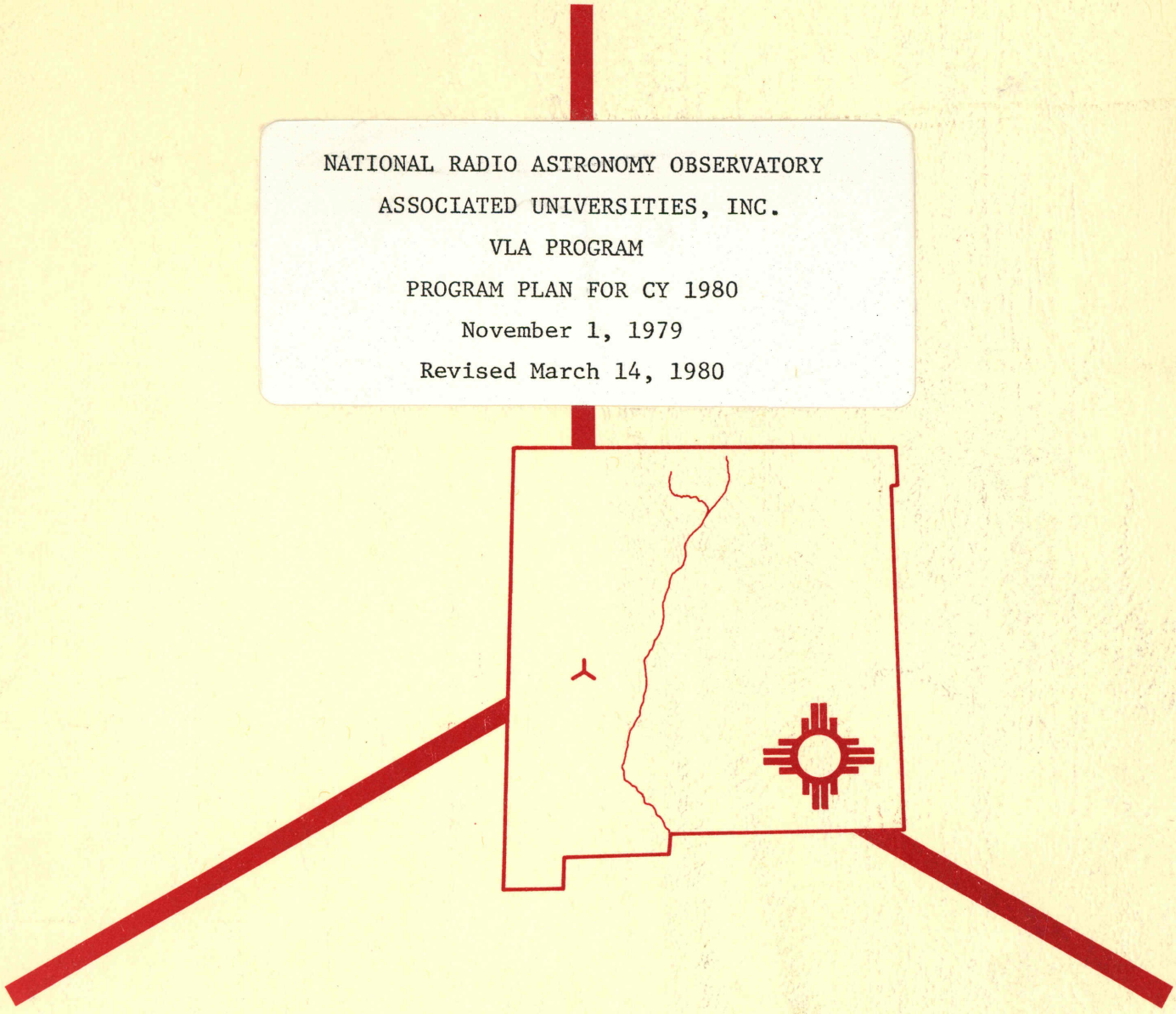
VERY LARGE ARRAY PROGRAM

NATIONAL RADIO ASTRONOMY OBSERVATORY
ASSOCIATED UNIVERSITIES, INC.
VLA PROGRAM
PROGRAM PLAN FOR CY 1980
November 1, 1979
Revised March 14, 1980



NATIONAL RADIO ASTRONOMY OBSERVATORY
P.O. Box 0, Socorro, New Mexico 87801

OPERATED BY ASSOCIATED UNIVERSITIES, INC.

UNDER CONTRACT WITH THE NATIONAL SCIENCE FOUNDATION

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ASSOCIATED UNIVERSITIES, INC.

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Galactic Radio Jets

INTRODUCTION

This update of the Program Plan for the design and construction of the Very Large Array Radio Telescope reports the progress which has been made during the last year, discusses changes that have been made in the previous plan, and forecasts activities to be undertaken during calendar year 1980, the last year of the Program. We expect relatively minor expenditures from the final 1980 construction funding to extend into 1981. Revised cost estimates and commitment schedules are included and discussed. Some sections, such as a description of the instrument and organizational details, are included to ensure that the Program Plan is self-contained to one who is not intimately acquainted with the previous Plans.

The CY 1979 Program Plan, submitted 1 December 1978, was based on funding levels of $11,500,000 in 1979 and $5,160,000 in 1980. It forecast a total Program cost of $79,030,000. By letter of 7 February 1979, the National Science Foundation instructed the National Radio Astronomy Observatory to reduce the level of 1980 funding to $4,700,000, a cut of $460,000. To meet this cut, Visiting Scientists Quarters No. 3 was eliminated from the Program and the scope of the Mass Data Storage was cut from $600,000 to $280,000.

On 31 August 1979, the Foundation increased 1979 funding by $203,000 and later advised NRAO that CY 1980 funding would be reduced to $4,500,000. This results in an overall construction cost estimate of $78,578,000.

A year ago it appeared that funding restrictions would require both a Phase V and a Phase VI wye construction contract. Two small contracts would result in a considerably higher total cost due to duplication of overhead costs. During the Spring of 1979, after receipt of the Davis-Bacon wage determination, it was decided to bid all remaining wye construction work as a single package, using a unilateral option to the contract for work which could not be financed until FY 1980. This procedure worked well and resulted in a savings to the Program of approximately $650,000.

This savings has permitted the inclusion within the present Program Plan of the following items: restoration of Visiting Scientist

Quarters No. 3, estimated to cost $107,000 including furniture; restoration of $220,000 of the $320,000 cut from Mass Data Storage System; inclusion of water sprinkler fire protection systems for seven small buildings, estimated to cost $120,000; and the inclusion of an addition to the Library-Office Building to house the Map/Image Processor equipment, estimated to cost $105,000 including furniture.

