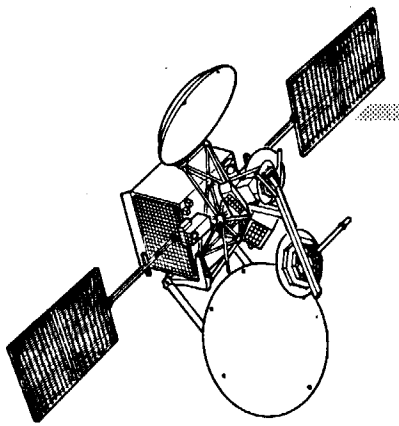
ADVANCED COMMUNICATIONS TECHNOLOGY SATELLITE (ACTS) PROGRAM



ROBERT BAUER
NASA LEWIS RESEARCH CENTER

ACTS PROJECT UPDATE

ACTS MINI WORKSHOP/NAPEX XVII
PASADENA, CA
06/14-15/93

ACTS

NASA

PROJECT STATUS

LAUNCH PREPARATIONS

- SPACECRAFT MATED TO TOS; VERTICAL PROCESSING FACILITY (VPF) COMPLETE; MOVE TO PAD BY 06/24 FOR INTEGRATION WITH DISCOVERY.

- TARGET LAUNCH DATE: JULY 15, 1993

- ACTS LAUNCH DATE DEPENDENT ON ENDEAVOR LAUNCH (JUNE 20)

ON ORBIT CHECKOUT

- TRANSFER/DRIFT ORBIT: COMPLETE AT ABOUT L + 11 DAYS

- MCP TURN-ON: ABOUT 8 DAYS AFTER DRIFT ORBIT WHEN S/C IS 3-AXIS STABILIZED. (KBT, UFB TURN-ON SHORTLY AFTERWARDS)

- FINISH SPACECRAFT (BUS/PAYLOAD) TESTING: ~30 DAYS AFTER LAUNCH (08/13).

- SYSTEM CHECKOUT FOLLOWS S/C TESTING: DURATION = 50 DAYS. COMPLETED 10/02.

ALL LEWIS READINESS REVIEWS COMPLETED. STS REVIEWS THROUGH JULY.

EXPERIMENTS PROGRAM STATUS

EXPERIMENTS PERIOD STILL BEGINS 10/04/93!

PROPAGATION EXPERIMENTS

- ALTHOUGH INITIAL KBT, UFB TURN-ON APPROXIMATELY AUG. 7, NO REQUIREMENT TO MMAS TO MAINTAIN SIGNALS UNTIL REFERENCE TERMINAL EQUIPMENT (RTE, PART OF MASTER CONTROL STATION) IS BROUGHT ON-LINE AUG. 13.

- USE AUG. 13 FOR APT ANTENNA ALIGNMENT BEGIN.

- FOR CLASS II AND USERS OF THE MULTIBEAM COMM. PACKAGE, USE EXPERIMENTS BEGIN DATE OF OCT. 4.

EOA EXPERIMENTS

- TOTAL OF 72 APPROVED EXPERIMENTS (INCLUDES PROPAGATION).

- 86 ORGANIZATIONS PARTICIPATING

- SPACECRAFT ALLOCATION FOR 1ST 6 MOS.- 98.9% OF PRIME HOURS
  78.2% OF OFF PRIME HRS

ACTS

NASA

EARTH STATION STATUS

NGS/MCS

- TERMINAL INSTALLATION AT LEWIS COMPLETED. READY TO SUPPORT TRAINING AND FLIGHT SIMULATIONS.

- COMSAT OPERATORS HIRED AND ON-BOARD.

T1 VSAT

- PROBLEMS ENCOUNTERED WITH HPFD'S. M/A-COM AND STEINBRECHER UNITS BEING CORRECTED AND TESTED.

- ENHANCEMENTS BEING WORKED INCLUDE: S/W MOD's, ECHO CANCELLERS, CABLE LENGTH, UPLINK POWER LEVELING, AND UPLINK/DOWNLINK ATTENUATORS.

