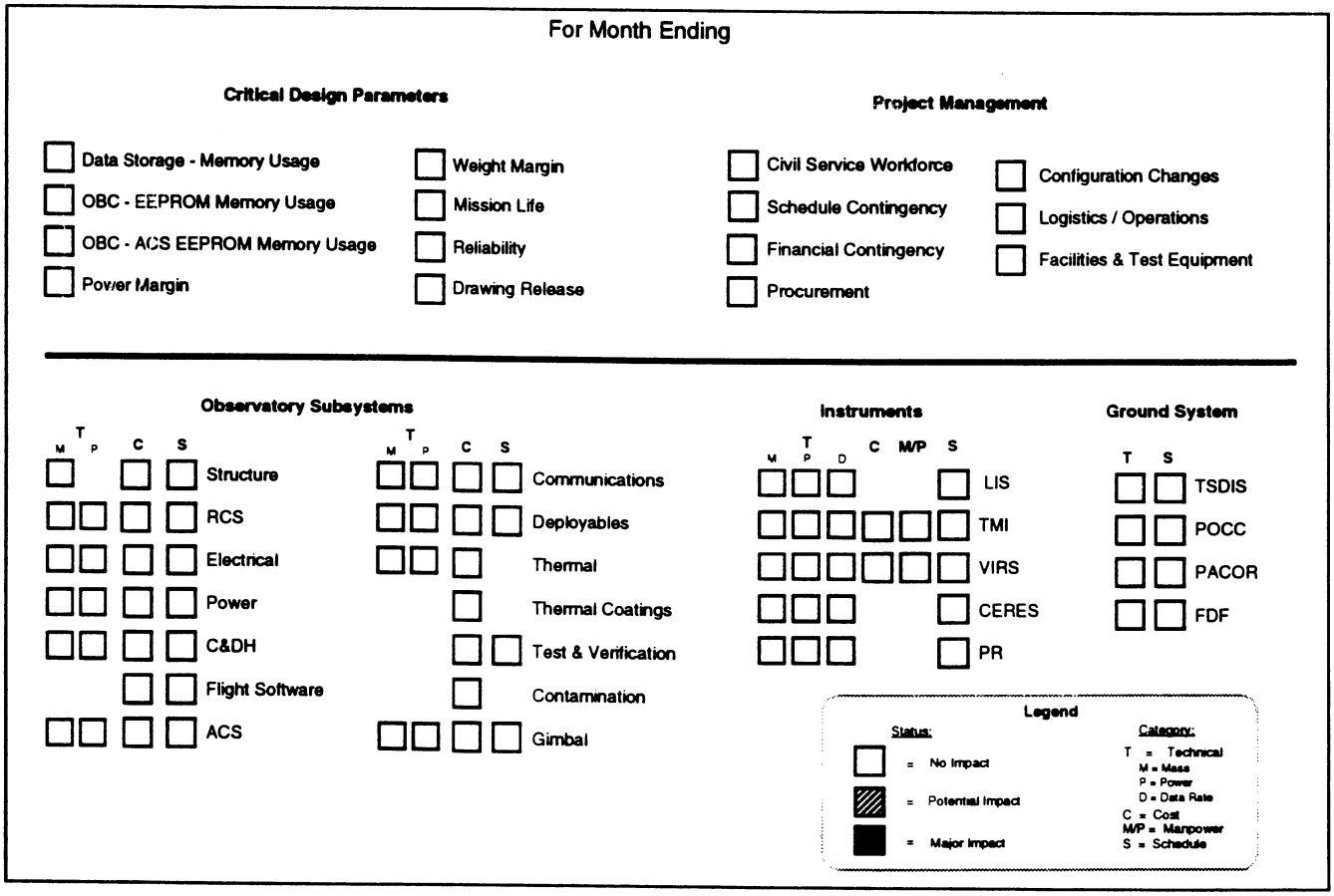

Figure 9. TRMM Risk Assessment Summary

Second, the risk is identified as a potential impact if performance reflects the existence of problems, concerns or potential impacts on the project unless timely and effective action is taken. In the third category, the risk poses no negative impact on meeting TRMM cost, schedule and technical requirements. When an alert zone threshold is passed, an analysis is conducted by the responsible manager to determine the cause of the problem and a corrective action plan is generated to restore the indicator to the desired state. The Risk Reduction Plan documents these products and provides an audit trail for the project to assign, track and close the corrective actions.

