PERFORMANCE ASSURANCE

IMPLEMENTATION PLAN

FOR THE

X-RAY TIMING EXPLORER

December 15,1992

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

CAMBRIDGE, MASSACHUSETTS

PERFORMANCE ASSURANCE

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AT

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Contract NAS5-30612

Document No. 64-02017
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December 15,1992

INTRODUCTION

SCOPE

This plan describes the Product Assurance functions performed by MIT on the X-ray Timing Explorer Project. It includes the disciplines of Reliability, System Safety, Test, Material & Process Control, Parts Control, Configuration Management, Quality Assurance, Contamination Control, and Software Integrity. The paragraph numbering system in this plan, in most cases, matches the PAR for ease of cross referencing. In order to maintain this synchronized numbering system, this introduction is unnumbered. Since subsequent sections of this document discuss specific hardware items, a brief description of the experiment hardware is included. In addition, acronyms used in this plan are listed for reference.

XTE EXPERIMENTS

The X-ray Timing Explorer (XTE) is to carry three experiments;the Proportional Counter Array (PCA), the All Sky Monitor (ASM), and the High Energy X-ray Timing Experiment (HEXTE). The PCA and ASM will use a combined on-board Experiment Data System (EDS). The PCA is to be provided by Goddard Space Flight Center (GSFC), the EDS and ASM by the Massachusetts Institute of Technology (MIT), and the HEXTE by the University of California at San Diego (UCSD). The PCA, EDS, and ASM will be operated jointly by GSFC and MIT and are being designed as a combined experiment. The purpose of XTE is to study X-ray source variability and spectra for a broad range of time intervals (microseconds to months), over a broad energy range (2 to 200 keV).

PROPORTIONAL COUNTER ARRAY (PCA)

The PCA objectives are to make temporal and spectral measurements of the X-ray flux from the brightest several thousand X-ray sources. These objectives are accomplished by means of a one (1) square meter array of five (5) proportional counters having a total effective area of about 6000 cm^2. As such, the PCA will generate about 10^4 counts s^{-1} for a source as bright as a Crab or about 2 x 10^3 counts s^{-1} per detector. This source intensity will be typical of many important observations. The maximum expected count rate is a factor of 20 larger, or 4 x 10^4 counts s^{-1} per detector.

ALL SKY MONITOR (ASM)

The ASM consists of three Scanning Shadow Cameras (SSC's) mounted such that they can be rotated through 360 degrees by a motor drive. The ASM, including the rotation mechanism, is mounted on the

XTE Instrument Support Platform in such a way as to maximize the sky coverage during one 360 degree rotation of the SSC's. Under normal conditions, ~ 70% of the sky is scanned once per satellite orbit. The energy range of the ASM is 2 to 10 keV. Typical counting rates in the ASM detectors are 100 to 1000 counts s^{-1} per detector. Further details can be found in the MIT document 64-02007, "ASM Functional Description and Requirements".

EXPERIMENT DATA SYSTEM (EDS)

The EDS will take digital data from the PCA and the ASM, operate on this information, and format a data stream which will then be sent to the spacecraft (S/C). A series of nearly identical subassemblys, called Event Analyzers (EA's), will perform functions simultaneously (in parallel) on the data stream. Each EA will include dedicated event processing circuitry to select and accumulate data, a microprocessor to carry out control functions and calculations, and memory for storage of data and instructions. This subassembly will allow flexible allocation of types of data within the available telemetry capacity according to the scientific objectives of a particular observation. The PCA data will normally be compressed by the EDS to 18 kbps. The ASM data will be compressed to ~3 kbps. Thus the EDS will normally output a 21 kbps data stream to be merged with the HEXTE data by the spacecraft. For some observations, the EDS will put a high data rate (256 - 512 kbps) into a special spacecraft channel for times on the order of 30 minutes. Further details can be found in the MIT document 64-02006, "EDS Functional Description and Requirements".

ACRONYMS

A/D	Analog to Digital
AID	Altered Item Drawing
AQL	Acceptance Quality Level
ASM	All Sky Monitor
AWO	Assembly Work Order
CAD	Computer Aided Design
CDR	Critical Design Review
CDRL	Contract Data Requirements List
CI	Configuration Item
CSR	Center for Space Research
CTL	Configuration Traceability List
CVCM	Collected Volatile Condensable Material
DPA	Destructive Physical Analysis
DRD	Documentation Requirements Description
EA	Event Analyzer
ECO	Engineering Change Order
EDS	Experiment Data System
EEE	Electronic, Electrical, and Electromechanical
EGSE	Electronic Ground Support Equipment
EMC	Electromagnetic Compatibility
EP	Explorer Platform
ER	Established Reliability
ESD	Electrostatic Discharge
FAM	Flight Assurance Manager
FMEA	Failure Modes and Effects Analysis
FMECA	Failure Modes, Effects, and Criticality Analysis
FOR	Flight Operations Review
FRACAS	Failure Reporting and Corrective Action System
FRB	Failure Review Board
FRR	Flight Readiness Review
GFP	Government Furnished Property
GIDEP	Government-Industry Data Exchange Program
GSFC	Goddard Space Flight Center
GSE	Ground Support Equipment
GSI	Government Source Inspection
HD	Hardware Developer

HDBK	Handbook
HEXTE	High Energy X-ray Timing Experiment
JAN	Joint Army-Navy
JANS	Joint Army-Navy, Space
JANTX	Joint Army-Navy, Testing Extra
JANTXV	Joint Army-Navy, Testing Extra, with pre-cap visual inspection
JSC	Johnson Space Center
kbps	kilobits per second
keV	kiloelectronvolt
ksi	Thousand pounds per square inch
LDC	Lot Date Code
M&P	Materials and Processes
MIP	Mandatory Inspection Point
MIT	Massachusetts Institute of Technology
MRB	Material Review Board
MSFC	Marshall Space Flight Center
MUA	Material Usage Agreement
NASA	National Aeronautics and Space Administration
NDE	Non-Destructive Evaluation
NHB	NASA Handbook
NSPAR	Nonstandard Part Approval Request
ONR	Office of Naval Research
PA	Performance (or Product) Assurance
PAIP	Performance Assurance Implementation Plan
PAR	Performance Assurance Requirements
PCA	Proportional Counter Array
PDR	Preliminary Design Review
PER	Pre-Environmental Review
PI	Principal Investigator
PIL	Parts Identification List
PPL	Preferred Parts List
PSR	Pre-Shipment Review
PWB	Printed Wiring Board
QA	Quality Assurance
QCI	Quality Conformance Inspection
R&QA	Reliability and Quality Assurance
RIU	Remote Interface Unit

RTV	Return to Vendor
s^{-1}	per second
S/C	Spacecraft
SCD	Specification (or Source) Control Drawing
SCEF	Stress Corrosion Evaluation Form
SCR	System Concept Review
s/he	she or he
SID	Selected Item Drawing
S/N	Serial Number
SOR	System Operations Review
SPEC	Specification
SSC	Scanning Shadow Camera
STD	Standard
STS	Space Transportation System
TBD	To Be Determined
TBR	To Be Revised
TWL	Total Weight Loss
UCSD	University of California at San Diego
XTE	X-ray Timing Explorer

EXCEPTIONS AND DEVIATIONS

Listed below are thirty (30) topics, contained in twenty-five (25) specific paragraphs and Sections in the Performance Assurance Requirements (PAR) document, GSFC-410-XTE-001, and/or the Performance Assurance Implementation Plan (PAIP), MIT document 64-02017. These specific topics are divided into three (3) categories. Category 1 is a list of tasks for which the Massachusetts Institute of Technology (MIT) will clearly not be compliant with the requirements of the PAR. The PAIP details the methodology which will be used by MIT to accomplish, what is believed to be, the NASA/GSFC intent in imposing the requirement stated in the PAR. Category 2 lists tasks which may or may not be compliant with the PAR and depend on an interpretation of the PAR or the contract. The Category 3 task is an item which is not required by the PAR or the contract, but MIT considers it significant enough to be included in this PAIP.

CATEGORY 1

PAGE	PARAGRAPH	PARAGRAPH TITLE/(DEVIATION)
16	1.3.1 d	Software Development Documentation
25	2.5	Design Reviews
26	Section 3	Performance Verification (64-02005) •3.4.1 All instrument structural analysis is being performed by GSFC. MIT's role is limited to the support and review of these analyses, and does not include any certification as to their correctness or conformance to the requirements of the PAR. •3.4.6.2 It is assumed that externally induced shock test, if required, will be done at the Observatory level. •3.5.1 EMC verification tests will be conducted at the Observatory level. •3.6.5 Storage of flight hardware will, by definition, be in environments sufficient to protect it from extremes of temperature and humidity. No analysis or test will be performed.

PAGE	PARAGRAPH	PARAGRAPH TITLE/(DEVIATION)
27	Section 4	System Safety MIT, as a private university, does not intend to notify the GSFC Project Safety Manager of deviations from State of OSHA safety

requirements. These issues are covered in the MIT Safety and Health Plan, which is Attachment E to Contract NAS5-30612.

PAGE	PARAGRAPH	PARAGRAPH TITLE/(DEVIATION)
28	5.2.1.1	Standard Parts: Special Cases
29	5.2.2.1	Hybrid Microcircuits
30	5.2.2.2	Parts Qualification
33	5.2.6	Destructive Physical Analysis (use of electrical rejects and no DPA on selected military parts and hybrids with MIT pre-cap) (Also see Figure 5-2, 8/)
36	5.5	Radiation Hardness (additional testing)
38	6.2.4	Stress Corrosion Evaluation Form
52	7.3.1.1	Definition of "Critical Item"-(see Appendix A)
54	7.6	Government Furnished Property Reliability
75	8.14.3.4	Surveillance Inspection (periodic inspections and tests)
78	8.17	Stamp Control System (signatures)
80	8.20	Handling, Storage, Preservation, Marking, Labeling, Packaging, Packing, and Shipping (procedures)

PAGE	**PARAGRAPH**	**PARAGRAPH TITLE/(DEVIATION)**
84	10	SPAIP generated in response to GSFC-410-PAR-001, Rev. A, not GSFC-410-XTE-001

CATEGORY 2

19	1.12	Deliverable Data (CDRL)

29	5.2.2	Nonstandard Parts (qualification and QCI)
29	5.2.2	Nonstandard Parts (screening)
36	5.6	Parts used in Life Tests
38	6.2.4	Structural Loadpath materials
51	7.2.3.2	Checking Mechanical Drawings(checker)
52	7.3.1.1	Critical Items List(catastrophic failures)
62	8.8	MIT Receiving Inspection (random sample tests on non-critical materials and no additional tests at RI) (Also see Figure 8-2, 9/)
83	Section 9	Contamination Control The GSFC-generated Contamination Control Plan has not been released as of the date of this PAIP. It is assumed that the MIT-generated Contamination Control Plan, 64-02011, Rev. B, dated 12/11/92, will comply with the requirements of the GSFC document when it is released.

CATEGORY 3

62	8.8	MIT Receiving Inspection (100% testing)

SECTION I GENERAL REQUIREMENT

1.2 GENERAL

MIT/CSR has an organized Reliability and Quality Assurance Program. However, this function is being expanded and augmented to accomplish the requirements of the X-Ray Timing Explorer (XTE) Project, as specified in GSFC-410-XTE-001.

The PAR requires the existence of a rather substantial support organization (System Safety, Reliability Engineering, Parts Engineering, Materials and Processes,etc.). MIT has these support functions, whereas most sub-contractors do not. Therefore, MIT will work closely with those sub-contractors and perform most of these functions at MIT on their behalf. As a result, MIT will limit the flowdown of PAR requirements imposed on sub-contractors, in order to meet project cost constraints.