HIGH DATA RATE

- MOTOROLA/BBN CONTRACTED TO DEVELOP (622 MBPS MAX THROUGHPUT).

- CDR HELD 04/28-29/93 AT BBN.

- DELIVERY OF OPERATIONAL TERMINALS IS 08/94 (QUANTITY = 5).

EARTH STATION STATUS, cont.

USAT

- DELIVERY OF OPERATIONAL TERMINALS IS 08/94 (QUANTITY = 5).
- PRODELIN SELECTED AS ANTENNA SUPPLIER.
- ALL CRITICAL H/W ORDERED; PROJECT ON SCHEDULE & WITHIN BUDGET.

AMT/AERO

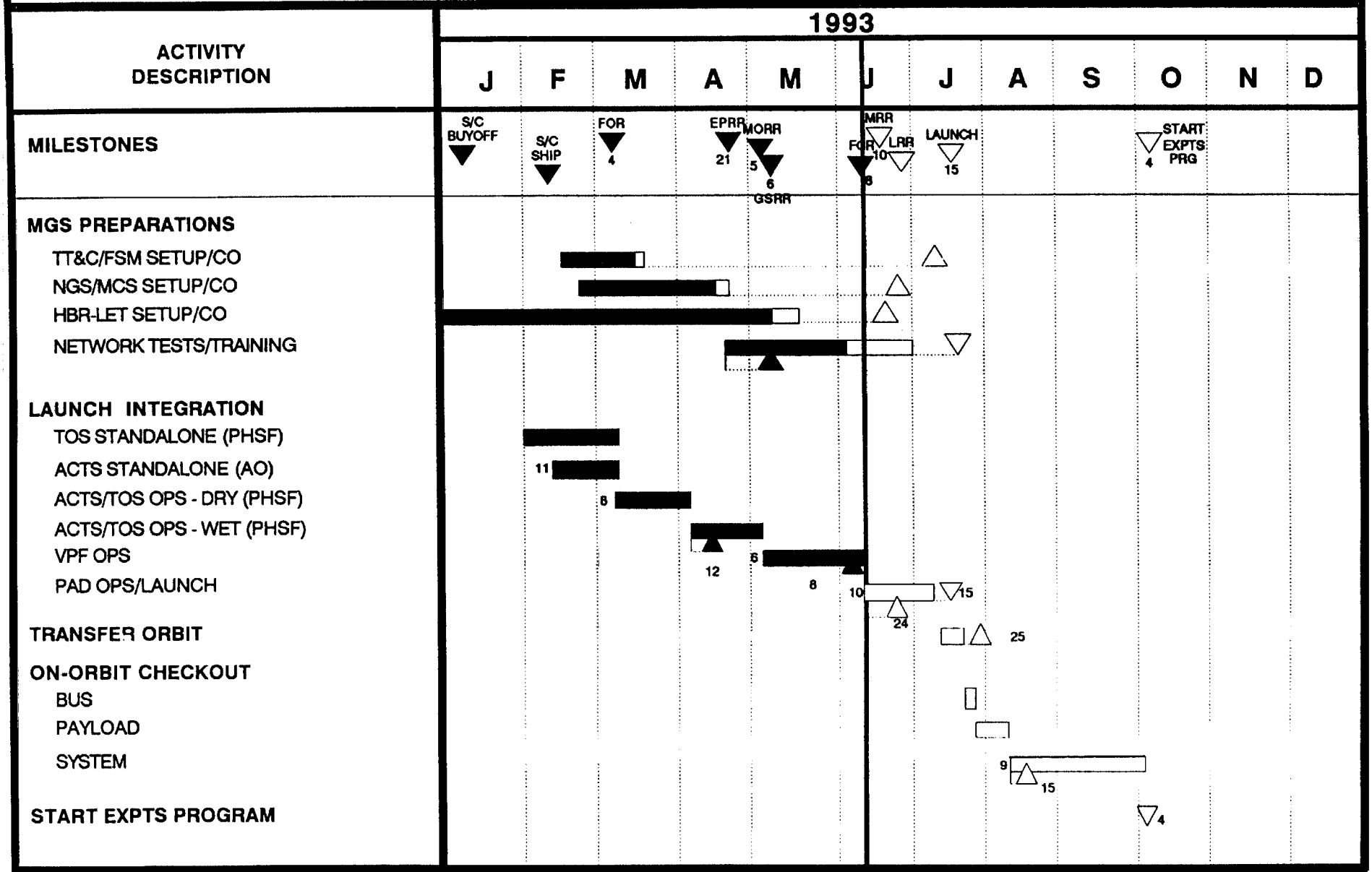
- AMT ON SCHEDULE TO BEGIN EXPTS. IN 10/93.
- AERO EXPT. TO BEGIN 03/94