Configuration Changes

Purpose: To track the status of engineering changes (Class I) in terms of timely action to avoid schedule and/or cost impact.

Data ground rules:

- Track age of Configuration Change Requests (CCRs)
- Change quantity measured by count of approved change logged into configuration control.

Alert zones:

☐	No Impact or	Age of CCR less than 45 days
▨	Potential Impact or	Age of CCR between 45 and 60 days
■	Major Impact	Age of CCR over 60 days

Figure 10. TRMM (CCRs) Indicator Summary

Figure 10 illustrates the risk indicator summary for the TRMM Configuration Change Requests. The project recognizes that failure to act upon change requests in a timely manner could affect the project's ability to accomplish cost and schedule goals. The alert zones reflect the project's goals for the disposition of all change requests in 45 days. The accompanying status shown in Figure 11 provides a monthly record of TRMM's performance against these pre-established thresholds.

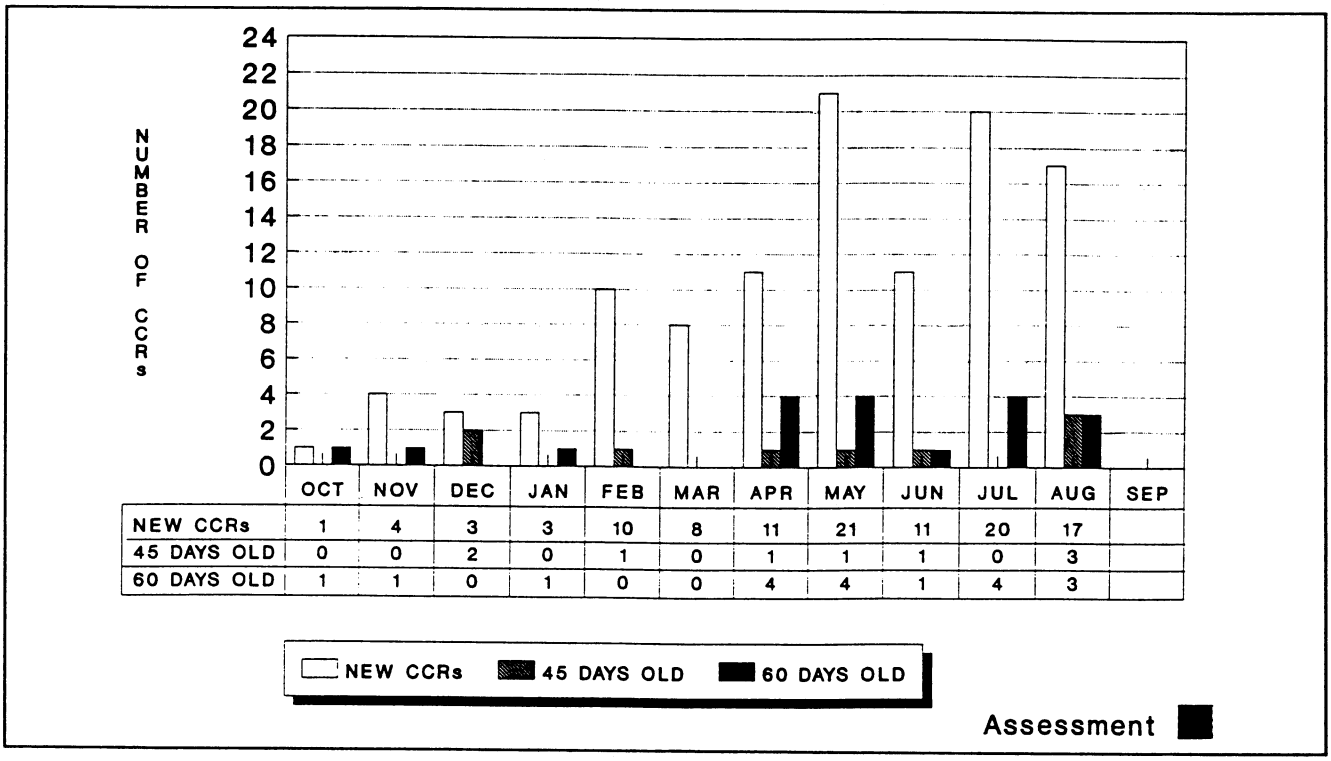

Figure 11. TRMM Project Configuration Change Requests

When the assessment is unfavorable, a Risk Reduction Plan is generated (Figure 12) which analyzes the cause, impact and corrective action. The thresholds for the alert zones were set jointly by the responsible subsystem manager and the project manager, and are intended to represent a reasonable goal for that indicator. These thresholds were sometimes adjusted several times in the preliminary months of the Risk Assessment Report until all parties felt that the appropriate goals were reflected accurately.