The estimate includes a contingency of $582,000 although, in accord with the Foundation letter of 7 February 1979, $400,000 of this sum has been immobilized for potential state tax liabilities. In a letter to the Foundation dated 15 March 1979, NRAO objected to fixing any part of the construction contingency to a specific item since it in essence abrogates our project management responsibilities. A decision against the State was issued 2 April 1979 in United States District Court, Santa Fe, preventing the State from assessing gross receipt and compensation tax. The State filed a notice of appeal on 15 June 1979. Both the State and the Unived States have filed briefs with the Tenth District Court of Appeals in Denver. No hearing date has yet been set.

During the past two years we have been able to use the VLA in its partially completed state for system tests and calibration, as well as for astronomical observations. We have been able to schedule typically 17 antennas for approximately 50 percent of the time, the remainder being used for construction. The response of the astronomical community is overwhelming. Excellent and exciting results have been obtained and are appearing in the literature. VLA maps have been featured on the covers of SCIENCE (31 August 1979) and of NATURE (11 October 1979).

We enter the final year of construction with an optimistic hope of finding a significant fraction of our contingency, $582,000, uncalled for. We also have hopes of effecting further savings during this construction period. Any such savings, as well as unneeded contingency funds, will represent a reduction in the total construction costs of the VLA. If such a situation does occur and we find ourselves able to return monies to the Foundation, we would feel obligated to call attention to those items not included in the present Program Plan which we consider important for the future efficient operation of the VLA. These include dichroic reflectors, a Visitor's Center and a

second map/image processor. We propose, at a later date, to request funding approval for a least some of these items from any remaining funds from the current budget as the financial picture becomes clear or near the end of construction.

It is the intention of the National Radio Astronomy Observatory that activities during CY 1980 will follow the detailed Program Plan set forth. Should unforeseen conditions arise which require a major shift of emphasis or change the material or data presented in any substantial manner, the 1980 Plan will be revised.

SUMMARY

CY 1979 saw the continuation of scientific operations at about the same level as in 1978 although construction and test operations maintained their priority. In March of 1979 a decision was made to limit the number of antennas operating at one time to 17 and to hold operating time to approximately 50% of the available hours each month. The reason behind this decision was that VLA manpower was not sufficient to construct the remaining antenna systems and at the same time operate and maintain the existing systems at a level above 17 antennas operating 50% of the time. An additional reason was that the computers had to be available for software development about 50% of the available hours. This condition will continue until about mid-summer of 1980 when additional antennas will be integrated into the system and hours of operation will increase, until by January 1981 the VLA will be operating with 27 antennas in excess of 90% of the available hours.

During November 1979 twenty-three antennas will have obtained first fringes and twenty-one will have been declared operational. The maximum "on wye" baseline in use will be 27.6 km from Antenna Station AW8 on the West arm to Antenna Station AE6 on the East arm. In addition, the North arm of the wye is in use out to Antenna Station CN7 at 1.1 km from the center. Downtime, which averaged 12% for the 1978 year, has stayed about the same during 1979. This is based on all four receiving wavelengths being operational. A considerable effort to make the various elements, including software, more dependable was launched in 1979 and will be continued during 1980. Lack of qualified manpower has hampered this effort. Additional details are included on Figure 5, Operational Summary of the VLA.

Fabrication of the antennas will be completed on 9 November 1979 as scheduled some years ago. Transporter No. 2 will be tested and accepted by April. Manufacture and installation of the electronics have proceeded close to schedule and a number of retrofits have been made to improve system performance and reliability. Development of the software

for the computer systems has kept pace with the expanding requirements of the astronomers. By years end all computer system hardware will be under order with the exception of the mass data storage system. In this area procurement will be delayed to see if the optical disk technology will be perfected. If so, it will result in an order of magnitude reduction in cost per bit. Site and Wye construction proceeded well and at present all remaining wye work is under firm price contract.

CY 1980 will see the continued mechanical and electronic outfitting of antennas with first fringes for Antenna No. 28 scheduled for July 1980. The balance of the year will be devoted to tuning up all antenna and electronic systems so that all will be in proper working order by the end of the year. In the computer area, 1980 will be devoted to improving the continuum software and perfecting the spectral line software. The Fast Fourier Transform system will be installed and made operational, and by mid-year the mass storage hardware will be placed on order. The wye construction should be completed by October and the installation of the 60 mm waveguide system by the end of the year. During 1980 an addition to the Library-Office Building to house the Observer Map/Image Processor will be completed as will be the Visiting Scientist Quarters No. 3. The first Observer Map/Image Processor is scheduled for installation in mid-1980.

Near the end of 1980 the VLA construction Program will be completed. At that time some 35 employees will have to be terminated.

DESCRIPTION OF THE INSTRUMENT

Higher resolution and sensitivity have always been major goals of radio astronomy instrumental development. The general concept of a very large antenna system that could obtain radio pictures with very high resolution, sensitivity, and speed was developed in the early sixties. The initial studies at the NRAO in 1961 and 1962 led to the detailed design beginning in 1964. The design study was carried out by the NRAO staff, with the assistance of a number of radio astronomers from other institutions, and it resulted in the Proposal for the Very Large Array (VLA), published in 1967 (Vols. I and II), 1969 (Vol. III), and 1971 (Vol. IV).

In order to achieve the desired angular resolutions, a radio telescope with dimensions of 35 km (23 miles) is needed. Since a conventional radio telescope having these dimensions is impossible to construct, other techniques which will simulate such a telescope must be used. By interconnecting several separated, smaller diameter antennas, the information leading to the desired resolution can be obtained. Many configurations of the antenna elements are possible, and careful studies of this problem, with the purpose of optimizing the use of a relatively small number of antennas, have resulted in the VLA system, consisting of 27 antennas, each 25 meters (82 feet) in diameter, distributed along three 21 km (13 mile) arms of an equiangular wye. All the antennas will be movable over railroad tracks so that the picture area (field of view) and the resolution may be varied within wide limits. In this respect, the VLA is similar to a zoom lens.

