MAY 1976

NATIONAL RADIO ASTRONOMY OBSERVATORY

MAY PROJECT REPORT

VLA PROJECT

June 10, 1976

NATIONAL RADIO ASTRONOMY OBSERVATORY

MONTHLY PROGRESS REPORT

VLA PROJECT

MAY 1976

SITE AND WYE

Subcontract VLA-167; Site Warehouse and Maintenance Shop Buildings; Paul D. Goar Construction Company; $147,805

1. All painting and exterior grading of the warehouse and maintenance buildings has been completed. Gutters and downspouts have been installed. Still lacking completion are delivery of main circuit breakers, the toilet room wall heater, and minor electrical work. Both buildings are currently being occupied and utilized by NRAO.

This contract is estimated at 99% complete.

Subcontract VLA-149; Wye Construction; Burn Construction Company, Inc.; $2,913,000

1. Grade beams have been poured at antenna foundations DW-1, DE-7, 8, and 9, DN-6, 7, 8, and 9, and CN-5, 6, 7, 8, and 9. Grade beam forms have been built at CE-6, and steel is in place at DE-4 and CE-6. Rough excavation for grade beams is complete at DE-5, and fine grading at DN-1. Forms for antenna pedestals have been constructed at DW-5 and DE-1.

2. Interchange panels have been assembled for all spurs of the north and east arms. Single track has been laid on the north arm to station 59+52, on the east arm to station 64+20, and on the north/east transition. Spur and interchange track is complete at CW-6. The switches and rail crossing have been installed for the north/east transition and the maintenance vehicle spur.

3. Foundation pads have been poured for transformers TE-2 and 3, TW-1, 2, 3, and 4, and TN-2 through TN-11 including the DN-9 isolating switch. Pedestal receptacles are being roughed-in at CW-6, 7, and 8. Grounding cable is being installed to foundation pedestals and rail.

This contract is estimated at 65% complete.

Subcontract VLA-65; George A. Rutherford, Inc.; $2,395,400

1. Testing and balancing of the Control Building mechanical systems is 80% complete. Minor punch list work is being performed on the

mechanical systems and controls. On May 14, Associated Universities, Inc., took possession of the Control and Cafeteria Buildings, water and sewage systems, roadways, parking lots, and site and wye electrical power.

This contract is estimated at 99.5% complete.

Waveguide signal distributors have been installed beneath the floor of the electronics room and await final testing. The installation of the catwalk in the lab and work area is 50% complete. Some electronics racks have been installed in the digital room of the Control Building. The Centrex telephone system has been completely installed at the Site.

Waveguide runs between DW-7/DW-8 and DW-8/DW-9 have been set to line and grade. Approximately 1100 ft. of the west lead-in trench for the north end of the casing under the swale and running to DW-1 has been cleaned after being flooded.

ANTENNA DIVISION

Progress of work by the Antenna Division during the month of May achieved the following status:

Antenna No. 3

Outfitting on the maintenance pad continued during the month and is essentially complete.

Antenna No. 4

Antenna No. 4 assembly was completed in the assembly building on May 19. The antenna was moved to the master pad for cleanup, final alignment, and acceptance tests. The panel setting RMS was measured to have a RMS value of 0.0113 inches at the 50^{0} position, azimuth lean was measured to be 15 arc second and the alignment of the focal mount to the collimation axis was measured as to have 0.020 inches displacement. Servo tests were under way at end of month and the antenna was approaching acceptance.

Antenna No. 5

The assembly of the pedestal is complete through elevation wheel and axle. Azimuth drives installed. The elevation axle and bearings have been aligned to azimuth axis. The reflector structure is approximately 75% complete. The elevation offset from the azimuth axis was measured to be 0.020 inches as compared to specified limit of 0.100 inches.

Antenna No. 6

Trial assembly has been completed at Hobbs, New Mexico and the various components shipped to Site.

Antenna No. 7

The trial assembly of this antenna is in progress at Hobbs.

The completed focusing feed mounts have been received at the Site for antennas 5 through 10. All azimuth and elevation gear reducers, motor drives and gear segments are on hand for the antennas through unit 10. Modifications to the trucks of the transporter were completed on May 17 by E-Systems and the transporter has been returned to service.

