

NOVEMBER 1976

NATIONAL RADIO ASTRONOMY OBSERVATORY

NOVEMBER PROJECT REPORT

VLA PROGRAM

DECEMBER 13, 1976

NATIONAL RADIO ASTRONOMY OBSERVATORY

MONTHLY PROGRESS REPORT

VLA PROGRAM

NOVEMBER 1976

SITE AND WYE

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

Alignment and final grading of the main line trackage is 93% complete and maintenance vehicle spur line is 90% complete.

All antenna station spurs and interchanges are complete as is the grouting of the base plates.

This contract is now 98% complete.

Waveguide

Between antenna stations BW6 and BW7, approximately 2400 feet has been assembled in the trench and 200 feet has been set to line and grade and shaded with backfill material. Backfilling and installation of zinc strips has been completed from stations CW9 to BW6, and BW7 to BW8.

ANTENNA DIVISION

Antenna No. 4

Moved to CW8 on November 17, 1976.

Antenna No. 6

Outfitting was completed and the antenna was moved to DW8 on November 9, 1976.

Antenna No. 7

Moved to Maintenance Pad on November 10, 1976. Outfitting is progressing.

Antenna No. 8

Moved to Master Pad on November 15, 1976.

Antenna No. 9

Assembly is progressing in the Assembly Building.

Antenna No. 10

Partial delivery of material at Site.

SYSTEMS INTEGRATION DIVISION

The following observing sessions were conducted this month:

November 1-3	Program AB1, Brown (NRAO) and Condon (Virginia Polytechnic Institute), Study the Spectral Index of Objects Identified with Neutral Colored Optical Sources. 23 hours of observing with 4 antennas at C and K Bands.
November 8-10	32 hours of interferometer test and calibration.
November 11-15	Program AH2, Hjellming, Clark, and Brown (NRAO), Detailed Spectra of Radiosources. 82 hours of observing with 4 antennas at all bands.
November 29-December 1	37 hours of interferometer test and calibration.

For all these sessions Antennas 1 to 4 were in use at stations DW2, DW3, CW7, and CW9. By the end of the month Antennas 1 and 2 were outfitted for all bands, Antennas 3 and 4 were outfitted for 6, 2, and 1.3 cm.

ELECTRONICS DIVISION

In the feed area the polarization of the present 2 cm band feeds was measured by determining the instrumental polarization of the VLA antennas at the 3 dB points of the beam. The instrumental linear polarization averaged 1 to 2% around the 3 dB circle with a worst case value of 4%. This is probably acceptable, but a corrugated horn will also be tried for comparison next month. A first attempt at correcting the circular polarization beam squint by mode generation in the feed was made using the C Band horn. No significant reduction in beam squint was obtained and later analysis showed that the modes generated, a pair of orthogonal  $TE_{21}$  modes, were not the correct ones. A new mode generator to provide a  $TE_{21}$  and a  $TE_{01}$  mode will be tested in the near future.

Delivery of the new 4.5-5.0 GHz paramps is now 3 months late. The problem is an unexpected resonance in the passband of the circulator, and AIL is giving it their full attention. Comtech Labs found that 2 paramps returned to them for repair failed because of cracked substrate. Operational front ends are being monitored to determine if this cracking is likely to be a characteristic of all the Comtech paramps.

A second module of the new L2 design has been completed and a second new L3 is well advanced. Two each of these local oscillator modules are required before tests of their performance in the system can be made. It is planned to make such tests on Antennas 6 and 7 early in 1977. Detailed investigation of the phase stability of other local oscillator modules has proceeded, and the use of the L2 harmonic generator to provide reference frequencies to the 2-4 GHz Synthesizer (L6), as planned in the modified system, has been found to reduce the temperature coefficient of phase of the L6 output by a factor of 10. Measurements are also being made on the Fringe Generator (L7) module although here the performance of the original design is much more nearly satisfactory than in some other cases. Some design improvements are also receiving attention in the master local oscillator system, involving the L17 module that provides the fine tuning capability at the Control Building.

Waveguide connection out to station BW8 has almost been completed, and only a short section near BW6 remains to be installed. The attenuation of the original 1.24 km length from CW5 to CW9 was remeasured on November 17 and essentially no change was found over the two month period since the previous measurement. Waveguide has been installed on Antenna 6.

