FAST AURORAL SNAPSHOT EXPLORER (FAST)

ANTENNA SUBSYSTEM DEVELOPMENT PLAN

January 27, 1992

FAST
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DEVELOPMENT PLAN

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Date

I. GENERAL DESCRIPTION OF WORK

The Antenna Subsystem is one of the major components of the spacecraft communications system. The development of the antenna subsystem consists of eight main tasks:

Antenna Design - The spacecraft configuration has been studied to determine the most suitable antenna types. Various antenna models will be designed and fabricated. (currently 70% complete)

Engineering Model Development - Once ideal antenna designs have been achieved, engineering models will be constructed. (currently 50% complete)

Engineering Model Testing - A mock-up of the spacecraft will be delivered by the Structures and Mechanical Systems Branch, with fabrication consultation from the Antenna and Tracking Section. Radiation patterns of the entire antenna subsystem will be measured.

Power Divider Procurement - A power divider will be procured from a microwave products vendor.

Coaxial Cable Procurement - Low-loss flexible coaxial cable assemblies will be procured.

Flight Unit Fabrication and Testing - The flight and flight spare antennas will be fabricated and tested in-house. System radiation patterns will be measured with the flight antennas mounted on the mock-up.

Verification - The flight and flight spare antennas will be qualified, per the FAST Verification Plan. For more details, see Section XII.

Integration and Test - The flight antennas will be integrated to the spacecraft and long and short functional tests will be performed periodically.

A subsystem overview, manpower summary, costing plan, and activity flow plan highlight the remainder of this document.

II. APPLICABLE DOCUMENTS

The following documents and drawings should be referred to for the Antenna Subsystem design, definition, and specification.

FAST-SPEC-005	Requirements Document for SMEX FAST Mission
TBS	FAST Support Instrumentation Requirements Document (SIRD)
TBS	Systems and Operations Requirements Document (SORD) for the SMEX Project FAST Mission
FAST-OPS-001	SMEX Program FAST Mission Operations Concepts
FAST-TEV-001	Verification Plan for the FAST Mission
GSFC S-740-88-999	Performance Assurance Requirements for SMEX Spacecraft (Rev. A)
Dwg. GC1524450	Block Diagram / Antenna Subsystem / FAST
Dwg. GC1524451	Rectangular Ring Microstrip Patch Antenna / FAST

III. REQUIREMENTS

The FAST mission requirements are fully specified in the Requirements Document for SMEX FAST Mission. The requirement applicable to the Antenna Subsystem is stated below. Gain values are based upon link calculations as of PDR.

- Minimum system gain of -3 dBic over a ±45° band, omnidirectional about the spacecraft rotational axis, for the high data rate downlink (currently at a frequency of 2215 MHz)

Additional requirements indirectly placed on the antenna subsystem include:

- Minimum system gain over 90% of the sphere of -22 dBic for low rate downlink (currently at a frequency of 2215 MHz) and -31 dBic for uplink (currently at a frequency of 2039.64 MHz).

- Polarize the electric field left-hand circularly

III. REQUIREMENTS (continued)

The antenna subsystem also imposes the following requirements on the mechanical system:

- Position the antennas so that the element's main beam is parallel to the cone traced out by the nominal nadir vector
- Locate the antennas to permit an unobstructed ±45° view angle, centered about the plane perpendicular to the spin axis, from the center of each antenna element
- Provide an dimensionally and materially (conductive/dielectric) mock-up of the spacecraft for use in measuring system radiation patterns

IV. SUBSYSTEM ELEMENTS

The basic elements of the Antenna Subsystem are the antennas, power divider, and the RF cables. Each element is defined below:

Antennas - Four flight and two flight spare microstrip patch antennas will be designed, fabricated, tested, and qualified.

Power Divider - A power divider will divide and combine the RF signals between the diplexer and the four antenna elements.

RF Cables - Flexible coaxial cable will interconnect the subsystem elements.

V. SUBSYSTEM DESCRIPTION

The elements described in Section IV comprise the total Antenna Subsystem. In the transmit mode, RF energy from the transponder's diplexer will be applied to the coaxial cable which interfaces to the power divider. This signal is divided equally in amplitude and phase between the four equal length cables to the antennas. Each antenna then radiates its portion of this energy. In receive mode, RF energy from each of the four antennas impinges on the antennas and is transferred to each of the antenna coaxial cables. These signals are applied to the power divider which combines them into a single signal. This composite signal is then transferred to the transponder's diplexer via the interfacing coaxial cable. A system block diagram is available in Drawing GC1524450.

