

DECEMBER 1976

NATIONAL RADIO ASTRONOMY OBSERVATORY

DECEMBER PROJECT REPORT

VLA PROGRAM

JANUARY 18, 1977

NATIONAL RADIO ASTRONOMY OBSERVATORY

MONTHLY PROGRESS REPORT

VLA PROGRAM

DECEMBER 1977/6

SITE AND WYE

Subcontract VLA-149; Wye Construction; Burn Construction Company, Inc.  
\$3,001,176

All antenna station spur trackage has been completed on all arms, and only minor adjustments of grade and final dressing of ballast slope remain. Alignment and raising to final grade of main line trackage is 96% complete. Maintenance vehicle spur line is complete and serviceable with only dressing of ballast remaining.

This contract is estimated at 99% complete.

Subcontract VLA-167; Paul D. Goar Construction; \$165,228

Foundation, grade beam and partial concrete floor was poured for a 20 foot by 40 foot lean-to extension of the Maintenance Building for installation of emergency power generators.

Waveguide

Waveguide installation has been completed on the southwest arm between the Control Building and Antenna Station BW8.

ANTENNA DIVISION

Antenna No. 7

Mechanical outfitting is complete on Maintenance Pad at end of month with the exception of touch-up painting. Antenna will be moved to CW5 for installation of electronics in early January.

Antenna No. 8

Servo tests were completed on December 10, 1976 with an observed natural frequency of 2.35 cycles/second in elevation and a natural frequency of 2.45 cycles/second in azimuth. Minor discrepancies and touch-up painting were completed and on December 17 the antenna was accepted.

Antenna No. 9

Reflector mated to pedestal first part of December and rough setting of panels started. Panel rough setting was 50% complete on December 17 when E-Systems shutdown for holidays.

### Antenna No. 10

The reflector hub structure assembly of Antenna #10 was started on December 15, 1976. Structural parts for Antenna #10 are on Site with the exception of one trailer load of miscellaneous parts which are ready for shipment.

### Antennas 11-28

Structural materials for Antennas 11-28 have all been ordered with approximately 85% of material delivered to Structures Inc. at Hobbs. Cutting of parts for Antennas 11-15 is approximately 50% complete with subassembly of members underway.

Purchase orders have been placed for all major mechanical and drive components with receipt of first shipments at the following schedule as shown:

Elevation Gear Segments - January 1977  
Speed Reducers - February 1977  
Servo System - Late February 1977  
Angle Data System - Early February 1977  
Azimuth Bearing - Late January 1977  
Surface Panels - February 1977  
Drive Motors - January 1977

On December 15, 1976, Antenna #2 was moved from Station CW9 to Station BW8 extending the southwest Arm length from 6,385 feet to 17,135 feet.

### SYSTEMS INTEGRATION DIVISION

The following observing sessions were conducted this month:

December 2-6	Program AR4, Rudnick, Owen and Spencer. All from NRAO, Charlottesville. Study of Nuclear Components in Extended Radio Galaxies..81 hours of observing with 4 antennas at all bands.
December 13-15	37 hours of interferometer test and calibration.
December 16-20	Program AJL, K. Johnston (Naval Research Laboratories), C. Wade (NRAO, Charlottesville) Preliminary Astrometric Observations to Evaluate the use of the VLA for Radiosource Positions...81 hours of observing with 5 antennas at C-Band.
December 27-29	36 hours of interferometer test and calibration.

At the end of the month Antennas 1 to 5 were located at stations DW2, BW8, DW3, CW8 and CW6. The maximum baseline was 5.2 km. Antennas 1 and 2 were outfitted for all bands. Antennas 3 and 4 were outfitted for 6, 2, and 1.3 cm. Antenna #5 was outfitted for 6 cm.

Single dish tests on Antenna #5 were completed with measured efficiency of 47% at 1.3 cm.

#### ELECTRONICS DIVISION

Installation of electronics on Antennas #5 and #6 was completed and Antenna #5 was brought into operation in the array on December 9. Single dish testing of Antenna #5 was completed. The measured efficiency of 47% at 22.3 GHz on this antenna suggests that the accuracy of reflector panel alignment is improving as more antennas are constructed. Single dish testing on Antenna #6 will be carried out in January. Waveguide installation was completed out to BW8, allowing observations over a baseline of 5.2 km to commence on December 16, 1976.