ACTS
LeRC Current Assessment

BASELINE: TBD

STATUS : 6/08/93

PREPARED BY: COOK/BEZNOSKA



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July 1993

ACTS On-Orbit Checkout Plan

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15 ACTS LAUNCH	16	17 TRANSFER ORBIT INJECTION
18	19	20	21	22	23	24
	DRIFT ORBIT					
25	26	27	28 3 AXIS STABILIZED	29	30	31
DRIFT ORBIT			S/C BUS TESTS			

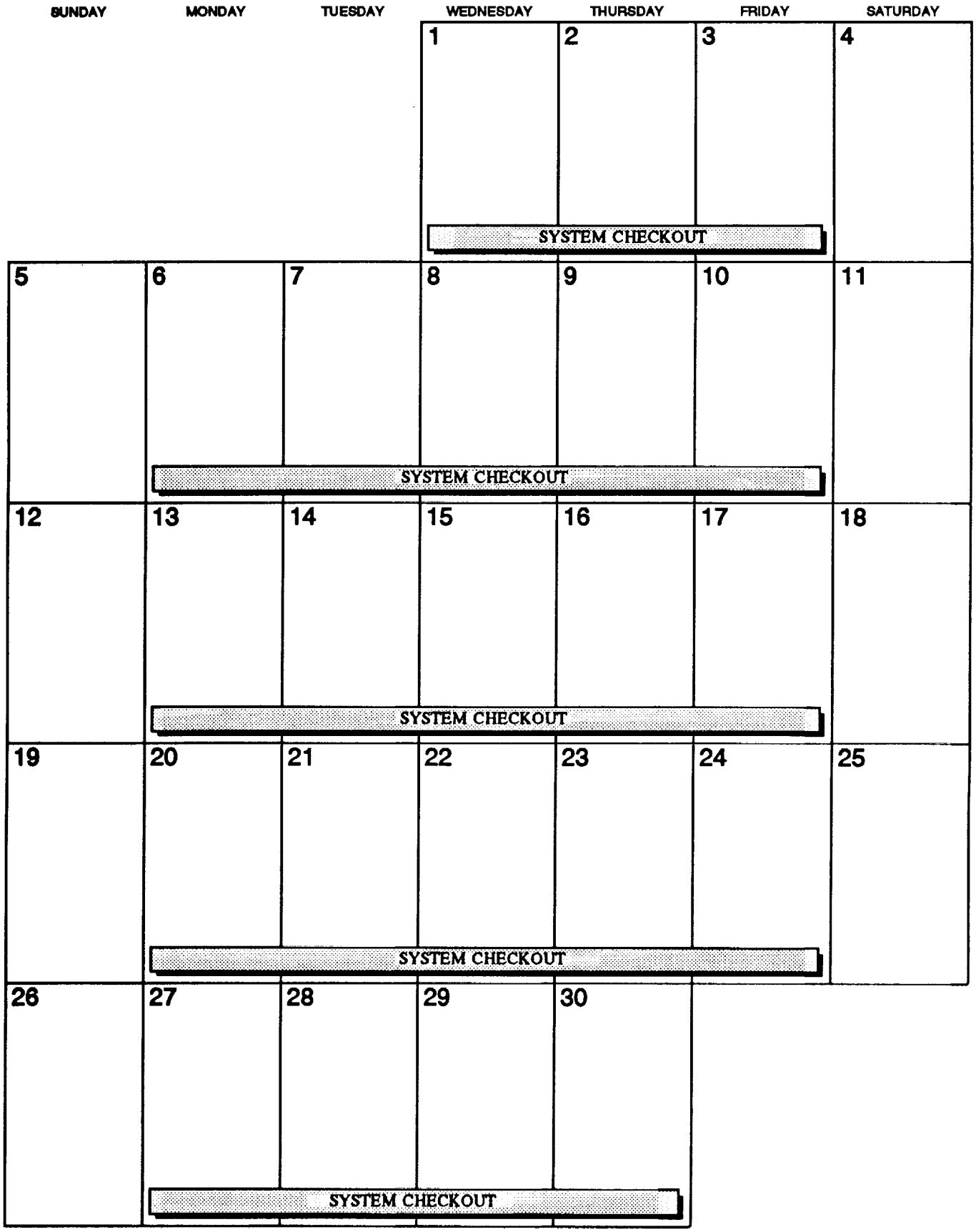
August 1993

ACTS On-Orbit Checkout Plan

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
1	2	3	4 PAYLOAD CHECKOUT (MCP TURN-ON)	5	6	7 **KBT, UFB TURN-ON (ESTIMATE)**
			PAYLOAD CHECKOUT			
S/C BUS TESTS						
8	9	10	11	12	13 BEGIN SYSTEM CHECKOUT (RTE turn-on)	14
PAYLOAD CHECKOUT						
S/C BUS TESTS						
15	16	17	18	19	20	21
	SYSTEM CHECKOUT					
22	23	24	25	26	27	28
	SYSTEM CHECKOUT					
29	30	31				
	SYSTEM CHECKOUT					

September 1993

ACTS On-Orbit Checkout Plan



October 1993

ACTS On-Orbit Checkout Plan

SUNDAY	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY	SATURDAY
					1 SYSTEM CHECKOUT	2
3	4 EXPERIMENTS PERIOD BEGINS	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

ACTION ITEM RESPONSE

TOPIC: NASA's PLANS TO DISSEMINATE SATELLITE MANEUVERS, EPHEMERIS, AND UNUSUAL EVENTS (ACTS BULLETINS)

ASSIGNED TO: ROBERT BAUER, NASA LEWIS

ACTION TAKEN:

- Topic was discussed at ACTS Operations Working Group session based on example provided by T. Pratt from Olympus program to determine what information MMAS can provide and how often.
  - Description of S/C maneuvers and list of S/C position information that is to be provided is enclosed.
  - S/C position information updated after each maneuver (~ 1/wk) with refined post-maneuver data.
  - All unusual events and events impacting experiments will be posted.
  - *NOT PROVIDED* - Antenna pointing data for each site.

- Bulletin Board Status
  - System to be implemented by Computer Services Division at Lewis; ACTS Experiments Office to be system administrator.
  - INTERNET access.
  - Will have interactive and read-only applications.
  - To be used as primary communication tool for routine information to all experimenters.
  - Requirements drafted; estimate is to have e-mail list on-line by July 9.
  - Back-up position: If system unavailable by beginning of ACTS beacon turn-on, information will be fax'd to experimenters.

PROPOSE: S/C information be E-mailed directly to all propagation experimenters (or to one name/site).
Create a propagation distribution list.
NEED: INTERNET addresses and FAX numbers for all propagation experimenters.

ACTS ORBIT & ATTITUDE CONTROL OPERATIONS

Procedures

Contained in S/C Operating Instruction SOI-ACTS-A-01, Attitude Control Operations.

ACTS S/C Analyst generates maneuver schedules and maneuver parameters.

ASOC off-line computer supports all operations.