SYSTEM INTEGRATION DIVISION

Three observing runs were conducted this month. A fourth one was scheduled but was lost in its entirety due to problems with the cryogenic system as described in the electronics division section.

Run No. 1

6 h of visibility measurements
1 h of pointing tests on A1
10 h down with DCS problems
23 h down with cryogenics problems

Run No. 2

1 h to bring the system up
2 h down with L.O. problems in modules L7 and L11
22 h pointing with A1
1 h pointing with A2
14 h visibility measurements

Run No. 3 - R. Hejellming observer

2 h to bring the system up
20 h pointing A1 and A2
18 h visibility measurements

Antenna No. 3 outfit was 67% complete at the end of month.

ELECTRONICS DIVISION

Preliminary measurements have been made at 6cm wavelength in the interferometer mode of the receiving system polarization performance. Instrumental cross polarization in linear polarization is at the 1 to 2% level. Cross polarization in circular polarization also appears to be at about the 1% level although more measurements are needed to verify this. There is no pointing difference between the beams for the two linear polarizations but for the two circular polarizations there is a pointing difference of 0.8 arc minutes. This last problem may be due to asymmetric mode generation in the circular polarizer and is under investigation.

The 1.3cm feed and the Front End were mounted on Antenna 3 on 24 May in preparation for the single dish testing. The phase locked L.O. modules for the 1.3cm and 2cm wavelength mixers in front ends 01 and 02 have been received from Charlottesville and are being tested. This will allow interferometry to begin at 1.3 and 2cm. Three 18-21cm upconverters have been returned to AIL because of cracks in the substrate. AIL has agreed that their design is faulty and are working on an improved design. The cryogenics systems on antennas 01 and 02 failed during the observing run of 4 May because the helium used to charge them was contaminated. They were shut down for 12 days while a liquid nitrogen cold trap was obtained to allow purification of the helium. This cold trap should prevent recurrence of this problem. Front End 04 was cooled down for the first time on 24 May and is undergoing final fabrication and testing.

The 20mm waveguide has been installed in Antenna 3 and is being tested. Four rotary joints fabricated by Acoma from NRAO drawings are now being plated and will be tested during the coming month. The waveguide signal distributors have been mounted in the Control Building beneath the W rack locations and are ready for testing with the arrival of a Hitachi engineer on June 21. Monitoring has started on the waveguide run between DW2 and DW9 which was installed using the new installation technique described in the April progress report. Tests show a slight deterioration in straightness but more time is needed to determine if the deformation is significant. On the night of 3 May a flash rainstorm filled the open waveguide trench from the Control Building to the center of the Wye with water. A total of 200 meters of waveguide in four separate pieces was filled with muddy water. This waveguide was flushed with high pressure water then dried with a pull-through and warm air. Mechanically the waveguide does not seem to have been affected, and tests will be made soon to determine the effect on r.f. performance. Development of the sector coupler is progressing. Tests on a model have been made for coupling values of 10 dB, 13 dB, and 16 dB. The 16 dB coupler had an insertion loss of 0.15 dB and operated over the whole band 28-40 GHz. A prototype 16 dB coupler is under construction.

In the L.O.-IF area, the B and W racks for systems 3-6 have been received from Charlottesville. B3 and W3 have been tested and are ready for operation. The IF-L.O. laboratory test system is now in operation. This system allows the test and development of modules independent of the systems used for observation. The development of an interim antenna L.O. Transmitter (L3) module for systems 7 to 10 is progressing. This will replace the previous version which used a frequency multiplier subassembly supplied by an outside vendor but found to be unsatisfactory. Some minor design changes are being completed for testing in modules L4 and L14 to reduce spurious signal levels and increase the acceptable range of signal levels. Building has been completed on a prototype of the new modem and debugging is under way.

All the equipment for the six antenna delay and multiplier systems has been moved into the new Control Building and has been integrated. In the Control-Monitor system the parity error problem has been essentially solved by making changes in the local Buffer and Antenna Buffer. During the observing run of 17 May the parity error rate averaged 91/hour for monitor data and 16/hour for command data.