1.3 PERFORMANCE ASSURANCE IMPLEMENTATION PLAN (PAIP)

This PAIP describes how MIT will meet the requirements detailed in the GSFC PAR. Tasks to be performed, documentation, and forms to be submitted are contained in the applicable sections. Wherever the existing MIT system deviates from the PAR, the system will be described and the deviation will be identified. See previous page for exceptions and deviations.

1.3.1 PREPARATION OF THE PAIP

Details of this plan are specified in the Performance Assurance Requirements (PAR) for the Explorer Missions, GSFC-410-XTE-001. This Performance Assurance Implementation Plan (PAIP) encompasses all ten (10) sections of the PAR, plus one (1) additional section not included in the PAR. Seven (7) Massachusetts Institute of Technology (MIT) documents are included with this PAIP by reference but are separate plans and are controlled separately. These are:

Section 3 Performance Verification

MIT 64-02005 Instrument Test and Verification Plan

MIT 64-02005.01 Verification Matrix

Section 4 System Safety

MIT 64-02016 System Safety Implementation Plan

Section 7 Design Assurance and Reliability

-and-

Section 8 Quality Assurance

MIT 64-02014 Configuration Management Plan

Section 9 Contamination Control

MIT 64-02011 Contamination Control Plan

Section 10 Software Assurance

MIT 64-02019 Software Performance Assurance Implementation Plan

A. ORGANIZATION

This describes the organization and responsibilities of the MIT/XTE project, the Center for Space Research (CSR), and the Performance Assurance (PA) relationship between these functions.

The organization of the MIT/XTE Project is shown in figure 1-1. The responsibility and control of the PA aspects of the project reside with the Product Assurance Manager. The dominant feature of this management structure is the division of responsibility and authority between the Principal Investigator, the Project Manager, and the Product Assurance Manager. This division produces a delicate balance between the desire to produce the best possible experiment from a scientific viewpoint, the need to meet externally imposed cost and schedule constraints, and the CSR commitment to produce high quality, reliable experiments. This structure has been used at the CSR for about twenty (20) years and does depend on each function recognizing and accepting their respective roles. None of the three is the supervisor of another. In the case of a disagreement, the Director or Associate Director of CSR will arbitrate or direct a resolution of the problem.

Although the existence of a separate Product Assurance function, in parallel with the Project Manager, is fairly standard, this PA group is specific to the XTE Project. As a result, there is a close working relationship between the Project Manager and the XTE PA Manager. In a sense, the PA Manager is part of the project team along with the other staff members. He is the team member responsible for all Performance Assurance functions, in the same fashion as the Project Engineer is responsible for interfaces, technical coordination, and instrument performance. Although the PA Manager has direct access to CSR Management, his close involvement with the project usually obviates the need to use this access and assures that PA disciplines are an integral part of the development effort. The PA Manager is one of three (3) required signatories on the Engineering Change Order (ECO) which releases or modifies any flight hardware or software documentation. Therefore, the PA Manager is cognizant of all flight designs and is responsible to assure that the subject ECO does not jeopardize the XTE Project Performance Assurance goals and requirements. The PA Manager or one of his staff is intimately involved in all aspects of design, fabrication and test activities. That Product Assurance professional has the authority to stop the activity if s/he determines that the integrity of the hardware, software, test, or design is at risk.

The overall organization of the Center for Space Research (CSR) is shown in figure 1-2. This figure shows the organizational relationship of the XTE Product Assurance Manager (listed as the Reliability and Quality Assurance Manager in this figure), the XTE Project Manager, and other functional organizations within CSR.

For all MIT Departments and interdisciplinary Centers (such as CSR), the function of personnel management (including industrial safety) is the responsibility of the Administrative Officer.

MIT ORGANIZATION CHART

INSERT

Figure 1-1

MIT/CSR ORGANIZATION

INSERT

FIGURE 1-2

1.3.1 PREPARATION OF THE PAIP (continued)

B. MIT PROCEDURES AND INSTRUCTIONS

Copies of MIT procedures referenced herein have been submitted to GSFC. Revised procedures will be resubmitted as they are revised.

C. SUB-CONTRACTED HARDWARE

In general, the EDS and ASM will be designed, fabricated, integrated and tested in-house at MIT. Several assemblies (or subassemblies) have been or will be sub-contracted. Three (3) significant hardware items are the subject of subcontract activity. These are:

1. Detector in the scanning shadow camera (SSC)
2. High voltage power supply in the SSC
3. Hybrid Microcircuits in the SSC

When a decision is made, any item to be sub-contracted will be covered by detailed specifications (including a flow-down of the PAR requirements), a statement of work, and a purchase order. PA has input and signature authority in this process. The basic elements of the PAR apply equally to sub-contracted items as well as MIT fabricated hardware. As stated in paragraph 1.2 above, MIT will perform many of the support functions relating to performance assurance on behalf of the sub-contractor. Those tasks which the sub-contractor is capable of performing, will be detailed in the statement of work and/or specifications.

D. IDENTIFICATION OF SOFTWARE DEVELOPMENT DOCUMENTATION

The Software Management Plan (SMP), MIT document 64-02003, and Software Performance Assurance Implementation Plan, MIT document 64-02019, detail the software development process and procedures. Documentation requirements are included therein. MIT will not prepare a separate document list and schedule of this activity.

1.4 USE OF PREVIOUSLY DESIGNED, FABRICATED, OR FLOWN HARDWARE

As stated in the Introduction, MIT is the Hardware Developer (HD) for the EDS and ASM. These are both new designs. MIT will not be utilizing previously designed hardware.

1.5 PERFORMANCE ASSURANCE MANAGEMENT

The organization charts in paragraph 1.3 above, show unimpeded access to higher management. Note that for MIT/XTE, the Safety Officer is the Performance Assurance Manager.

1.6 PERFORMANCE ASSURANCE STATUS REPORT

The PA Manager will submit monthly status reports to be included in the monthly progress report. As a minimum, the status report will include significant problems, unresolved safety hazards, and a summary of ALERT activity. Status reports started the first month after PDR and will terminate at hardware delivery.

1.7 SURVEILLANCE

The government agency responsible for the supervision of MIT is the Office of Naval Research (ONR). Several representatives reside on-campus or at the near-by Charles Stark Draper Laboratory Inc.. MIT source inspection activities will be coordinated with these representatives. MIT/CSR will continue to cooperate with and support the ONR representative.

1.8 PROCUREMENT REQUIREMENTS

The PA Manager will participate in the selection of all sources for flight hardware. In addition, PA will participate in the preparation of procurement documentation to assure that all applicable flow-down requirements are imposed on the source. As described in paragraph 1.3.1 C above, the PA Manager must sign all requisitions for flight hardware.

1.9 AUDITS

MIT PA will audit sub-contractor assurance activities in conjunction with other activities at the vendor, such as MIT source inspections and precap visual inspections. Each audit will encompass two (2) broad areas. A systems audit will be employed to evaluate the nature, application and effectiveness of operating procedures and extent of compliance of operating personnel to the prescribed procedures. A product audit will be employed to evaluate hardware compliance to drawings, parts and materials lists, specifications, and assurance requirements prescribed by the purchase order. These audits will be conducted in a manner which assures measurement of conformance to the purchase order requirements, associated drawings, specifications, supporting systems and procedures. All audits will be documented detailing items reviewed, deficiencies noted, and corrective actions taken on the deficiencies. Historical records will be maintained on all audits performed.

With respect to internal audits, the PA Manager will periodically inspect the MIT/XTE documentation, procedures, and hardware, to assure compliance with the PAR and this PAIP. One should note that the "project organization" at MIT/CSR and the active role of the PA Manager within the project (signing all ECO's, responsible for all bonded stock, equipment calibration responsibility, etc.) makes it virtually impossible not to comply with the requirements set-up by the PA Manager. Therefore, this audit process becomes essentially a review of the PAR and PAIP to assure that nothing has been overlooked.

1.10 APPLICABLE DOCUMENTS

This Performance Assurance Implementation Plan (PAIP) is in response to the Performance Assurance Requirements (PAR), GSFC-410-XTE-001, and the applicable documents contained therein. However, the Software Performance Assurance Implementation Plan is in response to the previous PAR, GSFC-410-PAR-001, Rev. A, dated April 1991.

1.11 NOT USED

1.12 DELIVERABLE DATA

Deliverable data is as specified in Attachment D of the contract (Contract Documentation Requirements List and Descriptions) (CDRLD), and takes precedence over Appendix C of the PAR. Note that, in general, the PAR requirements have been incorporated into Attachment D of the contract. However, the following changes have been incorporated into the current CDRLD.

Modification to requirements

The requirement to deliver technical documents: **Fracture Control Implementation Plan; Fracture Analysis Report; Safety Data Package Input; Stress Analysis Report; and NASTRAN Finite Model; have been deleted.**

H.6 Handling Procedure
The QA stamp requirement is changed to QA signatures.

1.13 WAIVERS

In the event waivers are needed, MIT will request waivers on the form presented in figure 5-3. All deviations and exceptions are listed in the "Exceptions and Deviations" section of this PAIP. Those items listed in that portion of the approved PAIP, do not require additional waivers. If there are additional variances from the PAR in other parts of the PAIP, the PAR will take precedence.

SECTION 2 ASSURANCE REVIEWS

2.1 GENERAL

MIT will support system level reviews as necessary to assure sound designs and proper analysis. As a baseline, MIT assumes that the agenda items for each review is as defined by the appropriate Documentation Requirements Description (DRD) of section B of the Contract Documentation Requirements List and Descriptions (Attachment D of the MIT XTE Contract).

2.2 GSFC FLIGHT ASSURANCE REVIEWS

The various system level reviews will be supported by handouts, data, drawings, copies of deliverable documentation, and oral presentation. Review presentation material will be delivered to the GSFC Project Office one week prior to the scheduled review. MIT will support splinter meetings resulting from the main review. In addition, MIT will accept action items from the review meetings and respond to these action items.

2.3 GSFC FLIGHT ASSURANCE REVIEW PROGRAM

Following is a list of the scheduled design reviews and MIT's anticipated involvement in each review.

System Concept Review (SCR)

This review was held in November of 1989. Hence, the SCR is not a review listed in the MIT Phase C/D contract. MIT supported the SCR by making an oral presentation, supplying documentation and drawings, and providing technical support. MIT also responded to several Action Items which were generated by the review team.

Preliminary Design Review (PDR)

The PDR was held in November 1991. MIT prepared and presented drawings, analysis, documentation, and the other supporting material necessary to perform a preliminary review on the designs of the EDS, ASM, and flight software activity. Also included were the design test data and information available at that time. Data presented at PDR are listed below:

1. Analysis, reports and models required at this time as specified by the CDRLD.

2. Pertinent drawings, schematics, diagrams, specifications, breadboards, etc., pertaining to instrument hardware design.

3. Single point failure modes with risk assessment*

(* Only required at the interface level, ie.. to the first level of interface between the systems and the spacecraft.)

4. Safety compliance data package

5. Software development or design

6. GSE Design

7. Test Plans

8 Estimated weight, power, volume

9. Concerns in R &QA, parts, materials, NSPARS, waivers, contamination, etc.

10. Status of action items from SCR.

Critical Design Review (CDR)

CDR is scheduled for March of 1993. MIT will prepare and present drawings, analysis, documentation, and other supporting material necessary to perform a critical review on the final design of the EDS and ASM and flight software activity. Data to be presented at

CDR is as listed below. Also included will be design test data and information available at that time as well as the plans for testing of the flight hardware.