- Stationkeeping
- Ranging
- Momentum Unloading
- Yaw Control
- S/C Offset Pointing

Stationkeeping

Goal is to do N/S maneuver on weekends for minimum experiment impact but E/W maneuver may be necessary during week.

Notify experimenters of possible pointing degradation due to attitude disturbances during maneuver.

North/South

Maintains inclination within +/-0.05° box.
Expect 3 to 4 week intervals with 0.01° margin.

Execute near ascending node per orbit determination for minimum fuel usage.

Plan primary and alternate day (Sat & Sun).

Maneuver duration expected to be < 2 hours.

N/S Coupling to E/W

E/W drift correction (if necessary) at least two days after N/S.

East/West

Drift correction maintains longitude within +/-0.05° box.

Expected at 11 to 14 day intervals for 0.01° margin.

Execution time (~apogee/perigee) depends on eccentricity.

Maneuver duration expected < 1/2 hour (small disturbance).

Eccentricity Control

Second half of E/W, 12 hours later (apogee/perigee) if required.

Ranging

Done before and after maneuvers for orbit determination.

Done hourly from 5-15 minutes past hour over 24-48 hours.

Transparent to experiment operations.

Typical Stationkeeping Timeline (ASOC activities)

M- 21 days	Distribute schedule with approx. S/K times
M- 3 days	Activate Ranging to update ephemeris
M- 1 day	S/C Analyst generates final N/S maneuver parameters based on most recent OD
M- 1 hr	Turn-on RMAs to warm up Enable thrusters to warm up cat bed heaters Upload parameters to ASP 1 Enable S/K APEMAC Request NGS load CRG for abort cmds
M- 5 min	Activate Gyro Bias Estimator
M- 0	Activate maneuver (~1/2 hr before asc. node) N/S Coarse Mode Send maneuver run cmds to reset backup timer
M+ 1 hr	Switch to N/S Fine Mode to reduce disturbances
M+ 90 min	Terminate maneuver Disable thrusters and RMAs
M+ 2 hrs	Activate Ranging to confirm maneuver performance
M+ 2 days	S/C Analyst determines day/time for next E/W maneuver and generates final maneuver parameters based on orbit determination

E/W maneuver and subsequent stationkeeping operations over life of mission follow similar two day timeline.

Optimization of maneuvers and evaluation of orbit and attitude disturbances expected to improve as S/C Analyst gains familiarity with S/C characteristics.

Momentum Unloading

Required every 5-7 days to control MWA speed.

Expected Wednesday night and/or weekends to maintain margin on wheel speed. Can be combined with stationkeeping.

APEMAC enabled/disabled by command.
Manual mode is backup.

Expected to be transparent to experiments due to small thruster pulses.

Yaw Control

Ephemeris upload required at least weekly to ASP RAM.

Planned for Sunday (after S/K).
Transparent to experiment but prudent to avoid LET-MSM configuration periods or BFN/MSM initialization.

S/C Analyst generates ephemeris in ASOC Off-line computer with output reformatted for hex commands.

S/C Analyst checks coefficients for continuity.

Operator uploads files to ASP 1 (approx. 1 hr) before first new window.

ASP upload verified by dump of ASP 1 before first new window.

Modifications to Estimator Table handled same way if required based on On-orbit Checkout evaluation.

S/C Pointing (for MBA optimization and characterization)

Commands provide static pitch or roll offset to Autotrack or ESA by biasing the zero attitude reference in 0.005° steps.

Pitch offset (ATR/ESA bias) commands sent at approx. one minute intervals for immediate stable offset.

Roll offset requires MTA or MWA pivot and ATR/ESA bias and will cause nutation. MBA requirements needed to define details.

Variable offsets can be loaded into 24 hour ASP table with six minute intervals.