COMPUTER DIVISION

Asynchronous Subsystem

A major portion of the activities of the Asynchronous Computer Group during May were related to preparation for the move to New Mexico. According to present scheduling the computer system will be dismantled for moving June 14-15 and will arrive at the VLA Site around June 21.

During May the first use of data tapes supplied from the synchronous computer system resulted in some data display and analysis mainly oriented to determing baseline errors. Programs solving for errors in Bx, By and Bz were used to determine baselines from recent test observing runs, and various programs to index, list, and plot data previously placed in the run data based were successfully used.

The initial mapping system from CANDID now include both a direct transform program and an FFT program, with the necessary components for weighting, tapering, and gridding. Most of the improved simulation and subsequent mapping package was completed and this will now be the basis for future, low priority simulation and mapping development.

"Curly-bracketed-expressions", or CBE's, have been extensively used as the major data and parameter selection format in CANDID. Capabilities to store data arrays and retrieve data arrays from CANDID were implemented. Retrieval of rows and section of binary arrays for visibilities and maps for listing, plotting, and analysis were implemented.

Synchronous Subsystem

During May the Synchronous Computer Group resumed its support of interferometer test observing.

In addition, we have implemented a new observing request card format, implemented standard labels on magnetic tapes (necessary for data security) and have begun the modifications necessary to support the new intern correlator (the ten antenna system). The conversion of the system from UTC to IAT based clocks is now complete and working. A preliminary section of a monitor data limit checker is being tested.

PROJECT MANAGEMENT

Purchase orders and subcontracts placed in May 1976 totaled $484,000. Of this total, approximately 200 were purchase orders amounting to $122,000 and subcontracts totaling $362,000 were awarded.

Request for proposal for VLA-211, Wye Communications System, was initiated in May at an estimated price of $250,000.

A subcontract for the take up and shipment of rail at Mare Island Naval Shipyard, McClellan AFB and Torrance Naval Supply Center was also awarded in May 1976. Rail take up is progressing at Crab Orchard, Ill., and has been completed at the three Texas locations.

Preparations have been made for the move of the asynchronous computer and affiliated personnel in Mid-June. Also, the phone service and furnishing of the Control Building to accommodate the new arrivals has been completed.

Personnel

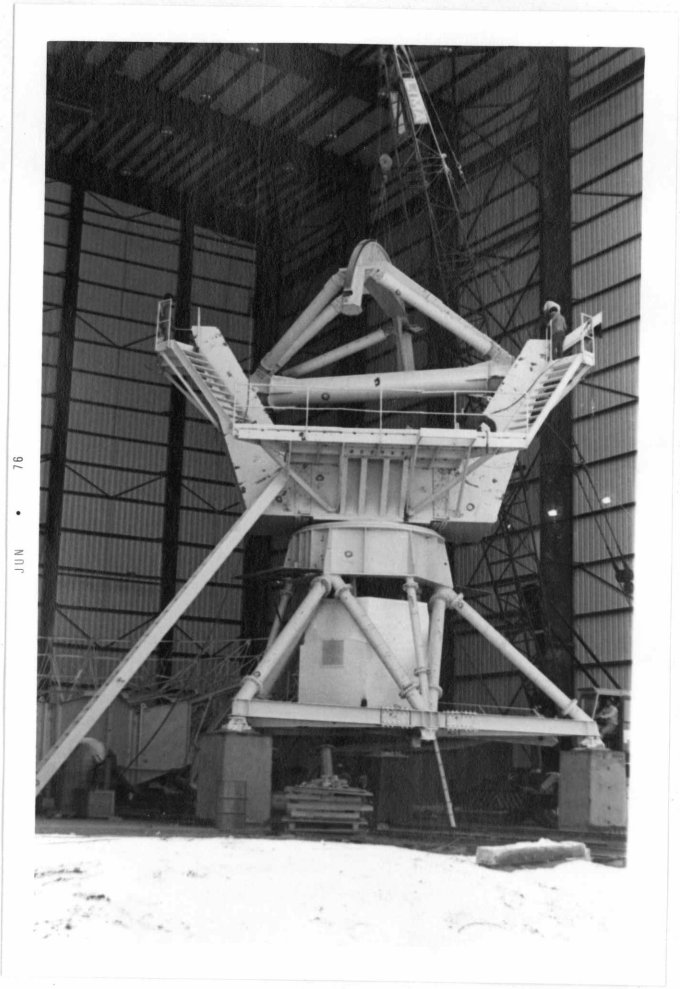
The personnel changes as of May 31, 1976 are as follows:

