

OCTOBER 1976

NATIONAL RADIO ASTRONOMY OBSERVATORY

OCTOBER PROJECT REPORT

VLA PROJECT

November 19, 1976

NATIONAL RADIO ASTRONOMY OBSERVATORY

MONTHLY PROGRESS REPORT

VLA PROJECT

October 1976

SITE AND WYE

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

All antenna station spur trackage and interchange areas have been completed. Alignment and grading of the main line trackage is 80% complete. Grouting of antenna foundation base plates is 75% complete. The total contract is estimated at 97% complete.

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

This contract is now 100% complete.

Waveguide

Waveguide installation is proceeding toward antenna station BW-8.

ANTENNA DIVISION

Antenna No. 6

Outfitting on the maintenance pad continued with installation of the subreflector, completion of waveguide and touch-up painting remaining for completion.

Antenna No. 7

Servo and acceptance testing was completed, and the antenna was accepted on October 29, 1976. Servo tests revealed a natural frequency of 2.25 cycles/second in E1, and a natural frequency at 2.2 cycles/second in Hz.

Antenna No. 8

Assembly of the structure has been completed to the point of the final adjustment of the reflector panels.

Antenna No. 9

Structural materials, panels, and mechanical equipment on hand at Site ready for assembly.

Antenna No. 10

Trial assembly in progress in Hobbs.

Antenna No. 11-28

75% of the structural materials have arrived in Hobbs. The fabricator has started cutting and fabricating of detail parts for Antennas 11-14.

SYSTEMS INTEGRATION DIVISION

The following observing sessions were conducted this month:

October 4-6	25 hours of interferometer testing at 6 cm with 3 antennas, 8 hours of 2, 1.3 cm interferometry, and 6 cm feed tests.
October 18-20	36 hours of observing on program AJ-1, Astrometry, with 3 antennas.
October 26-28	11 hours of interferometer testing with 4 antennas, and 12 hours with 2 antennas.

ELECTRONICS DIVISION

Five of the new 18-21 cm feeds have been ordered and should be ready to put on antennas in January 1977. More tests have been made to investigate the cause of a 2 min.arc. pointing difference between the two linearly polarized beams at 18 cm. A mode filter has been placed between the orthomode-junction and the feed, and the pointing difference was reduced to an acceptable value of 0.5 arc.min.

Single dish tests on Antenna 4 were completed and gave a measured antenna efficiency of 36% compared to an expected value of 43%. The reason for the low efficiency is thought to be an incorrectly aligned subreflector. This will be investigated when some beam patterns can be measured in interferometer mode.

The first of the production run of new 6 cm feeds was installed on antenna 04 allowing the first fringes with a 4 element array to be obtained on October 18. The front-end was installed on antenna 05 and prepared for single dish tests. The compressor and helium lines were installed on antenna 06.

Tests of the new L2 and L3 local oscillator modules have continued and a value of 0.4° per $^{\circ}\text{C}$ at 1200 MHz has been achieved for the temperature coefficient of phase of L2 and L3 combined. This resulted from the use of the slightly more complicated version of L3; the simpler design gave approximately twice as large a coefficient of phase, and will therefore not be used. The 50 MHz harmonic generator in the new L2 will replace the one in the L6 (2-4 GHz Synthesizer) modules; and as the month closes tests are in progress to determine the improvement in phase stability of the L6 output using the new scheme.

Investigation of the curvature of the waveguide between CW5 and CW9 indicates that the increased curvature leading to the loss increases described in last month's report occurs almost entirely in the vertical phase. This suggests soil settlement is the cause, not seasonal variation in moisture. Tests of the waveguide between BW5 and BW6, which was laid with the improved technique for soil compaction, show lower initial attenuation, and a smaller increase after two months than the waveguide buried with the original technique used for CW5 to CW9. During tests with the mechanical mouse in a recently laid section of waveguide between BW7 and BW8, an end of the helix wire became entangled with the mouse cable. The damaged waveguide had to be located, dug up and replaced. This was the first time that the necessity to replace buried waveguide has been encountered, and no unexpected problems occurred. Rotary joints and 20 mm waveguide have been received from the Fujikura Company for Antennas 7 to 10. Extensive tests on models of the sector coupler installed in the waveguide run on the southwest arm were made during the month.