1. Presentation of the final design, and changes in design from the PDR. Final design data on electrical, mechanical, stress, thermal, etc.

2. All item required at CDR as specified in the CDRLD**.**

3. Software development update.

4. Final performance designs.

5. Remaining concerns such as reliability, safety, parts,handling, etc. .

6. Updated test plans and mission operation plans.

7. Status of action items from previous review.

8. GSE development status.

9. System safety implementation status.

System Operations Review (SOR)

MIT will support the SOR by attendance, supplying documentation and drawings, and providing technical support.

PRE-ENVIRONMENTAL REVIEW (PER)

The PER is scheduled for October 1993 for the EDS and February 1994 for the ASM. MIT will support the PERs by preparation and presentation of data as listed below.

1. Updates of items required for earlier reviews.

2. Malfunction/Failure report summary.

3. MRB decision summary

4. Status of test software

5. EGSE and MGSE readiness.

6. Results of tests performed.

7. Environmental test program/plan.

PRE-SHIPMENT REVIEW (PSR)

The PSR for the EDS is scheduled for January 1994 and June 1994 for the ASM. MIT will support the PSRs by preparation and presentation of the items listed below. All items for the Acceptance Data Package will be completed and available for review.

1 Status of Pre-Environmental Review recommendations and action items.

2. Hardware Status
   a. Results of test program
   b. Rework after environmental tests
   c. Results of calibrations
   d. Instrument performance - Measured parameters vrs. Requirements/MIT assessment
   e. Readiness for shipment
3. Malfunction Reports (MRs)
   a. Summary listing
   b. Discussion of open MRs

4. Deviations/Waivers
   a. Summary listing
   b. Open items

5. Contamination Control
   a. Certification of Cleanliness

6. Safety Status

a. Open items on hazard reports

7. Shipment Plans
   a. Packaging/handling/environmental monitoring
   b. Method
   c. Escort

8. Pre/post shipment testing plan

9. Instrument I&T at (1) GSFC, (2) at launch site
   a. Special requirements

10. Liens against hardware and software
    a. Non-flight items
    b. Material approvals
    c. Open NSPAR's
    d. Open malfunction reports/deviations/waivers
    e. Incomplete software
    f. Plans for close-out of open items

FLIGHT OPERATIONS REVIEW (FOR)

MIT will support the FOR by attendance, supplying documentation and drawings, and providing technical support.

FLIGHT READINESS REVIEW (FRR)

MIT will support the FRR by attendance, supplying documentation and drawings, and providing technical support.

2.4 SYSTEM SAFETY

Each review prepared and presented by MIT (PDR, CDR, PER, and PSR) will include system safety as an agenda item. This will cover hazards, corrective actions, and action item closures, both at MIT and sub-contractors.

2.5 MIT REVIEW REQUIREMENTS

In accordance with GSFC letter from T. S. Russell to P. Greer, dated July 14, 1992, section 2 on page 2, the requirement for internal reviews is a spacecraft requirement which does not apply to MIT. MIT conducts weekly meetings which are documented and reviews the various design activities. These weekly reviews are constructive critiques of the design and are not progress/schedule oriented. The entire MIT/XTE staff attend and participate in the discussions. The weekly meetings allow for good cross-fertilization and differing points of view from the various disciplines. MIT will not conduct additional internal design reviews.

SECTION 3 PERFORMANCE VERIFICATION

Performance verification is the subject of

MIT Document 64-02005; Instrument Test and Verification Plan

-and-

MIT Document 64-02005.01; Verification Matrix

SECTION 4 SYSTEM SAFETY

System Safety is the subject of

MIT Document 64-02016; System Safety Implementation Plan

SECTION 5 PARTS CONTROL

5.1 GENERAL

This Parts Control Section details the tasks which MIT will perform on the XTE Program to standardize and control the use of Electronic, Electrical, and Electromechanical (EEE) parts. The goal of this parts control program is:

- minimize the number of different parts selected
- utilize standard parts wherever possible
- limit the use of nonstandard parts
- document and control nonstandard parts

5.2 ELECTRONIC, ELECTRICAL, AND ELECTROMECHANICAL (EEE) PARTS

5.2.1 STANDARD PARTS

MIT will endeavor to use standard parts (as defined in the PAR and detailed in the PPL) wherever possible without severely limiting the design performance. Standard parts will be Grade 1 or Grade 2 parts selected from the PPL or MIL-STD-975. In addition, the following are considered Standard Parts:

- All MIL-M-38510 Microcircuits
- All MIL-S-19500 JANTX and JANTXV Semiconductors
- All parts procured to GSFC S-311 Specifications
- All DESC certified Vendor 883 and SMD compliant parts received directly from the part manufacturer and source inspected by MIT

It is anticipated that all discrete semiconductors will be JANTXV and all passive devices will be Established Reliability (ER) of the lowest failure rate available.

5.2.1.1 STANDARD PARTS: SPECIAL CASES

This requirement does not apply to MIT.

5.2.2 NONSTANDARD PARTS

In those cases where standard parts are not available for the intended application, MIT will, where possible, select qualified high reliability parts. Part screening will be performed on

all nonstandard parts in accordance with the applicable table in the PPL, Appendix C. In accordance with clarifications provided in NASA/GSFC letter RS/XTE/035/90 dated 15 August 1990, from R. Shelley to B. Klatt, the following qualifications will be performed on semiconductor products:
(subject correspondence is included in Appendix B at the end of this document).

DIODES and TRANSISTORS
Steady State Life Test at 125°C for 1000 hours on a screened lot. Reference Group B requirements of MIL-S-19500. No Group C will be performed.

MICROCIRCUITS
Steady State Life Test at 125°C for 1000 hours on a screened lot. No Quality Conformance Inspection (QCI) will be performed.

The Parts Engineer is the focal point for all non-standard parts. Any nonstandard part is the subject of a Non-Standard Part Approval Request (NSPAR) with all applicable supporting analysis, qualification, usage, and reliability data along with procurement control specifications. A summary of the MIT proposed procurement requirements for nonstandard parts is shown in Figure 5-2; Parts Procurement Matrix for Nonstandard Parts. Full Military QCI and Part Qualification will not be performed on nonstandard parts.

5.2.2.1 HYBRID MICROCIRCUITS

Hybrid microcircuits will be manufactured by a manufacturer certified per MIL-STD-1772 and listed in QML-38534. The hybrid microcircuits will be Level H, Option 2, per MIL-H-38534. In accordance with NASA letter from W. Davis and T. Mecum to W. Mayer dated February 27, 1992, (see Appendix B) QCI and DPA sample size shall be per NASA/GSFC document S-311-200, Rev. B.

5.2.2.2 PARTS QUALIFICATION

Nonstandard parts shall be qualified in accordance with the following correspondence (see Appendix B):

- NASA letter from W. Davis and T. Mecum to W. Mayer dated March 23, 1992.
- NASA letter from D. Schulz to Distribution dated March 3, 1992.
- MIT letter with interpretations from B. Klatt to W. Davis dated March 8, 1992

5.2.3 DERATING

In conjunction with the stress analysis discussed in paragraph 7.3.2 of the Design Assurance and Reliability section, each part will be assessed for stress ratio and its conformance to the derating requirements of the PPL.

5.2.4 PARTS SPECIFICATIONS

Standard parts will be procured by using the specifications designated for the appropriate part in the PPL. Nonstandard parts will be controlled with Source Control, Specification Control, Selected Item, or Altered Item Drawings. These drawings will conform to the standard six part format of MIL-STD-490. In most cases, nonstandard parts are selected from other high reliability standards. This allows MIT to use that part control drawing as a reference basis for an Altered Item Drawing (AID) or Selected Item Drawing (SID). Where other high reliability standards are not available, complete Source Control or Specification Control Drawings (SCD) will be prepared. These will completely identify the part and cover all aspects of manufacture, Reliability and Quality Assurance requirements, testing, acceptance/rejection criteria, and screening. See Figures 5-1 and 5-2; Parts Procurement Matrix for Standard and Nonstandard Parts.

PARTS PROCUREMENT MATRIX

STANDARD PARTS

Figure 5-1

INSERT

PARTS PROCUREMENT MATRIX

NON-STANDARD PARTS

Figure 5-2

Insert

5.2.5 RESCREENING

Discrete semiconductors used in the EDS or ASM, will be subject to 100% Particle Impact Noise Detection (PIND) testing. If DESC certified, Vendor/883 or SMD compliant microcircuits, received from distributors, are used, the following will be imposed:

- Destructive Physical Analysis (DPA) per S-311-M-70
- 100% Particle Impact Noise Detection (PIND) testing
- Pre Burn-in Electrical measurements @ -55, +25, and +125° C
- Dynamic Burn-in for 160 hours
- Post Burn-in Electrical measurements @ -55, +25, and +125° C

See Figures 5-1 and 5-2; Parts Procurement Matrix for Standard and Nonstandard Parts.

5.2.6 DESTRUCTIVE PHYSICAL ANALYSIS (DPA)

DPA will be performed on samples from each lot date code of nonstandard semiconductors, hybrid microcircuits, and nonstandard monolithic microcircuits. See Figure 5-2; Parts Procurement Matrix for Nonstandard Parts. GSFC S-311-M-70A will be used as the DPA method and criteria for reject. MIT will select a test laboratory (Hi-Rel, Unisys, etc.) for the actual analysis. DPA samples will be selected from electrical rejects rather than selecting samples at MIT Receiving Inspection, as suggested in GSFC S-311-M-70A. This will eliminate the destruction of high cost parts and still provide the needed information on fabrication integrity. Failure of any sample will be submitted to the Material Review Board (MRB) for disposition.inspection. DPA samples for Hybrid Microcircuits shall be per S-311-200, Rev. B. See NASA letter from W. Davis and T. Mecum to Dr. W. Mayer dated February 27, 1992 (see Appendix B).

5.2.7 ALTERNATIVE APPROACHES

In the event that a standard part cannot be accommodated and when the processing of a nonstandard part cannot be made consistent with the quality of a standard part, or the second option has a significant cost impact, MIT will submit a waiver request to

NASA/GSFC. Waiver requests will be documented on the Waiver Request Form, figure 5-3. The waiver request will explain the options and rationale for the proposed approach. Waiver requests will be considered by MIT, particularly for those subassemblies which have a natural multiplicity, such that a part failure would have only a minimal impact on the overall experiment performance.

WAIVER REQUEST

<table>
<tr><td>Date Prepared:</td><td>Waiver No.</td></tr>
<tr><td colspan="2">Initiated By:</td></tr>
<tr><td>COMPONENT AFFECTED:
P/N: Name:</td><td>ITEM AFFECTED:
P/N: Name:</td></tr>
<tr><td colspan="2">Original Requirements:</td></tr>
<tr><td colspan="2">Waiver Requested:</td></tr>
<tr><td colspan="2">Justification/Reason:</td></tr>
<tr><td colspan="2">Related Action and Effect:
(include cost/price)</td></tr>
</table>

FUNCTION	APPROVAL SIGNATURE	DATE
MIT Performance Assurance Manager	______________________	__________________
MIT Project Engineer	______________________	__________________
MIT Project Manager	______________________	__________________
GSFC Representative	______________________	__________________
GSFC Project	______________________	__________________

Figure 5-3

5.3 EEE DEVICES

All EEE part types not listed in paragraph 5.2.1 herein, and used by MIT in the EDS and/or ASM, will be controlled as nonstandard parts.

5.4 PARTS/DEVICES IDENTIFICATION LIST(PIL)

All parts used by MIT in the EDS and ASM will be listed in the Configuration Data Base. The Parts Identification List (PIL) will be derived from the configuration Data Base which includes NSPAR and radiation hardness status for EEE parts.