Equipment for Antennas 7 to 10 currently in assembly by Bira Inc. of Albuquerque includes modems and monitor and control modules. These modules will incorporate all design modifications that have been found necessary as a result of operating experience over the past year. Construction by the Charlottesville group for the same antennas is well advanced, and for 150 out 180 units all assembly and wiring has been completed and final testing is in progress. For the spectral processor a development contract for the custom integrated circuits has been let to Silicon Systems of Irvine, California and a first design review is expected to take place in mid-December.

#### COMPUTER DIVISION

##### Asynchronous Subsystem

A new program was written to read the Modcomp data tapes and produce a listing, in sequential time order, of 10 second records for up to 12 correlators. This avoids the slowness of CANDID and intricacies of the data base which are not necessary for such a listing.

In CANDID, an operator to give a full listing of the VISDATA structure was improved. The basic TYPE operator was improved; it senses whether the program is running in batch or interactive mode and prints out the appropriate number of characters for the line printer or the terminal screen. Routines to use the VISDATA structure's correlator-based data and solve for the antenna-based gain and phase calibration factors are being developed.

The programs which read and plot monitor data have been improved. Batch jobs have been set up which retrieve a standard set of monitor data and plot it after every observing run.

The optimization of CANDID is progressing, with factors of at least 2 to 3 increase in speed and an overall reduction in program size assured. The actual speed and size improvements cannot be reliably predicted, of course. Increased speed (a factor of 2 to 3) and reduction in size (factor of 3 to 4) have already been realized in the basic arithmetic operators by recoding them in MACRO. Most of the other changes currently being implemented must be incorporated all at once since they involve fundamental parts of CANDID. Major areas of work where greater efficiency and reduction in size can be obtained by recoding in MACRO, reorganization, and more efficient SAIL code are: interpretation, symbol handling, and storage management.

Design and discussions concerning a new data base format were begun during November. The data base would be implemented using the external file format already planned for CANDID's extended storage. A sequential, optionally sorted, file forms the basic data base design, enabling users to access data with a minimal amount of routines and overhead. Actual implementation is planned to begin in December, with concurrent tests of a simplified data base version.

In October and November Bob Hjellming and Nancy Vandenberg separately visited the Westerbork Synthesis Radio Telescope and related facilities in the Netherlands. Much information concerning WSRT and advice for the VLA was gathered. A report containing information and recommendations will be written.

#### Synchronous Subsystem

November has mostly been a time of small housecleaning chores. The chief changes have been the addition of software to monitor and check the performance of the correlator system, and the first steps in an "easy reload" system, which greatly simplifies and shortens the operator errors. Efforts to interface the fixed head disk to the DEC-10 system continues in both hardware and software. To facilitate the latter, we are sending a programmer to a three week school covering the DEC software system.

#### PROJECT MANAGEMENT

During the month of November we placed 220 procurement transactions, including purchase orders, new subcontracts, and amendments to subcontracts. Total dollars spent was \$4,313,815.00.

The take up of rail at Hill AFB, Utah is complete.

Open house was held on November 7, 1976 at the Site with a full tour of our facilities. Over 2000 people attended.

# Personnel

The personnel changes as of November 30, 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	38	3	0	41**
Computer	14	0	0	14
Systems Integration	4	0	0	4
Project Management	<u>24</u>	<u>2</u>	<u>1</u>	<u>25*</u>
Total	97	5	1	101

\* 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 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 and two Ku Band Horns for Antennas 7 through 10 due for delivery 12/15/76. Balance by 12/30/76.
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	2313 pieces of waveguide and 3780 coupling sleeves have been received. 1400 pieces of waveguide will be coated 12/06/76. 600 pieces of waveguide and 600 coupling sleeves will be shipped 12/30/76 from Japan.
VLA-134 P.O. 53578	Air Products and Chemicals, Inc.	Helium Compressors and Cryogenic Refrigerators	8/15/75	\$ 139,545	11/01/76	Delivery of units for Antennas 7 through 10 was completed in November 1976.
VLA-149	Burn Construction Co., Inc.	Site Construction Phase III	9/25/76	\$ 3,001,176	10/25/76	Work is Approx. 98% complete.
P.O. 53880	N. M. Tech.	Labor Hour Contract	9/01/75	\$ 15,000	8/31/76	Approx. \$10,280 spent effective 11/30/76.
VLA-167	Paul D. Goor 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.