In the development of the spectral processor, checkout of the bread-board version of the recirculator card has been a major item during this month, and is close to being satisfactorily completed. Satisfactory bids on the two custom integrated circuits have been received, and an order will be placed shortly.

Assembly of modems and monitor and control modules for Antennas 7 to 10 is in progress at local electronics assembly companies, and procurements and assembly by the Charlottesville group are on schedule.

COMPUTER DIVISION

Asynchronous Subsystem

During October many of the primary activities of the asynchronous computer group concerned testing, debugging, and augmenting the DEFINED operator-oriented data reduction system. A much faster version of GETVIS to get data from the data base into CANDID was implemented based upon a core routine (GETOBS) written in SAIL. The first maps from roughly calibrated VLA data were obtained and gotten all the way through the system to the COMTAL display screens. The actual first map was made from 6 cm data on Nova Cygni 1975 as observed with the first full three-baseline run on September 21-22.

The least squares solution routine (LSQ) was modified to return not only the solution array, but also the error array and array of correlation coefficients. The MONDAT/MONPLT program to allow access and plotting of monitor data from magnetic tapes were improved and a system of providing this information for each run was implemented. A procedure for attempting to get the data from each test observing run into a data base file in the DEC-10 as soon as possible was begun. Once various problems are eliminated the goal is to provide such a data base and listing of its contents within 24 hours after a test observing run; this is a temporary procedure until the data can be taken from the fixed head disk.

Dr. Carl Bignell joined the asynchronous computer group as an astronomer/programmer.

Synchronous Subsystem

Operation as two subarrays, with two antennas on each subarray was verified by seeing data from both pairs.

A user's manual for the observation preparation program (Computer Memo #133) has been prepared.

The fixed head disk interface to the DEC-10 is working on the I-0 bus, but the direct memory access (necessary for practical use) is not yet working.

PROJECT MANAGEMENT

During the month of October 1976, the VLA project placed 175 purchase orders totaling \$80,211 and Subcontracts or Amendments to Subcontracts that totaled \$206,284. Requests for proposals were also issued for design review of transport vehicle, fabricated metal parts for electronics modules as well as the Invitation for Bid on Site Construction Phase IV.

The take up of rail at Hill AFB, Utah continues.

Personnel

The personnel changes as of October 31, 1976 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	0	7
Antenna	10	0	0	10
Electronics	40	0	2	38**
Computer	13	1	0	14
Systems Integration	4	0	0	4
Project Management	<u>24</u>	<u>0</u>	<u>0</u>	<u>24**</u>
Total	98	1	2	97

* Includes one part-time person

**Includes one temporary person

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 cost
VLA-6	E-Systems, Inc.	28 Radio Telescopes	10/18/73	\$18,131,767	3/1/77	NRAO has taken possession of Antenna Nos. 1 through 7. Antenna 8 is on schedule.
VLA-53	R. F. System	K and Ku Band Feed Horns	1/26/76	\$ 109,168	6/7/76 7/19/76 11/15/76	K and Ku Band Feeds for Antennas 3 through 6 have been received and accepted. Two K and two Ku Band Horns for Antennas 7 through 10 due for delivery 11/15/76. Balance by 12/1/76.
VLA-70 P.O. 52322	Sumitomo Electric USA, Inc.	4373 pieces of waveguide 4480 each coupling sleeves	1/27/75	\$ 1,446,634	1/15/77	2313 pieces of waveguide and 2350 coupling sleeves have been received. 1000 pieces of waveguide and 1030 each coupling sleeves have cleared customs and will be coated approx. 11/30/76. 500 pieces of waveguide and 500 coupling sleeves shipped 11/30/76 from Japan.
VLA-134 P.O. 53578	Air Products and Chemicals, Inc.	Helium Compressors and Cryogenic Refrigerators	8/15/75	\$ 139,545	11/1/76	Delivery of units for Antennas 7 through 10; two units delivered 10/15/76; two units promised by 11/30/76 due to retrofitting with ss tubing after fabrication.
VLA-149	Burn Construction Co., Inc.	Site Construction Phase III	9/25/76	\$3,001,176	10/25/76	Work is Approx. 97% complete.
P.O. 53880	N. M. Tech.	Labor Hour Contract	9/1/75	\$ 15,000	8/31/76	Approx. \$9,219 spent effective 10/31/76.
VLA-160 P.O. S-00120	Wutzke RR Tie Co.	20,000 Used Cross Ties	10/17/75	\$ 109,000	12/31/75	Balance of 1650 cross ties cancelled for convenience of government.