VI. TRADE STUDIES

The only remaining trade study concerns determining the element dimensions which yield an acceptable system radiation pattern and impedance match. (estimated completion date: 5/12/92).

VII. MAKE/BUY PLAN OF SUBSYSTEM ELEMENTS

The antennas will be fabricated in-house by the Antenna and Tracking Section. The other subsystem elements will be procured from outside vendors.

VIII. MANPOWER

As of January 27, 1992, civil service manpower from the Antenna and Tracking Section for this project is divided as shown in Table 1.

Table 1: Man-Year Requirements

NAME OF INDIVIDUAL	AREAS OF ASSISTANCE	MY FY92	MY FY93	MY FY94
Ken Hersey	Antenna Design	0.4	0.5	0.3
Carl Riffe	Antenna Design	0.2	0.2	0.2
Roger Ratliff	Fabrication	0.2	0.2	
Vince Briani	Testing/Cabling	0.2	0.2	
Billy Williams	Testing	0.2	0.2	
Berlin Wittig	Soldering	0.2	0.2	
	TOTALS	1.4	1.5	0.5

IX. COSTING PLAN

The total cost for the Antenna Subsystem is broken down into each of the subsystem elements. Table 2 itemizes these estimates.

Table 2: Cost Estimates

SUBSYSTEM ELEMENT	FY92 (K$)	FY93 (K$)	TOTALS
Antennas	10	14	24
Power Divider		1	1
Coaxial Cables		20	20
TOTAL	10	35	45

X. SCHEDULE

The Antenna Subsystem Activity Flow Plan is presented on the next page.

XI. GSE REQUIREMENTS

During Integration and Testing (I&T), some GSE will be used to verify basic system operations. This I&T GSE includes a Field Strength Meter and a Network Analyzer. The Microwave Technology Branch will provide this equipment.

XII. VERIFICATION

The Antenna and Tracking Section will perform functional tests (VSWR and radiation patterns) on the antennas with the spacecraft mock-up at our antenna range. Also, an initial calibration will be made for the near-field field strength test. This test will be repeated during I&T, and shall serve as the "Antenna Subsystem Short Functional." The remainder of the verification tests include: Mass Properties, Random Vibration, Sine Burst, and Mechanical Shock, and Thermal Cycling.

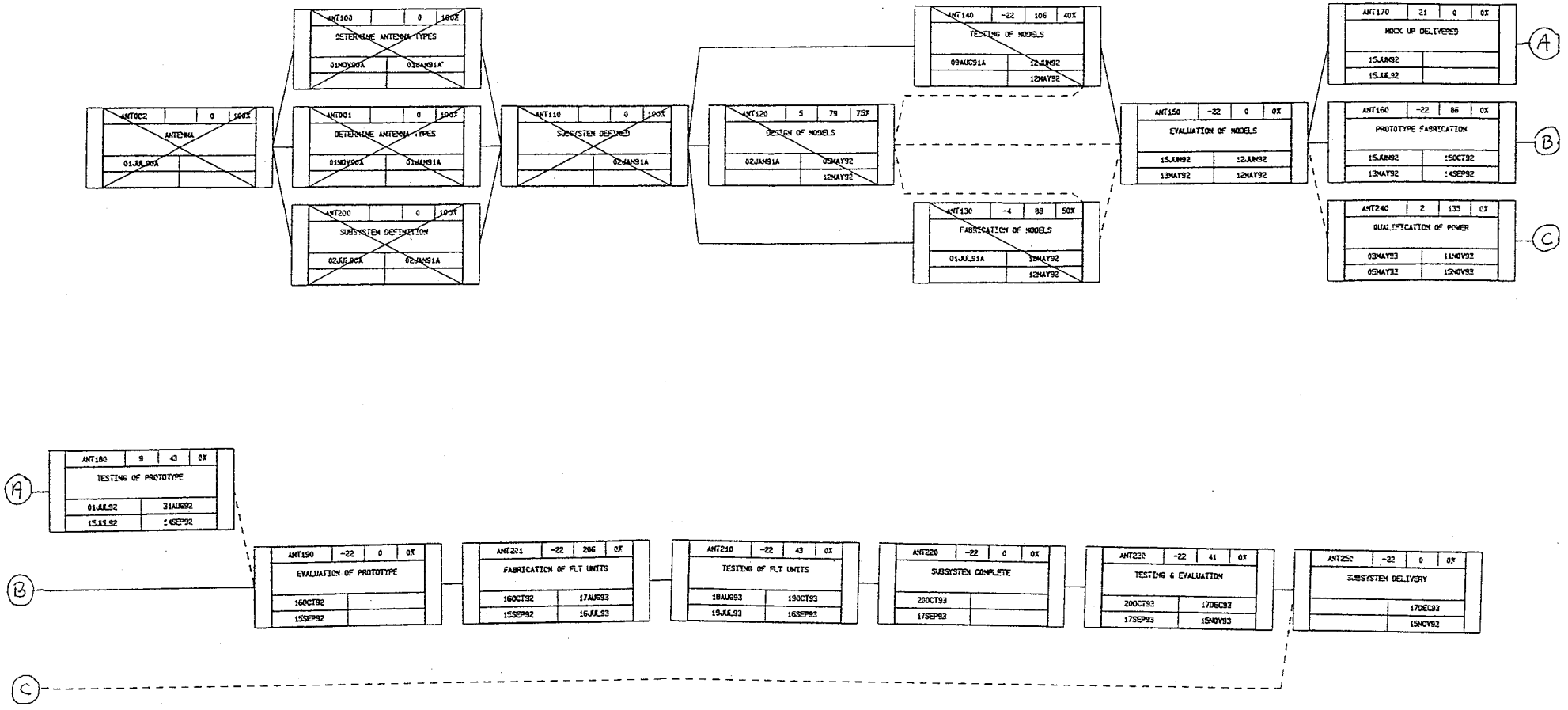
The power divider will be tested through the SMEX Flight Assurance Manager as specified in the component's certification log.

