MARCH 1976

NATIONAL RADIO ASTRONOMY OBSERVATORY

MARCH PROJECT REPORT

VLA PROJECT

April 12, 1976

NATIONAL RADIO ASTRONOMY OBSERVATORY

MONTHLY PROGRESS REPORT

VLA PROJECT

MARCH 1976

SITE AND WYE

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

The east and west endwall and roof paneling and insulation of the warehouse building are complete. All trim is in place, lacking only mounting of rain gutters. The 15KVA transformer has been mounted, and panels, feeders, and branch circuits are being roughed-in. The structural frame of the maintenance building has been erected. All roof and exterior and interior wall paneling, insulation, and trim have been installed. Ridge ventilators, doors and frames have been installed in both buildings. Electrical conduit work is being installed in both buildings.

This contract is estimated at 80% complete.

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

1. Pier drilling and belling and placement of pier reinforcing steel and concrete have been completed at antenna foundations DE-7 through CE-9 and DN-2 through DN-9. Grade beams have been poured at BW-5 and BW-6 and DW-2 through DW-6. Grade beam forms and steel are in place at DE-2 and CE-5. Rough excavation for grade beams has been performed at DE-9, while fine grading is complete at DE-1. Antenna pedestals have been poured at CW-6, 7, and 8, and forms are being constructed at DW-9. 4" PVC casement for 20 mm waveguide has been laid at DW-2 and 3, BW-5 and 6, DE-1, 2, and 9, and CE-5.

2. Embankment for the west arm is approximately 80% complete. Removal and recompaction is complete to station 447+00. All moving and shifting of west arm yardage has been performed.

3. Ballast has been distributed along the west arm from the apex to station 23+10 and from 64+00 approximately to 158+00. Construction of mainline trackage has been initiated at station 64+00.

4. 15KV primary cable has been laid along the north, east, and west arms with the exception of feeds between CW-5 and DW-1. Transformer pads are being roughed-in and primary stub-ups are placed for north arm transformer pads TN-2 through TN-12 and on east arm pads TE-3, 4, 5, and 6.

Eighty-five construction workers were employed on this contract at the end of March. This contract is estimated at 39% complete.

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

1. The 105 ton water chillers have been started up and readied for full operation. The plenum chambers of the west mechanical room are complete and the sound attenuators, humidifiers, filters, and filter racks have been installed. Insulation of ducts and chilled water and heat piping is 85% complete. The fire protection system is 100% complete. All plumbing fixtures and hardware have been mounted in the Control Building.

2. Vinyl-asbestos floor tile has been laid in the Cafeteria and on both levels of the Control Building. The acoustic drop-in ceiling of the Control Building is complete. The exterior slump-block walls have been sealed for moisture protection. Painting of gypboard walls, metal trim, and exposed concrete is 95% complete.

3. Bus duct and lighting fixtures have been hung in the Control Building lab and work area. Lighting fixtures and lamps have been installed in the east mechanical room. Feeders are 100% complete and branch circuits 95% complete in the Control Building.

This contract is estimated at 95% complete.

ANTENNA DIVISION

Antenna No. 3

During the month of March Antenna No. 3 was completed to the point of servo installation, cabling, painting and acceptance testing. Panel installation and final alignment was completed in Mid-March with a final installation RMS of 0.0125 inches as compared to spec requirement 0.018 inches. Azimuth and elevation gear reducers were tested at the Philadelphia Gear Co. They arrived at the Site on March 18, and were installed in the antenna. Results of the stiffness tests of the redesigned gearboxes revealed a stiffness of 5.62×10^6 ft. lbs. for azimuth and 3.52×10^6 ft. lbs. per radian for elevation reducers as compared with specified 5.0 and 3.5×10^6 ft. lbs. per radian. The antenna was moved from the assembly building to the master foundation on March 29 for final alignment and checkout.

Antenna No. 4

Reflector back-up structure is approximately 65% assembled. Base pedestal assembly started on March 29, 1976. All components were on Site at end of month with the exception of the gear reducers which were enroute.

Antenna No. 5

Trial assembly has been completed at Hobbs. Components are now being sand blasted and painted. Shipment of component parts to VLA Site is expected in Mid-April.