Division	Previous Level	Additions	Reductions	Current Level
Site and Wye	7	1	0	8
Antenna	9	0	0	9
Electronics	38	0	0	38
Computer	14	0	0	14
System Integration	3	0	0	3
Project Management	21	1	1	21*
TOTALS	92	2	1	93

*Includes one part-time person.

p5-76-1 Assemby of Track at CN9

p5-76-2 East Arm to North Arm Connection



p5-76-3 Antenna No. 5

p5-76-4 Mechanical Equipment Room - Control Building

VLA PROJECT
MAJOR SUBCONTRACTS AND PURCHASE ORDERS PLACED

NUMBER P.O. SUBCONTRACT	VENDOR	ITEM DESCRIPITON	DATE PLACED	DOLLAR AMOUNT	DELIVERY DATE	CURRENT STATUS - ALL FIRM FIXED PRICE CONTRACTS EXCEPT WHERE NOTED
VLA-5	BWH/CVR Joint Venture	E/A Title I and II	6/17/73	$ 1,028,269		Title I - Completed Title II - Completed Title III - Work in progress in conjunction with VLA-65 and VLA-149. Fixed price plus cost reimbursables.
VLA-6	E-Systems, Inc.	28 Radio Telescopes	10/18/73	$17,549,422	3/1/77	NRAO has taken possession of Antenna Nos. 1, 2, and 3. We should take possession of Antenna No. 4 on week of 6/2/76.
VLA-14	Comtech Lab., Inc.	Parametric Amplifiers	3/13/74	$ 221,000	7/15/75	10 each additional parametric amplifiers purchased on Amendment No. 1. Nine units have been received.
VLA-29	Sterling-Detroit	Focusing Feed Mounts	6/17/74	$ 328,582	8/15/76	Sterling Mount for Antennas No, 3 through No. 10 have been received and are being outfitted. Order is complete.
VLA-44	Digital-Equip. Corporation	Asynchronous Computer	6/17/74	$ 1,006,869	2/15/75	FFT did not pass acceptance tests and this portion of the order may be cancelled.
VLA-53	R. F. System	K and Ku Band Feed Horns	1/26/76	$ 73,776	4/15/76 5/24/76	K Band Feeds for Antennas 3 through 6 will be shipped by 6/7/76. Ku Band Feeds will all be shipped by 7/19/76.
VLA-65	Geo. A. Rutherford Inc.	Site Construction Phase II	12/16/74	$ 2,395,400	6/1/76	Work is essentially complete.
VLA-70 P.O. 52322	Sumitomo Electric USA, Inc.	4373 pieces of waveguide 4480 each coupling sleeves	1/27/75	$ 1,446,634	12/31/76	2313 pieces of waveguide and 2350 coupling sleeves have been received. Amendment No. 3 has been accepted by vendor.
VLA-72 P.O. 52432	Hitachi Shibaden Corp. of America	3 ea. waveguide signal distributors	2/7/75	$ 230,000	12/15/75	Units have been installed at VLA Site. Due for final acceptance in June 1976.