5.5 RADIATION HARDNESS

MIT will maintain a listing of all parts in the EDS and ASM and the rationale for acceptance with respect to radiation hardness. Because radiation effects information is frequently unavailable, MIT will utilize all information provided by NASA/GSFC or the part manufacturer, cross referenced to the EDS and ASM parts lists. The MIT Configuration Data Base will contain single event upset and total ionizing dose information, where available. MIT will not conduct additional testing for radiation effects.

5.6 PARTS USED IN LIFE TEST

In accordance with MIL-M-38510, paragraph 4.3.2.3, and verbal instructions received from NASA/GSFC, life tests are considered non-destructive. This is true only if the junction temperature (T_j) does not exceed the maximum specified T_j for the part. Therefore, MIT has the option of using sample parts which have been used in, and successfully passed, the 1000 hour life test.

SECTION 6 MATERIALS AND PROCESS CONTROL

6.1 GENERAL

MIT controls processes and the usage of materials, starting at the initial design stage and continuing throughout the entire life of the project. Detailed listings of materials and processes (M&P) designed into flight hardware will be prepared and submitted to NASA/GSFC. The first submittal was preliminary and was submitted before PDR. The final materials and processes lists will be submitted thirty (30) days before CDR.

6.2 SELECTION CRITERIA

6.2.1 CONVENTIONAL APPLICATIONS

The design of the EDS and ASM will be based on the use of those materials and processes which have been used previously by MIT or have been proven and are acceptable to NASA. The materials and processes documents listed below will be used in the selection and application of M&P.

Volumes 1 - 7	GSFC Material Tips
TM82275	Spacecraft Ball Bearings
TM82276	Liquid and Grease Lubricants
N-75-24848	Spacecraft Materials Guide
N-84-26751	Offgassing Data
No Number	GSFC Materials Selection Guide
NHB 8060. 1B	Flammability, Odor, and Offgassing
GSFC GMI 5340. 1	M & P Program Implementation
MSFC-HDBK-527 E	Materials Selection List
MSFC-SPEC-522B	Stress Corrosion Cracking
SP-R-0022A	Vacuum Stability of Polymeric Materials

6.2.2 NONCONVENTIONAL APPLICATIONS

It is not anticipated that any unique or exotic materials or processes will be needed in the design and fabrication of the EDS and ASM. If such an application does become necessary however, MIT will seek the guidance of NASA/GSFC Materials Specialists.

6.2.2.1 MATERIALS USED IN "OFF-THE-SHELF-HARDWARE: SPACECRAFT

This requirement is not applicable to MIT.

6.2.3 SPECIAL PROBLEM AREAS

The MIT XTE design does not incorporate any of the following:

- cooled detectors
- welded materials
- critical high-strength fasteners
- pressurized systems
- composite materials

Special attention will be given to stress corrosion cracking and lubrication. This attention will be in the form of extraordinary care in material selection, special analysis where necessary, and consultation with NASA/GSFC Materials Specialists. The specified mission environments are benign with respect to materials for radiation effects, galvanic corrosion, and hydrogen embrittlement.

6.2.4 INORGANIC MATERIALS

Metallic materials used in primary and secondary structures will be selected from the tables of acceptable materials listed in table 1 of MSFC-SPEC-522B and, class A materials listed in MSFC-HDBK-527. Any deviation from this will be documented in a Material Usage Agreement (MUA), however, the accompanying Stress Corrosion Evaluation Form (SCEF) will be completed by GSFC/Swales as part of the memorandum of understanding (MOU) related to structural analysis. Copies of these forms are included in figures 6-1 and 6-2 respectively. Completed forms will be submitted to NASA/GSFC with rationale and data when required. Materials in a structural loadpath will conform to the requirements stated above for primary and secondary structures (including the use of an MUA for deviations).

6.2.4.1 FASTENERS

MIT has purchased stainless steel fasteners for use in the ASM and EDS.

6.2.4.1.1 FASTENERS: SPACECRAFT

This requirement is not applicable to MIT.

6.2.4.1.2 FASTENERS: INSTRUMENT

MIT has purchased fasteners from a manufacturer listed in Appendix 1 of GSFC document S-313-100. The requirements of S-313-100 are being adhered to. MIT does not intend to use any high strength fasteners, rivets or shear pins. In addition, there are no applications where nuts and bolts will present a potential for a single point failure. MIT receiving inspection will visually inspect (100%) nuts and bolts with ultimate strengths < 140 ksi. See Figure 8-2.

6.2.5 ORGANIC MATERIALS

Non-metallic materials will be selected specifically to be noncombustible and non-generators of contaminating materials resulting from outgassing. These organics will be materials which comply with a Total Mass Loss (TML) of 1% or less and a Collected Volatile of Condensable Material (CVCM) of 0.1 % or less, when measured in accordance with paragraph 6.0 of JSC-SPR-0022A.

<table>
<tr><td colspan="3">MATERIALS USAGE AGREEMENT</td><td colspan="2">Usage Agreement No</td><td>Page of</td></tr>
<tr><td colspan="2">Project: Subsystem:</td><td colspan="2">Originator:</td><td colspan="2">Organization:</td></tr>
<tr><td>Detail Drawing</td><td colspan="2">Nomenclature</td><td>Using Assembly</td><td colspan="2">Nomenclature</td></tr>
<tr><td></td><td colspan="2"></td><td></td><td colspan="2"></td></tr>
</table>

<table>
<tr><td colspan="4">Material and Specification</td><td colspan="3">Manufacturer and Trade Name</td></tr>
<tr><td colspan="4"></td><td colspan="3"></td></tr>
<tr><td rowspan="2">Usage</td><td rowspan="2">Thickness</td><td rowspan="2">Weight</td><td rowspan="2">Exposed Area</td><td colspan="3">Environment</td></tr>
<tr><td>Pressure</td><td>Temperature</td><td>Media</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="7">Application:</td></tr>
<tr><td colspan="7">Rationale:</td></tr>
<tr><td colspan="4">Originator:</td><td colspan="3">Program Manager: Date:</td></tr>
<tr><td colspan="4">MSFC/Materials & Process Laboratory</td><td colspan="3">Materials Applications Evaluation Board</td></tr>
<tr><td colspan="4">Accept Date
Reject</td><td colspan="3">Accept Date:</td></tr>
<tr><td colspan="4"></td><td colspan="3">Reject</td></tr>
</table>

FIGURE 6-1

STRESS CORROSION EVALUATION FORM

1. Part Number ______________________________
2. Part Name ______________________________
3. Next Assembly Number ______________________________
4. Manufacturer ______________________________
5. Material ______________________________
6. Heat Treatment ______________________________
7. Size and Form ______________________________
8. Sustained Tensile Stress - Magnitude and Direction
    a. Process Residual ______________________________
    b. Assembly ______________________________
    c. Design, Static ______________________________

9. Special Processing ______________________________
10. Weldments
    a. Alloy Form, Temper of Parent Metal ______________________________
    b. Filler Alloy (if none, indicate) ______________________________
    c. Welding Process ______________________________
    d. Weld Bead Removed? yes ( ) no ( )
    e. Post-Weld Thermal Treatment ______________________________
    f. Post-Weld Stress Relief ______________________________

11. Environment ______________________________
12. Protective Finish ______________________________
13. Function of Part ______________________________

____

14. Effect of Failure ______________________________

____

15. Evaluation of Stress Corrosion Susceptibility ______________________________

____

16. Remarks ______________________________

____

NOTE: Numerical data to be provided by GSFC/Swales

FIGURE 6-2

6.2.6 PROCESS SELECTION

Only those processes which have been proven on previous space projects or are listed in NASA specifications as being acceptable for space flight applications will be used. MIT will avoid processes which could adversely affect materials properties. The processes employed on the EDS and ASM will be itemized on the Materials Process List; Figure 6-6.

6.2.7 SHELF LIFE CONTROLLED ITEMS

Age sensitive products which have a limited shelf life are recorded on the shelf life tag. The only limited shelf life materials which MIT intends to use, in the fabrication of the EDS and ASM, are epoxies. Data which is recorded is:

product name
purchase order number
manufacturer
manufacturer's lot code
date of manufacture
shelf life and storage conditions
expiration date

The date of manufacture and the expiration date are also recorded on the product unit package.

6.2.8 WELDING AND BRAZING

MIT does not intend to incorporate welding or brazing into the ASM and/or EDS design.

6.2.8.1 WELD FILLER MATERIAL

It is not planned to use weldments in procured items for the ASM and EDS. If weldment is used however, the requirements of MSFC-STD-655 (Appendix B) will be imposed.

6.2.9 PURCHASED RAW MATERIALS

Material certifications will be required from suppliers of raw materials. If the raw material is to be used in a critical application (item is on the "Critical Items List"), MIT will obtain chemical and physical tests, on a sample of the raw material, from an independent source.

6.2.10 MATERIAL CERTIFICATION

Any primary or secondary structure fabricated outside of MIT will be done with materials supplied by MIT. This material will be drawn from MIT bonded stores and delivered with the drawings to the supplier. Test and inspection records of the fabrication materials will be maintained by MIT

6.2.11 RAW MATERIALS USED IN PURCHASED PRODUCTS

The requirements of paragraph 6.2.9 above will be flowed-down to suppliers of purchased products. Those suppliers will be required to maintain acceptance test and analysis data for MIT review.

6.3 MATERIALS REVIEW

Performance Assurance will verify the acceptability of materials and processes by reviewing drawings and parts lists. The PAR materials and processes requirements will be flowed down to MIT subcontractors and suppliers. MIT Quality Assurance will audit these vendors to assure compliance.

6.4 DOCUMENTATION

MIT will prepare and submit to NASA/GSFC,materials and process lists in the format which is presented in Figures 6-3 through 6-6.
These lists will detail the following:

- Inorganic Materials (Figure 6-3)
- Polymeric Materials (Figure 6-4)
- Lubricants (Figure 6-5)

- Processes (Figure 6-6)

In addition, nonconventional materials applications data will be submitted to NASA/GSFC for approval. Engineering Drawings for materials applications will be available upon request. MUAs may be submitted as stated in paragraph 6.2.4 above. The as-built materials list will be submitted as part of the as-built configuration list.

INSERT

FIGURE 6-3

INORGANIC MATERIALS LIST

INSERT

FIGURE 6-4

POLYMERIC MATERIALS LIST

INSERT

FIGURE 6-5

LUBRICATION LIST

INSERT

FIGURE 6-6

PROCESS LIST

SECTION 7 DESIGN ASSURANCE AND RELIABILITY

7.1 GENERAL

This Design Assurance and Reliability Section details the tasks which MIT will perform on the XTE Program to standardize and control the design. The methods described herein provide a comprehensive, planned, and controlled Reliability Program. It is integrated into the total Performance Assurance Implementation Plan (PAIP) to ensure that various task elements dovetail with other portions of the PAIP and duplication of effort is eliminated. The goal of design assurance and reliability is to integrate Reliability and Quality Assurance (R&QA) principles into the analysis, design, fabrication, assembly, and test processes. This will help ensure that the EDS and ASM will meet the test, integration, and mission life reliability goals MIT expects of it's hardware.

7.2 DESIGN ASSURANCE

7.2.1 REQUIREMENTS

To integrate reliability into the design process, the R&QA Manager works closely with the Engineers, Programmers, and Technicians throughout the C/D phase of the XTE Program. The R&QA Manager meets on a daily basis with Engineering and Project Management to discuss XTE Reliability and Quality Assurance problems. This will help maximize mission reliability while minimizing the human element which leads to failure.

