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GEOTAIL Spacecraft

Historical Data Report

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March 1993

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ABBREVIATIONS AND ACRONYMS

CCAFS	Cape Canaveral Air Force Station
CDHF	Central Data Handling Facility
CPI	Comprehensive Plasma Instrument
DBL	Dynamic Balance Laboratory (at ESA-60)
EFD	Electric Field Detector (Instrument)
EGSE	electrical ground support equipment
ELV	Expendable Launch Vehicle
EPIC	Energetic Particle and Ion Composition (Instrument)
ESA-60	Explosive Safe Area - 60
GSE	ground support equipment
GSFC	Goddard Space Flight Center
HEP	High Energy Particles (Instrument)
HGA	High Gain Antenna
ISAS	Institute of Space and Astronautical Science (Japan)
ISTP	International Solar-Terrestrial Physics
LC-17A	Launch Complex 17A
LEP	Low Energy Particles (Instrument)
LGA	Low Gain Antenna
LSSE	Launch Site Support Engineer (MDSS)
LSSM	Launch Site Support Manager (NASA)
MDSS	McDonnell Douglas Space Systems
MGA	Medium Gain Antenna
MGF	Magnetic Fields (Instrument)
MGSE	mechanical ground support equipment
MILA	Merritt Island Launch Area
NASA	National Aeronautics and Space Administration
PANT	probe antenna
PWI	plasma wave instrument
RCS	Reaction Control System
RF	radio frequency
S&A	Sterilization & Assembly Building (at ESA-60)
WANT	wire antenna

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SECTION I

INTRODUCTION

1.1 Purpose

The purpose of this GEOTAIL Historical Report is to document ground processing operations information gathered on the GEOTAIL mission during processing activities at the Cape Canaveral Air Force Station (CCAFS). It is hoped that this report may aid management analysis, improve integration processing and forecasting of processing trends, and reduce real-time schedule changes.

1.2 Scope

The GEOTAIL payload is the third Delta II Expendable Launch Vehicle (ELV) mission to document historical data. Comparisons of planned versus as-run schedule information will be displayed in this report. Information will generally fall into the following categories:

- Payload stay times (Payload Processing Facility/Hazardous Processing Facility/Launch Complex-17A)
- Payload processing times (planned, actual)
- Schedule delays
- Integrated test times (experiments/launch vehicle)
- Unique customer support requirements
- Modifications performed at facilities
- Other appropriate information (Appendices A & B)
- Lessons Learned (reference Appendix C)

1.3 Background

This report is developed from information and records (test notes, log book entries) specifically designed for historical data analysis.

1.4 Method

For evaluation purposes, this report will only cover ground processing activities from payload arrival at CCAFS through Launch Complex 17A (LC-17A) operations.

In Table 4-1, a comparison will be made between the planned and actual processing operations as was documented by the NASA/KSC Launch Site Support Manager (LSSM) and MDSS/KSC Launch Site Support Engineer (LSSE).

Additional information related to launch delays, Lessons Learned (documented problem areas and recommended solutions) are included in the Appendices.

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SECTION II

PAYLOAD DESCRIPTION

2.1 Spacecraft Overview

The GEOTAIL spacecraft is a spin stabilized spacecraft utilizing mechanically despun antennas. The diameter of the spacecraft is approximately 2.2 meters (7.22 feet) with a height of 1.6 meters (5.25 feet). The wet weight of the spacecraft is approximately 980 kg (2,156 pounds) including 332 kg (730.4 pounds) of hydrazine fuel. The design life of GEOTAIL is about four years. Figure 2-1 shows an outside view of the GEOTAIL spacecraft in its operational configuration. Figure 2-2 depicts a system block diagram of the spacecraft. Figure 2-3 shows the interface of the spacecraft with the launch vehicle (Delta II, Type 6925).

The GEOTAIL spacecraft has a complement of seven scientific instruments, with the United States providing two and the Japanese providing three complete instruments. The other two instruments are shared. The principal roles of the seven instruments on board the GEOTAIL spacecraft are divided into magnetic-field measurements, electric-field measurements, plasma and plasma wave analysis, and measurement of energetic particles.

Comprehensive Plasma Instrument (CPI): This instrument is supplied by Louis Frank, University of Iowa, Iowa City. The CPI will obtain complete three-dimensional plasma measurements in Earth's magnetotail. Plasma parameters, including heat flux and field-aligned current density, will be measured by a Hot Plasma and Ion Composition Analyzer and a Solar Wind Ion Analyzer. The plasma data will be correlated with the magnetic field, plasma waves, energetic particles, and auroral imaging data to determine the magnetotail plasma dynamics. Studies will be made to distinguish the source of plasma and the mechanisms and efficiency of the coupling of the solar-wind energy (measured by instruments on the Wind satellite) into the magnetosphere as a function of the upstream solar-wind conditions.

Energetic Particle and Ion Composition Instrument (EPIC): EPIC is supplied by Donald Williams, Applied Physics Laboratory Johns Hopkins University, Laurel, Maryland. EPIC uses an ion composition spectrometer and a telescope to measure the charge state, mass, and energy of ions. These measurements will be used to study the relative importance of ion sources and mechanisms for acceleration, transport and loss of particles, the formation and dynamics of magnetospheric boundary layers and their influence on magnetospheric behavior will be studied. Especially important will be the determination of particle sources in the large-scale structures such as bubbles of plasma called plasmoids.

Electric Fields Detector (EFD): This instrument is provided by Koichiro Tsuruda, ISAS. GEOTAIL's measurement of the electric field in the tail is key to developing a theory about the formation of the magnetotail. Electric fields in the near-Earth magnetosphere are closely coupled with the ionospheric electric field. EFD will study this coupling, especially during substorms, using electric-field antennas sampling at 64 samples per second and an electron beam technique at 2 samples per spin. In addition, the merging of magnetic fields in the plasma sheet generates inductive electric fields that help to accelerate particles, which can be measured by other instruments on board the spacecraft.

High Energy Particles Instrument (HEP): HEP is supplied by Tadayoshi Doke, Waseda University, Tokyo. Measurements of high-energy particles can indicate plasma boundary surfaces and reflect whether magnetic field lines are open or closed. The composition and charge state of energetic particles provide rich information on where particles originate, and on solar events that produce different energetic-particle signatures. The origin and acceleration of galactic cosmic rays and their modulation in our galaxy also will be investigated.

Low Energy Particles Instrument (LEP): Toshifumi Mukai, ISAS, provides the LEP instrument. Low-energy electrons will be observed in the magnetotail and in the interplanetary medium to study the nature and dynamics of magnetotail plasmas, analyze the plasma conditions under which particle acceleration takes place, and study plasma circulation and its variability in response to fluctuations in the solar wind and in the interplanetary magnetic field. Particles from Earth's ionosphere will be identified and the entry of plasmas into the magnetosphere from the magnetosheath will be studied to improve our understanding of open versus closed magnetospheres.

Magnetic Fields Instrument (MGF): Susumu Kokubun, University of Tokyo, Japan provides the MGF instrument, with Ronald Lepping, of NASA's Goddard Space Flight Center (GSFC), supplying a flux gate magnetometer. Information about the dynamics of the transport of mass, momentum, and energy between the magnetospheric and ionospheric plasma can be inferred from monitoring changes in the magnetic-field configuration in various regions. MGF will investigate magnetic merging in the magnetotail, which is thought to produce a plasmoid, that flows down the tail during the active periods. Also, MGF will observe the distant tail to determine its magnetic-field structure-whether well ordered or filamentary, for example - and its dynamic changes associated with substorms.

Plasma Waves Instrument (PWI): Hiroshi Matsumoto, Kyoto University, Japan, provides this instrument which has a Multi-Channel Analyzer (MCA) component from Roger Anderson, University of Iowa. During GEOTAIL's excursions from the near-Earth to the distant-tail regions, PWI will measure plasma waves to sample phenomena related to plasma dynamics in the different regions on various scales.