Each antenna element consists of a steel structure carrying a shaped reflector which is movable in azimuth and elevation in order to be able to point to any part of the sky. The reflector structure supports an aluminum reflector surface consisting of 172 aluminum panels. The surface accuracy and the precision of the drive system

permit operation at wavelengths as short as 1.2 cm. During operation, the antennas are placed on observing stations. Seventy-two such stations will permit the four different configurations planned for the array. The antennas will be moved between observing stations by two transport vehicles; one such transporter is now available, running on a double, standard gauge railroad track system, and a second will be ready for use in early 1980. A reconfiguration of the antenna system, using two transporters, is estimated to take a maximum of about thirty-six hours. When the railroad tracks are not used for moving antennas, they will be used for transportation of maintenance personnel and equipment.

The initial operating wavelengths for the system will be 21 cm, 6 cm, 2 cm, and 1.2 cm, with full polarization measurement capabilities. Spectral line capabilities for the array are also being developed.

The central computer system will control the telescopes, monitor the system performance, and collect and analyze the data. The system output will consist of high resolution maps of the observed objects.

Power and telephone communications between the central site complex and the observing stations will be distributed through buried cables. Signal and local oscillator distribution, as well as control and monitor signals of all antenna functions, will be accomplished by a buried circular waveguide system.

The central building complex consists of several buildings. A 22,060 square foot Control Building houses the control room, central electronic equipment, digital delay equipment, large central computers, specialized shops, laboratories, and office space. Three small, prefabricated metal buildings, which total 20,000 square feet, house maintenance shops, the electronic and cryogenic shops, storage facilities, and office space. The subcontractor, who is fabricating and assembling the antennas, has constructed a 14,600 square foot Assembly Building, which he will use during his contract and which

will be available for later use for antenna maintenance. In addition, a 5,320 square foot Cafeteria Building and a 2,400 square foot Office-Library Building have been constructed, and a grouping of Visiting Scientist Quarters will be constructed, as well as necessary site work, water supply, sewage, electric utility, and similar facilities.

ORGANIZATION

Program Organization

The NRAO organization is shown on the accompanying Organization Chart (Figure 2). The VLA has been designed and is being procured as a program of the NRAO, with the observatory being its own "prime contractor" for the job. Overall responsibility for the design and procurement of the VLA rests with the Director of the NRAO, who, in turn, is responsible to the President of the Board of Trustees of AUI. AUI, in addition to its internal trustee committees, has the NRAO Visiting Committee to assist it in reviewing and evaluating the performance of the NRAO. The Director has the NRAO Users Committee, the VLA Advisory Committee, and the VLA Post-Processing Committee to assist and advise him on VLA matters. A description and the membership of each of these committees is given in Appendix A.

Within the NRAO, primary responsibility for the VLA design has been assigned to H. Hvatum, Associate Director. Responsibility for the construction implementation has been assigned to J. H. Lancaster, Assistant Director and VLA Program Manager. On June 7, 1978, C. M. Wade was appointed Assistant Director for VLA Operations.

Program Implementation and Staffing

Implementation of the VLA, including the contracting and managing of all fabrication and construction, is the responsibility of the Program Manager. This work is being carried out according to previously agreed upon drawings, specifications, budgets, and time schedules.

On January 1, 1973 the Program was officially begun with the transfer of 15 existing NRAO staff members to the VLA. This staff has gradually increased since then to the present level of 127 full-time members. Beginning in January 1977, at the start-up of scientific operations, the staff was divided for cost-keeping reasons into Construction, Operations, and Common Cost centers. This breakdown is shown on Page 9.

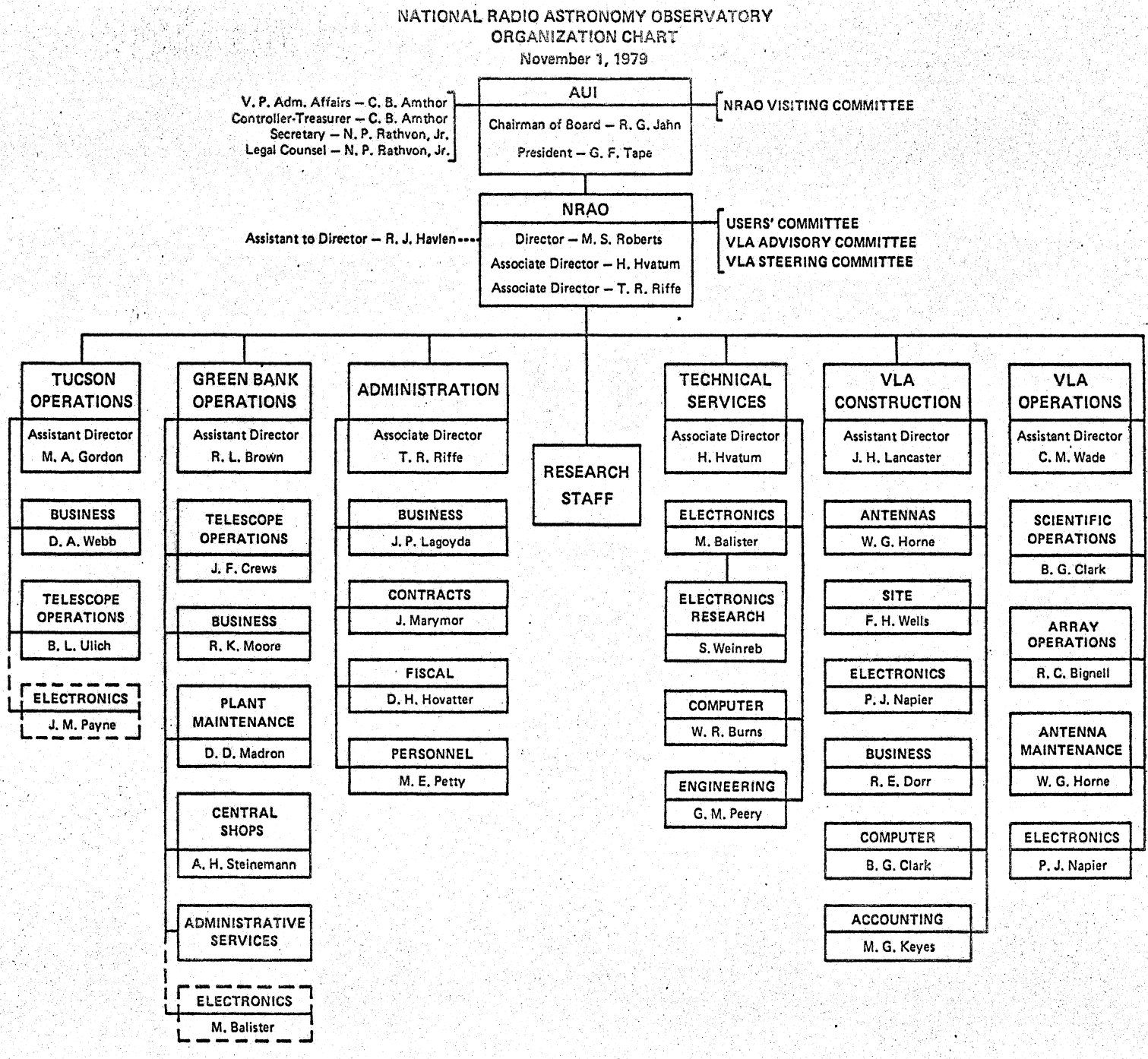
	1978 Program Plan Forecast 12/31/79	Present Level 11/01/79	Present Forecast 12/31/79	Planned Level 12/31/80
CONSTRUCTION GROUP				
Antenna	5	5	5	2
Electronics	29	26	29	20
Computer	5	5	5	2
Systems Integration	0	0	0	0
Site and Wye	2	2	2	2
Program Management	3	2	2	2
TOTALS	44	40	43	28
COMMON COST GROUP				
Business	20	19	20	19
Fiscal	5	5	5	5
Plant Maintenance	7	7	7	7
TOTALS	32	31	32	31
OPERATING GROUP				
Site Management	4	4	4	6
Antenna Division	12	9	12	15
Electronics Division	24	24	24	28
Computer Division	9	9	9	12
Operations Division	11	10	11	13
TOTALS	60	56	60	74
TOTAL FULL-TIME PERSONNEL	136	127	135	133