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-174	Lawrence Hefner	Provide Labor and Equipment	1/26/76	\$ 62,400	2/28/77	Approx. \$54,237 spent effective 11/30/76.
VLA-177 P.O. S-00985	Fujikura Cable Works Ltd.	Waveguide Coupling Components	3/05/76	\$ 134,985	6/11/76 10/30/76	Delivery was completed in November 1976.
P.O. S-01147	Fujikura Cable Works Ltd.	Rotary Joints	3/30/76	\$ 7,660	10/30/76	Delivery was completed in November 1976.
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 12/15/76. Balance due to be tested 12/30/76.
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. \$6,173 spent effective 11/30/76.
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 11/30/76.
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	Cable was delivered in November 1976. 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 in 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	Acknowledgement copy of P.O. has not been returned yet.
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.

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-234	Design Review of Transport Vehicle	\$ 20,000	9/28/76	11/01/76	11/15/76	11/30/76	E-Systems, the only bidder, asked for extension of bid closing to 11/04/76.
VLA-240	Fabricated Metal Parts	\$ 60,000	10/28/76	11/23/76	12/15/76	12/30/76	Proposals from three companies are being evaluated.
VLA-244	High-Speed Array Processors	\$ 175,000	11/11/76	12/17/76	1/05/77	1/31/77	Proposals solicited from 13 companies.
VLA-245	Standby Power Source	\$ 70,000	11/19/76	12/13/76	1/30/76	1/15/77	Proposals solicited from 5 companies.

CY - 1976

VERY LARGE ARRAY

Status as of November 30, 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	97,107	4,130,546	780,444	4,910,990	156,010	11,252	144,758
12000	Antenna System	7,721,000	84,050	3,153,654	4,539,096	7,692,750	28,250	17,151	11,099
13000	Electronic System	2,691,000	221,113	1,969,685	435,926	2,405,611	285,389	58,954	226,435
14000	Computer System	720,000	68,264	544,769	85,805	630,574	89,426	22,283	67,143
16000	Systems Integration	93,000	7,058	69,596	3,186	72,782	20,218	5,754	14,464
17000	Project Management	692,000	56,688	591,951	52,057	644,008	47,992	30,394	17,598
	Contingency	102,000	---	---	---	---	102,000	---	102,000
<hr/> Total VLA		17,086,000	534,280	10,460,201	5,896,514	16,356,715	729,285	145,788	583,497

TOTAL PROJECT  
VERY LARGE ARRAY  
Status as of November 30, 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	106,867	10,861,211	782,255	11,643,466	188,940	11,252	177,688
12000	Antenna System	13,230,344	84,050	8,661,275	4,539,751	13,201,026	29,318	17,151	12,167
13000	Electronic System	7,279,934	221,113	6,536,975	436,959	6,973,934	306,000	58,954	247,046
14000	Computer System	2,528,589	68,264	2,274,827	111,199	2,386,026	142,563	22,283	120,280
16000	Systems Integration	139,000	7,058	116,147	3,194	119,341	19,659	5,754	13,905
17000	Project Management	1,588,961	56,688	1,485,200	52,316	1,537,516	51,445	30,394	21,051
	Contingency	102,066	---	---	---	---	102,066	---	102,066
<hr/>									
	Total	36,701,300	544,040	29,935,635	5,925,674	35,861,309	839,991	145,788	694,203
	1977 Funding	7,000,000	---	---	4,270,599	4,270,599	2,729,401	---	2,729,401
	TOTAL VLA	43,701,300	544,040	29,935,635	10,196,273	40,131,908	3,569,392	145,788	3,423,604

# NATIONAL RADIO ASTRONOMY OBSERVATORY

## VLA--FINANCIAL STATUS REPORT (in thousands)

As of: November 30, 1976

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Item	Project Ceiling	Allocation to Date			Unallo- cated Balance	Outlook			No
		Allocated	Expended and Committed	Allocated Balance		Est. to Complete	Est. Total	(Over) Under Ceiling	
Site and Wye	27,860	11,832	11,643	189	16,028	16,080	27,723	137	
Antennas	20,400	13,230	13,201	29	7,170	8,013	21,214	(814)	
Electronics	17,000	7,280	6,974	306	9,720	10,184	17,158	(158)	
Computer	4,850	2,529	2,386	143	2,321	2,959	5,345	(495)	
Systems Integration	400	139	119	20	261	165	284	116	
Project Management	2,650	1,589	1,538	51	1,061	1,339	2,877	(227)	
Subtotal	73,160	36,599	35,861	733	36,561	38,740	74,601	(1,441)	
Contingency	2,840	102	---	102	2,738	3,522	3,522	(682)	
Total	76,000	36,701	35,861	840	39,299	42,262	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.)