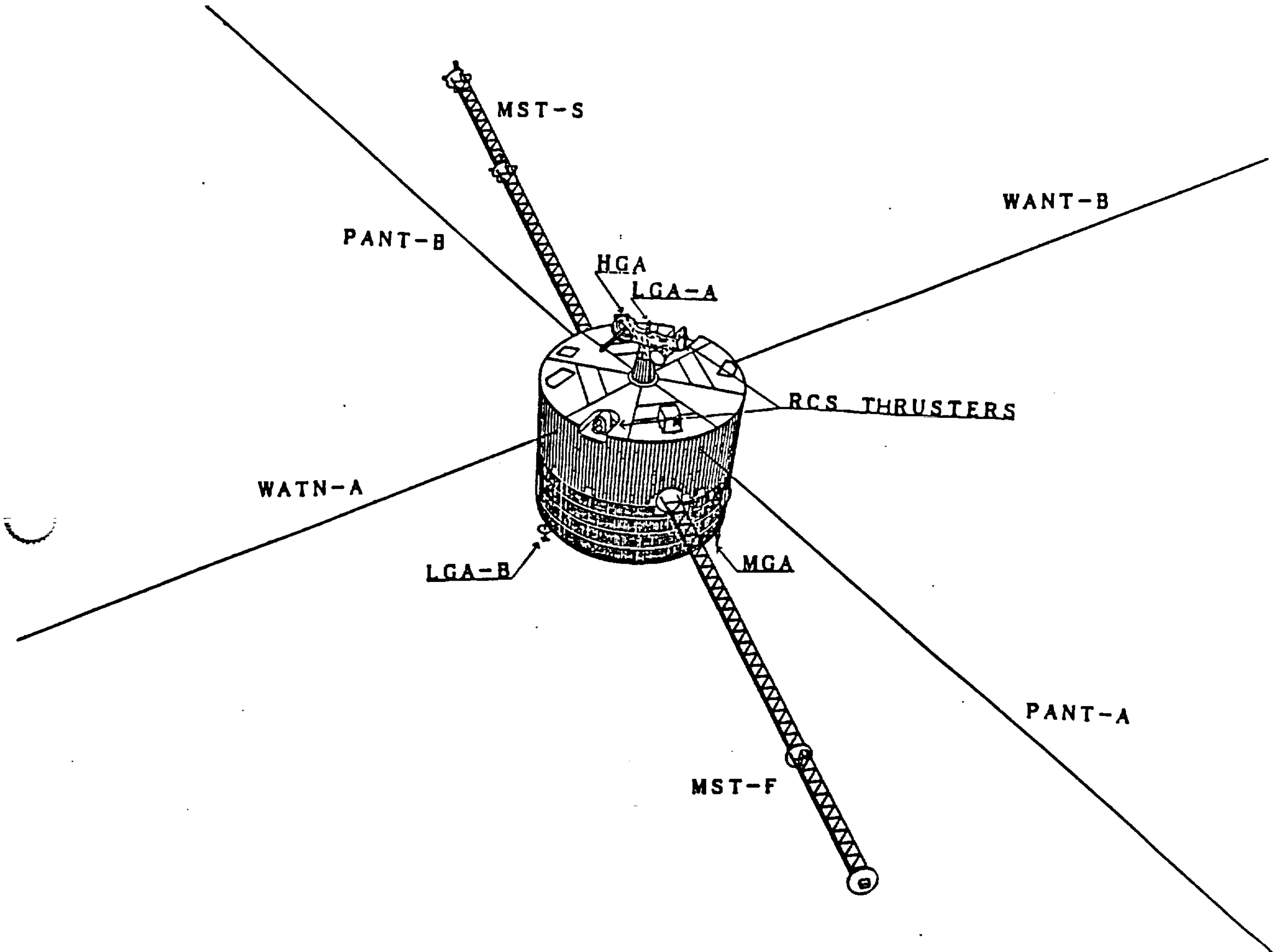

Figure 2-1. GEOTAIL Spacecraft, External View

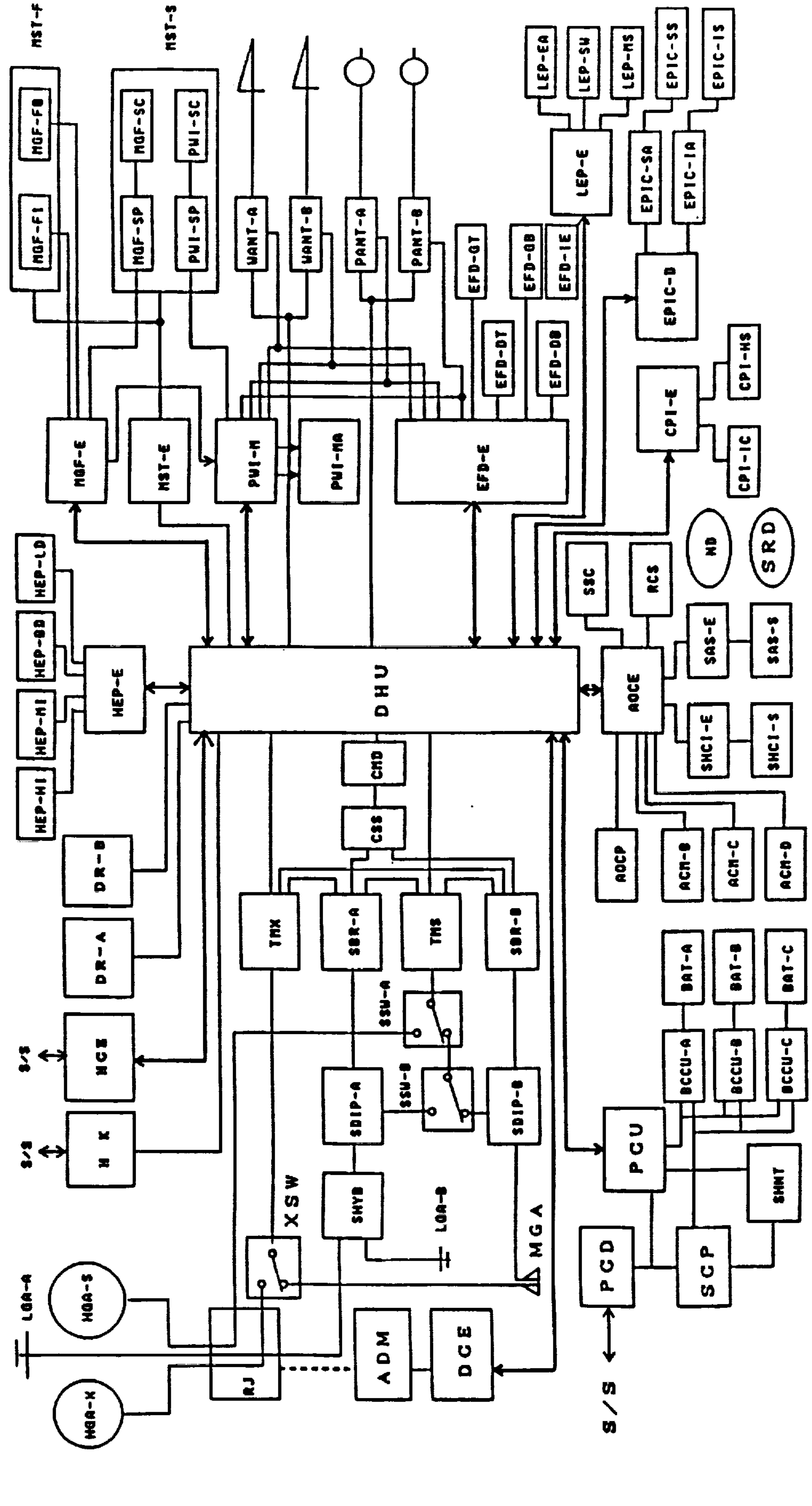

Figure 2-2. GEOTAIL Spacecraft, System Block Diagram

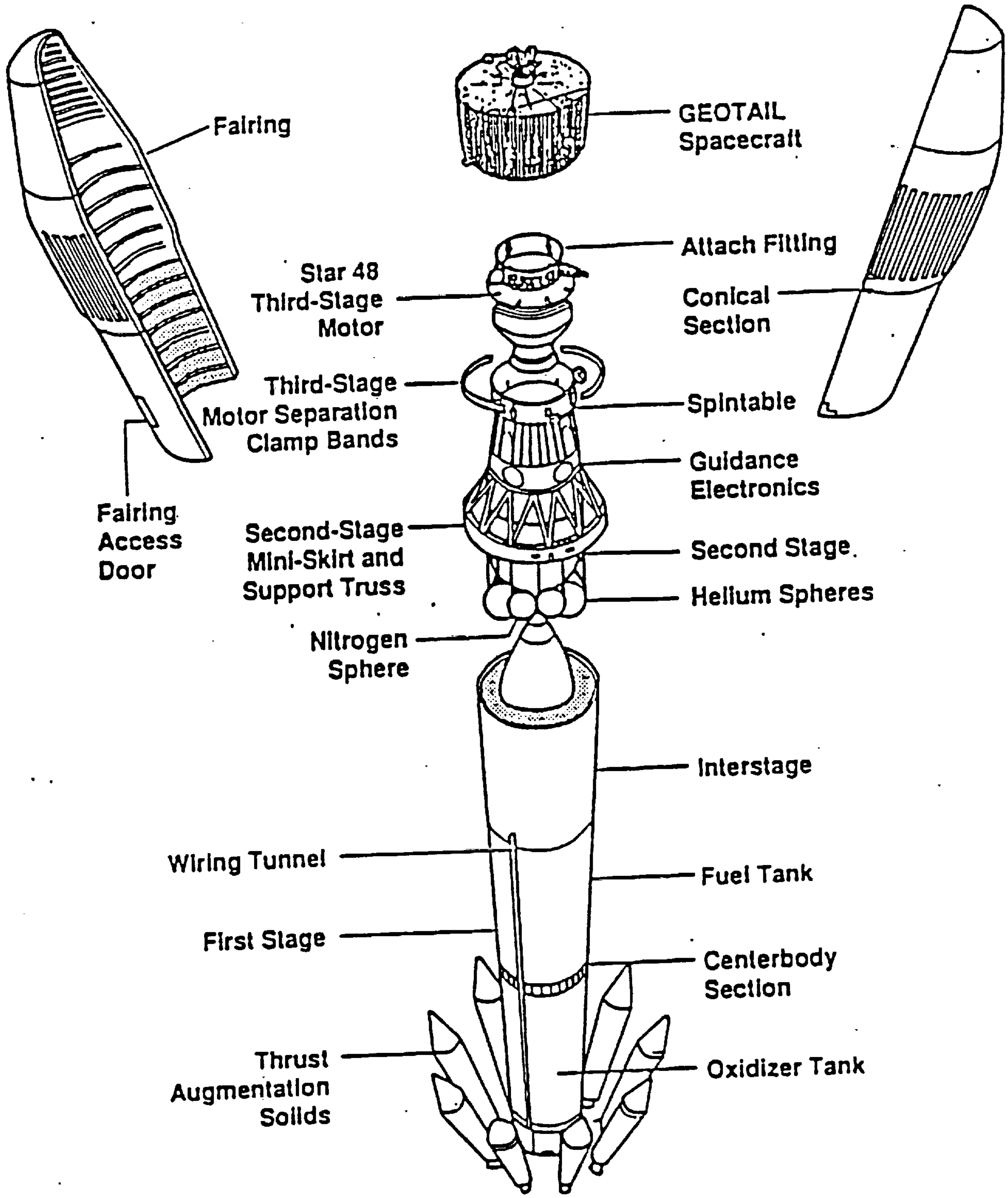

Figure 2-3. GEOTAIL Spacecraft/Launch Vehicle Interface

2.2 Mission Objectives

The main objectives of the GEOTAIL Mission are to:

- Determine the overall plasma, electric, and magnetic field characteristics of the distant and near geomagnetic tail;
- Determine the role of the distant and near-Earth tail in substorm phenomena and in the overall magnetospheric energy balance and relate these phenomena to external triggering mechanisms;
- Study the processes that initiate magnetic field reconnection in the near-Earth tail and observe the microscopic nature of the energy conversion mechanism in the reconnection region;
- Study plasma entry, energization, and transport processes in interaction regions such as the inner edge of the plasma sheet, the magnetopouse and the bow shock, and investigate associated boundary layer regions.

2.3 Program Background

The Japanese Institute for Space and Astronautical Science (ISAS) located at Sagamihara, Japan, constructed the GEOTAIL spacecraft for launch on a Delta II expendable launch vehicle from CCAFS in July 1992. GEOTAIL will use the gravity of the Moon to assist its orbit on the night side of the Earth, where the magnetotail is stretched out as a result of the impact of the solar wind encountering the Earth. GEOTAIL's orbit will extend from 220 Earth radii (1,401,620 km or 756,875 nautical miles) at its farthest point to 8 Earth radii (50,960 km or 27,518 nautical miles) at its nearest point.

The NASA Deep Space Network (DSN) will collect the data from the GEOTAIL spacecraft via radio link and the Goddard Space Flight Center (GSFC) Data Capture Facility (DCF) will assemble the data into computer files. The International Solar-Terrestrial Physics (ISTP) Central Data Handling Facility (CDHF) will store, catalogue, and organize the data. The CDHF will also create summaries, called key parameters, of the raw spacecraft data which will be used by the experiment investigators as a kind of index to the bulk data. In addition, ISAS will acquire real-time science data from the Japanese instruments from their Usuda tracking station in Japan. This data will be processed at the Sagamihara Operations Center and distributed to the Japanese investigators.

SECTION III

GROUND PROCESSING OPERATIONS

3.1 Payload Processing Facility (Building AO)

The GEOTAIL spacecraft was originally scheduled to be processed in Building AE (cleanliness class 10,000 facility) because of the scientific instruments' susceptibility to contamination. However, due to delays in the launch of the Extreme Ultraviolet Explorer (EUVE) payload, which was processed through Building AE in the same timeframe, it was decided to process the GEOTAIL spacecraft inside of a NASA/KSC procured portable clean room located in the South end of the Building AO High Bay.

3.1.1 Spacecraft and Ground Support Equipment Arrival and Setup

The GEOTAIL spacecraft and associated mechanical and electrical ground support equipment (GSE) arrived at the CCAFS skid strip via a 747-C aircraft on the morning of May 8, 1992. The spacecraft and GSE were unloaded from the 747 using KSC/CCAFS handling equipment (K-loader, forklifts, flatbed trailers, etc.) and then delivered to Building AO. Some of the flight instruments were hand-carried to Building AO by ISAS personnel. The spacecraft container was unloaded from its trailer using a forklift and was positioned into the airlock. After cleaning, the container was moved into the south high bay using the high bay crane operated by ISAS contractor personnel. On May 10, 1992, the mechanical GSE was cleaned in the airlock and then moved into the high bay and set up by ISAS contractor personnel. The electrical GSE was unpacked and moved into Rooms 103 and 104 and positioned. After positioning the equipment, the electrical GSE interface cables were connected and routed between the various EGSE racks. Connection of the EGSE racks to facility a.c. power sources was performed by KSC/CCAFS personnel in cooperation with ISAS contractor personnel. On May 12, 1992, the spacecraft was removed from its shipping container and set upon the spacecraft movement dolly. The spacecraft scientific instruments GN_2 purge equipment was set up and a purge was started late in the afternoon. Work scaffolding was also set up around the spacecraft to provide proper access. The spacecraft was then moved into the portable clean room for processing.