In the feed area a mode generator for the  $TE_{21}$  and  $TE_{01}$  modes was tested at 4.93 GHz on a 6 cm feed in an attempt to reduce the circular polarization beam offset. The total beam separation was reduced to 0.16 arc.min., representing 1.8% of a beamwidth. This represents a significant improvement over the uncorrected value of 6% of a beamwidth. The problems of bandwidth, linear polarization generation and gain loss have still to be investigated for this mode generator.

AIL has isolated the resonance problem in the new 4.5-5.0 GHz paramps and found it to be caused by incorrect magnetic field distribution on the ferrite bias magnets in the circulators. They are due to ship the first set of paramps in the first week of January.

During the month two types of cryogenic failures occurred. Three compressors had valve plates fracture. Air Products say that these failures were due to incorrect clearances on the valve plates and they will be corrected by shimming. The second type of failure was caused by the continued cold weather during the month. On Antenna #6 oil in the oil-return capillary line became too viscous and oil carryover in the helium resulted. This will be corrected by heat-sinking the capillary line to a warm part of the compressor.

Two each of the new L2 and L3 local oscillator modules have been completed and tested on the bench. In final lab tests the overall temperature coefficient of phase was measured to be  $0.5^{\circ}$  per  $^{\circ}C$  at 1800 MHz, which is a factor of 13 less than for the original design. Installation of these modules on Antennas #3 and #5 for system testing is planned for the latter half of January. Measurement of the phase stability of other modules is continuing and minor modifications are being made when the performance can be improved. A redesign to the L17 modules, which are used only in the master local oscillator, is also in progress. This will enable the fine tuning capability to be implemented, although this will not be required until the spectral line system is ready for use.

Progress on modules and racks for systems 7 to 10 continues in Charlottesville, and shipment of the completed equipment to the Site is scheduled for the latter half of January. Modems and monitor and control modules for the same systems are being assembled in New Mexico and are in a similar stage of readiness. Design of the new IF module required to provide the narrower bandwidths for spectral line observations is progressing.

The first design review meeting for the custom integrated circuits for the spectral processor was held on December 20 at Silicon Systems Inc., Irvine, California. Good progress has been made on the multiplier integrated circuit and computer simulation indicates that the design will have adequate speed with significantly less power dissipation than the specified maximum. The design of the integrating counter was delayed by about two weeks by a manpower problem at Silicon Systems but is now starting.

Two new staff members started work in the Electronics Division December 13, 1976, G. G. Nadkarni as a technician in the front end group and E. L. Thoroughman as a technician in the monitor and control group.

#### COMPUTER DIVISION

Work continued on making the MODCOMP software systems more reliable and convenient. A new system of maintaining the monitor log is being implemented, due to occasional data losses in the previous one. A few additions were made to the observing list formats for additional flexibility.

Work was begun on an on-line scan averaging program, deemed necessary to tell if the equipment is operating reliably.

The table sizes were expanded to accommodate up to nine antennas without recompilation.

The effort of the DEC-10 programming group heavily emphasized design of a new disk data structure for correlation data. The design is now complete and implementation has begun.

Design effort has also gone into a data structure for the system monitor data.

A program library of the map manipulation routines used to process Westerbork data has been received and preliminary look at implementing some of them on the VLA graphics system is underway.

The continuing effort to optimize the execution of the CANDID programming language was maintained at slightly greater than the one-programmer level.

The stand-alone program which lists data directly from the MODCOMP output tape has been expanded to provide data selection and averaging.

PROJECT MANAGEMENT

During the month of December 1976 the VLA Program placed 260 purchase orders and subcontracts totaling \$438,548.

