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OBSERVATIONS ON THE NASA PROPAGATION PROGRAM

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ABSTRACT--Several personal observations are offered on the NASA Propagation Program.

1. INTRODUCTION

The Science Review of the NASA Propagation Program held in September 1986 resulted in 14 Principal Recommendations. Current activities of the program reveal that the recommendations have in the main been successfully implemented and the program has evolved beyond conditions prevailing at the time of the review. A personal assessment of the current program is offered here.

2. OBSERVATIONS

The activities reflected in presentations at NAPEX XVI and the associated ACTS Miniworkshop reveal a vigorous and broadly-based program focused on problems of current interest to the propagation and satellite-user communities. Participation by attendees from several foreign countries and other U.S. national organizations show that cooperative efforts and active monitoring of foreign propagation activities are being successfully pursued to the benefit of the program. In the time since the Science Review of the NASA Propagation Program (Booker et al., 1987), the recommendations of the Review Panel have generally been addressed successfully within program constraints.

Not all recommendations were pursued to the same degree (nor deserved to be). The Panel understood that it was NASA's duty to address the recommendations as appropriate within funding and other constraints to promote program goals. Some recommendations became obsolete (e.g., the suggestion to investigate possible ACTS optical experiments became moot when the laser communications package was deleted from the spacecraft). In some areas, the program has had quite visible benefits, such as recent application of land mobile-satellite measurement results in deliberations on radio spectrum allocations at WARC'92.

The level of attention in the case of Recommendation 7, which encouraged increased study of intersystem interference caused by precipitation scatter and other mechanisms, might be questioned. Though perhaps not so critical for the distributions of terminals characteristic of present systems, interference theoretically is the ultimate limiting factor to deployment of communication systems using the radio spectrum. The Panel concluded that NASA's previous pioneering investigations of interference (in preparation for the 1979 WARC) should be reviewed and updated.

In hindsight, this opinion was substantiated by the creation in 1990 of Task Group 3 of CCIR Study Group 12, charged with a comprehensive review of procedures for calculating coordination area in Appendix 28 of the Radio Regulations, and proposing modifications thereto. TG 12-3 has recently concluded its work on Appendix 28, perhaps without benefit of sufficient propagation information (a notable exception being results supplied for W. Europe from the COST 210 project). However, the motivation for the updating of Appendix 28 as well as the bases for revisions appear to have been more political and commercial than technical, with substantial

reliance on practical systems experience over the past 20 years. The lack of broader-based propagation data for interference applications does not seem to have had major negative consequences, at least that are apparent at present.

3. CURRENT PROGRAM

Recently the propagation program has focused less on UHF/L-band frequencies used by Land Mobile-Satellite Services, and more on propagation at Ka-band and higher frequencies, akin to NASA's original propagation research interests. Redirection is of course impelled by the impending launch of NASA's 30/20-GHz Advanced Communications Technology Satellite (ACTS), and is consistent with current trends in satellite communication systems. NASA/JPL preparations for propagation measurements with ACTS are well under way, preceded by substantial and valuable equipment development and measurement phases with the Olympus satellite.

The current program covers a broad array of studies: K-band propagation addressing emerging requirements (low-margin systems, adaptive mitigation); satellite sound broadcasting at L-band with plans for S-band measurements; areal rainfall features; EHF radiometric studies of cloud attenuation; continuing development of handbooks, including the recent publication of NASA Reference Publication 1274 for LMSS systems; and planning for investigations of K-band mobile propagation (with ACTS) and LEO satellite systems. The participation at NAPEX XV and the ACTS Miniworkshop confirms the recommended national and international cooperation.

I am impressed with the current activities of the Propagation Program. In consideration of the small budget, I think the program achievements are in fact rather remarkable.

REFERENCE

1. H.G. Booker, G. Brussaard, K.S. McCormick, and D.V. Rogers, "Science Review of the NASA Radio Propagation Program," *Report STC-2127*, Science & Technology Corporation, Hampton, Virginia, February 1987.



**ADVANCED COMMUNICATIONS
TECHNOLOGY SATELLITE
PROPAGATION STUDIES MINIWORKSHOP**

Chairman:

Faramaz Davarian

Jet Propulsion Laboratory



**STATUS OF ACTS PROPAGATION EXPERIMENTS AND EXPERIMENTER
SELECTION**

JOHN KIEBLER

- * 31 PROPOSALS FOR PROPAGATION EXPERIMENTS WERE RECEIVED**
- * PROPOSAL EVALUATION HAS BEEN COMPLETED**
- * 7 CLASS I EXPERIMENTS SELECTED FOR CONTRACT NEGOTIATION**
- * 2 CLASS II EXPERIMENTS SELECTED FOR CONTRACT NEGOTIATION**
- * 2 ADDITIONAL CLASS II EXPERIMENTS SELECTED CONTINGENT
UPON AVAILABLE FUNDING**