3.1.2 Reaction Control System Pressure Demonstration Test

On May 14, 1992, the Reaction Control System (RCS) GSE was unpacked, cleaned, and moved from the airlock into the high bay and set up near the spacecraft. On May 15, 1992, the spacecraft was moved out of the portable clean room, lifted up and rotated in preparation for the RCS Pressure Demonstration Test. The hoses connecting the RCS tanks to the GH_E supply were connected and a leak check performed. The electrical cable connecting the spacecraft to the RCS EGSE was connected and an RCS EGSE functional check was performed. The RCS Pressure Demonstration Test (RCS tanks pressurized with helium gas to the maximum expected operating pressure and leak checked) was successfully performed on May 18, 1992.

An RCS latch valve and thruster valve leak check was then successfully performed on May 19, 1992.

On May 20, 1992, six dummy RCS thrusters were removed from the spacecraft and replaced with the actual flight module thrusters. The final two dummy RCS thrusters were removed from the spacecraft and replaced with actual flight module thrusters on May 21, 1992. Preparations were also made for the RCS thruster module leak check. On May 22, 1992, the RCS tanks were again pressurized with GH_E. The RCS thrusters were pressurized by opening the RCS thrusters with the RCS EGSE, and the RCS flight module valves were leak checked. There were no leaks thus verifying the entire RCS thruster module. Thruster module protective covers were installed and the RCS EGSE equipment was removed from the high bay.

3.1.3 Security Incident

On Monday, May 25, 1992 (Memorial Day holiday), at approximately 12:30 pm, the Roving Security Guard checked the entrance to the Building AO clean room and found everything to be in order. At 6:20 pm, the Roving Security Guard discovered that the clean room door was unlocked and that the security lead seal was missing. Both NASA and MDSS were immediately notified. An investigation was performed and Linda D'Amico, MDSS Security, filed a report on the incident. The report stated that the spacecraft and ground support equipment were inspected and there was no damage nor disturbance of hardware. Evidently, the security guard at the entrance to the clean room had not closed and re-sealed the door prior to leaving his post after completion of the day's activities.

3.1.4 Scientific Instruments/Experiment Packages Installation

On May 27, 1992, the Comprehensive Plasma Instrument (CPI), the Electric Field Detector (EFD) Instrument, and the Energetic Particle and ION Composition Instrument (EPIC) were installed onto the spacecraft and a functional test of all three instruments successfully performed. On May 28, 1992, the High Energy Particle - Low Energy Particle Detector (HEPD-LEPD) was installed on the spacecraft and successfully tested. The Electric Field Detector - Top Gun (EFD-TG) was installed and successfully tested and the thermal shield support for the Comprehensive Plasma Instrument - ION Composition Experiment (CPI-IC) was installed. On May 29, 1992, the GN_2 purge line to the EFD Instrument was connected and checked to be operating properly. The Comprehensive Plasma Instrument (CPI) to Digital Processing Unit (DPU) functional test was then successfully performed.

3.1.5 Spacecraft Conductivity Checks

Spacecraft conductivity checks were performed on June 1, 1992. On June 2, 1992, spacecraft conductivity checks continued including solar cells, scientific instruments/sensors, and the bottom shelf of spacecraft. Spacecraft conductivity checks including the top shelf of the spacecraft were concluded on June 3, 1992.

3.1.6 Spacecraft Power "On"/S-Band Receiver and Telemetry Subsystem Test

On June 3, 1992, the GEOTAIL spacecraft was powered "on" for the first time since its arrival in the U.S.A.. On June 4, 1992, the spacecraft was again powered "on" and a test of S-band receivers A and B was successfully performed. The spacecraft telemetry subsystem was also successfully tested.