Design criteria is controlled on several fronts. These are in the form of plans, procedures, specifications, and standards. Listed below are design control documents to be implemented on the MIT/XTE design of the EDS and ASM.

Processes	Numerous XTE process specifications, derived from existing MIT/CSR specifications (QAP's). See Attachments
Fabrication	64-02017.2004 and Workmanship Standards and Assembly Manuals
Drafting	64-02017.2005 and DOD-STD-100

Safety	MIT document 64-02016; System Safety Implementation Plan
Design Control	MIT/CSR Design Manual
Specifications, Changes	MIT document 64-02014; Configuration Drawings, and Management Plan
Parts and	Configuration Data Base and Materials and Materials Processes List
Handling	64-02017.2006
Inspection	64-02017.2003
Contamination	MIT document 64-02011; Contamination Control Plan

7.2.2 DESIGN ASSURANCE SUPPORT

As an integral part of the project team, the R&QA Manager works side-by-side with designers to assist in the design process. Checklists are used by R&QA as a reminder of the detailed elements of producibility, testability, inspectability, and repairability, along with reliability, maintainability, safety, and quality. Characteristics of the design which require inspection, test, or analysis will be identified on lower tier drawings to advise Engineers and technicians of these requirements. Critical processes not verifiable by test, analysis or inspection will be strictly controlled by MIT or NASA process specifications.

7.2.3 SPECIFICATIONS, DRAWINGS, AND PROCEDURES

7.2.3.1 DESIGN SPECIFICATIONS

The All Sky Monitor (ASM) and Experiment Data System (EDS) designs are dictated by the following MIT documentation:

64-02009	EDS - PCA Science requirements

64-02012	EDS - ASM Science Requirements
64-02013	ASM Instrument Science Requirements

Each subassembly which is designed and fabricated by a subcontractor will be tightly controlled by a design specification, a statement of work, and numerous other MIT controlled documents. All of the above MIT documents are under configuration control per MIT document 64-02014.

7.2.3.2 CHECKING MECHANICAL DRAWINGS

Mechanical Drawings are usually prepared, by a Mechanical Engineer on a computer, using a Computer Aided Design (CAD) software package. At the completion of the mechanical layout, the Engineer reviews the drawing for correctness, completeness, producibility, and proper requirements. The drawing is then transferred to a draftsperson who incorporates the various notes, generates the details for the configuration data base, etc. . In addition, before the drawing is released, it is reviewed and the Engineering Change Order (ECO) is signed by the Project Engineer, the Performance Assurance Manager, and the Project Manager. Mechanical drawings will not be reviewed by a separate "Checker".

7.2.3.3 DOCUMENTATION REVIEW

The Performance Assurance Manager will ensure that all design specifications, drawings, and test procedures are reviewed for completeness and correctness. Included in this review will be assurance that each is functionally and physically compatible with interfacing design requirements. These reviews will occur both initially and for any changes made to the documents.

7.3 RELIABILITY ANALYSIS

7.3.1 FAILURE MODE, AND EFFECTS, ANALYSIS (FMEA)

7.3.1.1 INSTRUMENT FMEA

A Failure Mode, and Effects, Analysis (FMEA) will be instituted early in the design phase of the XTE Program to facilitate prompt detection of catastrophic failures (as defined by the PAR). The FMEA will be scheduled and completed concurrently with the design effort so that the design will reflect analysis conclusions. Design Engineering will perform the several analyses. In accordance with the second sentence of paragraph 1.1 of the PAR, the MIT design is predominantly "single string" and does not, in general, incorporate redundant hardware. The FMEA on the EDS and ASM, will be performed at the interface level only and will be to the first level of interface between the EDS and the XTE Spacecraft. The ASM FMEA will be limited to passive telemetry sensors and spacecraft power supply interfaces. Open and short (high and low) circuit failure conditions will be examined, with catastrophic failures analyzed to the part level. The mechanical FMEA for the EDS and ASM will be at the interface level only and will consist mainly of a structural analysis / fracture control report prepared by Swales Inc. The FMEA's will be used as inputs to test planning activities. All catastrophic failures will be listed on the critical items list. The results and current status of the FMEA's will be presented at the Preliminary Design Review (PDR) and Critical Design Review (CDR).

The FMEA will be documented with the following information:

a. Identification of the system under analysis
b. Part number of the system
c. Failure Effect resulting in cessation of normal operation
d. Effect upon the mission

e. Level of Severity
   1. Catastrophic - failures that prevent the achievement of mission success
   2. Critical - failures that significantly degrade the achievement of mission success
   3. Significant - failures which could degrade mission objectives
   4. Minor - failures which have no mission effect or cause a slight degradation in performance

f. If the effect is catastrophic, failure modes are examined and identified to the part level.

NOTE: Mission success for MIT hardware is defined as retention of at least 60 % of the scientific value of the ASM and the EDS.

7.3.1.2 SPACECRAFT FMEA

This requirement is not applicable to MIT

7.3.2 PARTS AND DEVICES STRESS ANALYSIS

A worst case stress analysis will be performed on each EEE part in the EDS and ASM. This analysis will be documented in the format presented in figure 7-1, and the calculated stresses and stress ratios compared to the derating requirements of MIL-STD-975 and the PPL. The stress analysis will be updated as the design changes. The stress analysis and derating will be available for NASA/GSFC review upon request.

7.4 TREND ANALYSIS

The EDS contains no components which are susceptible to performance stability problems. Within the ASM, each of the three (3) scanning shadow cameras (SSCs) has a gas filled sealed detector. The density of the gas inside the detectors is critical to gain stability. Variation of this gas density is best detected by measuring the gain of the SSC. This parameter will be monitored from the time the SSC is first tested until the final test prior to integration of XTE into the launch vehicle. Data will be recorded periodically and compared with initial values.

7.5 LIMITED LIFE ITEMS

Limited life items are defined by the PAR as "all hardware subject to degradation because of age, operating time, or number of cycles, such that it's expected life is less than twice the required life when fabrication, test, integration, and mission operation are combined". At the present time, it is expected that no items will fall into this category.

If any items are so identified in the design process, MIT will include them on the Limited Life Items List. This list will include the expected life of the item and the rationale for placing the item on the list. If a Limited Life Items List is warranted, the preliminary list will be submitted as soon as the item is identified. See paragraph 1.12 herein. The final list will be submitted thirty (30) days before Critical Design Review (CDR).

7.6 GOVERNMENT FURNISHED PROPERTY RELIABILITY (GFP)

MIT does not intend to perform a reliability analysis of the GFP used in the EDS. Since these items were specified and purchased by GSFC, any such analysis must be performed by GSFC.

INSERT

Figure 7-1

SECTION 8 QUALITY ASSURANCE

8.1 GENERAL

This section details the tasks to be performed under Quality Assurance and the methods employed by MIT to accomplish those tasks. The Quality Control System currently in place at MIT will be utilized to the maximum extent practical and consistent with the requirements of GSFC-410-XTE-001. The XTE Project Office at NASA/GSFC will be kept up to date on the status of the MIT Quality Assurance Program through the monthly status report.

8.2 SUPPORT OF DESIGN REVIEWS

The Performance Assurance Manager is an integral part of the design team as discussed in paragraph 1.3.1 A herein. As such, MIT Performance Assurance will give part of the presentation and participate in the support team for design reviews as discussed in paragraph 2.3 herein.

8.3 DOCUMENT CHANGE CONTROL

Configuration control at MIT is described in the Configuration Management Plan (MIT document 64-02014). As described in paragraph 1.3.1 herein, the Configuration Management Plan is included with this PAIP. Figure 3.1 of 64-02014 is a configuration tree which is an example of the MIT configuration data base. This data base will grow to includes all the applicable documents in the MIT/XTE Project. These listed documents range from global XTE Project Plans such as this PAIP, down to detail part procurement and test specifications.

The PA Manager is one of three required signatories on each change and/or new release of any project controlled documentation. The completeness and accuracy of an Engineering Change Order (ECO), the revision level, and the change effectivity, are all part of the ECO review process. Control of in-process material configuration is accomplished as part of the normal inspection procedures. This uses Assembly Work Order (AWO) documents and change control information to assure proper configuration and to maintain a permanent record of configuration. The Assembly Work Order also lists the revision level to which the hardware was fabricated, assembled, inspected, and tested. These data are then incorporated into the acceptance data package such that it is an accurate and precise record of the hardware configuration.

8.4 IDENTIFICATION AND TRACEABILITY

Each part, subassembly, assembly and component is controlled by a unique drawing and/or number. These documents are under configuration management as described in MIT Document 64-02014. See Figure 8-1 for the MIT XTE Hardware Breakdown.

Subassemblies and assemblies will all be serialized and these serial numbers will be unique and not reused. Active non-military EEE parts will also be serialized. Standard parts as well as passive EEE parts may, but will not necessarily, be serialized. See Figures 5-1 and 5-2; Parts Procurement Matrix for Standard and Nonstandard Parts. Part manufacturer's name, lot date code (LDC), and where available, serial number, will be recorded on the configuration traceability list which is kept as a part of the assembly work order. Manufacturer's name and lot code of materials is likewise recorded on the configuration traceability list. Processes and procedures are recorded directly on the Assembly Work Order. As such, backward and forward traceability of parts, materials, and processes is maintained.

MIT HARDWARE BREAKDOWN

INSERT

FIGURE 8-1

8.5 PROCUREMENT

Procurement control documents will contain applicable requirements to assure the appropriate quality level of the item specified. Applicable requirements are dependent upon the commodity being purchased. The following will be considered for inclusion as a flow-down in all procurement documents.

8.5.1 PRODUCT CHANGES

Parts, materials, and processes purchased by MIT will be baselined after appropriate evaluation, analysis, and/or test. All changes after the baseline will be evaluated by MIT to insure that the intended change will not adversely affect reliability, quality, or the designed application.

8.5.2 AGE CONTROL AND LIMITED LIFE PRODUCTS

Age sensitive products which are used by MIT, will be recorded in a limited life items log. Data which must be recorded are: commodity, manufacturer, lot or date code, date of manufacture, shelf life, and expiration date. In addition, limited life products are recorded on the Shelf Life Tag as they are received at Incoming Inspection at MIT. This documentation is controlled by MIT Procedures Documents 64-02017.2002 (Fabrication Documentation) and 64-02017.2003 (Inspection and Documentation).See also, paragraph 8.9.2 herein.

8.5.3 INSPECTION AND TEST RECORDS

Procurement control documents will require that suppliers and subcontractors retain inspection and test records. Where available, inspection and test records will be requested to be delivered with the purchased item. MIT will retain these records for one (1) year after completion of hardware services. This is, in effect, thirteen (13) months after launch.

8.5.4 GOVERNMENT SOURCE INSPECTION (GSI)

MIT has discussed GSI with the ONR/GSFC Representative, and is including provisions for GSI where required. In addition, copies of all purchase orders (P O's) for flight

hardware are being submitted to the ONR Representative. If GSI provisions must be added to any P O, the
P O will be ammended to provide for Government access and notification of scheduled acceptance inspections and tests. Procurement documents for GSI items will include the following statement:"All work on this order is subject to inspection and test by the Government at any time and place. The Government quality representative who has been delegated NASA Quality Assurance functions on this procurement shall be notified immediately upon receipt of this order. The Government representative shall also be notified 48 hours in advance of the time that articles or materials are ready for inspection or test. "

8.5.5 NON-GSI PROCUREMENTS

Procurement of items which do not require Government Source Inspection will have the following statement in the procurement document:" The Government has the right to inspect any or all of the work included in this order at the suppliers plant. "

8.5.6 MIT SOURCE QA ACTIVITY

Where MIT source QA activity is required, as identified in paragraph 8.7 below, the following clause will be invoked in the purchase order:

"( )Inspection - MIT shall, at all times upon reasonable notice to Seller, be allowed access to Seller's facility for the purpose of inspection, progress evaluation, witnessing of fabrication, tests, packaging ...etc. Such inspections will be made in a manner which will not disrupt or delay the work in progress. Seller agrees to provide for the reasonable comfort, safety, and convenience of any MIT visitor."