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
P.O. S-00271	Timber Mtn. Forrest Products	20,000 Used Cross Ties	10/17/75	\$ 115,000	12/31/75	Balance of 3710 cross ties cancelled for convenience of government.
VLA-174	Lawrence Hefner	Provide Labor and Equipment	1/26/76	\$ 62,400	2/28/77	Approx. \$47,093 spent effective 10/31/76.
VLA-177 P.O. S-00985	Fujikura Cable Works Ltd.	Waveguide Coupling Components	3/5/76	\$ 134,985	6/11/76 10/30/76	Partial shipments are on schedule.
P.O. S-01147	Fujikura Cable Works Ltd.	Rotary Joints	3/30/76	\$ 7,660	10/30/76	Five each received 11/2/76. Balance due for shipment 11/15/76.
VLA-179 P.O. S-01046	AIL Div. of Cutler Hammer	Parametric Amplifiers	4/29/76	\$ 62,320	10/12/76	Four due to be tested 11/15/76. Balance due to be tested 11/30/76.
P.O. S-01946	Industrial Design Engineering Assoc.	Labor Hour Contract for Temporary Draftsman	7/21/76	\$ 9,100	1/26/77	Draftsman is working in drafting section at 2015 Ivy Rd., Charlottesville, Va. \$4,773 spent effective 10/31/76.
P.O. S-01984	J. J. Gustincic Consulting Engr.	Consultant Agreement	8/2/76	\$ 4,000	12/31/76	Consultant on K, Ku and C Band Horn. \$600 spent effective 10/31/76.
VLA-211 P.O. S-02412 P.O. S-02524	Executone Systems of New Mexico, Inc.	VLA Wye Comm. System	10/5/76	\$ 72,980.83	3/30/77	Cable is due to be delivered 11/20/76. Major part of installation is due to be completed by 12/31/77.
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 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. II for Inspection of Site Construction Phase IV	\$ 49,086	-----	-----	10/28/76	11/15/76	Amendment No. II covers price for inspection of certain aspects of Site Construction Phase IV.
VLA-6	Amendment No. 19 for Antennas 11-20	\$3,330,636	-----	-----	10/14/76	11/1/76	Amendment No. 19 authorizes E-Systems to complete antennas 11-20 and releases \$3,330,636 for completion.
VLA-29	Amendment No. 3 for Sterling Mounts 11-16	\$ 195,450	-----	-----	10/5/76	11/1/76	Amendment No. 3 excises AUI's option to purchase sterling mounts for antennas 11-16.
VLA-70	Change Order No. 4 to P.O. 052322	\$ 355,152.50	-----	-----	10/8/76	11/1/76	Change Order No. 4 is to purchase 5000 additional meters of TE ₀₁ waveguide.
VLA-229	128 K Words of Main Memory	\$ 50,000	9/9/76	9/29/76	11/5/76	11/20/76	Proposals solicited from four companies. Three proposals undergoing technical evaluation.
VLA-230	Site Construction Phase IV	\$1,500,000	10/4/76	11/4/76	11/22/76	12/15/76	Bid closing date was extended from 11/4/76 to 11/11/76 due to question over Davis-Bacon wage rates. Bids were solicited from 35 companies.
VLA-233	Custom Integrated Circuits	\$ 164,000	9/24/76	10/15/76	10/20/76	11/15/76	Proposals solicited from fifteen companies. Three proposals received. Contract submitted to NSF for approval 10/20/76.
VLA-234	Design Review of Transport Vehicle	\$ 20,000	9/28/76	11/1/76	11/15/76	11/30/76	E-Systems, the only bidder, asked for extension of bid closing to 11/4/76.
VLA-240	Fabricated Metal Parts	\$ 60,000	10/28/76	11/23/76	12/1/76	12/15/76	Proposals solicited from five companies.