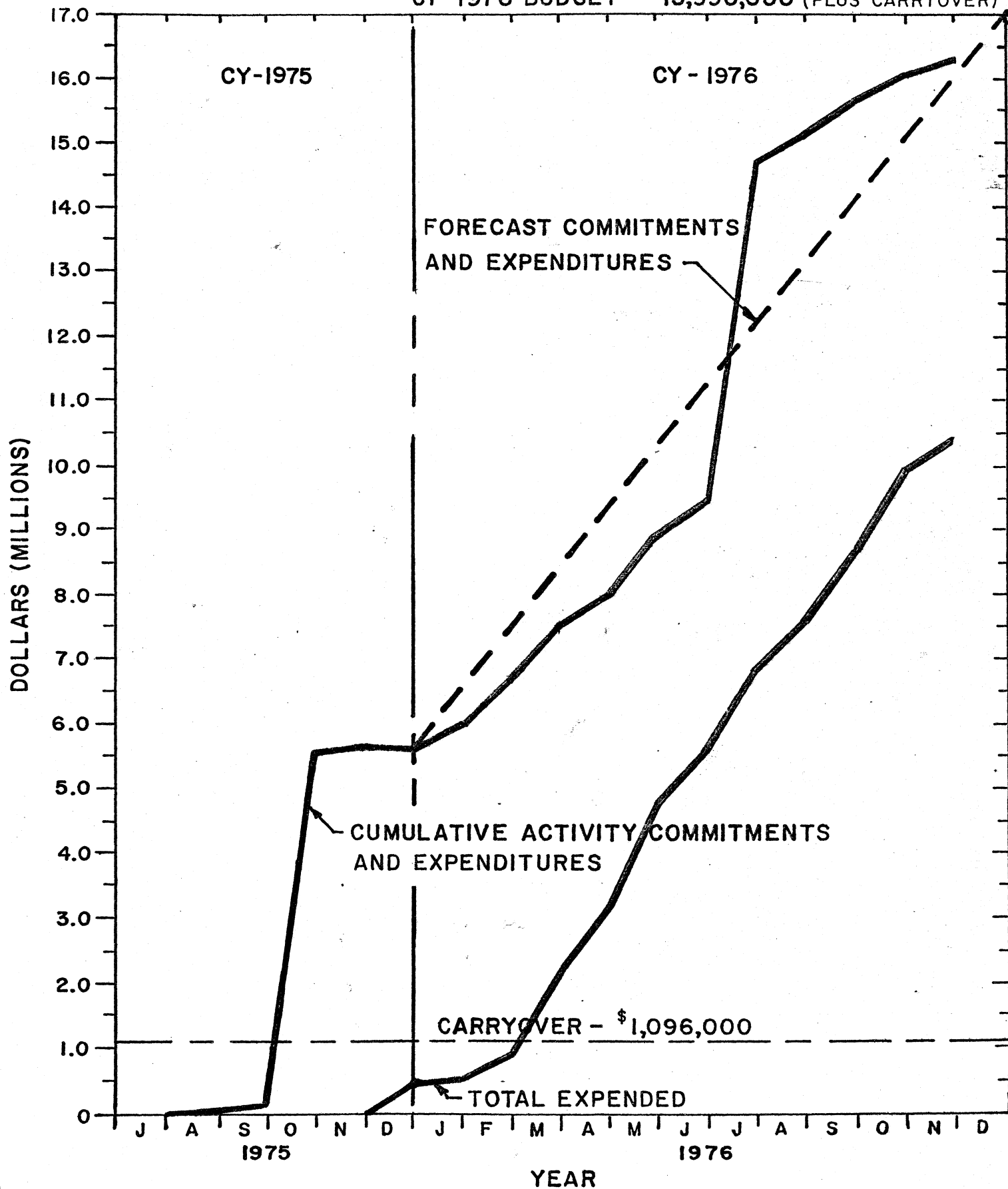
Column (7) - Estimate to Complete: Original estimate updated to take into account current or known costs.

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

UPDATE DATE: 11/15/76

11/15/76