XIII. DOCUMENTS TO BE PRODUCED

In addition to this Development Plan, subsystem drawings and Integration & Test Procedures will be produced.

XIV. ACRONYM LIST

FY	Fiscal Year
GSE	Ground Support Equipment
K$	Thousands of Dollars
MHz	Megahertz
MY	Man-Year
RF	Radio Frequency
SMEX	Small Explorer
VSWR	Voltage Standing Wave Ratio


ANT002 | 0 | 100%
ANTENNA
01JUL90A
ANT100 | 0 | 100%
DETERMINE ANTENNA TYPES
01NOV90A
02JAN91A*
ANT001 | 0 | 100%
DETERMINE ANTENNA TYPES
01NOV90A
01JAN91A
ANT200 | 0 | 100%
SUBSYSTEM DEFINITION
02JUL90A
02JAN91A
ANT110 | 0 | 100%
SUBSYSTEM DEFINED
02JAN91A
ANT120 | 5 | 79 | 75%
DESIGN OF MODELS
02JAN91A
05MAY92
12MAY92
ANT140 | -22 | 106 | 40%
TESTING OF MODELS
09AUG91A
12JUN92
12MAY92
ANT130 | -4 | 88 | 50%
FABRICATION OF MODELS
01JUL91A
12MAY92
12MAY92
ANT150 | -22 | 0 | 0%
EVALUATION OF MODELS
15JUN92
12JUN92
13MAY92
12MAY92
ANT170 | 21 | 0 | 0%
MOCK UP DELIVERED
15JUN92
15JUL92
ANT160 | -22 | 86 | 0%
PROTOTYPE FABRICATION
15JUN92
15OCT92
13MAY92
14SEP92
ANT240 | 2 | 135 | 0%
QUALIFICATION OF POWER
03MAY93
11NOV93
05MAY92
15NOV93
A
B
C
ANT180 | 9 | 43 | 0%
TESTING OF PROTOTYPE
01JUL92
31AUG92
15JUL92
14SEP92
ANT190 | -22 | 0 | 0%
EVALUATION OF PROTOTYPE
16OCT92
15SEP92
ANT231 | -22 | 206 | 0%
FABRICATION OF FLT UNITS
16OCT92
17AUG93
15SEP92
16JUL93
ANT210 | -22 | 43 | 0%
TESTING OF FLT UNITS
18AUG93
19OCT93
19JUL93
16SEP93
ANT220 | -22 | 0 | 0%
SUBSYSTEM COMPLETE
20OCT93
17SEP93
ANT230 | -22 | 41 | 0%
TESTING & EVALUATION
20OCT93
17DEC93
17SEP93
15NOV93
ANT250 | -22 | 0 | 0%
SUBSYSTEM DELIVERY
17DEC93
15NOV93
A
B
C