3.1.7 Antenna Installation

The High Gain Antenna (HGA), Medium Gain Antenna (MGA), and Low Gain Antenna (LGA) were installed onto the spacecraft on June 5, 1992.

3.1.8 Spacecraft Functional Testing

June 8, 1992 was spent performing GEOTAIL spacecraft functional tests. The following systems were successfully tested: Command and Data Handling (C & DH); Power Control Subsystem (PCS); Data Recorder (DR); Heater Control Electronics (HCE); Attitude & Orbit Control System (AOCS); Despin Control System (DCS); Reaction Control System (RCS); WIRE Antenna (WANT); and Probe Antenna (PANT). Spacecraft Functional Testing continued on June 9, 1992. Functional tests of the following GEOTAIL Scientific Instruments/Experiments were successfully performed: Common Instrument (CI); Plasma Wave Instrument (PWI); Electric Field Detector (EFD); High Energy Particle Experiment (HEP); Low Energy Particle Experiment (LEP); and Comprehensive Plasma Instrument (CPI). Additional functional testing of the HEP, CPI, EPIC, PWI, EFD, and LEP instruments was conducted on June 10, 1992.

3.1.9 Spacecraft Flight Batteries Charging/Conditioning

June 11-12, 1992, was spent charging/conditioning the spacecraft flight batteries. The portable air conditioning unit was set up and used to cool the batteries during the charging operations. The unit functioned well and kept the batteries within the temperature and humidity specification.

3.1.10 Spacecraft Deep Space Network Compatibility Test

On June 16, 1992, the GEOTAIL spacecraft Deep Space Network Compatibility Test was successfully performed. Ranging and telemetry data was successfully passed from Building AO to MIL-71 to GSFC's Central Data Handling Facility (CDHF). The Data Recorder was also dumped for readout by the CDHF.

3.1.11 Spacecraft Closeout/Preparations to Move

Preparations to move the spacecraft from Building AO to ESA-60 were made on June 17, 1992. The RCS mechanical GSE was also prepared for the move from AO to ESA-60. The spacecraft was powered "on" and the Data Recorder was positioned for the flight configuration. On June 18, 1992, the spacecraft container was prepared, the spacecraft was set down on the container base, and the container canopy was installed. A GN_2 purge of the container was established.

3.2 Hazardous Processing Facility (Explosive Safe Area - 60)

3.2.1 Spacecraft Arrival and Setup

The GEOTAIL spacecraft was moved from Building AO to the Sterilization and Assembly (S&A) Building at ESA-60 on June 19, 1992. The spacecraft container was unloaded from a KSC supplied transporter/trailer via forklift and moved into the S&A airlock. The container was cleaned and then moved into the South High Bay where the canopy was removed. The spacecraft was lifted out of the container and set on the spacecraft dolly. A dynamic balancing of the spacecraft adapter was also performed in the Dynamic Balance Laboratory (DBL) at ESA-60 on June 19.

3.2.2 Spacecraft Spin Balancing (Dry)

The spacecraft spin table adapter was moved from Building AO to the DBL at ESA-60 on May 26, 1992. An interface check of the adapter to the spin balance machine was successfully made the same day. The spacecraft was moved from the S&A Building South Bay to the DBL using the spacecraft dolly on June 22, 1992. The spacecraft was lifted and set down upon the spin balance machine in preparation for the dry spacecraft spin balance operation. On June 23, 1992, the dry spacecraft was spin balanced by the MDSS/PGOC crew. Even though the spacecraft had been spin balanced while in Japan, it was necessary to perform an additional spin balance while at ESA-60 because of changes to scientific instruments/experiment packages' weights. On June 24, 1992, the spacecraft was prepared for the move from the DBL back to the S&A South Bay, the RCS EGSE to spacecraft interface was functionally checked and the propellant loading equipment was leak checked.

3.2.3 Spacecraft Hydrazine Loading and RCS Tanks Pressurization

The spacecraft was moved from the DBL back to the S&A South Bay for hydrazine loading the morning of June 25, 1992. The propellant loading equipment was connected to the spacecraft and the RCS tanks were evacuated. Evacuation of the RCS tanks and other preparations for hydrazine loading continued on June 26, 1992. The pre-task briefing for hydrazine loading took place at 3:00 pm. Hydrazine loading (332 kg or 730.4 pounds) and low pressurization of the RCS tanks took place on June 27, 1992. Weather delays (lightning warnings) delayed the loading operation and it was not completed until 8:30 pm. A blanket pressure of 30 psia was established on the RCS tanks. On June 29, 1992, the RCS tanks were pressurized to maximum expected operating pressure of 300 psia. The spacecraft was prepared for the move back to the DBL and then moved at 8:30 pm.

3.2.4 Spacecraft Spin Balance (Wet)

The spacecraft was placed on the spin balance machine the morning of June 30 and then spin balanced for fuel settling and equalization. The RCS thruster latch valves were exercised "open" and "closed" during the operation. On July 1, 1992, the spacecraft was moved from the DBL back into the South Bay of the S&A Building.

3.2.5 Spacecraft Weighing and Mate to Third Stage and Third Stage Preparations

On July 2, 1992, the spacecraft was moved from the South Bay to the North Bay in preparation for weighing and mate to the third stage (PAM-D). The spacecraft was weighed by the MDSS/CCAFS crew on July 6, 1992. The spacecraft was lifted and weighed twice. The first weighing was 2223.7 lbs. (1010.77 kg); the second weighing was 2222.9 lbs. (1010.41 kg). The spacecraft was mated to the third stage (PAM-D) on July 7, 1992. This was a joint operation between MDSS/CCAFS and ISAS contractor personnel. The third stage (PAM-D) final preparations for launch took place on July 8, 1992. The flight clamp band was installed and tensioned; the flight clamp band retainers and springs installed; the Explosive Train Assembly (ETA) was connected; the separation assembly blanket was installed; and a final inspection and closeout photos of the payload were made.

3.2.6 Delta Transportation Canister Operations

The Delta Transportation Canister was moved from LC-17 to the S&A Building North Bay on the morning of July 9, 1992. The canister ring and conical section was cleaned and installed during the afternoon. The canister cylindrical shells were installed around the payload on July 10. The entire assembly was then transferred into the S&A Building airlock and set down onto the MDSS/CCAFS provided transporter on July 11, 1992. The GN_2 purge of GEOTAIL scientific instruments as well as a GN_2 purge of the Delta Transportation Canister was established and monitored.

3.3 Launch Complex-17A Operations

3.3.1 Spacecraft Arrival and Mate to Delta Launch Vehicle

The GEOTAIL spacecraft mated to the third stage (PAM-D) was transported in the Delta Transportation Canister from ESA-60 to Launch Complex-17A in the early morning of July 14, 1992. The Transportation Canister was hoisted to the White Room, the payload removed from the can and mated to the Delta launch vehicle second stage, the payload umbilical cables were connected, and the payload protective shroud installed. GN_2 purge of the scientific instruments was established. The third stage (PAM-D) was cabled up and continuity checks were performed.

3.3.2 Spacecraft Functional Test

On July 15, 1992, a problem was encountered during the start-up of the spacecraft functional test. The spacecraft could not be commanded from the Building AO checkout station. The spacecraft was powered down at 11:45 am for troubleshooting activities. Troubleshooting began at 1:00 pm and the problem was resolved at 2:00 pm. The problem was found to be reversed polarity on a spacecraft telemetry line from the blockhouse to Building AO. The functional test started again at 2:30 pm and was successfully completed at 4:30 pm. An RF link test was then completed between the blockhouse and Building AO.

3.3.3 Launch Vehicle/Spacecraft Flight Program Verification Test

The Delta II launch vehicle/GEOTAIL spacecraft Flight Program Verification Test was successfully performed on July 16, 1992. A spacecraft "power-on" stray voltage test was completed and the launch vehicle second stage flight battery was connected. On July 17, 1992, the launch vehicle "power-off" stray voltage test was performed. The Safe and Arm (S & A) ordnance was installed and connected.

3.3.4 Delta Fairing Operations

On July 18, 1992, the spacecraft umbilical extension cables were removed and the Delta II fairing was installed around the payload. Shortly after installation, the fairing air flow was turned "on". Fairing cleat and wedges installation took place on July 20, 1992.

3.3.5 Readiness Reviews

A Mission Flight Readiness Review was held at the E&O Building, Conference Room 116 at 9:00 am on July 20, 1992. The GEOTAIL Mission Launch Readiness Review was held at 9:00 am in the E&O Building, Conference Room 116, on July 23, 1992. Both the Delta launch vehicle and the GEOTAIL spacecraft were declared "launch ready".

3.3.6 Spacecraft Final Closeouts

A final spacecraft functional check and a spacecraft RF link test was made between LC-17, Building AO, and MILA on July 21, 1992. A final Camberra Tracking Station to MILA to Building AO spacecraft data flow test was performed on July 22, 1992. GEOTAIL spacecraft final closeouts were completed at 2:00 pm and a final engineering walkdown of the entire launch vehicle was performed at 11:00 pm on July 23, 1992.