CY - 1976

VERY LARGE ARRAY

Status as of October 31, 1976

<u>Project Number</u>	<u>Description</u>	<u>Allocation</u>	<u>Monthly</u>	<u>Expended</u>	<u>Committed</u>	<u>Total</u>	<u>Balance</u>	<u>Outstanding Obligations Pending</u>	<u>Net Balance</u>
11000	Site and Wye	5,067,000	207,051	4,033,439	867,864	4,901,303	165,697	26,910	138,787
12000	Antenna System	7,721,000	896,828	3,069,604	4,594,097	7,663,701	57,299	33,063	24,236
13000	Electronic System	2,691,000	93,088	1,748,573	464,829	2,213,402	477,598	216,706	260,892
14000	Computer System	720,000	24,566	476,505	107,034	583,539	136,461	44,690	91,771
16000	Systems Integration	93,000	5,060	62,538	2,411	64,949	28,051	12,332	15,719
17000	Project Management	672,000	51,999	535,263	48,918	584,181	87,819	60,398	27,421
	Contingency	122,000	---	---	---	---	122,000	---	122,000
Total VLA		17,086,000	1,278,592	9,925,922	6,085,153	16,011,075	1,074,925	394,099	680,826

TOTAL PROJECT
 VERY LARGE ARRAY
 Status as of October 31, 1976

<u>Project Number</u>	<u>Description</u>	<u>Allocation</u>	<u>Monthly</u>	<u>Expended</u>	<u>Committed</u>	<u>Total</u>	<u>Balance</u>	<u>Outstanding Obligations Pending</u>	<u>Net Balance</u>
11000	Site and Wye	11,832,406	222,051	10,754,344	880,778	11,635,122	197,284	26,910	170,374
12000	Antenna System	13,230,344	896,828	8,577,225	4,594,752	13,171,977	58,367	33,063	25,304
13000	Electronic System	7,279,934	93,241	6,315,877	465,863	6,781,740	498,194	216,706	281,488
14000	Computer System	2,528,589	24,566	2,206,563	132,427	2,338,990	189,599	44,690	144,909
16000	Systems Integration	139,000	5,060	109,039	2,420	111,509	27,491	12,332	15,159
17000	Project Management	1,568,961	52,216	1,428,512	49,177	1,477,689	91,272	60,398	30,874
	Contingency	122,066	---	---	---	---	122,066	---	122,066
Total VLA		36,701,300	1,293,962	29,391,610	6,125,417	35,517,027	1,184,273	394,099	790,174

VLA--FINANCIAL STATUS REPORT
(in thousands)

As of: October 31, 1976

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Item	Project Ceiling	Allocation to Date			Unallocated Balance	Outlook			Notes
		Allocated	Expended and Committed	Allocated Balance		Est. to Complete	Est. Total	(Over) Under Ceiling	
Site and Wye	27,860	11,832	11,635	197	16,028	16,088	27,723	137	
Antennas	20,400	13,230	13,172	58	7,170	8,042	21,214	(814)	
Electronics	17,000	7,280	6,782	498	9,720	10,376	17,158	(158)	
Computer	4,850	2,529	2,339	190	2,321	3,006	5,345	(495)	
Systems Integration	400	139	111	28	261	173	284	116	
Project Management	2,650	1,569	1,478	91	1,081	1,399	2,877	(227)	
Subtotal	73,160	36,579	35,517	1,062	36,581	39,084	74,601	(1,441)	
Contingency	2,840	122	---	122	2,718	3,522	3,522	(682)	
Total	76,000	36,701	35,517	1,184	39,299	42,606	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.)