SYSTEM INTEGRATION DIVISION

Four observing sessions were conducted this month. The last three were performed on a modified time schedule that started Monday afternoon at 1500 hours and ran for 40 continuous hours. This permitted a more effective use of the remainder of the week for engineering tasks. The following tests were conducted:

Session No. 1

12 hours of visibility measurements on 3C 84 and 3C 286, 16 hours of interferometer pointing for Antenna 2 on standard sources, 12 hours down with high winds.

Session No. 2

35 hours of pointing tests on Antenna 2, 5 hours to bring the system on the air.

The pointing tests showed the elevation encoder of Antenna No. 2 was undergoing severe degradation in performance, similar to that experienced in December with the azimuth encoder of Antenna No. 1. The encoder was replaced with a new one.

Session No. 3

6 hours of interferometer pointing tests on A1, and 18 hours of pointing tests on A2, 13 hours of visibility measurements on standard calibrators.

Session No. 4

10 hours of interferometer pointing tests in both antennas, 2 hours of interferometer beam profiles, 20 hours of visibility measurements on standard calibrators, 2 hours of zenith drift scans for noise tests.

Observing runs were interrupted for the local oscillator system tests described in the Electronics Division Section. By the end of the month, further single dish tests on Antenna No. 2 were started to investigate its low aperture efficiency.

ELECTRONICS DIVISION

A contract has been placed with J. J. Gustincic for a full scale model of the 18-21 cm wavelength feed, the design study on which was completed last month. Delivery is expected about the second week of June. A proposal for design of a corrugated horn for the 6 cm band has also been received from Gustincic and is presently under consideration.

An order has been placed with Air Products Inc. for refrigerators and compressors for antennas 7 to 10. Dewars for antennas 4 to 6 were received from Noor Inc. of Albuquerque and were found to be satisfactory. An order was placed with the same company for Dewars for antennas 7 to 10. Assembly of the front end for antenna No. 3 has been completed. The parametric amplifiers have been satisfactorily tested and testing of other components is in progress.

An order has been placed with the Fujikura Company for 20 mm waveguide components for 9 antennas and 30 antenna stations. Drawings for the 20 mm rotating joints were completed and an order has been placed for four of them with the Acoma Company of Albuquerque. Progress has been made in the area of coupler design and results with the beam splitter type, in which a 45° window in the main line reflects power into a side arm, look particularly promising. A key feature of the new design is the introduction of a small amount of TE_{02} mode to cancel the unwanted TE_{02} generated by the coupler itself. Units with coupling in the range 10 to 25 dB, and unwanted ripple less than 0.1 dB over bands of 10 GHz, have been tested. Some preliminary measurements on a sector coupler design also look hopeful. The operation of laying waveguide along the arms of the array has commenced again after being discontinued during the winter months. A new method of preparing the trench bottom is being tested on the inner part of the west arm.

Almost all modules for antennas 3 to 6 have now been assembled and testing has been performed for more than half of them. The first outside construction of the newly designed T2 modules has been started. The new test system for Monitor and Control modules which was mentioned in the report for December 1975 has been brought into operation for the Data Set modules. It incorporates a minicomputer that exercises all functions of the module, and is working very well. In the Delay and Multiplier system the delay cards for the system that will handle twelve antennas have been tested and multiplier cards are complete and ready for testing.

System testing has continued and the reliability of the Monitor and Control system is now very much improved. Much effort is going into an examination of the phase stability of the local oscillator system. A bread-board design of a new version of the 50 to 600 MHz Multiplier module has been made in which the temperature coefficient of phase is about one third of that of the original design. The temperature coefficient of the Furukawa 20 mm flexible waveguide on antenna No. 1 has been measured to be < 100 parts per million per ^{o}C. Interferometer testing has been

suspended to allow a more concentrated effort on electronic testing and the IF and local oscillator rack from antenna No. 1 was moved from the vertex room to the electronics trailer on March 25 to simplify work on the electronics.

Meetings were held at the Site on March 30 to April 1 in which scientific and engineering staff from Charlottesville and Socorro discussed details of the spectral line system. As a result the electronic specifications have been finalized and detailed design is proceeding. Some aspects of the electronics where small changes or additions are required were also discussed. These include a modification of the scheme by which the 4.5-5.0 GHz signals from the front ends are converted to the IF bands used in the waveguide transmission, and the addition of pulse calibration and narrow IF channels for the spectral line system.