8.5.7 RESUBMISSION OF NONCONFORMING ARTICLES OR MATERIALS

Parts and materials rejected by MIT will be returned to the vendor (RTV) accompanied by a Material Review Action Report. MIT will require that in the event that the parts or materials are resubmitted to MIT by the vendor, the vendor must notify MIT that this is a resubmittal, identify the Material Review Action Report, identify the material resubmitted, describe the rework action, and submit evidence of corrective action to preclude recurrence.

8.6 REVIEW AND APPROVAL OF PROCUREMENT DOCUMENTS

Reliability is intimately involved in the preparation of Source/Specification Control Drawings (SCD). As such, the appropriate reliability, quality, screening, testing, qualification, and inspection requirements will be incorporated into the procurement documents. The SCD is part of the ECO package for release of the drawing.

At the time of procurement, the PA Manager reviews the purchase request and all referenced documents for completeness of requirements. All purchase requests for flight hardware must be reviewed and approved by PA before the purchase order may be issued. A copy of the purchase order will be forwarded to the Government representative.

8.7 MIT SOURCE INSPECTION

MIT source inspection will be employed when the procurement drawing (SCD/SID) requires and for procurement of the following commodities:

- major assemblies or sub-assemblies
- multilayer printed wiring boards
- any item requiring qualification testing by the supplier
- non-standard parts screened at a test house

See Figure 5-2; Parts Procurement Matrix for Nonstandard Parts.
NOTE: MIT does not intend to drop-ship any products directly from the source to NASA/GSFC

8.8 MIT RECEIVING INSPECTION

The procedure for receiving inspection is controlled and documented in MIT document 64-02017.2003, titled, Quality Assurance Inspection and Identification Documentation, which is an attachment to this PAIP. It must be noted, that Government Source Inspection (GSI) and MIT Source Inspection are considered to be an extension of the MIT Receiving Inspection Process.

All incoming flight parts and materials are tagged and inspected upon receipt and prior to acceptance into bonded stores. Material procurements will include a requirement for a summary or copy of the manufacturer's Inspection and Test records, traceable to the product, to be delivered to MIT with the product. Evidence of Government Source Inspection or MIT Source Inspection must accompany the materials received at MIT. If the material is to be used in a critical application, chemical analysis and physical tests will be performed on a sample of the material received by an independent test laboratory. No additional incoming tests will be performed at MIT. That is to say, MIT does not plan to random sample chemical and physical analysis on non-critical materials to verify the vendors Certificate of Compliance. See Figure 8-2; Receiving Inspection at MIT. Records and data on the incoming items are verified, and where necessary, additional testing is performed to assure acceptability. Receiving inspection data and records are compared with manufacturers data and source inspection information.

Shelf life controlled items are recorded in the Limited life Items Log in accordance with paragraph 6.2.7 herein. In addition, a "Shelf Life Tag" is prepared at Receiving Inspection in accordance with MIT Document 64-02017.2003; Inspection and Documentation Procedure. As stated in paragraph 8.5.8 herein, MIT does not plan to use weld filler material.

Acceptable items will be stored in a bonded stock area with acceptance records maintained by Quality Assurance. Non-conforming materials will be referred to the Material Review Board (MRB) for disposition. Each category of material (awaiting inspection, scrap, awaiting MRB action, RTV, in process, and acceptable for fabrication) will be segregated and identified with it's documentation.

Items which are susceptible to Electrostatic Discharge (ESD) will be handled in incoming inspection in the same manner as they are during fabrication of flight hardware. That is to say that the ESD protective packaging will only be opened and handled in an area which is ESD protected and approved by QA.

RECEIVING INSPECTION AT MIT

ITEM	TEST 9/	DATA REVIEW	100% VISUAL INSPECT	MEASURE DIMEN-SIONS	CHEMICAL ANALYSIS
EEE DISCRETES	100%	YES	YES	NO	N/A
MICROCIRCUITS	7/	YES	YES	NO	N/A
MECHANICAL PARTS FABRICATED	NO	YES	YES	YES 8/	YES 1/
MECHANICAL PARTS FABRICATED	NO	YES	YES	SAMPLE 2/	NO 3/
ASSEMBLIES	NO	YES	YES	NO	NO
FASTENERS (<140 ksi) 4/	NO	YES	YES	NO	NO
METALLIC RAW MATERIALS	NO	YES	YES	NO	YES 1/ 5/ 9/
NONMETALLIC RAW MATERIALS	NO	YES	YES	NO	NO 1/ 9/
ADHESIVES	6/	YES	N/A	N/A	NO 1/ 9/

1/ Not used

2/ All dimensions are measured and recorded by the Vendor

3/ Material is supplied by MIT from bonded stock

4/ Fasteners >140 ksi are not used

5/ Done by MIT or an Independent testing laboratory

6/ Each adhesive lot (100%), is sample tested for proper cure characteristics

7/ PPL and Military devices have 100% GSI. All others receive 100% MIT S.I.

8/ where applicable

9/ See exception in paragraph 8.8 and in Deviations and Exceptions

Figure 8-2

8.9 FABRICATION CONTROL

8.9.1 FABRICATION AND ASSEMBLY FLOW PLAN

MIT typically prepares an assembly flow plan for each project. The same will be done for the XTE Project. This plan will include all fabrication, assembly, processing, inspection, and test operations. However, this plan constitutes neither a procedure nor a schedule, but provides a breakdown of the flow of work from the subassembly level to the completion of subsystem fabrication and delivery to the test group. A block flow diagram will help identify the sequence of events and mandatory inspection points (MIP's), including GSI MIP's.

8.9.2 DOCUMENTATION

MIT/CSR employs a fabrication control documentation system for electronic assemblies and subassemblies. This system controls work flow, provides inspection test points, and provides electrical checkpoints for assemblies and subassemblies before they move on to the next assembly level. The complete set of documentation, as compiled throughout fabrication, inspection, and assembly level test, is called the "Assembly Work Order Paperwork Package". The basic unit of this package is the Assembly Work Order (AWO), and is augmented with a number of attachments. These are the AWO Build History Addendum, the Fault Log, the Component Traceability List (CTL), the Potting Log, the Revision Sheet, and the Mechanical Work Order. All documents referenced in the AWO and attachments (ie. assembly drawings, parts lists, schematics etc.), are controlled by the MIT/CSR Configuration Control System detailed in MIT document 64- 02014. Prior to the start of work on subassemblies and assemblies, the Assembly Work Order is reviewed and signed by the Design Engineer, the Quality Assurance Manager, and the Project Manager.

The AWO is a broad based control document which names and identifies the subsystem, assembly, or subassembly, in process. The AWO imposes many requirements, most by reference. Such items as tool, jig, and fixture identification, process specifications, and workmanship standards are listed in the description column of the AWO. Characteristics and tolerances are listed on the drawing which is detailed by revision at the top of the AWO. Age control for articles with limited shelf life characteristics is listed in the potting log which is attached to the AWO. Special conditions to be maintained such as environmental conditions or precautions are listed under "special Instructions" near the top of the AWO. Assemblers, testers and inspectors will signify performance of each task by date and signature on the assembly work order. Fabrication Documentation is the subject of MIT Document 64-02017.2002.

8.9.3 FABRICATION REQUIREMENTS

The requirements of the various NASA Handbooks (NHB's) will be adhered to in the design and fabrication of the EDS and ASM. Soldering,5300.4 (3A-1); Interconnecting Cables, Harnesses, and Wiring, 5300.4 (3G); Crimping and Wire Wrap, 5300.4 (3H); and Conformal Coating and Staking of Printed Wiring Boards and Assemblies, 5300.4 (3J) will all be identified in the description column beside the applicable operation on the AWO. Requirements for Printed Wiring Boards and Assemblies, 5300.4 (3I) will be imposed in the SCD for the PWB. QA will assure the requirements of the Design for Rigid Printed Wiring Boards and Assemblies, 5300.4 (3K) through the review and sign-off process of the MIT Configuration Management System. This is detailed in the Configuration Management Plan, MIT Document 64-02014. Workmanship Requirements for Electronic Equipment is the subject of MIT Document 64-02017.2004.

8.9.4 PROCESS EVALUATION AND CONTROL

MIT employs the use of detail specifications to control procedures and equipment required for critical processes. These detail specifications incorporate preparation of materials, equipment, and hardware, the various steps in the process, special conditions and environmental controls, and accept/reject criteria where applicable. Certifiable process equipment and Non-destructive Evaluation (NDE) testing are also included in the detailed process specification. Test and inspection requirements and records of verification are a permanent part of the Assembly Work Order.

8.10 CONTAMINATION CONTROL

Contamination control is monitored, audited, and administered by Quality Assurance during all phases of the XTE Project. This effort is detailed in the Contamination Control Plan, MIT Document 64-02011.

8.11 ELECTROSTATIC DISCHARGE (ESD) CONTROL

The EDS and ASM will be fabricated and assembled at XTE designated work stations. These work stations will be protected through earth grounding. In addition, tools, benches, stools, and equipment are likewise grounded. Technicians and inspectors utilize wrist straps for grounding through a controlled impedance. An ionized air flow is used for drying printed circuit assemblies after cleaning.

Incoming hardware which is ESD sensitive is examined to ensure that it was shipped in proper protective packaging. Incorrectly packaged items will be returned to the vendor. Properly packaged hardware which is ESD sensitive will only be received at an approved ESD protected work station. Upon acceptance, these items will be stored in the protective packaging in bonded stores in grounded metal lockers. In-process hardware which is ESD sensitive will only be handled at ESD protected workstations. It will be stored and transported in ESD protective bags and containers.

Circuits, parts, and assemblies designed by MIT will incorporate ESD protection such as series resistors on inputs to limit the effects of ESD transients. Preference in part selection will be given to devices which incorporate part protection networks.

Training in ESD awareness will be provided to MIT/XTE personnel who design, test, inspect, or handle ESD sensitive items. This training will be carried out by QA personnel. Applicable requirements for ESD control will be flowed down to MIT's subcontractors and suppliers. The total ESD program will be monitored and audited by QA. The ESD program which is in place at MIT is detailed in MIT Document 64-02017.2006 which is an attachment to this PAIP.

8.12 NONCONFORMANCE CONTROL

MIT uses a closed loop control system to identify, document, evaluate, disposition, and correct discrepancies. This system is documented in MIT document 64-02017.2008, and is an attachment to this PAIP.

Discrepant articles are controlled in such a way as to prevent their use in articles offered for delivery. Nonconforming articles are identified and separated from conforming work in process.

Provision has been made for the review, control, and disposition of nonconforming material. Each nonconformance shall be reviewed, and a disposition made by personnel vested with this responsibility, and positive corrective action taken to prevent recurrence of similar discrepancies. Material having minor discrepancies may be offered for review by the Material Review Board (MRB).

Each discrepancy shall be documented and traceable to the discrepant hardware. The nonconformance shall be described including analysis and corrective actions. Hardware disposition will be identified along with personnel involved in the decision making process. Nonconformances will be summarized and categorized such that any failure trends may be identified.