Figure 13 shows the risk indicator for the RCS schedule slack. This indicator, used for all subsystems and instruments, tracks slack trend status. Each month, the actual slack is compared to pre-established thresholds and risk reduction plans are generated as needed.

In RCS, the January 1993 slack dropped to 16 days due to a technical change in the thruster configuration. Since the first risk threshold of 32 days was passed, a Risk Reduction Plan was generated (Figure 14). This problem was resolved in May 1993 by negotiating an earlier delivery with the vendor at contract award, with no additional cost. This action increased the thruster slack to 33 days. With the thruster slack no longer in an alert zone, attention was then focused on the element with the least amount of slack, the Propellant Control Module (PCM).

The risk management system has allowed the project staff to effectively use constrained resources to focus on problems which could negatively impact cost, schedule or technical objectives. Although the system requires a great deal of discipline,

Log Number _____

TRMM PROJECT RISK REDUCTION PLAN

Problem Description _____ Name of Indicator _____

Originator _____ Date _____ Phone Number _____

Check the Alert Zone that applies:

___ ■ Major Impact ___ ▨ Potential Impact ___ ☐ No Problem, but has unfavorable trend ___ ☐ No Problem, but RRP desirable

Potential Impact: ___ Cost ___ Schedule ___ Technical Performance

Describe Problem

1. Summarize problem, identify cause, quantify impact to cost, schedule technical performance.

2. List hardware and/or software configured items affected.

Corrective Action Plan (Be specific, include dates when problem is expected to be resolved, attach separate schedule if necessary.)