3.3.7 Launch Operations

The Mobile Service Tower (MST) at LC-17A was "rolled back and secured" at 4:00 am on July 24. The GEOTAIL spacecraft was powered "on" and set to the "Launch Mode" at 5:30 am. Terminal countdown began at 7:30 am and the spacecraft was switched to "internal power" at 10:09 am. The spacecraft was determined to be "launch ready" at 10:21 am and liftoff occurred precisely at 10:26 am. The Delta II launch vehicle performed flawlessly and tracking/telemetry data from Camberra at 11:35 am showed solid "lock on" of the spacecraft.

SECTION IV

GEOTAIL HIGHLIGHTS

Table 4-1 highlights some of the major events of the GEOTAIL payload ground operations processing, and the Planned versus Actual schedule times are shown.

Table 4-2 shows the history of changes to the GEOTAIL launch date.

Appendices A and B consist of the as-planned and as-run Ground Processing Schedules for the GEOTAIL payload, respectively. Appendix C contains lessons learned from the GEOTAIL ground processing operations.

The as-planned Ground Processing Schedule was developed as a joint effort between the Japanese Institute for Space and Astronautical Science (ISAS); their support contractors - Nippon Electronics Corporation (NEC), Mitsubishi Heavy Industries (MHI), and the Sumitomo Corporation; the Goddard Space Flight Center (GSFC) - International Solar Terrestrial Physics Program Office (ISTP); McDonnell Douglas Space Systems (MDSS) - Delta Launch Vehicle Division; MDSS/CCAFS Launch Complex-17 Operations Office; the NASA-KSC Launch Site Support Manager; and the MDSS-KSC Launch Site Support Engineer.

This schedule was built from information gathered, coordinated, documented, and agreed to from several Ground Operations Working Group Meetings, Technical Interchange Meetings, and GEOTAIL Spacecraft/Delta II Launch Vehicle Integration Meetings.

The as-run Ground Processing Schedule was developed as a joint effort between members of the ISAS Launch Site Campaign Team, their support contractors, and the MDSS-KSC Launch Site Support Engineer who was responsible for generating daily Test Notes describing payload ground processing activities, anomalies, and test concerns on a day-to-day basis.

In general, the as-planned schedule and the as-run schedule were basically the same (a few minor differences) up until the time the spacecraft was moved from Building AO to ESA-60. About that time, the Extreme Ultraviolet Explorer (EUVE) payload, which was scheduled to be launched from LC 17-A, launch date was slipped from May 28 to June 7. After several management level meetings, it was decided to slip the GEOTAIL launch from July 14 to July 24 to allow adequate time to prepare LC-17A for GEOTAIL.

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SCHEDULED ACTIVITIES	PLANNED (1992)	ACTUAL (1992)
Spacecraft and GSE Arrival & offload at Bldg AO	May 8	May 8
GSE Unpacking	May 11-12	May 11-13
EGSE Set-up & Checkout in Rooms 103 &104	May 11-19	May 11-19
GN2 Purge Equipment Set-up & checkout	May 11	May 11-12
Spacecraft Container Removal & Spacecraft Receiving Inspection	May 12	May 12-15
RCS GSE Set-up & Checkout	May 14-15	May 14-15
RCS Pressure Demo Test	May 18	May 18
Spacecraft/Scientific Instruments Integration	May 26-29	May 26-29
Telemetry/Command Interface Checks	May 26-28	May 26-28
Electrical Power System EGSE Set-up & Checkout	May 20-27	May 20-27
EGSE/Spacecraft Interface Checks	May 28-June 3	May 28-June 3
EGSE-Land Line Interface Checks	June 3	June 3
Spacecraft Adapter Fit Check & Spin Balancing	June 1	May 26
Communications Subsystem Checks & Antennae Installation	June 4-5	June 4-5
Spacecraft functional Tests	June 8-10	June 8-10
Battery Charging/Reconditioning	June 11-12	June 11-12
Solar Array Validation	June 15	June 15
Operational Simulation Test with MILA	June 16	June 16-17
Move Spacecraft From Bldg AO to ESA-60	June 19	June 19
Spacecraft Dynamic Balance (dry)	not planned	June 23
Hydrazine Loading	June 21-23	June 27
Spacecraft Dynamic Balance (wet)	June 24	June 30
Spacecraft Weighing	June 26	July 6
Spacecraft Mate to PAM-D	June 29	July 7
PAM-D Final Preparations	June 30	July 8
EPS EGSE Move to LC-17 Blockhouse	June 22	July 8
EPS EGSE Set-up & checkout/Blockhouse	June 23	July 9
Spacecraft Installation into Delta Handling Canister	July 1	July 9-11
Spacecraft move to LC-17A, Erection & mating	July 2	July 14
GEOTAIL Spacecraft Functional tests	July 6	July 15
Flight Program Verification Test, Power On Stray Voltage Check	July 7	July 16
Power off Stray Voltage Check, Delta Ordnance Installation	July 8	July 17
Fairing Installation	July 9	July 18
Delta 2nd Stage Propellant Loading	July 10	July 21
GEOTAIL Spacecraft Final Functional checks & RF Link Check, Battery charging	July 11	July 21
Beacon & Range Safety Checks, Class A Ordnance Installation	July 13	July 22
GEOTAIL Final closeouts	July 14	July 23
Launch Countdown & Launch	July 14	July 24

Table 4-1. Comparison of Scheduled Activities

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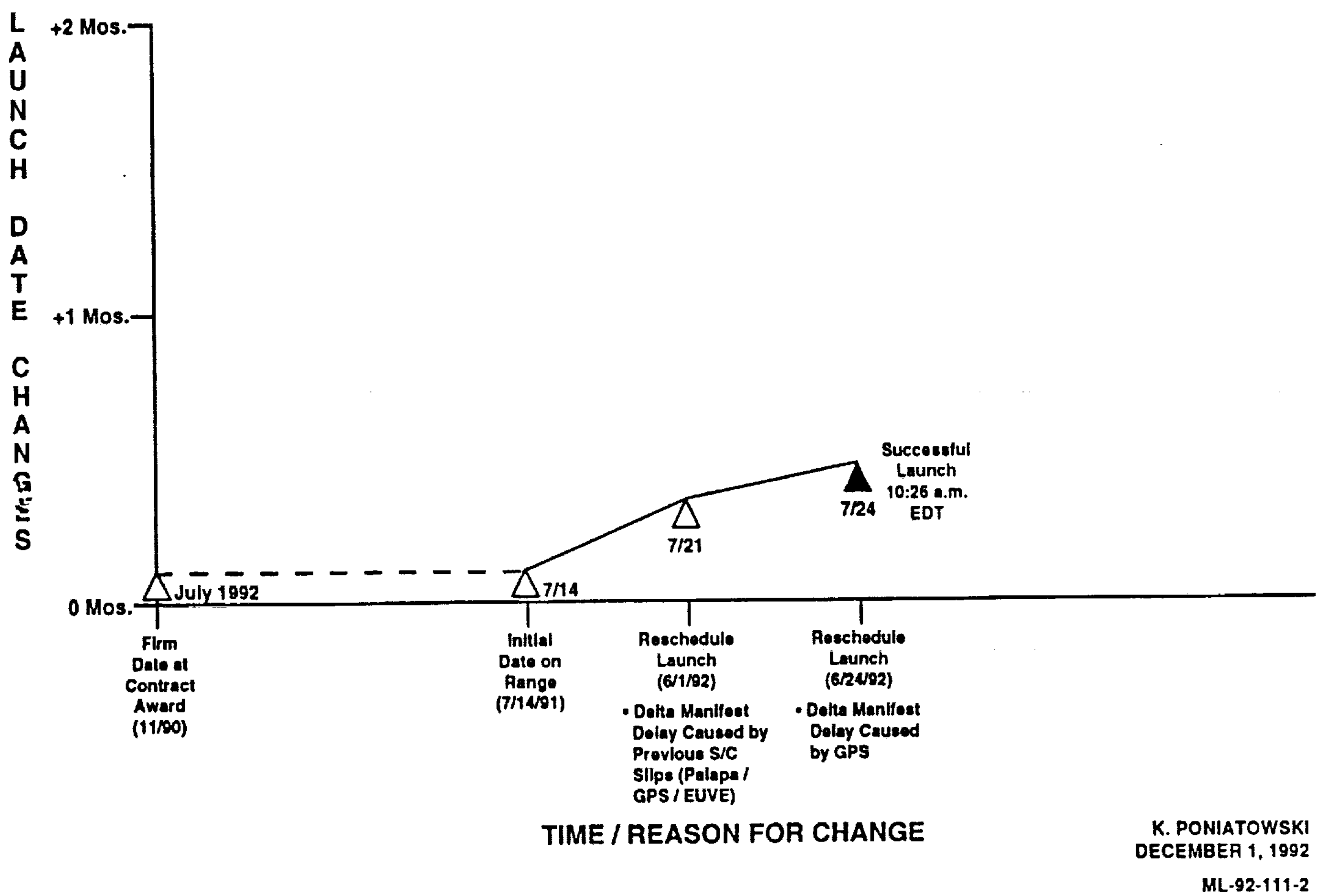