CLASS 1 EXPERIMENTS

- * UNIVERSITY OF BRITISH COLUMBIA
 - ACTS Ka-BAND PROPAGATION MEASUREMENTS IN A WEST COAST MARITIME CLIMATE
- * COLORADO STATE UNIVERSITY
 - Ka-BAND PROPAGATION STUDIES USING ACTS PROPAGATION TERMINAL AND THE CSU-CHILL MULTIPARAMETER, DOPPLER RADAR
- * UNIVERSITY OF ALASKA, FAIRBANKS
 - ACTS PROPAGATION MEASUREMENTS IN ALASKA
- * COMSAT LABORATORIES
 - ACTS UPLINK TRANSMIT POWER CONTROL MEASUREMENT EXPERIMENT
 - Ka-BAND PROPAGATION MEASUREMENTS EXPERIMENT USING ACTS SPACECRAFT

CLASS I EXPERIMENTS (CONTINUED)

- * STANFORD TELECOMMUNICATIONS, INC.**
 - A PROPOSAL FOR ACTS PROPAGATION EXPERIMENTS**
- * UNIVERSITY OF OKLAHOMA**
 - RAIN ATTENUATION STATISTICS FOR THE ACTS PROPAGATION
EXPERIMENT FOR CENTRAL OKLAHOMA**
- * UNIVERSITY OF SOUTH FLORIDA/FLORIDA ATLANTIC UNIVERSITY**
 - PROPAGATION MEASUREMENTS USING ACTS**

CLASS II EXPERIMENTS

*** JOHNS HOPKINS UNIVERSITY, APPLIED PHYSICS LABORATORY/
UNIVERSITY OF TEXAS, AUSTIN**

**- LAND-MOBILE-SATELLITE MEASUREMENTS IN CENTRAL
MARYLAND AND ALASKA USING ACTS: PASSIVE ANTENNA
TRACKING SYSTEM AND MOBILE RECEIVER SYSTEM**