Personnel

The personnel changes as of December 31, 1977 are as follows:

<u>Division</u>	<u>Previous Level</u>	<u>Additions</u>	<u>Reductions</u>	<u>Current Level</u>
Site and Wye	7	0	1	6
Antenna	10	0	0	10
Electronics	41	2	0	43**
Computer	14	0	0	14
Systems Integration	4	0	0	4
Project Management	<u>25</u>	<u>1</u>	<u>0</u>	<u>26*</u>
Total	101	3	1	103

\* Includes one part-time person

\*\* Includes one temporary person



p12-76-1

New L Band Feed



p12-76-2

Observations with a 5.2 km baseline  
Commenced December 16, 1976



VLA PROJECT  
MAJOR SUBCONTRACTS AND PURCHASE ORDERS PLACED

NUMBER P.O. SUBCONTRACT	VENDOR	ITEM DESCRIPTION	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	6/11/73	\$ 1,039,064		Title I - Completed Title II - Completed Title III - Work in progress in conjunction with VLA-149 and preparation of bid documents for Phase IV construction. Fixed price plus reimbursables.
VLA-6	E-Systems, Inc.	28 Radio Telescopes	10/18/73	\$ 18,131,767	3/01/77	NRAO has taken possession of Antenna Nos. 1 through 8. Antenna #9 is on schedule. Amendment 19 for Antennas 11-20 has been accepted by E-Systems.
VLA-29	Sterling-Detroit Co.	Focusing Feed Mounts	11/03/76	\$ 524,032	8/01/77	Delivery is on schedule for Antennas 11 through 16.
VLA-53	R. F. System	K and Ku Band Feed Horns	1/26/76	\$ 109,168	11/15/76	Two K Band Horns delivered by 12/19/76. Balance delivered by 1/30/77.
VLA-70 P.O. 52322	Sumitomo Electric USA, Inc.	5373 pieces of waveguide 5185 each coupling sleeves	1/27/75	\$ 1,801,827	1/15/77	3713 pieces of waveguide and 3780 coupling sleeves have been received. 600 pieces of waveguide and 600 coupling sleeves were shipped 12/19/76 from Japan.
VLA-149	Burn Construction Co., Inc.	Site Construction Phase III	9/25/76	\$ 3,001,176	10/25/76	Work is Approx. 99% complete.
P.O. 53880	N. M. Tech.	Labor Hour Contract	9/01/75	\$ 15,000	8/31/76	Approx. \$11,456 spent effective 12/31/76.
VLA-167	Paul D. Goar Construction Co.	Prefab Metal Maintenance and Warehouse Bldgs.	1/06/76	\$ 165,228	3/30/77	Amendment No. 1 issued for construction of Lean-to type addition to maintenance building. Work on addition is progressing on schedule.
VLA-174	Lawrence Hefner	Provide Labor and Equipment	1/26/76	\$ 62,400	2/28/77	Approx. \$62,116 spent effective 12/31/76.

VLA PROJECT  
MAJOR SUBCONTRACTS AND PURCHASE ORDERS PLACED

NUMBER P.O. SUBCONTRACT	VENDOR	ITEM DESCRIPTION	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	Vender has had trouble meeting specifications. One set is due for shipment 1/6/77.
P.O. S-01946	Industrial Design Engineering Assoc. for Temporary Draftsman	Labor Hour Contract	7/21/76	\$ 9,100	1/26/77	Draftsman is working in drafting section at 2015 Ivy Rd., Charlottesville, Va. \$7,597 spent effective 12/31/76.
P.O. S-01984	J. J. Gustincic Consulting Engr.	Consultant Agreement	8/02/76	\$ 4,000	12/31/76	Consultant on K, Ku and C Band Horn. \$600 spent effective 12/31/76.
VLA-211 P.O. S-02412 P.O. S-02524	Executone Systems of New Mexico Inc.	VLA Wye Comm. System	10/05/76	\$ 72,980.83	3/30/77	Installation was completed December 1976 on all antennas that have been delivered and all cable has been installed.
VLA-227	Fairmont Railway Motors, Inc.	Motor Vehicle for operation on RR Track and Ground	10/15/76	\$ 10,430.40	1/31/77	Delivery is on schedule.
VLA-229 P.O. S-02717	Digital Equipment Corp.	128K words of Main Memory and two Data Channels	11/30/76	\$ 83,760	1/30/77 3/31/77	Delivery is on schedule for 128K words of memory. Delivery of data channels will be 6/30/77.
VLA-233 P.O. S-02611	Silicon Systems, Inc.	Custom Integrated Circuits	12/12/76	\$ 164,000	3/21/77 6/30/77	Delivery is on schedule.
P.O. S-02998	AIL Div. Cutler Hammer	Upconverters	12/15/76	\$ 62,623	6/15/77 to 8/15/77	Delivery is on schedule.