VLA PROJECT
MAJOR SUBCONTRACTS AND PURCHASE ORDERS PLACED

NUMBER P.O. SUBCONTRACT	VENDOR	ITEM DESCRIPITON	DATE PLACED	DOLLAR AMOUNT	DELIVERY DATE	CURRENT STATUS - ALL FIRM FIXED PRICE CONTRACTS EXCEPT WHERE NOTED
P.O. 53637	Faron Gutierrez	Labor Hour for Carpenter Work	6/16/75	$ 5,000	6/5/76	Approx. $3,387 spent effective 5/30/76.
VLA-134 P.O. 53578	Air Products and Chemicals, Inc.	Helium Compressors and Cryogenic Refrigerators	8/15/75	$ 139,545	11/1/76	C.O. No. 1 issued to purchase units for Antennas 7-10.
VLA-146 P.O. 053619	Spacekom, Inc.	Mixers for IF/LO Modems	2/20/76	$ 74,600	5/31/76	60% of order shipped 5/27/76. Balance will be shipped 6/30/76.
VLA-149	Burn Construction Co., Inc.	Site Construction Phase III	9/25/75	$2,979,600	10/25/76	Work is approx. 65% complete.
P.O. 53880	N. M. Tech.	Labor Hour Contract	9/1/75	$ 15,000	8/31/75	Approx. $6,571 spent effective 5/30/76.
VLA-160 P.O. S-00120	Wutzke RR Tie Co.	20,000 Used Cross Ties	10/17/75	$ 109,000	12/31/75	18,435 ties have been delivered for stockpiling.
VLA-160 P.O. S-00271	Timber Mtn. Forest Products	20,000 Used Cross Ties	10/17/75	$ 115,000	12/31/75	11,150 ties have been delivered for stockpiling.
VLA-167	Paul Goar Construction Co.	Prefabricated Metal Warehouse and Maintenance Buildings	1/6/76	$ 147,805	4/30/76	Buildings are complete except for minor discrepancies.
VLA-174	Lawrence Hefner	Provide Labor and Equipment	1/26/76	$ 62,400	2/28/77	Approx. $8,964 spent effective 5/30/76.
P.O. S-00815	DeLuna Bluebird Bus Sales of N.M.	Coach	3/25/76	$ 53,626	8/1/76	Delivery is on schedule.
VLA-177 P.O. S-00985	Fujikura Cable Works Ltd.	Waveguide Coupling Components	3/5/76	$ 134,985	6/11/76 10/1/76	Partial shipment received 5/21/76. Next partial due for shipment 6/11/76.
P.O. S-00986	Hitachi Shibaden Corp. of America	Waveguide Adaptors	3/25/76	$ 47,800	6/30/76	Delivery of partial shipment by 6/30/76 is on schedule.
P.O. S-01147	Fujikura Cable Works Ltd.	Rotary Joints	3/30/76	$ 696	6/30/76	Delivery is on schedule.

VLA PROJECT
MAJOR SUBCONTRACTS AND PURCHASE ORDERS PLACED

NUMBER P.O. SUBCONTRACT	VENDOR	ITEM DESCRIPITON	DATE PLACED	DOLLAR AMOUNT	DELIVERY DATE	CURRENT STATUS - ALL FIRM FIXED PRICE CONTRACTS EXCEPT WHERE NOTED
VLA-179 P.O. S-01046	AIL Div. of Cutler Hammer	Parametric Amplifiers	4/29/76	$ 62,320	10/12/76	Delivery is on schedule.
S-01134	Digital Equip. Corp.	Eight Line Comm. Group	4/5/76	$ 5,060	8/30/76	Delivery is on schedule.
VLA-191 P.O. S-01162	Longwill-Scott Inc.	Rail Take Up Crab Orchard, Ill.	4/7/76	$118,385	7/31/76	Vendor started work 4/28/76. Eleven car loads have been shipped.

VLA PROJECT
PROCUREMENT ACTIVITIES INITIATED

RFP NUMBER	ITEM DESCRIPTION	ESTIMATED COST	ISSUE DATE	BID DUE DATE	SUBMISSION TO NSF DATE	AWARD DATE	CURRENT STATUS
VLA-211	VLA WYE Communication System	$260,000	5/6/76	6/8/76	6/15/76	6/30/76	Proposals solicited from eight companies.

NATIONAL RADIO ASTRONOMY OBSERVATORY

VLA--FINANCIAL STATUS REPORT
(in thousands)

As of: May 31, 1976

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
		Allocation to Date				Outlook			
Item	Project Ceiling	Allocated	Expended and Committed	Allocated Balance	Unallo-cated Balance	Est. to Complete	Est. Total	(Over) Under Ceiling	Notes
Site and Wye	27,860	11,906	11,063	843	15,954	16,660	27,723	137	
Antennas	20,400	8,590	8,106	484	11,810	13,108	21,214	(814)	
Electronics	17,000	7,465	5,973	1,492	9,535	11,185	17,158	(158)	
Computer	4,850	2,529	2,114	415	2,321	3,231	5,345	(495)	
Systems Integration	400	194	75	119	206	293	368	32	
Project Management	2,650	1,569	1,169	400	1,081	1,708	2,877	(227)	
Subtotal	73,160	32,253	28,500	3,753	40,907	46,185	74,685	(1,525)	
Contingency	2,840	948	---	948	1,892	3,438	3,438	(598)	
Total	76,000	33,201	28,500	4,701	42,799	49,623	78,123	(2,123)	

Notes: (1) Basic estimate is that of August, 1975.