Although for costing purposes the staff is split into Construction, Operation and Common Cost centers, it cannot be split so in actual practice except at the penalty of very inefficient operations. Each of the groups responsible for a specific technical portion of the construction and operation of the Array works together and reports to a single Group Leader. In this manner the maximum manpower may be utilized where priorities indicate. On June 7, 1978, a Telescope Operations Division was formed, reporting directly to Dr. Wade. The distribution of the staff by groups is shown in Figure 3, and a manpower summary graph is included in Figure 4.

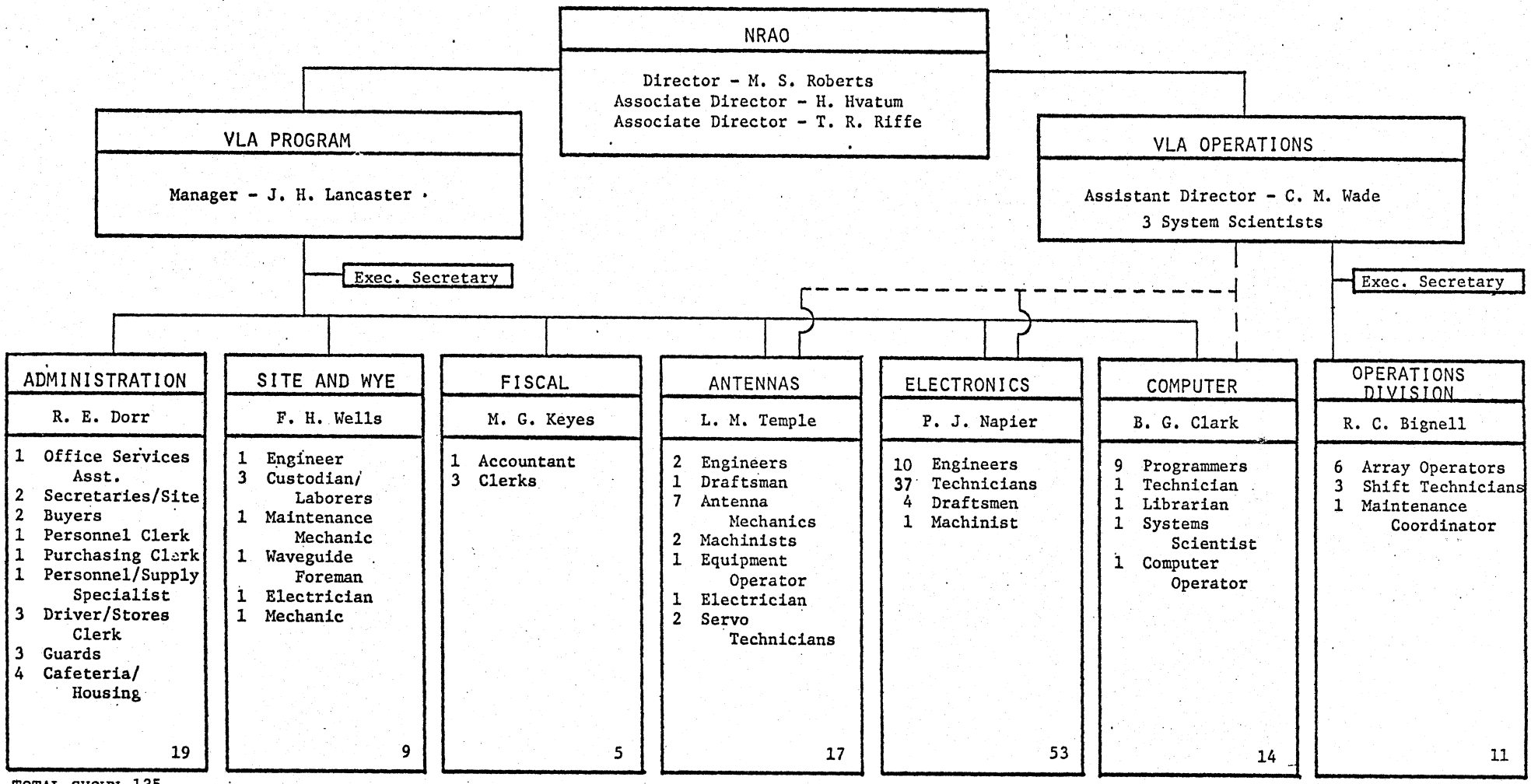
Transition to Operations

At the end of CY 1980, the VLA Construction Program will come to an end. During the last months of the year the construction staff will begin to decrease as various elements of the work are completed. On December 31, 1980 the Common Cost personnel will be transferred to the Operating payroll, along with approximately 8 individuals from the construction group. Present planning indicates that up to 35 persons will be terminated during CY 1980 and paid termination allowances in accordance with existing AUI-NRAO personnel policies.