VLA PROJECT  
PROCUREMENT ACTIVITIES INITIATED

<u>RFP NUMBER</u>	<u>ITEM DESCRIPTION</u>	<u>ESTIMATED COST</u>	<u>ISSUE DATE</u>	<u>BID DUE DATE</u>	<u>SUBMISSION TO NSF DATE</u>	<u>AWARD DATE</u>	<u>CURRENT STATUS</u>
VLA-5	Amendment No. 11 for Inspection of Site Construction Phase IV	\$ 49,086	-----	-----	10/28/76	1/31/77	Amendment No. 11 is being held until contract for site construction Phase IV is awarded.
VLA-149	Amendment No. 6 for earthwork and 8.1 miles of RR Track	\$536,000	-----	-----	12/13/76	1/31/77	Awaiting approval from NSF.
VLA-234	Design Review of Transport Vehicle	\$ 20,000	9/28/76	11/01/76	11/15/76	11/30/76	Proposal is being evaluated.
VLA-240	Fabricated Metal Parts	\$ 60,000	10/28/76	11/23/76	12/15/76	1/15/77	Awaiting approval from NSF.
VLA-244	High-Speed Array Processors	\$175,000	11/11/76	12/17/76	1/05/77	1/31/77	Proposals from two companies are being evaluated.
VLA-245	Standby Power Source	\$ 70,000	11/19/76	12/13/76	1/30/76	1/15/77	Proposals from two companies are being evaluated.
P.O. S-01742	Maintenance on DEC Computer	\$ 67,560	-----	-----	12/14/76	1/15/77	Awaiting approval from NSF.
VLA-247	Two Meter Flexible Waveguide	\$ 45,000	12/07/76	1/06/77	1/31/77	1/31/77	Proposals solicited from 18 companies.

CY-1976

VERY LARGE ARRAY

STATUS AS OF DECEMBER 31, 1976

		<u>ALLOCATION</u>	<u>TRANSFER TO FIXED ASSETS</u>	<u>EXPENDED MONTHLY</u>	<u>TOTAL EXPENDED</u>	<u>TOTAL COMMITT.</u>	<u>TOTAL</u>	<u>BALANCE</u>	<u>OUTSTANDING OBLIGATIONS PENDING</u>	<u>NET BALANCE</u>
11000	SITE AND WYE	4,860,391	206,609	456,833	4,380,769	349,395	4,730,164	130,227	---	130,227
12000	ANTENNA SYSTEM	7,715,582	5,418	1,643,595	4,791,831	2,921,741	7,713,572	2,010	---	2,010
13000	ELECTRONIC SYSTEM	2,691,000	---	299,703	2,269,389	246,468	2,515,857	175,143	---	175,143
14000	COMPUTER SYSTEM	610,792	109,208	88,203	523,764	31,011	554,775	56,017	---	56,017
16000	SYSTEMS INTEGRATION	93,000	---	8,889	78,485	986	79,471	13,529	---	13,529
17000	PROJECT MANAGEMENT	692,000	---	90,867	682,818	(1) 23,957	706,775	(14,775)	---	(14,775)
	CONTINGENCY	102,000	---	---	---	---	---	102,000	---	102,000
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	TOTAL VLA	16,764,765	321,235	2,588,090	12,727,056	3,573,558	16,300,614	464,151	---	464,151

(1) Includes uncommitted accrued liabilities totaling \$14,476 that will be reversed in January and expensed against common cost.