Temporary pitch/roll offset may require yaw ephemeris correction for one or both windows.

print:all notebookRUNNING VTVM1.....RUNNING VTVM1Resent-
From: OPEX@ESTEC
To: FUBDPT1@ITCASPUR,
JBELSHAW@ESTEC
Subject: NO SUBJECT
Date: Thu, 10 16 11:46 EDT ← October 16, 1992
Comment: Converted PROFS message

From: OPEX Coordinator (XEP)
----------Original Message----------
To: BARBESSE--ESTEC JBELSHAW--ESTEC
OPEX --ESTEC

FROM: M LOMBARDO - OLYMPUS MOM / F D'AMORE - OLYMPUS OOM
TO : J BELSHAW, B ARBESSER-RASTBURG, XEP ESTEC(OPEX) ← Olympus Propagation Experiment
INFO:

SUBJECT: OPEX; OLYMPUS EXPERIMENTERS ANTENNA POINTING FIT

ORBITAL PARAMETERS

ORBITAL ELEMENTS IN PEPSOC SYSTEM
SEMI MAJOR AXIS (KM) = 42165.401077
ECCENTRICITY = .000214
DECLINATION (DEG) = .451978
ASCENDING NODE (DEG) = 84.056627
ARG. OF PERIGEE (DEG) = 54.240946
TRUE ANOMALY (DEG) = 226.471957

STATE VECTOR IN PEPSOC SYSTEM
X - COMPONENT (KM) = 42024.301143
Y - COMPONENT (KM) = 3506.614390
Z - COMPONENT (KM) = -326.869435
X - COMPONENT (KM/SEC) = -.256068
Y - COMPONENT (KM/SEC) = 3.063475
Z - COMPONENT (KM/SEC) = .004512

SUBSATELLITE POINT
LONGITUDE (EAST,DEG) = -19.002
LATITUDE (NORTH,DEG) = -.444

EPOCH (UT) = 1992/10/15 AT 0: 0: 0

This information to be provided by GE ~ weekly.

ANTENNA POINTING DATA

START DATE (=REF. TIME) 1992/10/15 AT 0
END DATE 1992/10/20 AT 23

STATION		CONSTANT	LINEAR	SINUS	COSINUS
RAZ	AZ	223.1934	-.0078	.0704	-.2430
	EL	26.3918	.0038	.0740	-.4351
LESSIVE	AZ	210.3816	-.0085	.0575	-.1670
	EL	28.0500	.0027	.0832	-.4652
LOUVAIN	AZ	209.4821	-.0035	.0562	-.1600