8.12.1 DISCREPANCY CONTROL, DISPOSITION, AND REPORTING

8.12.1.1 DOCUMENTATION

Discrepancies will be recorded as soon as they are noted and confirmed, starting with receiving inspection. Discrepancies at incoming inspection will be documented on the inspection report which is included in MIT document 64-02017.2003; Quality Assurance Inspection and Identification Documentation. Discrepancies noted in the MIT manufacturing process will be initially documented in the Assembly Fault Log which is attached to the Assembly Work Order (AWO). Discrepancies which are confirmed as failures will be recorded, reported, and analyzed in accordance with paragraph 8.12.2 herein.

8.12.1.2 INITIAL REVIEW DISPOSITION

Quality Assurance will review each of the above discrepancies and disposition the hardware as follows:

- rework to specification
- scrap
- return to vendor (RTV)
- Material Review Board (MRB) action

8.12.1.3 MATERIAL REVIEW BOARD (MRB)

The MIT Material Review Board (MRB) consists of the Product Assurance Manager, the appropriate design or test Engineer, and the ONR representative as a minimum. This board may be augmented with knowledgeable individuals who are intimately involved with a specific discrepancy. The GSE Engineer and/or Manufacturing Manager are examples of such augmentation. A list of the MRB members will be submitted to the ONR representative for approval.

The MRB will make final disposition of the hardware. In the event that the MRB decision is not unanimous, the item will be withheld from further processing and the matter referred to the GSFC XTE Project Office for final resolution.

In addition to dispositioning hardware, the MRB will insure that closed-loop corrective action is implemented, perform trend analysis on failures, and assure that appropriate documentation is in place.

The only disposition available to the MRB over that available to Quality Assurance is "use-as-is". It is incumbent upon The MRB to assure that it's decisions will not adversely affect flight hardware.

8.12.1.4 SUPPLIER MATERIAL REVIEW BOARD (MRB)

MIT will, at it's discretion, and with the approval of NASA/GSFC, selectively delegate MRB authority to suppliers and subcontractors. One of the conditions of MIT delegating MRB authority, is that the supplier's/subcontractor's Government Representative must be a member of the MRB.

8.12.2 CONTROL, REPORTING, AND DISPOSITION OF FAILURES

A Failure Reporting, Analysis, and Corrective Action System (FRACAS) will be used at MIT. This is a closed loop system which identifies failures, reports them, documents the failure, assures analysis, determines corrective action, and follows-up to insure implementation of the corrective action.

8.12.2.1 FAILURE REPORTING

Failure Reporting, Analysis, and Corrective Action (FRACAS) will start with the first power application of the subsystem or the first operation of a mechanical item in a subsystem (i.e. first operation of the <u>completed</u> EDS or ASM). FRACAS will continue through formal acceptance by the Government and hardware shipment. Failures are defined as any departure from performance or testing requirements that affect the function of the EDS or the ASM. Ground Support Equipment (GSE) is specifically excluded from this task. See figure 8-1 for hardware definitions.

A failure report will be initiated as soon as a failure has been confirmed. MIT will provide failure notification to NASA/GSFC within one (1) working day after failure confirmation orally by telephone. Within three (3) working days after failure confirmation, MIT will send a written notification of failure to NASA/GSFC and the in-house Government quality representative utilizing form GSFC 4-2 (11/76).

All failures will be recorded in a Reliability Failure Log and the summary information submitted as a part of the monthly Performance Assurance Status Report. Each failure will be retained on the summary status report until the failure report has been closed out. A final report will be submitted detailing the analysis, cause, and corrective action. Corrective action will be closely coordinated with NASA/GSFC and the GSFC representative.

8.12.2.2 FAILURE REVIEW BOARD (FRB)

An FRB will be established for the XTE Project and will be comprised of the Project Manager or his representative, the Responsible Design Engineer, the Government Representative, and chaired by the Performance Assurance Manager. Each failure will be investigated and analysis will be performed to determine the cause of failure. Likewise, corrective action will be determined to preclude recurrence of the discrepancy. When fault isolation identifies a EEE part as the cause of the failure, that part will be sent to NASA/GSFC for failure analysis and recommended corrective action. When NASA/GSFC provides the failure analysis report and recommended corrective action to MIT, it will be incorporated into the malfunction report for close-out. It is incumbent upon the FRB to insure that corrective action is not only identified but also implemented. Follow-up on corrective action implementation at EEE parts manufacturers is the responsibility of NASA/GSFC. Decisions of the FRB will be unanimous.

8.13 ALERTS

MIT will respond to Government-Industry Data Exchange Program (GIDEP) ALERTs and SAFE-ALERTs. As ALERTs are received from NASA/GSFC, they will be reviewed for applicability on the XTE Project. Summary information will be disseminated within the project to design, project, quality, and fabrication personnel. This procedure is detailed in MIT Document 64-02017.2001, which is an attachment to this PAIP. Performance Assurance will respond to NASA/GSFC in the monthly status report on the applicability of each ALERT and proposed action where MIT/XTE hardware is impacted.

As a means of assuring that parts and materials which are the subject of an ALERT are not purchased, Quality Assurance reviews each purchase requisition for flight hardware. Each item is compared with the GIDEP ALERT Summary by GSFC Parts Engineers. Specific lot date codes or manufacturers (as detailed in the ALERT) will be noted on the purchase requisition and excluded from the procurement.

In the event that MIT experiences faulty hardware or an event which warrants an ALERT, Performance Assurance will prepare a DD 1938 form and submit it with substantiating information to NASA/GSFC.

8.14 INSPECTIONS AND TESTS

Fabrication and assembly of the EDS and ASM will incorporate inspections and tests at each level of assembly. These tests and inspections will be identified on the assembly work order and will call out the appropriate test or inspection procedure. The testers and inspectors will signify performance of each task by date and signature on the assembly work order. Discrepancies will be documented in the Fault Log. As stated in the Configuration Management Plan, MIT document number 64-02014, Quality Assurance approves all documentation prior to release and at each change.

8.14.1 PLANNING

Inspections and tests will be planned before the work starts. Mandatory Inspection Points (MIP's) will be identified in the assembly work order along with the required test. Test and inspection will start at receiving and continue through assembly to final delivery at each applicable step of the process. The designated Government Representative will be made aware of all test and inspection requirements to allow that individual to witness the MIT testing and inspection or conduct a separate inspection as deemed appropriate. Test equipment calibration will be planned to assure timely availability.

8.14.2 INSPECTION AND TEST PROCEDURES

Inspection and test procedures will be prepared to guide test personnel in the appropriate process. These procedures will be physically located at the appropriate work station. These procedures will vary from check-lists used at receiving inspection, to elaborate test procedures used for final functional acceptance. The procedures will be identified in the assembly work order.

8.14.3 INSPECTION ACTIVITY

The following inspections will be performed by MIT personnel. Government inspectors may perform similar inspections on a non- interfering basis.

8.14.3.1 IN-PROCESS INSPECTION

Inspection will start with receipt of parts and materials. Discrepancies will be documented in the Parts Inspection Report. Parts, materials, and processes will be verified on work in process before it progresses to the next step in the operation. The results will be recorded in the AWO. In-process inspections will be performed in a clean environment as required and as applicable to the fabrication environment of the item being inspected. Inspectors will be trained for their tasks, and where required (soldering, harnessing, coatings, crimping), certified .

Technicians inspect their own work when a specific operation has been completed. Usually, the technician will have the item "peer inspected" by another technician prior to submitting the work for formal Quality Assurance Inspection. Non-conformances are called "faults" and all significant faults are recorded in the fault log. Faults identified by the inspector are reworked and signed-off by the assembler. The inspector identifying the fault will reinspect the rework prior to the assembly going to the next assembly level. The fault log is attached to the assembly work order and becomes a part of the permanent record.

Inspections will be performed to the Engineering Drawings, Assembly Work Order, applicable Specifications (Material, Process,or Test), or as described in Inspection Operation Check Lists. These inspections will verify acceptability of dimensions, geometry, surface finish, fit, process, soldering, wiring, location and orientation of parts, functions, materials, etc. as applicable. On items which are fabricated by a vendor, in-process inspections will be performed by the vendor's Quality Assurance organization. MIT Performance Assurance will monitor the vendor's QA activity.

8.14.3.2 FINAL INSPECTION

Final inspection will be performed at the subassembly and assembly level in conformance with paragraph 8.14.3.1 above. All faults will be corrected or recorded in the fault log for the next higher assembly.
Inspections will be performed to the Engineering Drawings, Assembly Work Order, applicable Specifications (Material, Process,or Test), or as described in Inspection Operation Check Lists. These inspections will verify acceptability of dimensions, geometry, surface finish, fit, process, soldering, wiring, location and orientation of parts, functions, materials, etc. as applicable. All structural hardware dimensions will be inspected 100%. Any out of tolerance dimensions will be corrected or documented as a

discrepancy per paragraph 8.12.1 herein. Per agreement with NASA/GSFC, the structural/fracture control analysis will be done by NASA/GSFC under a sub-contract to Swales Inc. . The cognizant engineer from Swales will be a member of any MRB action at MIT involving structural items. Proposed dispositions of interface discrepancies will be referred to the GSFC Project Office for concurrence. On items which are fabricated by a vendor,final inspections will be performed by the vendor's Quality Assurance organization. MIT Performance Assurance will monitor the vendor's QA activity.

8.14.3.3 END-ITEM INSPECTION

End-item inspection will be performed at the subsystem level on the EDS, the ASM, and the ASM handling fixture. End-item Inspection will be in general conformance with paragraph 8.14.3.1 above. All faults will be corrected or itemized as an acceptable nonconformance, as authorized by NASA/GSFC, at delivery.

Inspections will be performed to the Engineering Drawings, applicable Specifications (Material, Process,or Test), or as described in the Mechanical Interface Control Drawing (MICD), and shall verify acceptability of dimensions, surface finish, fit, etc. as applicable. Discrepancies are recorded in the Flight Assembly/History Log of the applicable subsystem.

8.14.3.4 SURVEILLANCE INSPECTION

All parts and materials used in flight hardware will be stored in a bonded area which is secured by Quality Assurance. Only properly packaged items will be placed in bond. Parts and materials will be received in accordance with paragraph 8.8 herein prior to placement into bonded stock. At MIT/CSR, Quality Assurance maintains custody of the bonded stock room. Immediately prior to fabrication, assembly, or integration, items are kitted by bonded stock (QA) personnel. Those items will be examined in the kit before the next operation. No periodic or other inspections and tests will be performed while in bonded stock unless specifically required by the controlling drawing, procedure, assembly work order, or specification. Any unusual event relative to bonded stock will be reported promptly to GSFC.

8.14.3.5 PRINTED WIRING BOARD INSPECTION AND TESTS

Specification Control Drawings (SCD's) will be prepared for all Printed Wiring Boards (PWB's) used in deliverable flight hardware. These SCD's will flow down the requirements of MIL-P-55110 and/or NHB 5300.4(3I). PWB's and coupons will be inspected at the manufacturer's facility (MIT Source Inspection) for total compliance with the procurement specification. Test coupons will also be submitted to GSFC for evaluation, on a non-interfering basis.

8.14.4 QA ACTIVITIES DURING INTEGRATION AND TEST

Quality Assurance will closely monitor the integration process and witness all tests. Inspection will be performed by Quality Assurance Inspectors and nonconformances will be documented and recorded in the fault log. Test nonconformances which are confirmed failures will be reported in accordance with paragraph 8.12.2.1 herein. All integration and test operations will be performed in accordance with the applicable drawings and procedures. These activities will be performed in a clean environment as required and as applicable to the fabrication environment of the items being integrated, tested, or inspected.