TOTAL PROJECT  
VERY LARGE ARRAY

STATUS AS OF DECEMBER 31, 1976

	<u>ALLOCATION</u>	<u>TRANSFER TO FIXED ASSETS</u>	<u>EXPENDED MONTHLY</u>	<u>TOTAL EXPENDED</u>	<u>TOTAL COMMITT.</u>	<u>TOTAL</u>	<u>BALANCE</u>	<u>OUTSTANDING OBLIGATIONS PENDING</u>	<u>NET BALANCE</u>
SITE/WYE	9,054,365	2,778,041	456,926	8,540,095	349,863	8,889,958	164,407	---	164,407
ANTENNA	10,808,219	2,422,125	1,643,595	7,882,745	2,922,138	10,804,883	3,336	---	3,336
ELECTRONICS	7,279,934	---	299,174	6,836,839	247,385	7,084,224	195,710	---	195,710
COMPUTER	2,139,365	389,224	88,953	1,974,556	33,091	2,007,647	131,718	---	131,718
SYSTEMS INTEGRATION	139,000	---	8,889	125,036	995	126,031	12,969	---	12,969
PROJECT MANAGEMENT	1,588,961	---	90,867	1,576,067 <sup>(1)</sup>	24,217	1,600,284	(11,323)	---	(11,323)
CONTINGENCY	102,066	---	---	---	---	---	102,066	---	102,066
TOTAL	31,111,910	5,589,390	2,588,404	26,935,338	3,577,689	30,513,027	598,883	---	598,883
CY-77 FUNDING	7,000,000	---	190,093	190,093	4,565,940	4,756,033	2,243,967	---	2,243,967
VLA TOTAL	38,111,910	5,589,390	2,778,497	27,125,431	8,143,629	35,269,060	2,842,850	---	2,842,850

(1) Includes uncommitted accrued liabilities totaling \$14,476 that will be reversed in January and expensed against common cost.

VLA--FINANCIAL STATUS REPORT  
(in thousands)

As of: December 31, 1976

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Item	Project Ceiling	Allocation to Date			Unallo- cated Balance	Outlook			Notes
		Allocated	Expended and Committed	Allocated Balance		Est. to Complete	Est. Total	(Over) Under Ceiling	
Site and Wye	27,860	11,832	11,668	164	16,028	16,055	27,723	137	
Antennas	20,400	13,230	13,227	3	7,170	7,987	21,214	(814)	
Electronics	17,000	7,280	7,084	196	9,720	10,074	17,158	(158)	
Computer	4,850	2,529	2,397	132	2,321	2,948	5,345	(495)	
Systems Integration	400	139	126	13	261	158	284	116	
Project Management	2,650	1,589	1,600	(11)	1,061	1,277	2,877	(227)	
Subtotal	73,160	36,599	36,102	497	36,561	38,499	74,601	(1,441)	
Contingency	2,840	102	---	102	2,738	3,522	3,522	(682)	
Total	76,000	36,701	36,102	599	39,299	42,021	78,123	(2,123)	(4)

Notes: (1) Basis 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.

(4) Does not include 7,000,000 for CY-1977 program plan received on Amendment No. 23 to Contract NSF C-780.

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.)