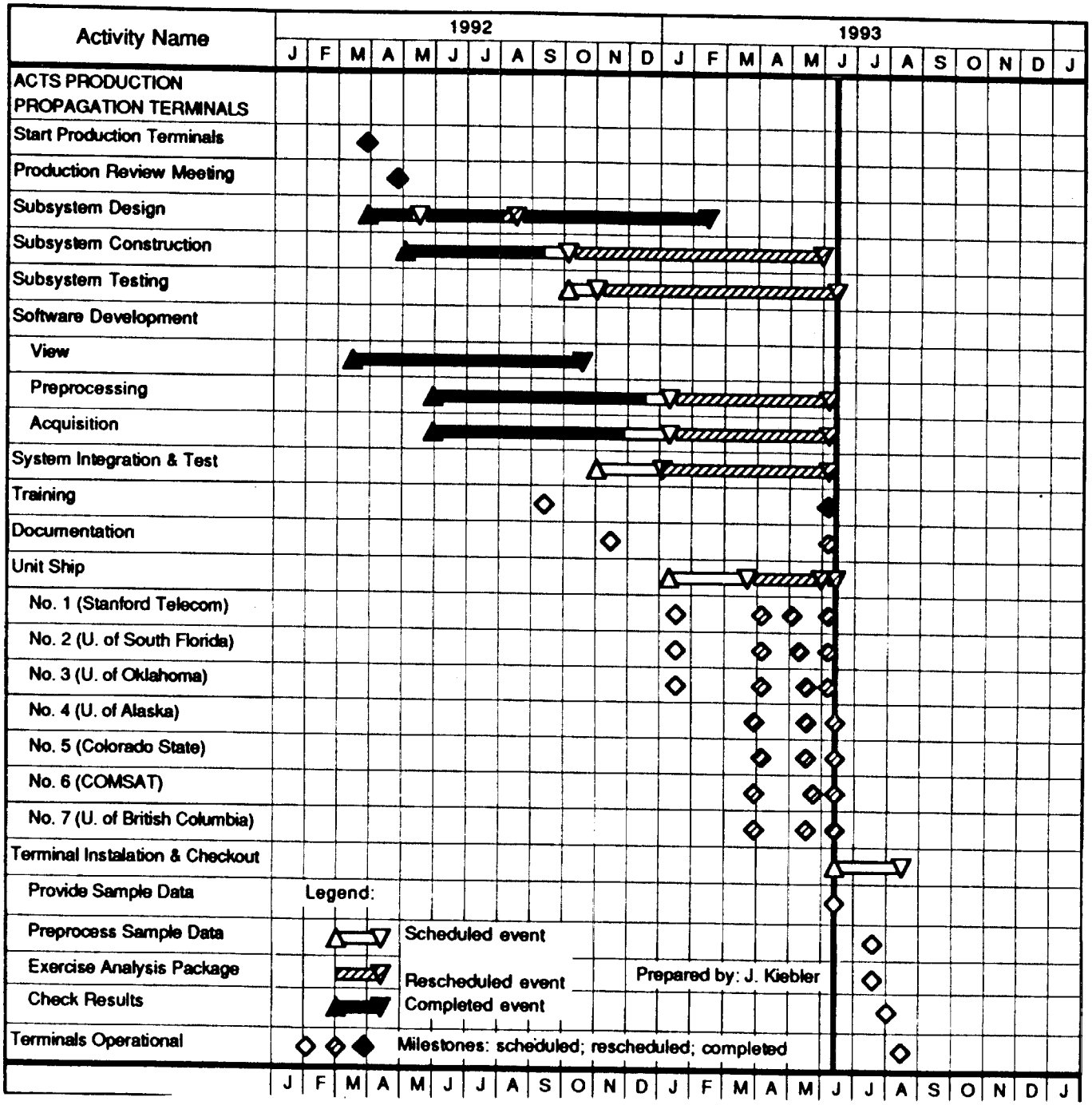
Drift SINE COSINE

ACTS Propagation Experiments: Status

- Class I experiment contracts in place
  - University of Alaska
  - Colorado State University
  - COMSAT Laboratories
  - University of Oklahoma
  - University of South Florida
  - Stanford Telecommunications
- Class I experiment contracts pending
  - Florida Atlantic University
- Class I experiment agreement
  - University of British Columbia
  - Agreement signed by NASA; Awaiting concurrence by Canadian Department of Communications

ACTS Propagation Experiments: Status (Cont.)

- Class II experiment contracts in place
  - COMSAT Laboratories
  - Johns Hopkins University
  - University of Texas
- Class II experiment contracts pending
  - Georgia Tech Research Institute
- Other propagation experiments
  - Agreement to formalize Teleglobe Canada experiment being drafted by DOC


Activity Name
1992
1993
J F M A M J J A S O N D J F M A M J J A S O N D J
ACTS PRODUCTION PROPAGATION TERMINALS
Start Production Terminals
Production Review Meeting
Subsystem Design
Subsystem Construction
Subsystem Testing
Software Development
View
Preprocessing
Acquisition
System Integration & Test
Training
Documentation
Unit Ship
No. 1 (Stanford Telecom)
No. 2 (U. of South Florida)
No. 3 (U. of Oklahoma)
No. 4 (U. of Alaska)
No. 5 (Colorado State)
No. 6 (COMSAT)
No. 7 (U. of British Columbia)
Terminal Instalation & Checkout
Provide Sample Data
Preprocess Sample Data
Exercise Analysis Package
Check Results
Terminals Operational
Legend:
Scheduled event
Rescheduled event
Completed event
Milestones: scheduled; rescheduled; completed
Prepared by: J. Kiebler