(2) Escalation included for future years at 6% for site and wye work; National Radio Astronomy Observatory labor, and minor antenna equipment items. Antenna estimate is based on the existing contract costs for fabrication of the antennas. No future escalation has been included for electronics or computer purchased equipment.

(3) Estimate excludes the following deferred items: Transporters #2 and #3, $615 K; Air Strip, $268 K.

Explanation to Accompanying Statement

Column (2) - Project Ceiling: Original estimates

Column (3) - Allocated: Funded by NSF and included in total funds provided in Contract C-780.

Column (4) - Expended and Committed: Actual cash paid out and orders written and accepted by vendors.

Column (5) - Allocated Balance: Column 3 less Column 4. (Current funds available for expenditure and commitment.)

Column (6) - Unallocated Balance: Column 2 less Column 3. (Funds due from NSF to fund the total project as originally estimated.)

Column (7) - Estimate to Complete: Original estimate updated to take into account current or known costs.

Column (8) - Estimated Total: Column 4 plus Column 7.

Column (9) - (Over) Under: Column 2 less Column 8.

CY-1976
VERY LARGE ARRAY

Status as of May 31,1976

Project Number	Description	Allocation	Monthly	Expended	Committed	Total	Balance	Outstanding Obligations Pending	Net Balance
11000	Site and Wye	5,111,000	579,742	2,178,416	2,119,652	4,298,068	812,932	92,622	720,310
12000	Antenna System	3,081,000	773,173	1,362,354	1,234,978	2,597,332	483,668	114,891	368,777
13000	Electronic System	2,876,000	198,649	751,400	634,793	1,386,193	1,489,807	379,384	1,110,423
14000	Computer System	720,000	28,122	249,752	56,109	305,861	414,139	160,373	253,766
16000	Systems Integration	148,000	5,361	23,829	4,336	28,165	119,835	31,567	88,268
17000	Project Management	662,000	42,564	202,100	74,144	276,244	385,756	182,023	203,733
	Contingency	948,000	-	-	-	-	948,000	-	948,000
	Total VLA	13,546,000	1,627,611	4,767,851	4,124,012	8,891,863	4,654,137	960,860	3,693,277