On March 22, 1976, Patrick A. Temple joined the electronics division as a junior technician in the front end group.

COMPUTER DIVISION

Asynchronous Subsystem

Work on our FFT box is being done by DEC software and hardware experts in an attempt to make it meet contract specifications; on May 1 their efforts will be evaluated. Meanwhile, contingency plans for procuring another FFT processor are being prepared. The high speed tape drives are still not integrated into our system, and DEC people are also at work on that problem. The tape drives will be accepted as soon as the hardware and software problems are fixed.

A design for the Combined Asynchronous Multi-processor (CAM) has been developed. This system will be the final combined continuum and spectral line data reduction system.

A two-dimensional FFT based on the half-plane algorithm is working but not yet integrated into the system. Tests comparing this FFT with the Green Bank interferometer package mapping programs have been successful.

The documentation maintenance and updating system is now being completely maintained in the DEC using the Scribe text formatter. Our documentation is divided into three major sections: the Project Book, a User's Manual, and a Staff Manual; together these are called the VLA Notebooks. These manuals will be maintained in computer-readable form and hard copies (distributed to VLA staff members) will be updated approximately once per month. We hope to have the documentation of our system as complete as possible before our move to the Site.

Implementation of curly bracketed expressions (CBEs) for data selection and parameter specification is nearly finished. This involved a new structure building operator. Completion of this notation will allow coding of pre-synthesis operators to proceed rapidly.

Vic Herrero spent one week with us getting started with the DEC-10 and CANDID. He also discussed the possible modes in which array operators and engineers could best make use of monitor data in our system.

Synchronous Subsystem

Most of the effort of the synchronous computer group during March was devoted to direct support of observations. The computer software has become first-stage reliable; that is, left to itself it continues to work reliably, but it is still easy for minor errors on the part of the operator to cause it to fail. Pointing measurements for Antenna No. 2 have been made and analysed and its pointing seems to be as good or perhaps slightly better than Antenna No. 1. These measurements were made in interferometer mode.

Work has continued in development of module level engineering programs which assist engineers in investigating the function of the various modules in a convenient way. A comprehensive test program for the correlator system is under development.

Planning has started on a set of major program revisions dictated by the experience with the interferometer observing.

PROJECT MANAGEMENT

Procurement actions during March 1976 totaled approximately $500,000. Included in this total were 175 purchase orders amounting to $100,000 plus award of Subcontracts amounting to $400,000.

Orders were placed for Antennas 7 to 10 with Air Products Inc. for refrigerators and compressors and with Noor Inc. of Albuquerque for Dewars. An order was placed with Fujikura Co. for 20 mm waveguide components for 9 antennas and 30 antenna stations. Also, an order was placed for four 20 mm rotary joints with the Acoma Co. of Albuquerque. In addition contracts for feed support structures, rail take-up, computer services and various electronic components were placed.

Rail take-up has commenced at Bastrop, Texas, is 70% complete at Mrytle Beach AFB and 90% complete at Redstone Arsenal.

On March 19, 1976, Dan Baca was hired in the Project Management Division as a maintenance trainee.

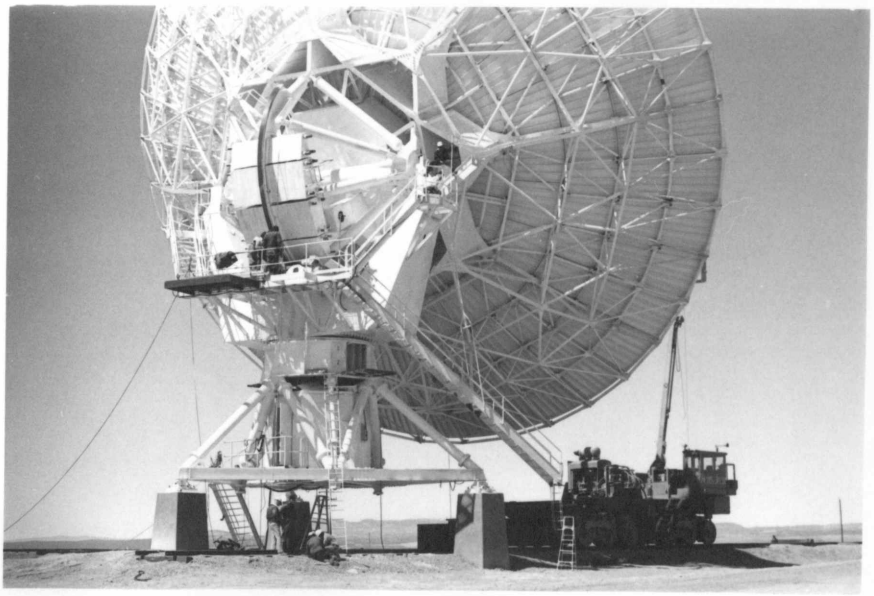
Personnel

The personnel changes as of March 31, 1976, are as follow:

Division	Previous Level	Additions	Reduction	Current Level
Site and Wye	7	0	0	7
Antenna	9	0	0	9
Electronics	38	1	1	38
Computer	14	0	0	14
Systems Integration	3	0	0	3
Project Management	20	1	0	21*
TOTALS	91	2	1	92

*Includes one part-time person.

p3-76-1 Shop Building Foreground and Warehouse



p3-76-2 Antenna No. 3 on Master Pad

p3-76-3 Antennas Nos. 1, 2, and 3

p3-76-4 Tie Placement Along West Arm

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	3/15/74 4/30/75 12/21/76	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	$17,591,262	8/9/75	NRAO has taken possession of Antenna Nos. 1 and 2. Antenna No. 3 is on schedule for the 4/15/76 delivery.
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. Six units were delivered and returned to factory to have input and output ports reversed. Five of these have been fixed and returned.
VLA-29	Sterling-Detroit	Focusing Feed Mounts	6/17/74	$ 328,582	3/1/75	Sterling Mount for Antenna No. 3 has been received and is being outfitted. Mount No. 4 is in transit.
VLA-44	Digital-Equip. Corporation	Asynchronous Computer	6/17/74	$ 990,869	2/15/75	Major parts of system delivered 12/16/74. Balance of system was delivered 10/15/75. FFT has not passed acceptance tests yet.
VLA-53	R. F. System	K and Ku Band Feed Horns	1/26/76	$ 73,776	4/15/76 5/24/76	K and Ku Band Feed Horns for Antennas 3 through 6 are on schedule.
VLA-65	Geo. A. Rutherford Inc.	Site Construction Phase II	12/16/74	$ 2,395,400	6/1/76	Work is about 98% complete.
VLA-70 P.O. 52322	Sumitomo Electric USA, Inc.	3313 pieces of waveguide 3410 each coupling sleeves	1/27/75	$ 1,085,129	3/30/76	1313 pieces of Item 1 and 1350 pieces of Item 2 have been received. 1000 pieces of items 1 and 2 under C.O. No. 1 cleared customs.

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-72 P.O. 52432	Hitachi Shibaden Corp. of America	3 ea. waveguide signal distributors	2/7/75	$ 230,000	12/15/75	Units are in storage at VLA Site. Due for installation and final acceptance in June 1976.
P.O. 53637	Faron Gutierrez	Labor Hour for Carpenter Work	6/16/75	$ 5,000	6/5/76	Approx. $3,387 spent effective 3/31/76.
VLA-134 P.O. 53578	Air Products and Chemicals, Inc.	Helium Compressors and Cryogenic Refrigerators	8/15/75	$ 139,545	10/17/75	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	Delivery is on schedule.
VLA-149	Burn Construction Co., Inc.	Site Construction Phase III	9/25/75	$ 2,913,000	10/25/76	Work is approx. 39% complete.
P.O. 53880	N. M. Tech.	Labor Hour Contract	9/1/75	$ 15,000	8/31/75	Approx. $6,462 spent effective 3/31/76.
VLA-160 P.O. S-00120	Wutzke RR Tie Co.	20,000 Used Cross Ties	10/17/75	$ 109,000	12/31/75	9,326 ties have been delivered.
VLA-160 P.O. S-00271	Timber Mtn. Forest Products	20,000 Used Cross Ties	10/17/75	$ 115,000	12/31/75	9,340 ties have been delivered.
VLA-167	Paul Goar Construction Co.	Prefabricated Metal Warehouse and Maintenance Buildings	1/6/76	$ 147,805	4/30/76	Work is approx. 80% complete.
VLA-174	Lawrence Hefner	Provide Labor and Equipment	1/26/76	$ 62,400	2/28/77	Approx. $1,130 spent effective 3/31/76.
P.O. S-00815	DeLuna Bluebird Bus Sales of N.M.	Coach	3/25/76	$ 53,626	8/1/76	Acknowledgement with delivery date has not been received.