Figure 2


NATIONAL RADIO ASTRONOMY OBSERVATORY
ORGANIZATION CHART
November 1, 1979
AUI
Chairman of Board – R. G. Jahn
President – G. F. Tape
V. P. Adm. Affairs – C. B. Amthor
Controller-Treasurer – C. B. Amthor
Secretary – N. P. Rathvon, Jr.
Legal Counsel – N. P. Rathvon, Jr.
NRAO VISITING COMMITTEE
NRAO
Director – M. S. Roberts
Associate Director – H. Hvatum
Associate Director – T. R. Riffe
Assistant to Director – R. J. Havlen
USERS' COMMITTEE
VLA ADVISORY COMMITTEE
VLA STEERING COMMITTEE
TUCSON OPERATIONS
Assistant Director
M. A. Gordon
BUSINESS
D. A. Webb
TELESCOPE OPERATIONS
B. L. Ulich
ELECTRONICS
J. M. Payne
GREEN BANK OPERATIONS
Assistant Director
R. L. Brown
TELESCOPE OPERATIONS
J. F. Crews
BUSINESS
R. K. Moore
PLANT MAINTENANCE
D. D. Madron
CENTRAL SHOPS
A. H. Steinemann
ADMINISTRATIVE SERVICES
ELECTRONICS
M. Balister
ADMINISTRATION
Associate Director
T. R. Riffe
BUSINESS
J. P. Lagoyda
CONTRACTS
J. Marymor
FISCAL
D. H. Hovatter
PERSONNEL
M. E. Petty
RESEARCH STAFF
TECHNICAL SERVICES
Associate Director
H. Hvatum
ELECTRONICS
M. Balister
ELECTRONICS RESEARCH
S. Weinreb
COMPUTER
W. R. Burns
ENGINEERING
G. M. Peery
VLA CONSTRUCTION
Assistant Director
J. H. Lancaster
ANTENNAS
W. G. Horne
SITE
F. H. Wells
ELECTRONICS
P. J. Napier
BUSINESS
R. E. Dorr
COMPUTER
B. G. Clark
ACCOUNTING
M. G. Keyes
VLA OPERATIONS
Assistant Director
C. M. Wade
SCIENTIFIC OPERATIONS
B. G. Clark
ARRAY OPERATIONS
R. C. Bignell
ANTENNA MAINTENANCE
W. G. Horne
ELECTRONICS
P. J. Napier

NATIONAL RADIO ASTRONOMY OBSERVATORY
VLA PROGRAM ORGANIZATION
JANUARY 1, 1980

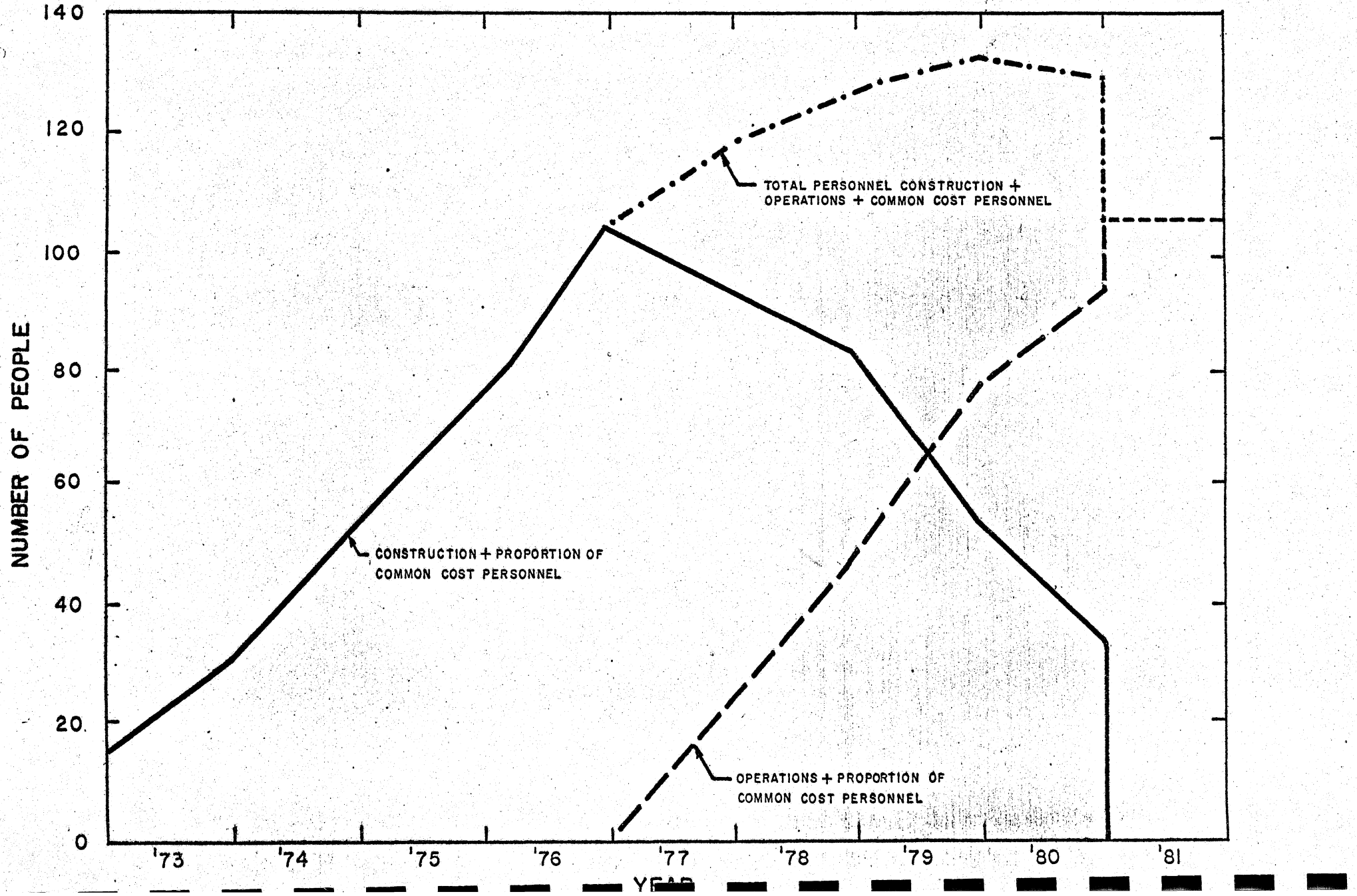


TOTAL SHOWN 135

Figure 3

Figure 4

VLA – NRAO
MANPOWER SUMMARY
CONSTRUCTION / OPERATIONS
NOVEMBER 1, 1979



PROGRAM ACCOMPLISHMENTS - 1979

General

Contractural work continued under Prime Contracts NSF AST 74-13427 and NSF AST 79-08925 with the National Science Foundation. The record of funds received to date is as follows:

Available	11/01/78		$65,749,189
Amendment No. 1 (CY79)	01/01/79	$5,675,000	$71,424,189
Amendment No. 4 (CY79)	04/06/79	$2,105,000	$73,529,189
Amendment No. 9 (CY79)	08/13/79	$ 20,000	$73,549,189
Amendment No. 10 (CY79)	09-04-79	$ 203,000	$73,752,189

The total appropriated to date is $74,078,000 and the difference, $325,811, between this amount and the $73,752,189 received, represents $15,700 withheld by the Foundation for the ECAC study of radio interference, $293,000 withheld for land acquisition and $17,111 withheld for the Ad Hoc Advisory Committee expenses.