Table 4-2. GEOTAIL Launch Date History

APPENDIX A

GEOTAIL MISSION AS-PLANNED SCHEDULES

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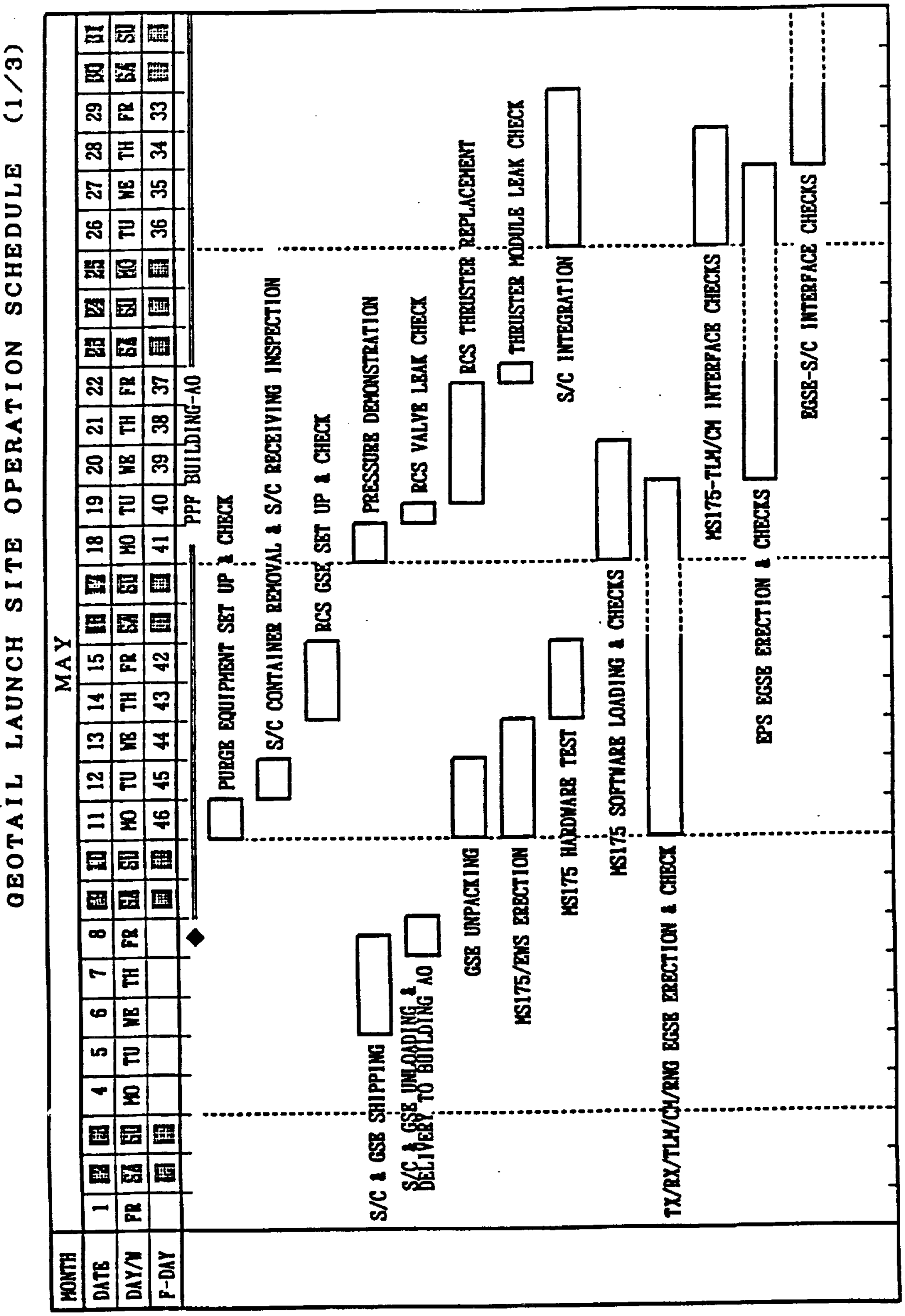

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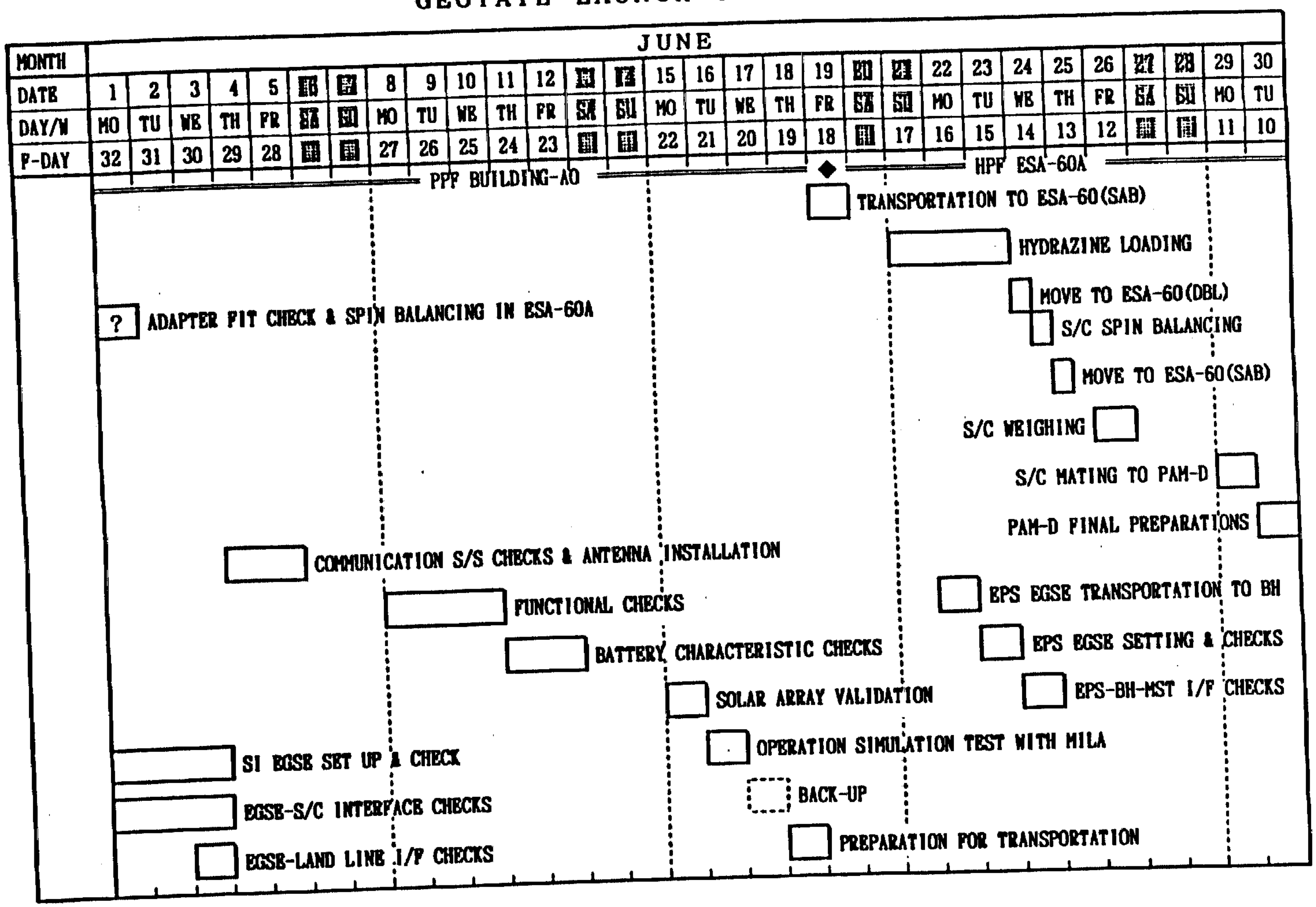
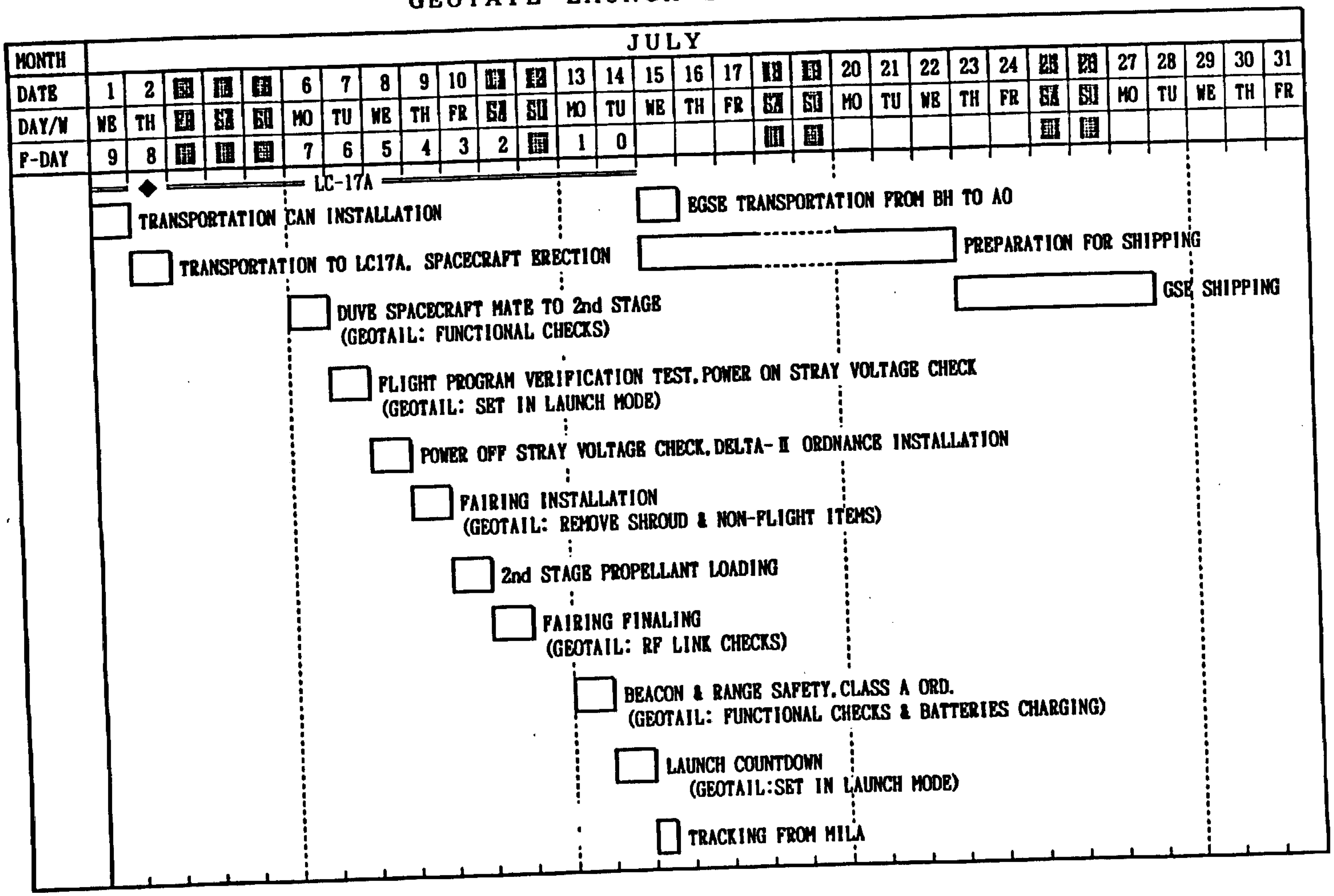
GEOTAIL LAUNCH SITE OPERATION SCHEDULE (2/3)