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-177						
P.O. S-00985	Fujikura Cable Works Ltd.	Waveguide Coupling Components	3/5/76	$ 134,985	6/1/76	Delivery of partial shipment by 6/1/76 is on schedule.
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
PROCUREMENT ACTIVITIES INITIATED

RFP NUMBER	ITEM DESCRIPTION	ESTIMATED COST	ISSUE DATE	BID DUE DATE	SUBMISSION TO NSF DATE	AWARD DATE	CURRENT STATUS
VLA-179	Parametric Amplifiers	$130,000	1/22/76	2/20/76	3/11/76		Proposals were received from three companies. NSF approval received 3/25/76 but additional negotiations are being carried on with bidders.
VLA-186 and 189	Rail Take-up Reese AFB, Webb AFB, Bastrop Depot and Ft. Sam Houston, Texas.	$ 59,000	2/11/76	3/10/76	3/15/76		Order awarded to Longwell-Scott within NRAO contractual authorization.
VLA-190	Feed Support Structures	$ 85,000	2/12/76	3/11/76			Order awarded to Structures Inc. within NRAO contractual authorization.
VLA-191	Rail Take-up Crab Orchard National Wildlife Refuge	$130,000	2/24/76	3/24/76	3/29/76		Proposals received from four companies.
S-01134	Eight Line Communications Group	$ 5,060	2/6/76	2/12/76	3/24/76		ADP equipment, NSF approval required.

...TIONAL RADIO ASTRONOMY OBSERVATORY

VLA--FINANCIAL STATUS REPORT
(in thousands)

As of: March 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	Unallocated Balance	Est. to Complete	Est. Total	(Over) Under Ceiling	Note
Site and Wye	27,860	11,816	10,395	1,421	16,044	17,328	27,723	137	
Antennas	20,400	8,590	7,986	604	11,810	13,228	21,214	(814)	
Electronics	17,000	7,465	5,575	1,890	9,535	11,583	17,158	(158)	
Computer	4,850	2,529	2,038	491	2,321	3,307	5,345	(495)	
Systems Integration	400	194	64	130	206	304	368	32	
Project Management	2,650	1,569	1,073	496	1,081	1,804	2,877	(227)	
Subtotal	73,160	32,163	27,131	5,032	40,997	47,554	74,685	(1,525)	
Contingency	2,840	948	---	948	1,892	3,438	3,438	(598)	
Total	76,000	33,111	27,131	5,980	42,889	50,992	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 March 31, 1976

Project Number	Description	Allocation	Monthly	Expended	Committed	Total	Balance	Outstanding Obligations Pending	Net Balance
11000	Site and Wye	5,021,000	609,825	1,065,572	2,552,653	3,618,225	1,402,775	113,658	1,289,117
12000	Antenna System	3,081,000	472,412	514,529	1,963,028	2,477,557	603,443	145,646	457,797
13000	Electronic System	2,876,000	165,492	377,102	604,310	981,412	1,894,588	579,599	1,314,989
14000	Computer System	720,000	29,727	192,977	36,157	229,134	490,866	205,113	285,753
16000	Systems Integration	148,000	5,060	13,818	4,152	17,970	130,030	39,960	90,070
17000	Project Management	662,000	45,775	115,003	64,794	179,797	482,203	229,848	252,355
	Contingency	948,000	---	---	---	---	948,000	---	948,000
	Total VLA	13,456,000	1,328,291	2,279,001	5,225,094	7,504,095	5,951,905	1,313,824	4,638,081