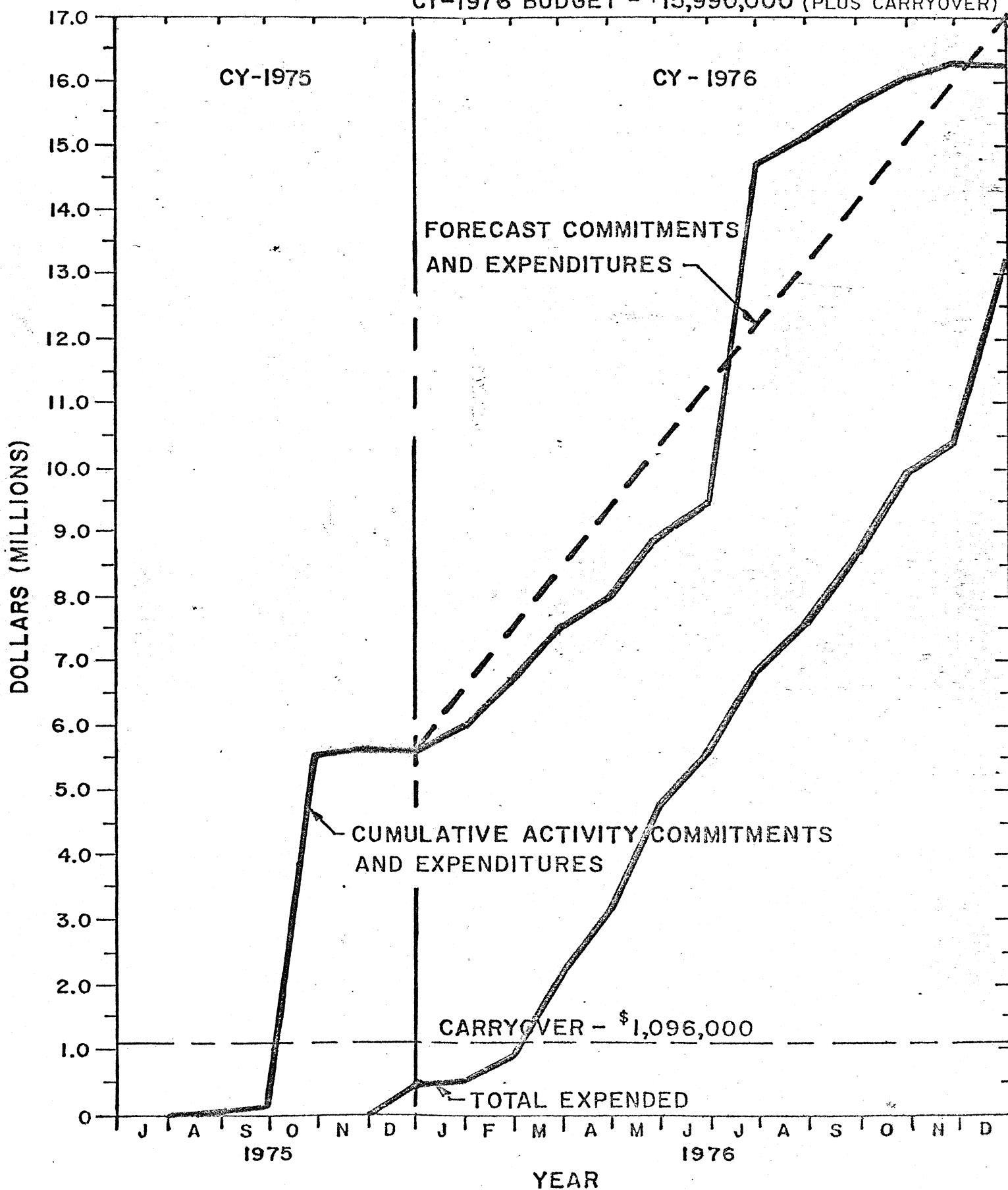
Column (7) - Estimate to Complete: Original estimate updated to take into account current or known costs.

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

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

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

CY-1976 BUDGET - \$15,990,000 (PLUS CARRYOVER)





# NATIONAL RADIO ASTRONOMY OBSERVATORY VLA ACTIVITY SCHEDULE

11/15/76

UPDATE DATE: 1/1/77

73 74 75 76 77 78 79 80 81 82  
J A O J A O J A O 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 F M A M J J A S O N D J A O J A O J A O J A O J