GEOTAIL LAUNCH SITE OPERATION SCHEDULE (3/3)



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APPENDIX B

GEOTAIL MISSION AS-RUN SCHEDULES

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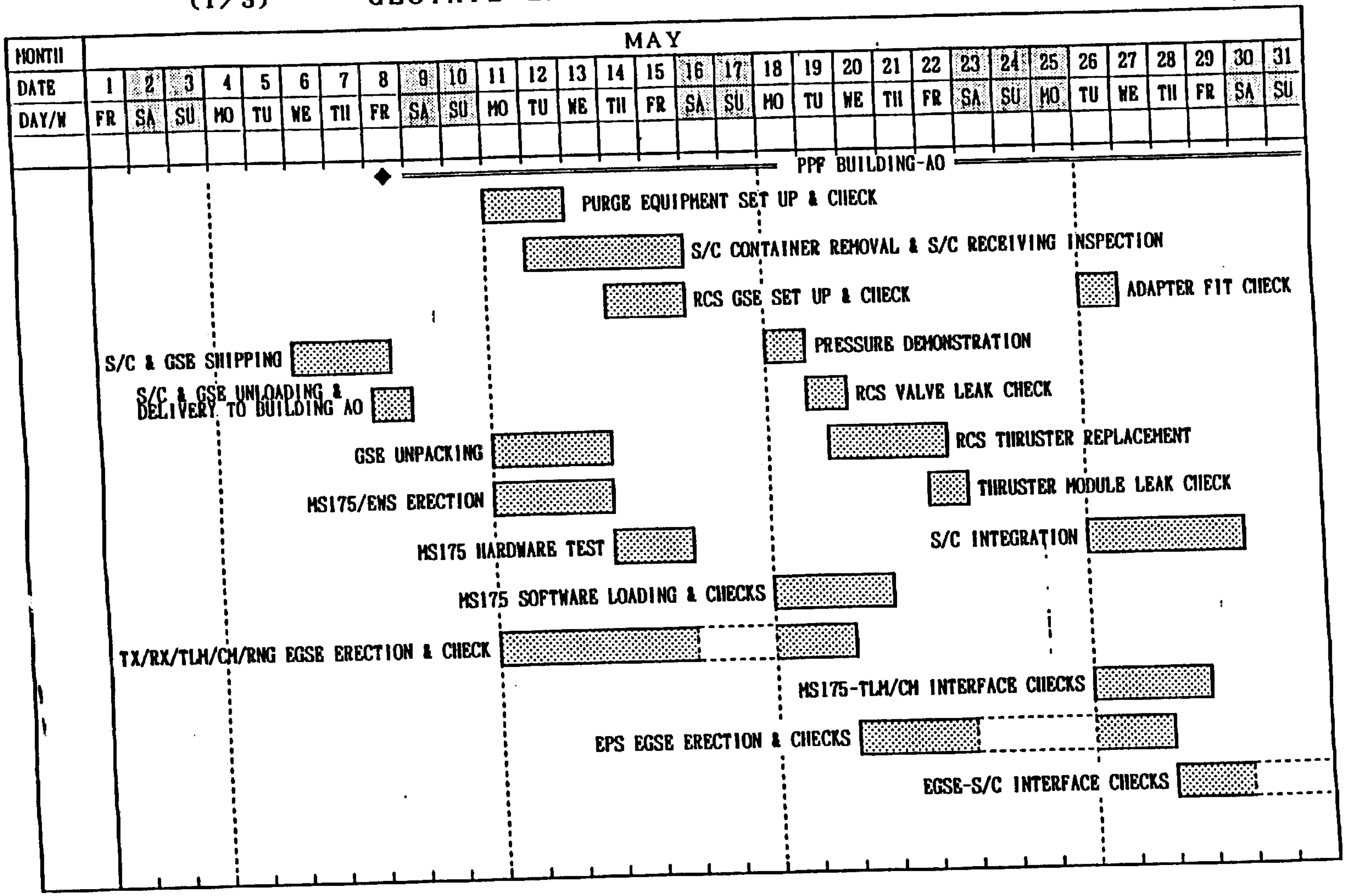
(1/3) GEOTAIL LAUNCH SITE OPERATION SCHEDULE