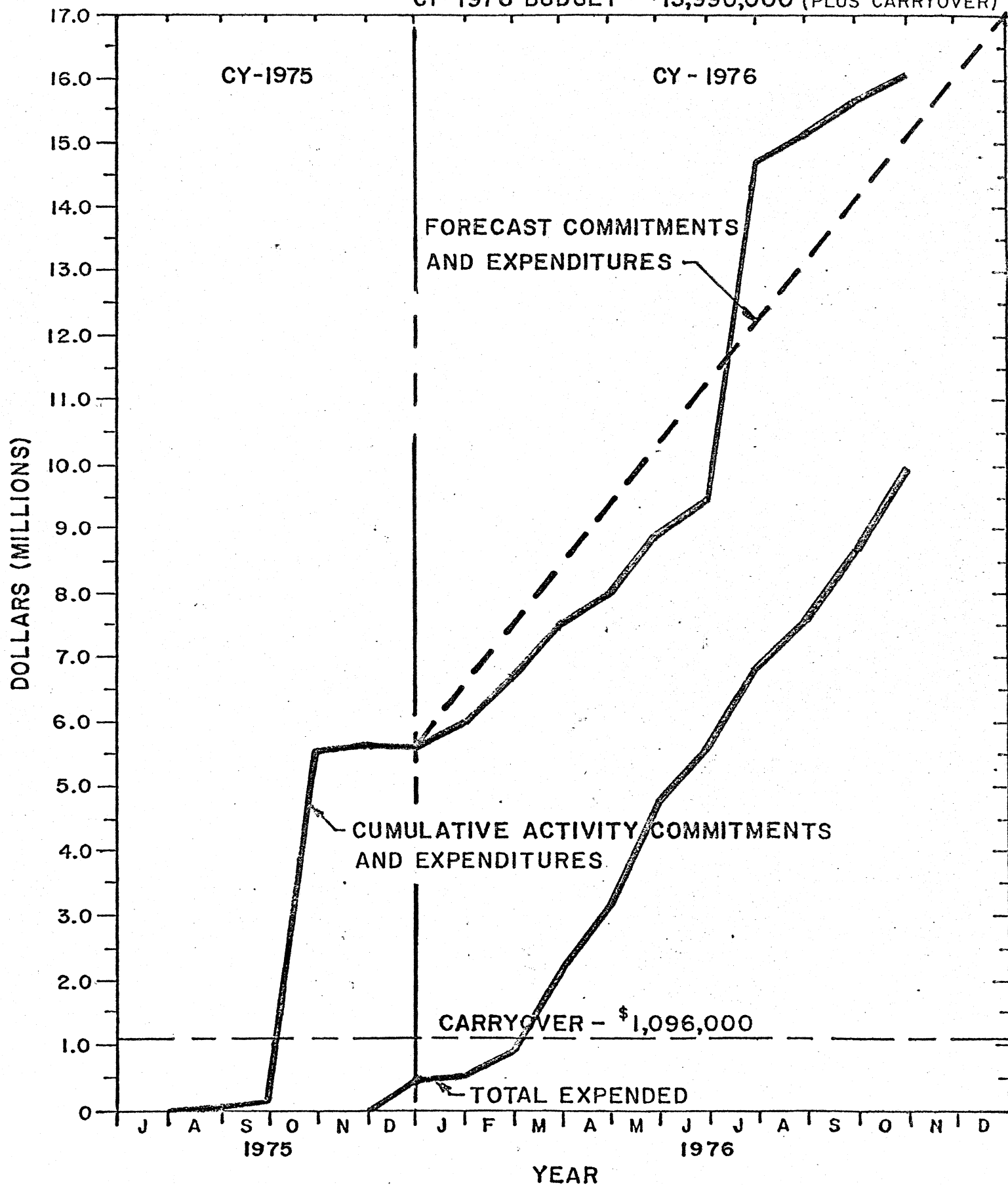
Column (7) - Estimate to Complete: Original estimate updated to take into account current or known costs.

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

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

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

11/15/75

UPDATE DATE: 11/1/78