TOTAL PROJECT

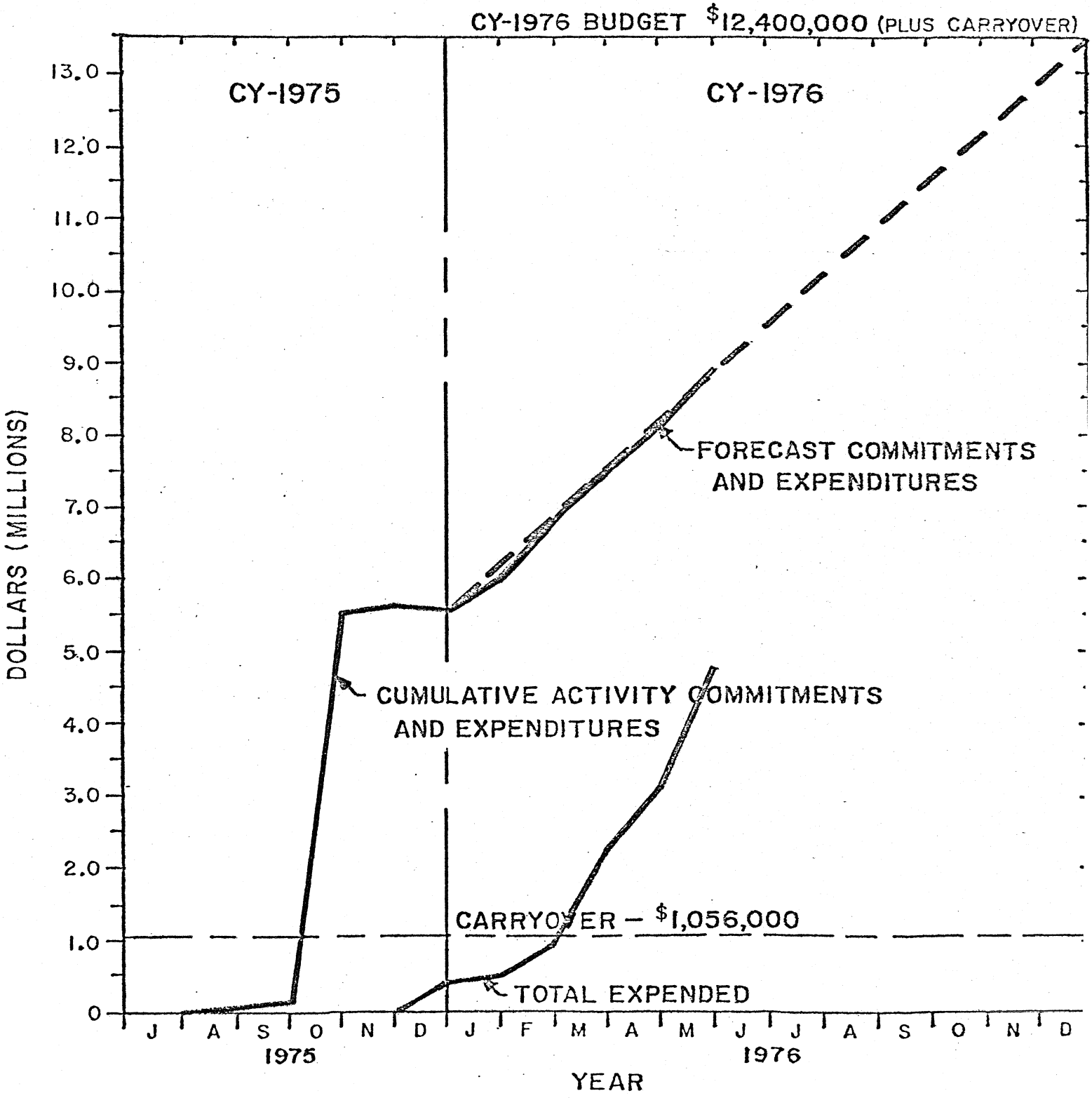
VERY LARGE ARRAY

Status as of May 31, 1976

Project Number	Description	Allocation	Monthly	Expended	Committed	Total	Balance	Outstanding Obligations Pending	Net Balance
11000	Site and Wye	11,906,406	650,197	8,490,288	2,572,386	11,062,674	843,732	92,622	751,110
12000	Antenna System	8,590,344	773,663	6,869,912	1,236,171	8,106,083	484,261	114,891	369,370
13000	Electronic System	7,464,934	247,177	5,285,312	687,917	5,973,229	1,491,705	379,384	1,112,321
14000	Computer System	2,528,589	63,123	1,863,238	251,064	2,114,302	414,287	160,373	253,914
16000	Systems Integration	194,000	5,373	70,380	4,344	74,724	119,276	31,567	87,709
17000	Project Management	1,568,961	42,640	1,094,439	74,946	1,169,385	399,576	182,023	217,553
	Contingency	948,066	-	-	-	-	948,066	-	948,065
	Total VLA	33,201,300(1)	1,782,173	23,673,569	4,826,828	28,500,397	4,700,903	960,860	3,740,043

(1) Total Project Allocation does not include $283,000 withheld by NSF for Army Corp. of Engrs. and $15,700 for ECAC study.