*** COMSAT LABORATORIES**

- ACTS WIDE AREA DIVERSITY EXPERIMENT

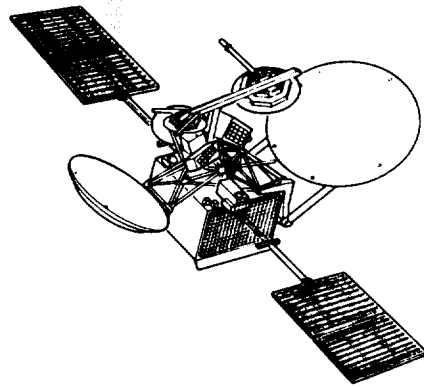
*** FLORIDA ATLANTIC UNIVERSITY**

- MODULATION AND CODING MEASUREMENTS USING ACTS

*** GEORGIA TECH RESEARCH CORPORATION**

**- RF PROPAGATION EFFECTS AND ACTS SATELLITE CHANNEL
CHARACTERIZATION FOR VERY SMALL APERTURE TERMINALS**

**ADVANCED
COMMUNICATIONS
TECHNOLOGY
SATELLITE (ACTS) PROGRAM**



**ROBERT BAUER
NASA LEWIS RESEARCH CENTER**

ACTS PROJECT UPDATE

**NAPEX XVI/ACTS PROPAGATION
MINI-WORKSHOP
HOUSTON, TX
05/30/92**

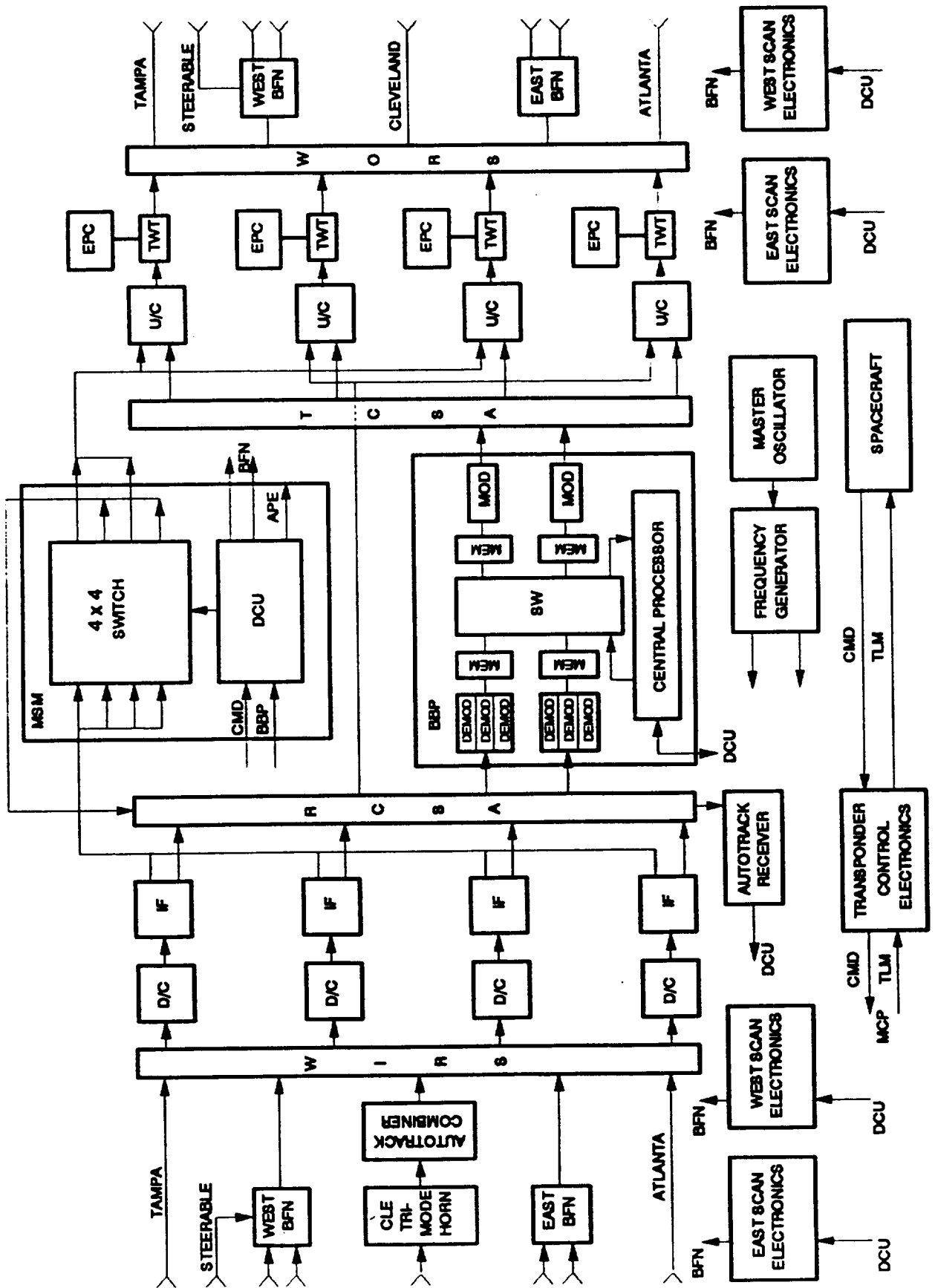
ACTS

NASA

SPACECRAFT STATUS

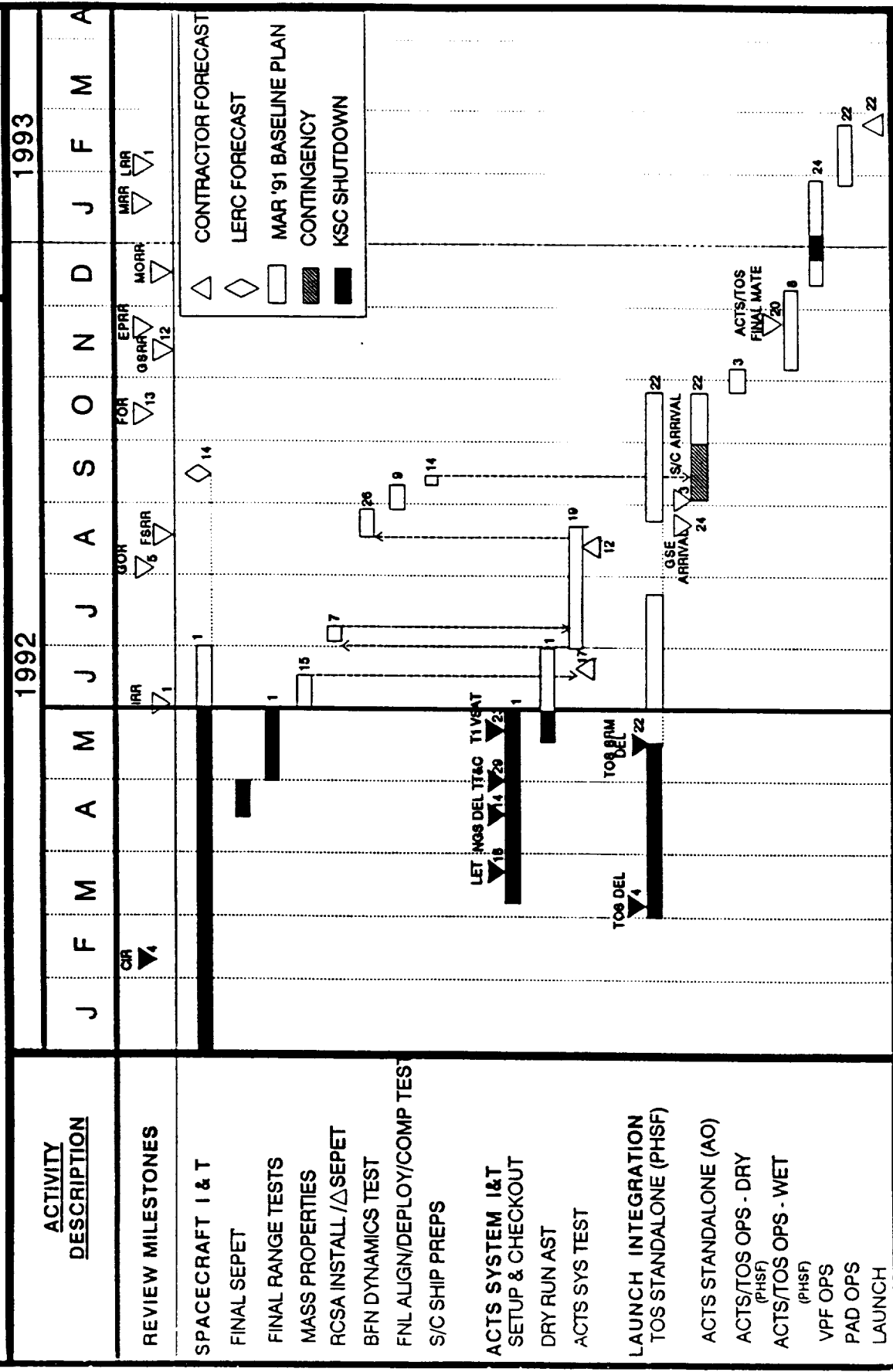
- THERMAL VACUUM TESTS COMPLETED ON JANUARY 31, 1992.
- CAUSE OF RECEIVE COAX SWITCH ASSEMBLY (RCSA) FAILURE IDENTIFIED AND CORRECTED.
- SPACECRAFT SHIP DATE TO KSC IS SEPTEMBER 2, 1992.
- LAUNCH DATE HOLDS AT FEBRUARY 22, 1992!
 - MANIFEST FOR STS-51
 - PAYLOAD BAY SHARED WITH ORFEUS-SPAS
 - UVPI = ULTRA-VIOLET PLUME IMAGER