8.14.4.1 VERIFICATION

Quality Assurance Inspectors will witness all testing. Before the start of testing, the Inspector will check the identity and configuration of the item being tested, and assure that all test equipment is within calibration throughout the test period. The test setup will be examined by the Inspector for correctness and s/he will assure that correct revisions of test and inspection documents are present and being used.

8.14.4.2 TEST DOCUMENTATION

All tests will be performed in accordance with the latest approved specifications and procedures. Actual test data will be recorded in the applicable Test Report in accordance with the Instrument Test and Verification Plan, MIT document 64-02005. Any fault will be documented in the Flight Assembly/History Log. Confirmed failures will be reported in accordance with paragraph 8.12.2.1 herein.

If rework or repairs are required, they will be documented in the Flight Assembly/History Log and/or assembly work order, as applicable, in accordance with paragraph 8.14.3.1 herein. If modifications are needed, the appropriate drawings and specifications must first be changed and approved.

8.14.4.3 POST TEST ASSURANCE ACTIVITY

At the completion of testing, the Inspector will assure appropriate stowage of the hardware and review all documentation for accuracy and completeness.

8.14.5 INSPECTION AND TEST RECORDS

Inspection and test records are traceable from the purchase order of parts and materials to final delivery of the end item. As each step in the assembly work order is completed, inspected, and tested, sign- off of the various technicians, inspectors, and testers is required directly on the assembly work order. Test data is recorded in the appropriate test report in accordance with the Instrument Test and Verification Plan, MIT document 64-02005. Testing is reported in the Flight Test Log. When sub-assemblies are integrated into assemblies, the subassembly work order and build records are combined into the next higher level assembly work order and build records. Likewise, as assemblies are integrated into components, the assembly work order and build record are combined into the assembly work order and build record of the component. Quality Assurance will review the documentation at the various levels to assure complete and accurate records. Copies of the appropriate records will be delivered to NASA/GSFC in accordance with DRD H.7, Acceptance Data Package, at the Pre-shipment Review (PSR). Complete fabrication, assembly, test, and inspection records will be retained by MIT.

8.15 CONFIGURATION VERIFICATION

Quality Assurance will assure that the as-built configuration agrees with the as-designed configuration through monitoring the build process, reviewing the traceability and fabrication records, and at inspection and test points. Hardware configuration as inspected will be compared with the design documentation and fabrication records to confirm proper configuration.

8.16 METROLOGY

8.16.1 GENERAL REQUIREMENTS

MIT/CSR has a documented system for calibration, documentation, recall, and control of test equipment. This is in conformance with MIL-STD-45662 and is detailed in MIT Document 64-02017.2007. The MIT document is an attachment to this PAIP.

8.16.2 INSTRUMENTS USED FOR MEASURING

Tools and gauges used to measure critical dimensions will be placed on the recall list for periodic checks or recalibration. Quality Assurance is responsible for calibration and utilizes the service of Charles Stark Draper Laboratories for calibration. All measurement standards used for calibration purposes have an accuracy traceable to the National Bureau of Standards. Only calibrated tools and gauges will be used for acceptance measurements.

8.16.3 PRODUCT MEASUREMENT PROCESS

The measuring equipment accuracy will be capable of measuring within 10 % of the tolerance of the item being measured. If this is not possible because of the nature of the measurement or the instrument, the recorded measurement will be annotated to identify the variance.

8.16.4 CALIBRATION MEASUREMENT PROCESS

The accuracy of the standards used in the calibration of the measuring instruments will be within 25 % of the tolerance of the parametric measurement. If this is not possible or is impracticable, MIT will so note on a calibration exceptions list.

8.17 STAMP CONTROL SYSTEM

A stamp control system will not be used. MIT will signify acceptance or rejection of items by inspectors full signature on the appropriate accompanying documentation. Acceptance signatures will be blue or black ink. Rejection signatures will be in red ink.

8.18 SAMPLING PLANS

Tests and inspections of the EDS and ASM and their respective assemblies and subassemblies will be done on a 100 % basis. No sampling will be employed at this level. Sampling inspections will be utilized for economical and effective assessment of fabricated mechanical parts in receiving inspection at MIT (see Figure 8-2).
Due to the small lot sizes (typically 1 - 6), a single piece will be sent to the Metrology Laboratory at Draper Laboratories for a 100% dimensional check. This information will be used to compare to the manufacturer's recorded measurements. Sample testing of parts for qualification will be in accordance with the Specification Control Drawing (SCD), which generally refers to MIL-STD-105. Sampling of printed wiring boards by destructive inspections and tests will be performed on coupon specimens in accordance with MIL-P-55110.

8.19 TRAINING AND CERTIFICATION

8.19.1 TRAINING

Technicians and Inspectors will be trained, certified, and recertified for specialty tasks on the XTE project. MIT does not maintain a training school at this level. If a search of the Boston, Massachusetts area is not successful in securing a vendor or facility to provide the training required, then Technicians, Inspectors, and the Performance Assurance Manager will be trained and certified as required at the NASA/GSFC facility operated by Paramax.

8.19.2 CERTIFICATION

Technicians and Inspectors will be certified in the following specialties:

- Soldering Electrical Connections
- Interconnecting Cables, Harnesses, and Wiring
- Crimping and Wire Wrap
- Conformal Coating and Staking

If recertification becomes necessary, as a result of any combination of the conditions listed in the NHB 5300.4 (XXX) handbooks controlling the above listed skills, retraining and/or recertification will be accomplished as stated in paragraph 8.19.1 above.

8.19.3 RECORDS

Performance Assurance will maintain records of all training, certification, and recertification. These records will be kept for each individual working on XTE so trained and certified.

8.20 HANDLING, STORAGE, PRESERVATION, MARKING, LABELING, PACKAGING, PACKING, AND SHIPPING

All XTE flight hardware will be fabricated, assembled, integrated, tested, marked, packaged, and shipped in the same area, by the same technicians. As such, the intent of this section will be implemented, but MIT will not prepare procedures covering the handling, storage, preservation, marking, labeling, packaging, packing, and shipping of all products.

Configuration Items (CI's) applicable to this section are:

- Experiment Date System (EDS)
- All Sky Monitor (ASM)
- ASM Handling Fixture
- EDS flight Spares
- ASM flight Spares

8.20.1 HANDLING

Due to the non-horizontal interface between the ASM and the Payload Module, a special handling fixture will be provided for use in mounting the ASM on the Payload Module. This is the only handling equipment involved in the MIT portion of XTE.

8.20.2 STORING, PRESERVATION, MARKING, LABELING, PACKAGING, AND PACKING

Flight hardware will be kept in bonded stores or the XTE fabrication area while in process at MIT. In preparation for delivery, flight hardware will be marked and labeled in accordance with MIL-STD-129 K. Preservation, packaging, packing, and preparation for potential short term storage will be per level C, Table III, of MIL-P-9025 G.

8.20.3 SHIPPING

In preparation for shipping flight hardware, MIT Quality Assurance will be involved in three (3) distinct reviews of hardware, documentation, procedures, etc. . The first two (2) of these reviews are conducted with NASA/GSFC in attendance. These are the Pre-environmental (PER) and the Pre-shipment Review (PSR). Immediately prior to shipment, MIT Quality Assurance will review, with the local Government Representative, final hardware, documentation, and open action items.

8.20.3.1 SHIPPING PREPARATION AT PER

Among the tasks covered in the Pre-environmental Review (PER), several will involve the completion of tasks in preparation for shipment as well as preparation for environmental testing. The Quality Assurance related items include:

a. Completion and acceptance of fabrication
b. Completion and acceptance of inspections
c. Product marking and identification

8.20.3.2 SHIPPING PREPARATION AT PSR

The tasks covered in the Pre-shipment Review (PSR) involve the completion of tasks in preparation for shipment. The Quality Assurance related items include:

a. Completion and acceptance of test operations
b. Special handling instructions for receipt at NASA/GSFC and/or NASA/KSC

8.20.3.3 SHIPPING PREPARATION AT MIT

MIT Quality Assurance will review the deliverable items prior to shipment of flight hardware. These will be coordinated with and reviewed by the local Government Representative and include the following:

a. Completion and approval of accompanying documentation
b. Proper packing, packaging, and marking (identification)
c. Loading and transportation methods are compliant
d. Compliance with NASA/GSFC instructions in the event of unscheduled removal of flight hardware from its shipping container
e. Attaching integrity seals on shipping containers
f. Close-out of action items from the Pre-shipment review
g. Quality Assurance sign-off of appropriate shipping documents

8.21 GOVERNMENT PROPERTY CONTROL

8.21.1 MIT RESPONSIBILITY

All property supplied by the Government in the execution of the MIT XTE Project will be received, inspected, and accounted for. The MIT Property Office will inventory, audit, and report on Government Property. Periodic inspection, maintenance, and calibration as supplied and specified in the user's manual will be performed as necessary.

8.21.2 UNSUITABLE GOVERNMENT PROPERTY

Government property which is faulty or otherwise not acceptable for MIT use will be considered discrepant material. The discrepancy will be documented and the GSFC Contracting Officer will be notified. No further action will be taken by MIT without written direction from NASA/GSFC.

8.22 GOVERNMENT ACCEPTANCE

Quality Assurance at MIT will review deliverable hardware to assure that all PAIP requirements have been accomplished. The associated acceptance data package will be reviewed for content, completeness, and that all required signatures are attached. The acceptance data package will be presented at the Pre-shipment Review (PSR), and one copy will accompany the hardware. The entire build documentation will be kept on file at MIT.

SECTION 9 CONTAMINATION CONTROL

Contamination Control is the subject of

MIT Document 64-02011; Contamination Control Plan

NOTE: This document (64-02011) will be revised (and renamed to "Contamination Control Procedures") as soon as the GSFC-generated "Contamination Control Plan" is released. However, no substantive changes are anticipated.

SECTION 10 SOFTWARE ASSURANCE

Software Assurance is the subject of

MIT Document 64-02019; Software Performance Assurance Implementation Plan

ATTACHMENTS

XTE PROCESS SPECIFICATIONS

PAIP REFERENCE	MIT DOCUMENT	SUBJECT / TITLE
8.13	64-02017.2001	ALERTS and SAFE-ALERTS
8.5.2 & 8.9.2	64-02017.2002	Fabrication Documentation
7,2,1, 8.5.2, 8.8, and 8.12.1.1	64-02017.2003	Inspection and Documentation
7.2.1 & 8.9.3	64-02017.2004	Workmanship Requirements for Electronic Equipment
7.2.1	64-02017.2005	Drawings and Specifications
7.2.1 & 8.11	64-02017.2006	Handling Requirements for Static Sensitive Parts
8.16.1	64-02017.2007	Calibration Procedure for Measuring /Testing Equipment
8.12	64-02017.2008	Nonconforming Material and Nonconforming Material Reports

APPENDIX A

GLOSSARY

Critical Item	Any item which appears on the Critical Item List (Section 7)

APPENDIX B

COPIES OF MIT AND/OR GSFC CORRESPONDENCE REFERENCED HEREIN

ITEM NUMBER	REFERENCE PARAGRAPH	REFERENCE
1.	5.2.2	NASA/GSFC letter RS/XTE/035/90 dated 15 August 1990, from R. Shelley to B. Klatt
2.	5.2.2.1 and 5.2.6	NASA letter from W. Davis and T. Mecum to W. Mayer dated February 27, 1992
3.	5.2.2.2	NASA letter from W. Davis and T. Mecum to W. Mayer dated March 23, 1992
4.	5.2.2.2	NASA letter from D. Schulz to Distribution dated March 3, 1992
5.	5.2.2.2	MIT letter with interpretations from B. Klatt to W. Davis dated March 8, 1992