VLA-NRAO
PROJECT REPORT
EXPENDITURES AND COMMITMENTS
CY-1976 CUMULATIVE ACTIVITY

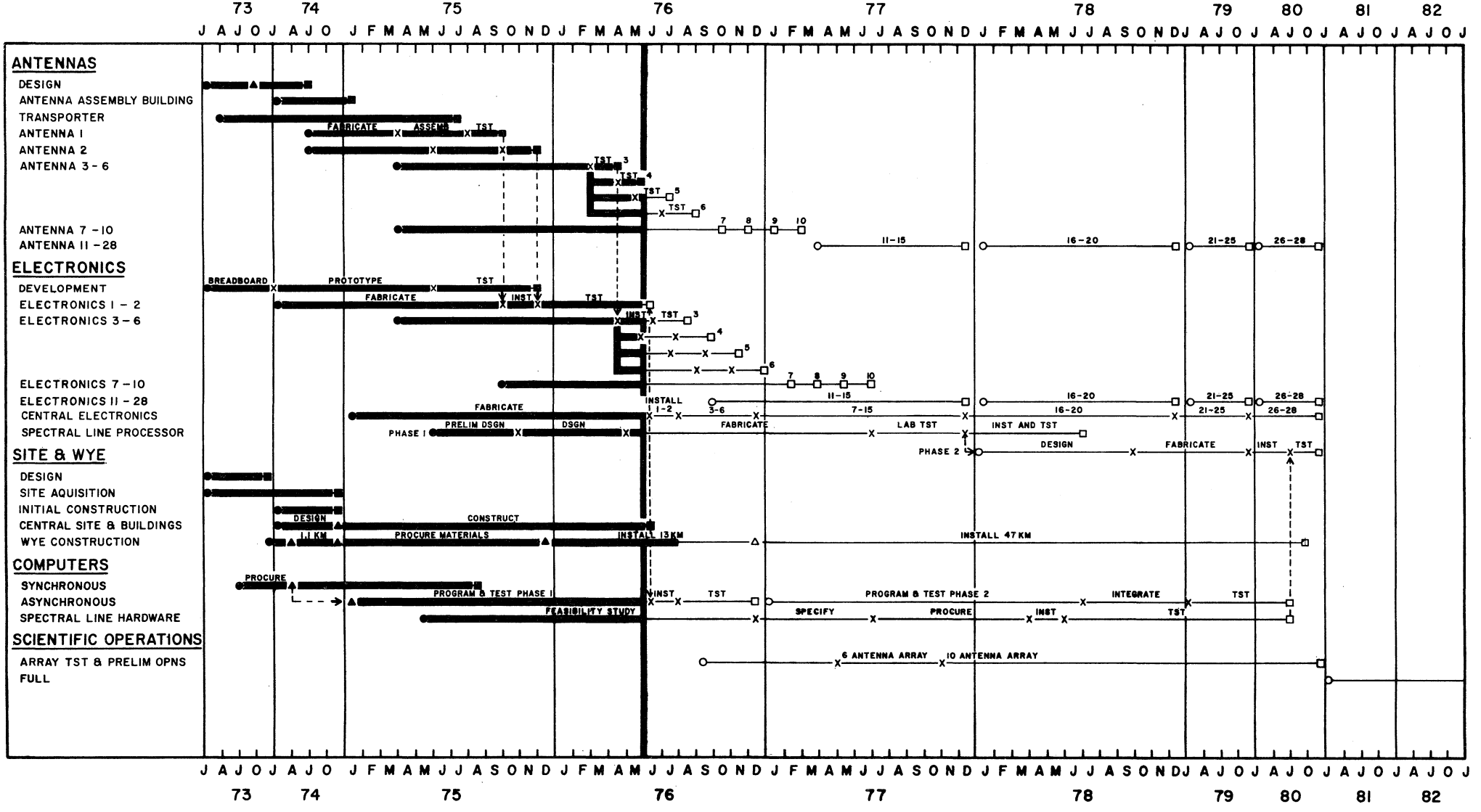


NATIONAL RADIO ASTRONOMY OBSERVATORY

VLA ACTIVITY SCHEDULE

11/15/75

UPDATE DATE: 6/1/76



ABBREVIATIONS

ASSEMBLE - ASSEMB	CH-VILLE - CV	INSTALL - INST	PRELIMINARY - PRELIM
COMPLETE - CMPL	DESIGN - DSGN	INTEGRATE - INTG	SELECT - SLCT
CONTRACT - CNTR	DETAIL - DTL	OPERATIONS - OPNS	TEST - TST

SYMBOLS

O START OF A PHASE △ CONTRACT AWARD

X END OF AN ACTIVITY □ END OF A PHASE

REV. NO.	REV. DATE	REVISION
1	12/4/75	WYE CMPL 10/80