By letter of 1 February 1980, the Foundation advised NRAO that 1980 funding would be in the amount of $4,500,000. When this sum is in hand, total funding for the VLA Program will total $78,578,000.

New Mexico Gross Receipts and Compensating Tax

During the Winter of 1979 and Spring of 1980, NRAO and the Foundation worked with the U. S. Department of Justice to prepare a strong case proving that the manufacturer of the VLA antennas should not be taxed by the State of New Mexico under provisions of the New Mexico Gross Receipts and Compensation Tax law.

The trial was held in Santa Fe on 2 April 1979 before Judge Santiago Campos and resulted in a favorable decision for the United States and against the State Bureau of Revenue and Taxation. The State was instructed to return the $127,000 paid under protest and not to assess additional taxes against E-Systems, Inc. This eliminates a potential liability against Program funds by $600,000 to $680,000.

On 15 June 1979 the State filed a Notice of Appeal with the Court. To date, briefs have been filed by the State and the United States. No trial date has been set. The NRAO attorney does not believe that the appeal has merit.

Land Acquisition

Condemnation Case - The three member land Commission, appointed by U. S. Judge Bratton, held a hearing in Las Cruces on 30 November 1978. Neither NRAO nor the Foundation had knowledge of the content of this meeting until 9 February 1979 when the Commission visited the VLA Site. At that time it was found the three ranchers were requesting a total payment of $3,300,000, compared to the $71,300 offered by the United States. Subsequent to this, a number of meetings were held with the U. S. Attorney for the State of New Mexico in an attempt to improve the Government's case. A second hearing before the Commission was held June 25th at which the Chairman refused to accept additional U. S. evidence. The U. S. Attorney did file a trial Brief on July 5th, supporting the Government's case. On July 27th the Commission submitted its report which recommended $219,000 as just compensation to the three ranchers. The U. S. objected to the report, the ranchers objected to the objections, and on October 18th Judge Bratton accepted the Commission's report and ordered payment to be made. As of 1 November 1979, it is not known whether the Government will appeal the Judgement but informal advice tends to indicate that no appeal will be taken.

Right-of-Way Over Bureau of Land Management Lands - On May 1st of 1974, the Corps of Engineers prepared a Land Withdrawal Document for over 840 acres of BLM land required for the VLA. This followed the issuance of a special land use permit which was issued 17 April 1974. On 23 July 1975 a Memorandum of Understanding, authorizing the construction of the VLA, was executed by the National Science Foundation and the Bureau of Land Management.

Then on 25 January 1979, BLM advised the Corps of Engineers that they could no longer issue a land withdrawal and that the National Science Foundation would have to apply for a Right-of-Way across the BLM lands involved. The necessary application papers were prepared by the Corps of Engineers and sent to the Foundation on 27 April 1979. They have not been forwarded to BLM to date.

Archaeological Study

Field work was completed on 11 May 1978 and the time since then has been used by the State University of New Mexico archaeological staff in preparing the final report. Principal difficulty has been in getting the various speciality consultants to submit their reports. The report has been promised prior to the end of 1979.

In order to keep the wye construction going, arrangements were made for the submission of a preliminary report to the State Historic Preservation Officer. This report was sent on 6 June 1979, and the continuation of construction activities was authorized by the State by letter of 18 June 1979.

Labor Provisions of Waveguide Labor Subcontract

On 26 January 1979, the Foundation advised that due to a series of new regulations issued by the U. S. Department of Labor, they would not approve the fifth yearly Labor-Hour Subcontract unless the NRAO recommendation was supported by independent legal counsel. On February 1st the Washington law firm of Steptoe & Johnson was again retained. The legal work was completed on March 15th which fully supported the proposed labor provisions of the Subcontract. The Foundation approved the Subcontract on March 16th.

Scientific and Test Operations

A summary sheet showing operating data is attached as Figure 5.

Figure 5

NATIONAL RADIO ASTRONOMY OBSERVATORY
VLA PROGRAM

OPERATIONAL SUMMARY OF THE VLA

PERIOD	OPERATIONAL TIME SCHEDULES	ANTENNAS NUMBER OPERATIONAL	ANTENNAS MAX. NO. USABLE	MAXIMUM NUMBER BASELINES	LONGEST "ON-WYE" BASELINE	AVERAGE DOWNTIME
YEAR ENDING:						
DECEMBER 1977	39%	9	10	45	10.5 KM	21%
DECEMBER 1978	54%	15	15	105	19.1 KM	12%
QUARTER ENDING:						
MARCH 1979	57%	16	16	120	19.1 KM	18%
JUNE 1979	51%	18	17	136	19.1 KM	13%
SEPTEMBER 1979	52%	20	17	136	20.4 KM	11%
MONTH ENDING:						
OCTOBER 1979	59%	20	17	136	20.4 KM	12%
NOVEMBER 1979 (ESTIMATED)	62%	21	17	136	27.6 KM	-