TOTAL PROJECT

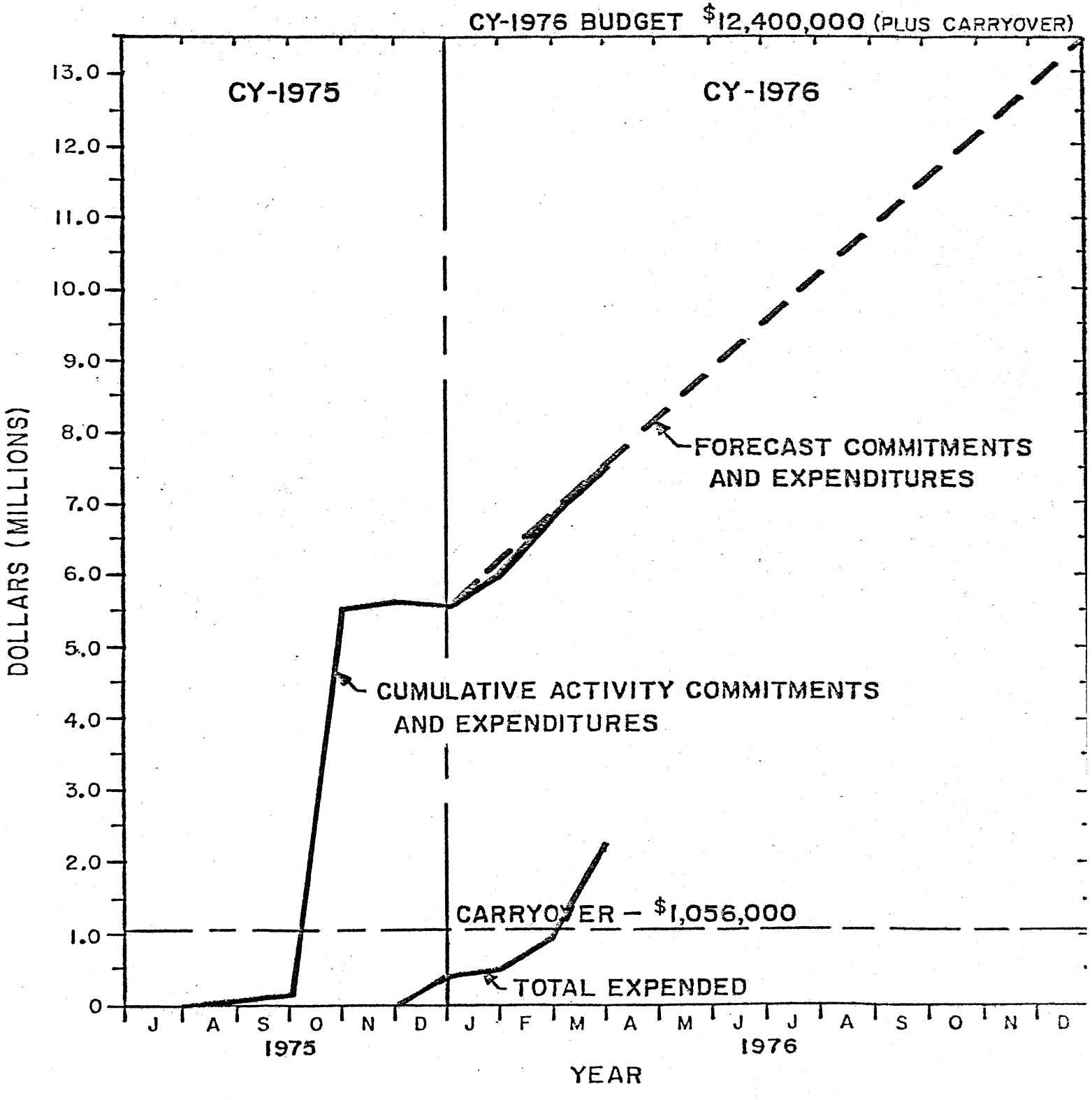
VERY LARGE ARRAY

Status as of March 31, 1976

Project Number	Description	Allocation	Monthly	Expended	Committed	Total	Balance	Outstanding Obligations Pending	Net Balance
11000	Site and Wye	11,816,406	1,035,174	7,201,541	3,193,257	10,394,798	1,421,608	113,658	1,307,950
12000	Antenna System	8,590,344	1,164,762	6,021,583	1,964,980	7,986,563	603,781	145,646	458,135
13000	Electronic System	7,464,934	439,191	4,814,201	760,841	5,575,042	1,889,892	579,599	1,310,293
14000	Computer System	2,528,589	33,408	1,771,462	266,112	2,037,574	491,015	205,113	285,902
16000	Systems Integration	194,000	6,096	60,289	4,240	64,529	129,471	39,960	89,511
17000	Project Management	1,568,961	45,309	1,007,266	65,666	1,072,932	496,029	229,848	266,181
	Contingency	948,066	---	---	---	---	948,066	---	948,066
	Total VLA	33,111,300(1)	2,723,940	20,876,342	6,255,096	27,131,438	5,979,862	1,313,824	4,666,038