COMMUNICATIONS ELECTRONIC PACKAGE (CEP)

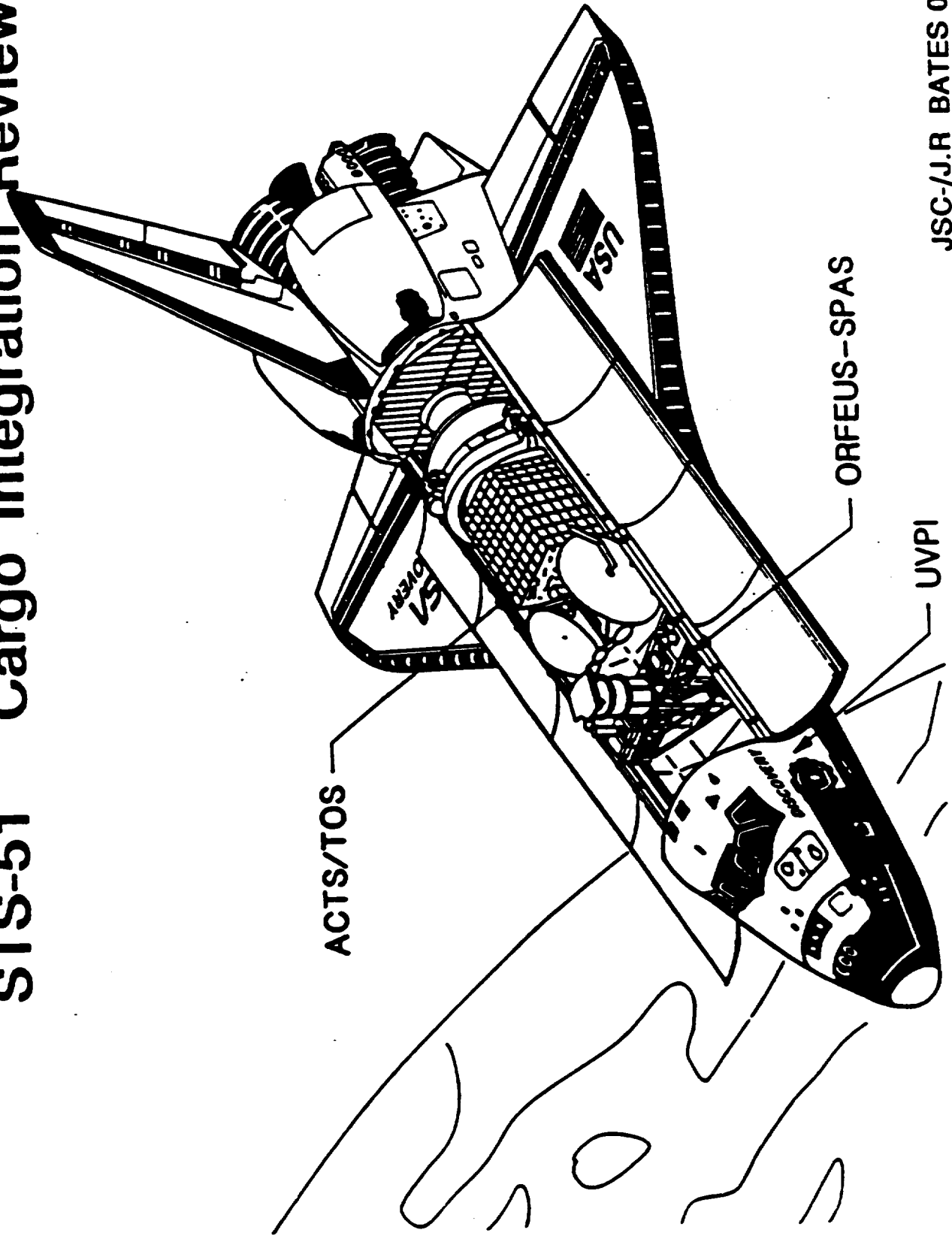


BASELINE: 3/21/91
 REV5: 5/1/92
 STATUS: 6/1/92
 PREPARED BY: B. BEZNOŠKA

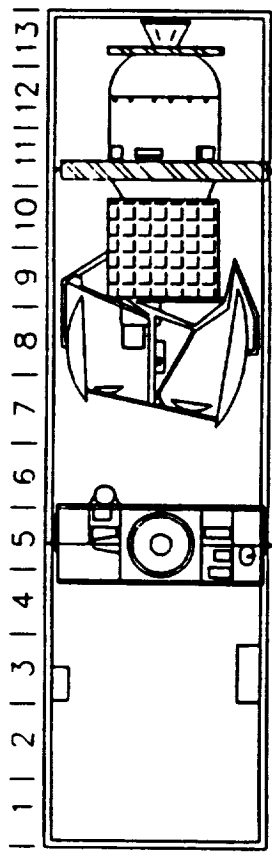
ACTS LERC CURRENT ASSESSMENT



STS-51 Cargo Integration Review

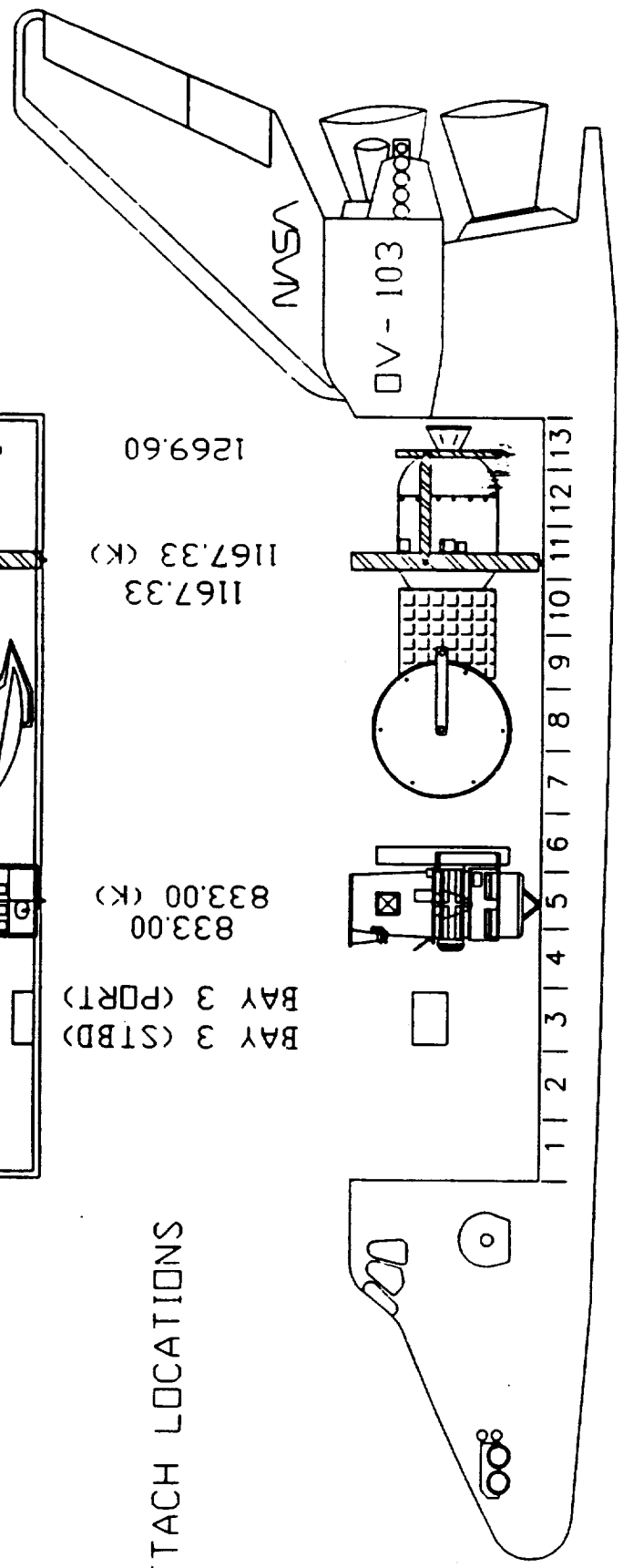


JSC-/J.R BATES 02/07/92



BAY 3 (STBD)
 BAY 3 (PORT)
 833.00 (K)
 833.00 (K)
 1167.33 (K)
 1167.33 (K)
 1269.60

ATTACH LOCATIONS



PAYLOADS
 ERPCL
 ORFEUS-SPAS
 EVA TOOLS
 ACTS

STS-51

J. SIDERS/DM22

FLIGHT OVERVIEW

ITEM

LAUNCH DATA:

DATE	FEBRUARY 22, 1993
TIME	11:55 GMT
WINDOW DURATION	11:55 TO 13:46/1HR 51 MIN
SITE/PAD	KSC/B

PROJECTED
CHANGES

FLIGHT DURATION:	8 + 2 DAYS	8 + 1 + 2 DAYS
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CREW:

5

ORBIT DATA:

ALTITUDE (POST OMS-2)	160 NM
INCLINATION	28.45 DEG
BETA ANGLE RANGE (OMS-2 TO EOM + 2)	-12.34 TO 19.97 DEG
WINDOW OPEN	-25.67 TO 14.69 DEG
WINDOW CLOSE	

VEHICLE DATA:

ORBITER	OV-103	
SSME POWER LEVEL	104/104	
NUMBER OF CRYO TANK SETS	4 (FULLY LOADED)	
OMS LOAD	15900 LBS	
FORWARD RCS LOAD	2446	
ORBITER SOFTWARE	OI - 21	
		16200 LBS

DEPLOY/INJECT NODE:

ACTS/TOS	6/7A
PRIMARY	22/23A
BACKUP	

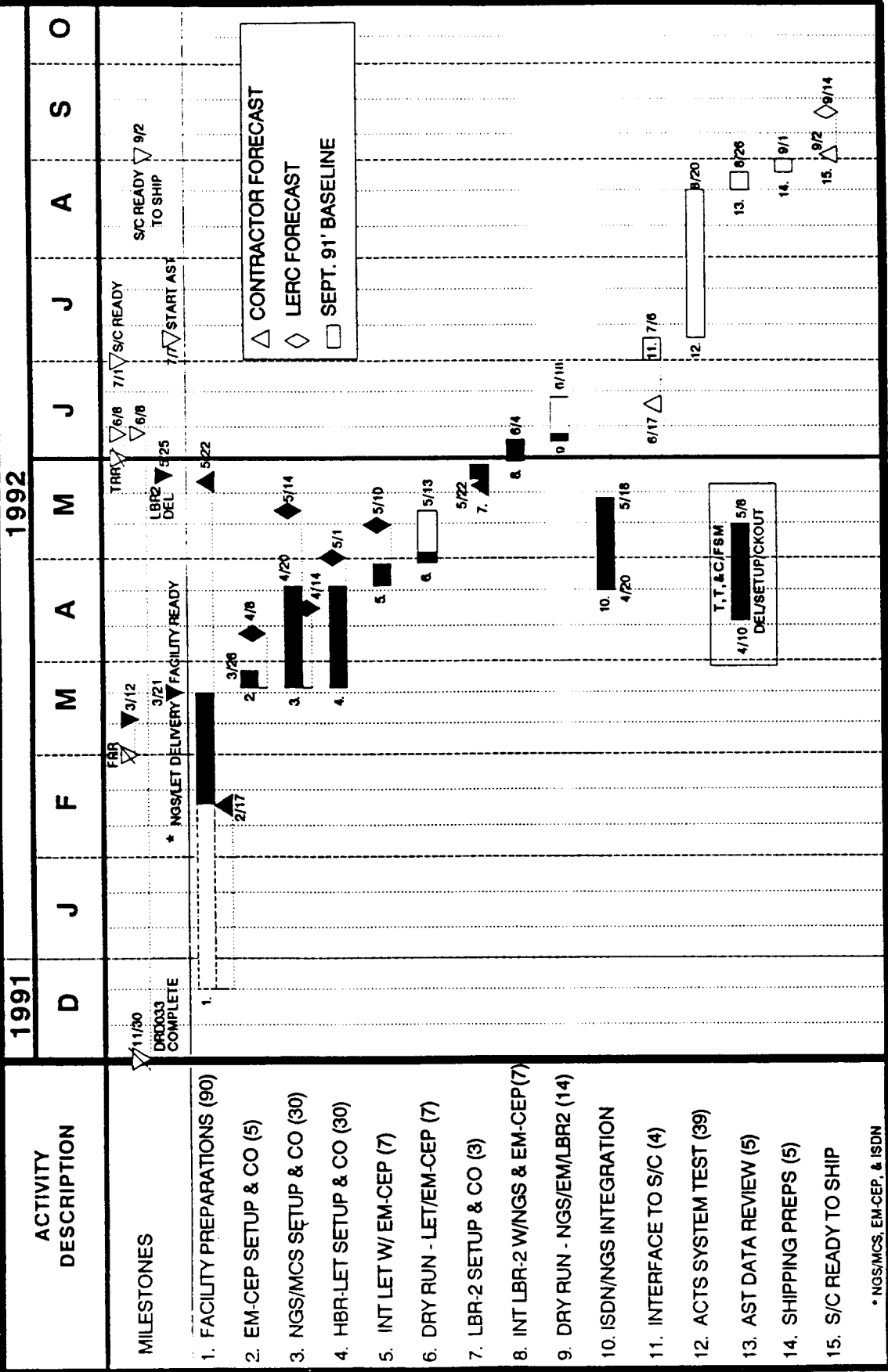
ACTS SYSTEM TEST

- PERFORM PRE-FLIGHT PAYLOAD CHECKOUT OF TESTS TO BE PERFORMED ON-ORBIT.
- NASA GROUND STATION/MASTER CONTROL STATION AND LINK EVALUATION TERMINAL SHIPPED TO GE IN APRIL AND INTEGRATED TO EM-CEP.
- T1 VSAT SHIPPED TO GE IN MAY.
- DRY RUN TESTS HAVE BEGUN.
- INTERFACE TO SPACECRAFT BEGINS JUNE 17, 1992.
- AST TO BE RUN THROUGH AUGUST 20, 1992.