Functional Manager Concurrence _____ Project Manager Concurrence _____

Figure 12. TRMM Project Risk Reduction Plan

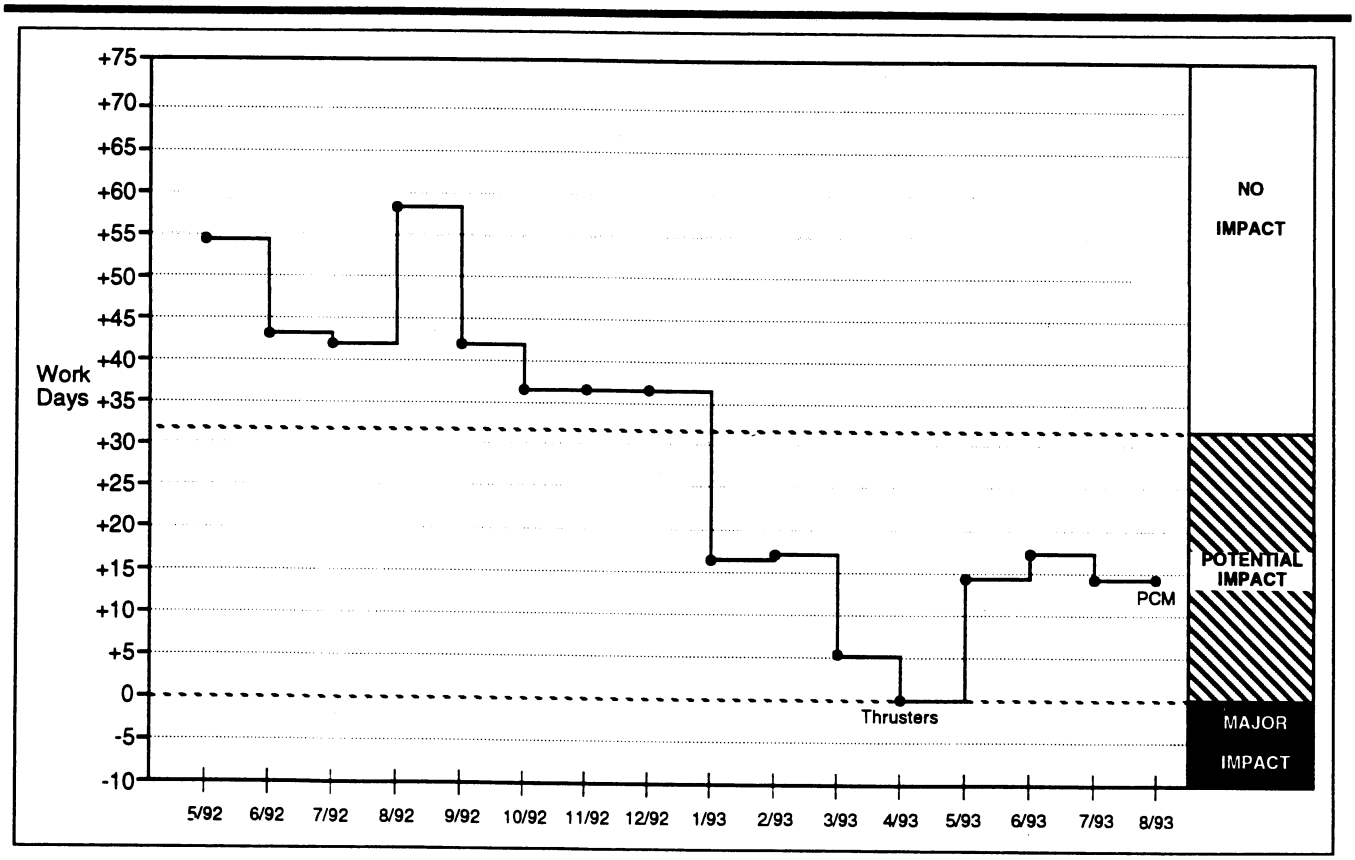

Figure 13. TRMM Reaction Control Subsystem Total Slack

Log Number 16

TRMM PROJECT RISK REDUCTION PLAN

Problem Description RCS - Schedule Name of Indicator Observatory-Schedule

Originator Walt Majerowicz Date 1/15/93 Phone Number x 5622

Check the Alert Zone that applies:

___ ■ Major Impact _X_ ■ Potential Impact ___ □ No Problem, but has unfavorable trend ___ □ No Problem, but RRP desirable

Potential Impact: ___ Cost _X_ Schedule ___ Technical Performance

Describe Problem

1. Summarize problem, identify cause, quantify impact to cost, schedule technical performance.
   Delivery of thruster delayed due to CCR OB-0066; total slack now +17 which is in excess of Alert Zone 1.

2. List hardware and/or software configured items affected.

Corrective Action Plan (Be specific, include dates when problem is expected to be resolved, attach separate schedule if necessary.)

1. Release RFP by 4/2/93 need technical and schedule estimates from bidder's in order to determine if 20.5 month lead time is realistic.
2. Begin investigating work-around plan for I&T assuming thruster impact.

Functional Manager Concurrence _____ Project Manager Concurrence _____

Figure 14. TRMM Project Risk Reduction Plan

planning and teamwork, the ultimate result focuses the entire project team on the critical problems. To date, the TRMM Project has succeeded in acheiving its cost and schedule goals, and the TRMM Project Office can provide GSFC and NASA management with very reliable status and forecast information. The TRMM Project Office's proactive management approach emphasizes prevention rather than correction. The ability to provide early warning and quick-reaction analysis when changes occur allows the team to make informed decisions and to optimize positive results. TRMM technical, resource and management personnel clearly understand their role in aggressively managing their responsibilities. TRMM's commitment to excellence, teamwork and communication will ensure the development of a high-quality satellite, delivered on schedule and within the approved budget. This progressive management system is one of the TRMM Project's contributions to improving NASA project management effectiveness and efficiency.