(1) Total Project Allocation does not include $273,000 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

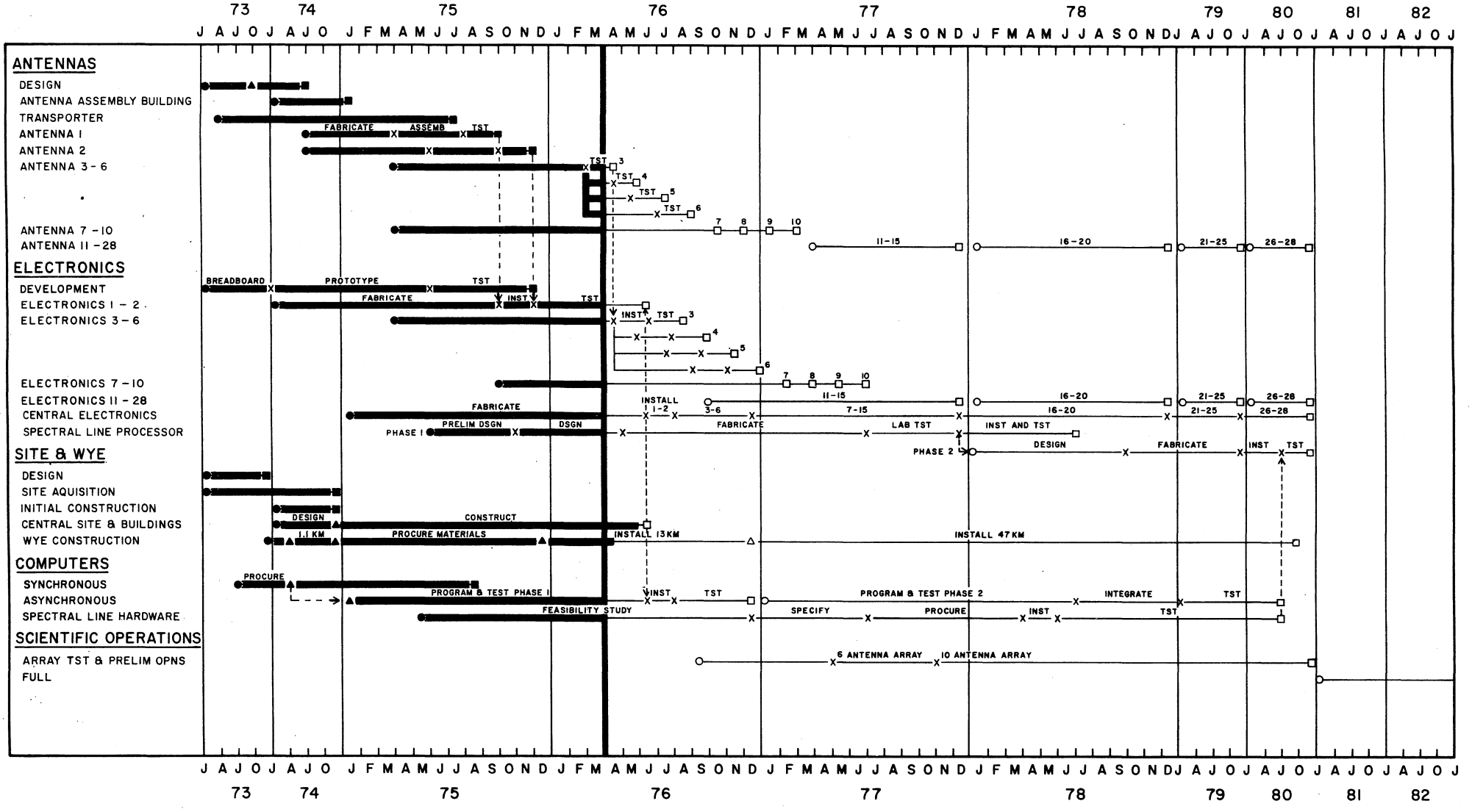


NATIONAL RADIO ASTRONOMY OBSERVATORY

VLA ACTIVITY SCHEDULE

11/15/75

UPDATE DATE: 4/1/76



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

- ○ 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