## ANTENNAS

DESIGN  
ANTENNA ASSEMBLY BUILDING  
TRANSPORTER  
ANTENNAS 1-6  
ANTENNAS 7-28

## ELECTRONICS

DEVELOPMENT  
ELECTRONICS 1-2  
ELECTRONICS 3-28

CENTRAL ELECTRONICS  
SPECTRAL LINE PROCESSOR

## SITE & WYE

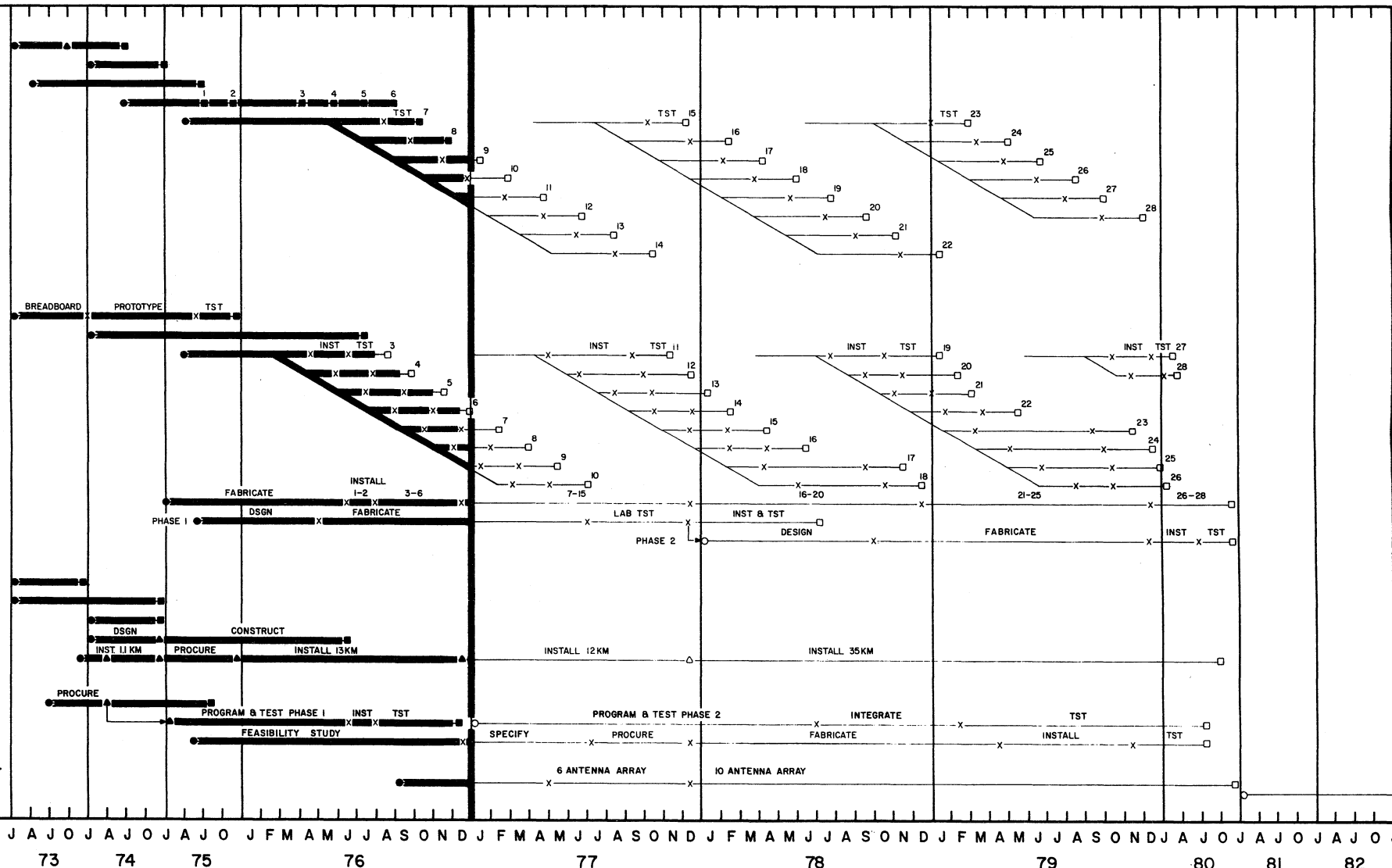
DESIGN  
SITE ACQUISITION  
INITIAL CONSTRUCTION  
CENTRAL SITE & BUILDINGS  
WYE CONSTRUCTION

## COMPUTERS

SYNCHRONOUS  
ASYNCHRONOUS  
SPECTRAL LINE HARDWARE

## SCIENTIFIC OPERATIONS

ARRAY TEST & PRELIM OPNS  
FULL



### SYMBOLS

O START OF A PHASE  
X END OF AN ACTIVITY  
△ CONTRACT AWARD  
□ END OF A PHASE

### ABBREVIATIONS

DSGN - DESIGN  
LAB - LABORATORY  
TST - TEST  
PREL - PRELIMINARY  
OPNS - OPERATIONS  
RAT - RATION

REV. NO.	REV. DATE	REVISION