RESULT



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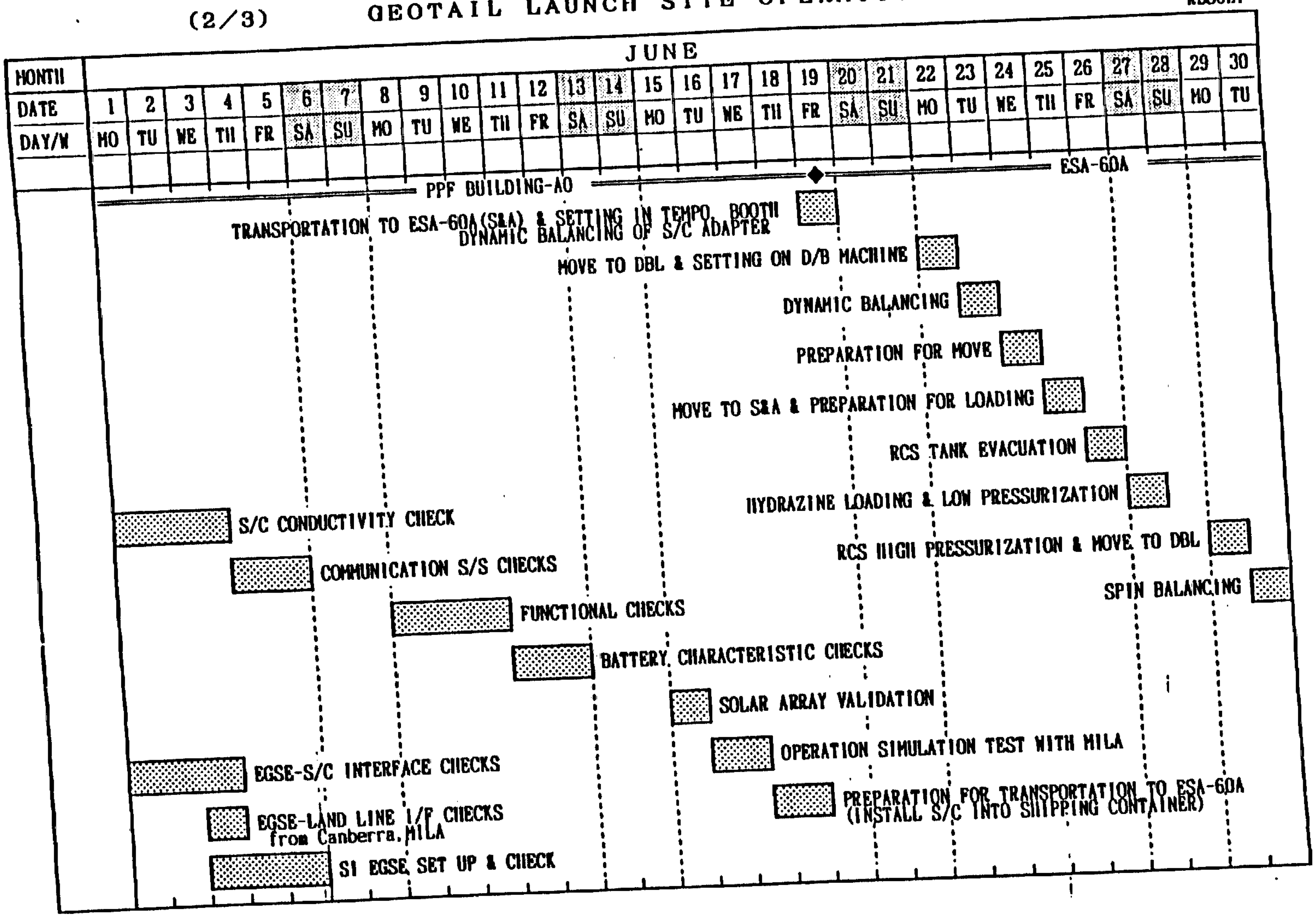
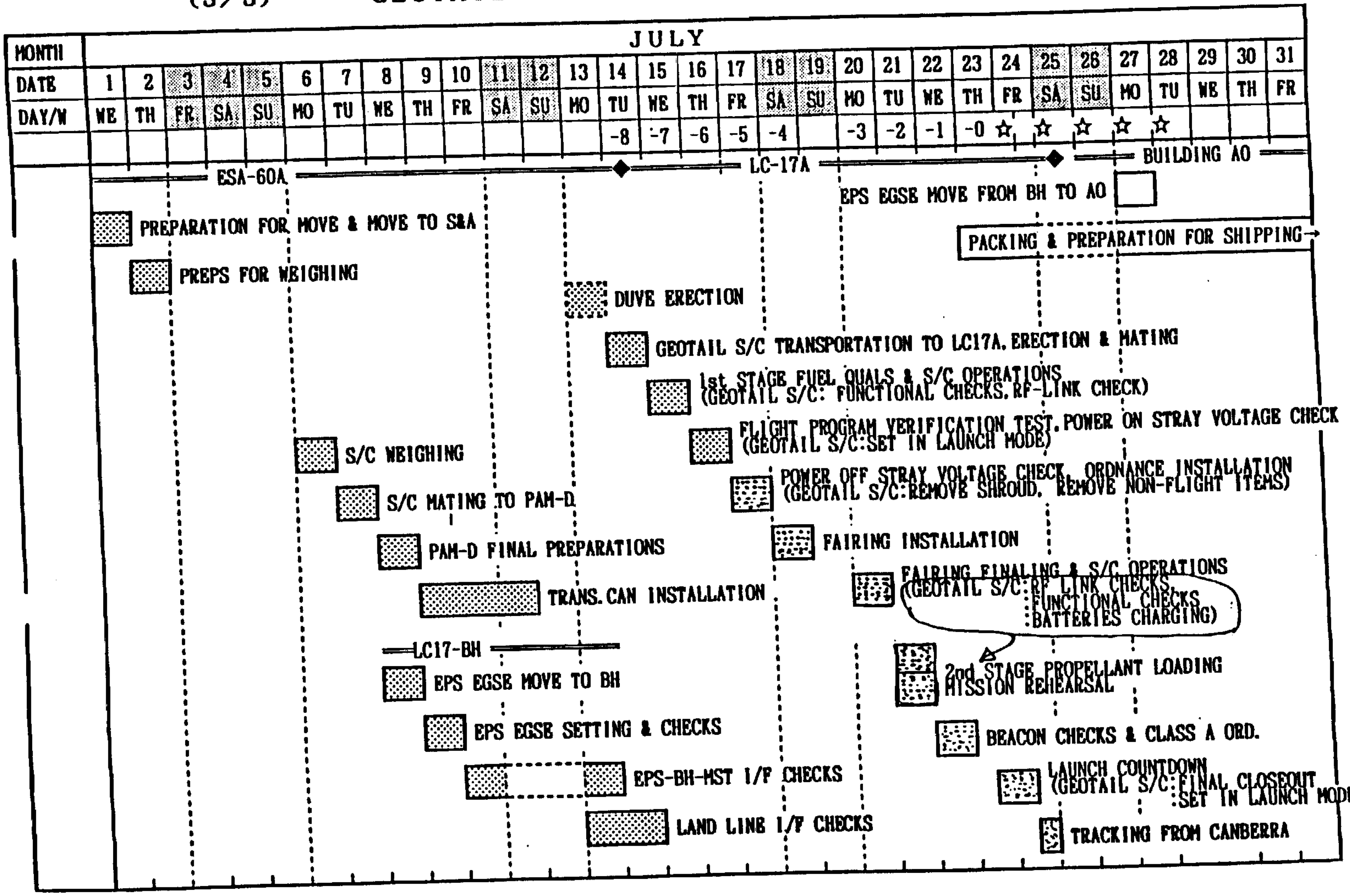
(2/3) **GEOTAIL LAUNCH SITE OPERATION SCHEDULE** RESULT



RESULT ~~REV 5.1~~

(3/3) GEOTAIL LAUNCH SITE OPERATION SCHEDULE



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APPENDIX C

GEOTAIL LESSONS LEARNED

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This section lists problems and important lessons learned and experience gained during the ground processing of the GEOTAIL payload. This information should aid in early identification of similar problems with future payloads in the same situation.

PROBLEM - The receipt of accreditation credentials for foreign nationals involved in GEOTAIL ground processing at CCAFS was very late. KSC had to support the foreign customers with escort service until badging credentials were available.

LESSON LEARNED - Foreign Nationals, involved in processing payloads through KSC/CCAFS, must be made aware of and provide feedback that they understand the requirement to submit accreditation credentials needed for badging/access to both the NASA Headquarters and Pentagon Office of International Affairs (OIA) at least six months prior to their arrival in the U.S.A..

PROBLEM - Additions to the approved access list for Building AO High Bay entry (Guard Orders) required frequent updates by Security.

LESSON LEARNED - The LSSM, LSSE and Facility Manager were given authority to add names to the approved access list. This aided daily operations and reduced delays.

PROBLEM - The Japanese arrived at CCAFS without some major test equipment (e.g. frequency analyzers, signal generators, line attenuators, multimeters, step down transformers, etc.). Even though they had been told numerous times at early-on meetings to bring all necessary test equipment and spare parts with them, they failed to do so. This resulted in the LSSM and LSSE having to expend an exorbitant amount of time and effort to locate this equipment at the KSC and USAF electronics equipment labs.

LESSON LEARNED - Foreign customers must me made to understand that electronic test equipment is in short supply at KSC/CCAFS and that such equipment is loaned out on an "as available and first come, first served" basis.

PROBLEM - The GEOTAIL Spacecraft Program Requirements Document (PRD), published in October 1991, identified the requirement for three (3) analog data circuits, 262 KBps bi-phase-m from LC-17 to Building AO. It was not until the Ground Operations Review meeting held on April 24, 1992 that we were told that the necessary fibre optics equipment was "on hand, but to date no work had been started on the installation". An action had to be assigned to the Range representative to track this requirement carefully to avoid any impact to the scheduled GEOTAIL launch date.

LESSON LEARNED - The Range needs to be more responsive to documented support requirements. Even though the necessary equipment was on hand, the Range Contractor was not told to start work on the installation of the required fibre optics lines until late into the spacecraft processing flow. The lines were supposed to be installed by June 15, 1992. It was early July before the work was completed.

POSITIVE LESSON LEARNED - The GEOTAIL morning and afternoon team meetings were beneficial for planning both the detailed flow and the next 72 hours of processing requirements. When schedules were built, the plan was followed to completion.

POSITIVE LESSON LEARNED - All GEOTAIL customer procedures (total 32) were received at the same time for review and comment. This proved to be very beneficial for review of the hazardous safety issues and led to a very complete support understanding of the overall mission.

POSITIVE LESSON LEARNED - The Launch Site Test Plan information submitted by the Japanese, including interfaces, requirements, and communication data, was excellent and was used as a single source of information. It was thought of as the "Bible" for GEOTAIL launch operations. Recommend all projects have such a document.

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CP-PSO	W. R. Fletcher	
CP-PSO	L. F. Kruse	
CP-PSO-A	M. Whitney	5
CS-GSD-2C	H. Morio	
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