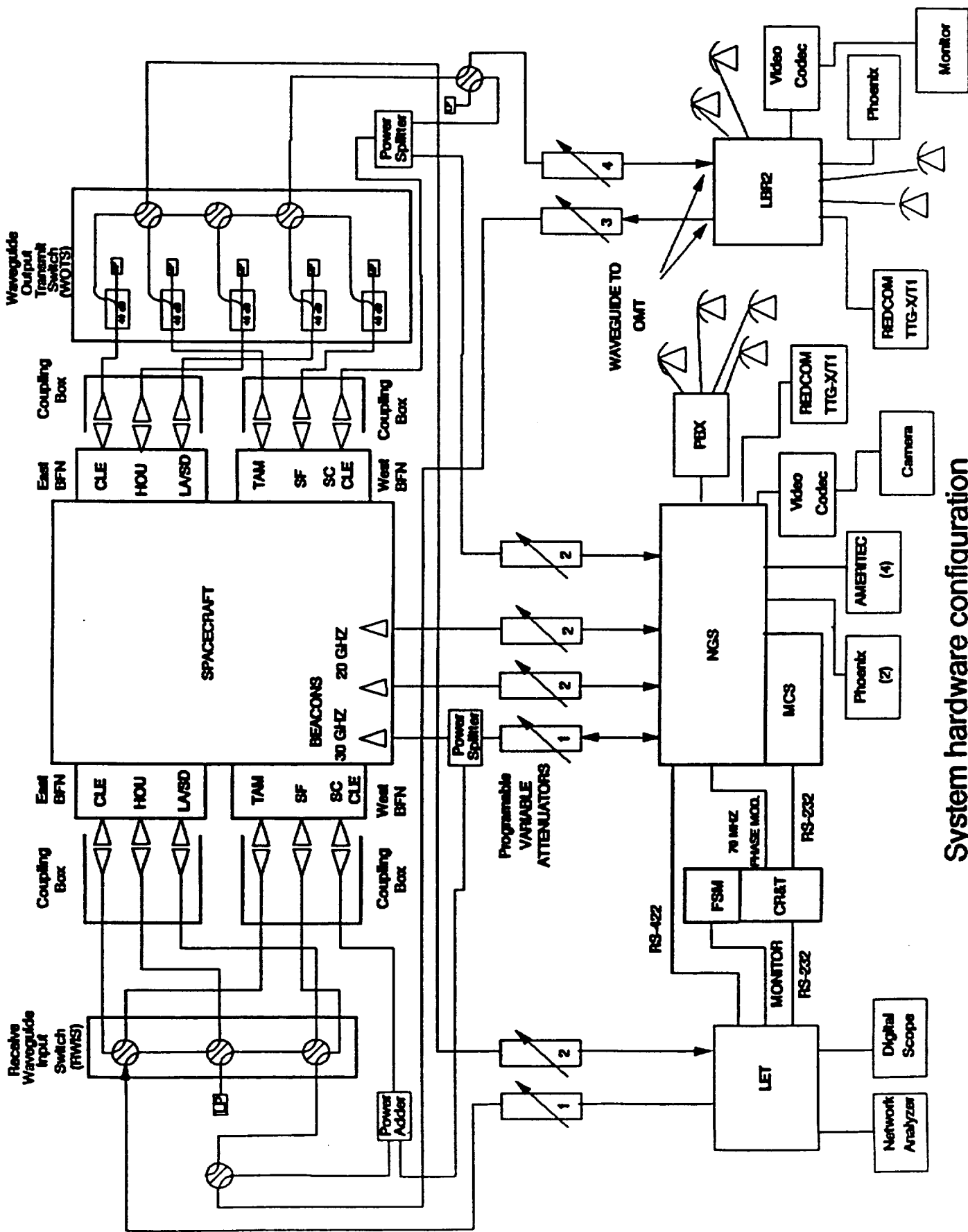
ACTS

SYSTEM INTEGRATION & TEST SCHEDULE

BASELINE DATE: 9/30/91
 REV 2: 3/30/92
 STATUS DATE: 6/1/92
 PREPARED BY: D.W. COOK



* NGS/MCS, EM-CEP, & ISDN
 1. LBR-2 WILL TAKE PRIORITY OVER HBR-LET IF THE LBR-2 PROTOTYPE ARRIVES PRIOR TO 5/25
 2. THE NUMBER IN () FOR ACTIVITIES 1-10, REPRESENTS CALENDAR DAYS. THE NUMBER IN () FOR ACTIVITIES 11-14 REPRESENTS 1-12 HOUR SHIFT WORKING 6 DAYS PER WEEK
 3. NGS/MCS & EM-CEP SLIP DUE TO DELAY IN FURNISHING GFE S/W.



System hardware configuration

EARTH STATION STATUS

- T1 VSAT - ACCEPTANCE TESTING COMPLETE. PROTOTYPE BEING SHIPPED TO GE FOR AST.
- HIGH DATA RATE TERMINAL - DEVELOPER HAS BEEN SELECTED IN RESPONSE TO DARPA BROAD AGENCY ANNOUNCEMENT (BAA). NASA PREPARING FOR NEGOTIATIONS. TERMINAL IS EXPECTED TO BE AVAILABLE IN EARLY '94.
- USAT - SYSTEM STUDY COMPLETE AND INDICATES A KA SYSTEM IS FEASIBLE AND WOULD OFFER ~2X COST SAVINGS OVER CURRENT VSAT TECHNOLOGY (PRIMARILY FOR SCADA APPLICATIONS). SO. CAL EDISON AND NASA WORKING TO DEVELOP DEMONSTRATION SYSTEM AT BOTH KU AND KA BAND.
- NGS - REPLACEMENT MEDIUM POWER AMPLIFIER ORDERED TO CORRECT SPURIOUS SHUT-OFF PROBLEMS. ISDN FULLY INTEGRATED.
- EXPERIMENTER NETWORK SERVICE PROVIDER - WILL PROVIDE SERVICE, INSTALLATION, AND TRANSPORTATION OF T1 VSATS. RFP TO BE RELEASED SOON; AWARD EXPECTED BY DECEMBER, 1992.

SUMMARY OF EXPERIMENTS SUBMITTED

EXPERIMENTS OPPORTUNITY ANNOUNCEMENT (30)

- 50 PROPOSALS RECEIVED.
 - 30 RECOMMENDED TO HQ FOR SELECTION IN APRIL.
 - 20 REQUESTED NASA FUNDING OR PROPAGATION TERMINAL.
- HQ IS PREPARING LETTERS ANNOUNCING SELECTION OR NON-SELECTION.
- INITIAL SPACECRAFT TIME SCHEDULED AND EARTH STATIONS ALLOCATED AS NEEDED. DETAILS TO BE WORKED BETWEEN NASA AND EXPERIMENTER.
- PROPOSALS STILL WELCOMED. FURTHER SUBMITTALS ANTICIPATED AFTER LAUNCH.

TECHNOLOGY VERIFICATION EXPERIMENTS (8)

- 8 INTERNAL NASA ENGINEERING-TYPE EXPERIMENTS.



SUMMARY OF EXPERIMENTS SUBMITTED, CONT.

PROPAGATION (~11)

- NRA 92-LERC-1 "ACTS PROPAGATION IMPLEMENTATION PROGRAM"
 - SELECTION MADE 4/17/92.
 - 7 RECEIVE-ONLY PROPAGATION TERMINALS TO BE ALLOCATED.
 - UP TO 4 OTHER EXPTS. UTILIZING ACTS COMMUNICATIONS CHANNELS.

OTHERS (7)

- NASA ISDN (SUPPORT NATIONAL ISDN USERS FORUM MEETINGS)
- NASA DEMONSTRATIONS
- DARPA - HIGH DATA RATE
- USAT
- AERONAUTICAL (JPL/NASA LERC SED AND APO)
- MARYLAND CENTER FOR THE COMMERCIAL DEVELOPMENT OF SPACE (CCDS)
- GE