11/01/79

Dated Highlights for the 1979 Period

November	1978	Sixteen antennas operating on a maximum "on-wye" baseline of 15.6 km.
November	28, 1978	Commission was appointed by U. S. District Court to consider Ake-Taylor-Dunlap request for additional compensation for land taken for the VLA.
December	4, 1978	Antenna No. 17 achieved first fringes.
December	15, 1978	Antenna station AW8 occupied. Maximum "on-wye" baseline increased to 19.1 km.
December	18, 1978	Antenna No. 14 declared operational.
December	29, 1978	Antenna No. 15 declared operational.
December	1978	Fringes were obtained from 15 antennas simultaneously.
January	17, 1979	Subcontract for Transporter No. 2 issued in the amount of $788,758.
January	19, 1979	Antenna Station DN8 occupied. North arm of wye activated. Baseline 0.4 km North.
February	2, 1979	Antenna No. 18 achieved first fringes.
February	19, 1979	Phase V wye construction plans issued for bid.
March	21, 1979	Antenna No. 19 achieved first fringes.
March	23, 1979	Antenna No. 17 declared operational.
March	26, 1979	Decision made to limit operating antennas to 17 and to hold operating time to approximately 50% of available hours each month.
March	27, 1979	Five bids received for Phase V construction. Apparent low $2,820,000 vs. estimate of $3,100,000.
March	28, 1979	Burn Construction Co. protested the award of Phase V construction to Wm. A. Smith Contracting. Protest rejected by AUI on March 29th.
April	2, 1979	New Mexico Gross Receipt Tax trial held. Judge Campos rendered judgement in favor of the U. S. Government and against State Bureau of Revenue and Taxation. He instructed the State to return $127,000 paid under protest and not to assess additional taxes against E-Systems, Inc.

April	26, 1979	Phase V wye construction contract issued in the amount of $2,820,000.
May	4, 1979	Antenna No. 20 achieved first fringes.
May	30, 1979	Antenna Station CN7 occupied. Maximum baseline 19.1 km E-W; 1.1 km N.
June	7, 1979	Meeting with U. S. Attorney for the State of New Mexico to discuss land acquisition case.
June	11, 1979	Antenna No. 16 declared operational.
June	15, 1979	New Mexico Gross Receipts Tax Final judgement in favor of U. S. Government appealed by the State.
June	25, 1979	Land Commission held second meeting in Albuquerque. Would not accept additional testimony from the Government.
July	2, 1979	Antenna No. 18 declared operational.
July	5, 1979	U. S. Attorney for the State of New Mexico filed Memorandum Brief to the Land Commission refuting certain claims made by ranchers Ake, Taylor and Dunlap.
July	13, 1979	Antenna No. 21 achieved first fringes.
July	27, 1979	Land Commission submitted its report which recommended $219,000 as just compensation to the three ranchers.
July	30, 1979	Antenna No. 19 declared operational.
August	6, 1979	The U. S. Attorney filed objections to the Commission's recommendations.
September	6, 1979	Antenna Station BE6 occupied. Maximum baseline 20.4 km E-W; 1.1 km N.
September	14, 1979	Antenna No. 24 achieved first fringes. (22 and 23 to follow).
September	26, 1979	Antenna No. 20 declared operational.
September	1979	Ranchers Ake, Taylor and Dunlap requested that the Land Commission's recommendations be approved by Judge Bratton.
November	1979	Antenna No. 22 scheduled to achieve first fringes. Antenna No. 21 to be declared operational Antenna Station AE6 scheduled to be occupied. Maximum E-W baseline to increase to 27.6 km.

ANTENNA SYSTEMS

Antennas - During the period of November 1978 to November 1979 the antenna subcontractor, E-Systems, Inc., completed the assembly of and delivered to AUI seven additional antennas, numbers 21 through 27. Antenna 28 is expected to complete checkout and acceptance by November 9th, which is three weeks ahead of the schedule established in July of 1976 when Amendment No. 18 was issued, and is 16 months ahead of the schedule established in October of 1973 when the original contract was issued.

The mechanical and electrical outfitting of antennas after delivery from the antenna subcontractor was performed by AUI mechanical forces during this period and included Antennas 18 through Antenna 24. Work performed includes installation of cable trays and cabling, addition of cryogenic compressor platform, installation of subreflector and subreflector supports, alignment and indexing of subreflector, installation of modified access stairways, installation of waveguide, installation of telephone activated fault resets and controls, and installation of antenna feeds.

Modifications made to antennas during this period included provision of single phase protection at antennas to protect antenna equipment if incoming line power does not have all three phases, addition of monitor on pedestal room fan and modification of ventilation in pedestal room, substitution of elevation limit switches activated by elevation gear rack in place of axis mounted cam limit switches and installation and calibration of anemometers on each antenna. An additional modification in process of installation will provide automatic stowing of an antenna at which the local wind velocity exceeds 50 MPH.

One of the more significant modifications accomplished during this period consisted of the conversion of the vertex room air conditioning system to a modulating system. The air conditioning system was originally specified to provide temperature control in the vertex room at $74^{o}F$ plus or minus $2^{o}F$ (a peak tolerance of $4^{o}F$). The system as designed and installed would, when properly adjusted, meet this specification. Although the room temperature held within tolerances,

the temperature environment of some of the electronic equipment within the racks mounted in the vertex room fluctuated. Also, the electronic equipment proved to be more temperature sensitive than had been anticipated, such that it was desirable to tighten the air conditioning control and to provide a greater volume of cooling air direct to the racks. The modulating system controls the cooling capacity of the evaporator section of the air conditioning system by bypassing a volume of refrigerant hot gas around the condensing and evaporating sections directly to the compressor (based on outside temperature), permitting the heaters to be run at minimum heat load. Ducts were added directly to the electronic racks to provide increased cooling air flow to the equipment. Temperature control within the rack to within 0.5 F (1 F peak to peak) has been achieved with this method.

Following as Figure 6 is the status of the antenna delivery schedule for Antennas 3 through 28 and Figure 7 setting out the design and achieved tolerances for Antennas 1 through 28. It will be noted that all mechanical tolerances are substantially better than those specified.

Since by November 1979, AUI has completed and placed into operation a total of 23 antennas, and the first two antennas have been in NRAO possession for four years, a scheduled preventive maintenance program has been in operation which provides routine inspections, cleaning, lubrication, testing, adjustment and servicing of the mechanical, structural and electrical features and components of the antenna system. A supply of spare components, parts and equipment is on hand to support the scheduled maintenance as well as failures.

Transport Vehicles - Transport Vehicle No. 1 was used during the period for movement of the antennas at the Assembly Building, movement of antennas for outfitting and testing, and movement of antennas between observing stations. As of mid-October, the transporter has made 133 successful moves. Not once has the transporter failed so that emergency measures would have to be taken. The transporter is also used extensively as the service vehicle in the lubrication, repair and maintenance of the antennas and equipment mounted on the antennas.

A contract in the amount of $788,758 was placed on 17 February 1979 with Logemann Brothers Company of Milwaukee, Wisconsin for the detailed design, manufacture and test of Transporter Vehicle No. 2, with delivery to NRAO scheduled for mid-March 1980. By April all detailed drawings and shop details had been approved, and the transporter is now in sub-assembly. Trial assembly at the manufacturer's plant will start the first week of November 1979. Transporter No. 2 will have increased stroke on lifting cylinders, a larger service crane and faster speed for support jacks.

Figure 6

NATIONAL RADIO ASTRONOMY OBSERVATORY
VLA PROGRAM

STATUS - PROCUREMENT OF ANTENNAS 3 THROUGH 28

E-SYSTEMS DELIVERY DATES

ANTENNA NUMBER	SCHEDULED	ACCEPTANCE	ANTENNA NUMBER	SCHEDULED	ACCEPTANCE
3	04/15/76	04/20/76	16	02/15/78	02/14/78
4	05/24/76	06/07/76	17	04/07/78	04/04/78
5	07/15/76	07/16/76	18	05/31/78	06/19/78
6	08/30/76	09/03/76	19	07/21/78	08/25/78
7	10/15/76	10/29/76	20	09/13/78	10/20/78
8	11/30/76	12/17/76	21	11/03/78	12/19/78
9	01/17/77	02/25/77	22	01/12/79	02/20/79
10	03/01/77	04/26/77	23	03/09/79	03/30/79
11	04/29/77	06/09/77	24	05/03/79	05/24/79
12	06/22/77	07/15/77	25	06/22/79	06/28/79
13	08/12/77	09/02/77	26	08/15/79	08/13/79
14	10/12/77	10/21/77	27	10/05/79	10/04/79
15	12/09/77	12/07/77	28	11/30/79	11/09/79

NATIONAL RADIO ASTRONOMY OBSERVATORY
VLA PROGRAM

ANTENNA MECHANICAL PARAMETERS

ITEM		UNIT	SPEC.	AVERAGE ANTENNAS 1-28
PANEL MANUFACTURE		IN RMS	0.015	0.0133
PANEL SETTING AT 50° EL.		IN RMS	0.018	0.0106
AZ CENTER TO FDN CENTER		IN	0.500	0.332
AZIMUTH LEAN		ARCSEC	18	11.5
ELEVATION ORTHOGONALITY		ARCSEC	18	6.5
ELEVATION OFFSET		IN	0.100	0.035
COLLIM. ORTHOGONALITY		ARCSEC	18	8.9
COLLIMATION OFFSET		IN	0.250	0.053
ALIGNMENT FOCAL MOUNT TO COLLIM. AXIS		ARCSEC	18	9.3
SERVO ERROR		ARCSEC RMS	3.24	---
RESONANT FREQUENCY	ROCKING	HZ	2.07	2.32
	TORSIONAL	HZ	2.15	2.38
SLEW RATE	ELEVATION	O/MIN	20	20
	AZIMUTH	O/MIN	40	40

Figure 7

ELECTRONICS SYSTEMS

During 1979 to the present time (October 1979) electronics outfitting and first operation has been completed on Antennas 17 through 21 and on Antenna 24. It is expected that Antennas 22 and 23 will be operating before the end of 1979. During the year, all necessary electronics hardware has been purchased to complete the project, including spare components and modules. Some construction which uses this hardware, such as the new baseband and front end IF systems and the modules for IF's B and D, will run over into 1980.

In general, electronics construction has proceeded smoothly, the only significant exception to this being the front end construction which has been complicated by problems with AIL parametric amplifiers. Since front end 20 AIL, the AIL Division of Cutler-Hammer, Inc., has been unable to build reliable parametric amplifiers because of difficulty in obtaining suitable varactors from their suppliers. Front ends 21 and 24 were built with room temperature GaAs FET amplifiers instead of cooled paramps which gave system temperatures about five times worse than normal. The paramps will be installed as soon as they are available. It is expected that AIL will solve their problems, but in the event that they do not, it is planned to replace the second paramp of each two-paramp set with a cryogenically cooled GaAs FET amplifier supplied by the NRAO Electronics Lab in Charlottesville. Prototypes of these amplifiers have been successfully tested and will be permanently installed in front end 22.

Lack of paramps prevented progress on retrofitting Comtech paramp front ends with AIL paramps. Currently five front ends still have Comtech paramps. Progress was made in replacing Air Products cryogenics systems with CTI systems. Currently six antennas still have Air Products systems. This retrofit has significantly improved the reliability of the cryogenics system; the mean time between failures (MTBF) of the CTI systems has been 27,000 hours, which compares very favorably with the 1300 hours achieved by Air Products.

A significant achievement during 1979 was the completion of the design of the spectral line baseband system and its release for production. The system was installed on Antennas 3 and 5 and first

spectral line observations were made. Installation of the system on remaining antennas is currently underway. As expected, the spectral line tests have detected new instrumental problems not previously seen in continuum observations. Most important of these problems are compression problems in the transmission system and some spurious signals at low frequencies. Construction of the second half of the spectral processor is currently underway. The design of the new front end IF system was completed and released for production. It was installed on Antennas 3 and 5 and will be installed on remaining antennas, starting in November 1979.

In support of the Solar Maximum Mission, modifications to the front end to make solar observing more convenient and accurate were designed and installed.

All 18-21 cm wavelength feeds were converted from linear to circular polarization providing, for the first time, a much needed polarization capability in this wavelength band.

The performance of the 60 mm waveguide system contines to be very good. Loss measurements on the previously installed waveguide on the West arm and on the newly installed waveguide on the North and East arms were made throughout the year. Figure 8 shows the loss of various sections of waveguide on the West arm as a function of time. There is now no indication of loss increasing with time. Figure 9 shows the loss of the 14.644 km of guide buried on the East arm. The VLA loss specification is less than 1.4 dB/km. Figure 10 shows the loss of the most recently buried 4.9 km of waveguide on the North arm. During the year the design and construction of an on-line loss measurement test set using waveguide Channel 11 was completed. This test set, which is now being brought into operation, will continuously measure the loss of the waveguide to give early warning of any problems.

Considerable progress was made on understanding the phase stability, polarization, spurious signal and theoretical-sensitivity performance of the array. While the array is quite usable with respect to all of these system parameters, long term study will undoubtedly allow improvements to be made.

In the area of maintenance, good progress was made in the construction of specialized test sets to make the repetitive trouble-shooting and testing of electronics modules easier. Throughout the year maintenance support was at a lower level than will be finally needed because of limitations in manpower and spare components. This situation will improve by mid-1980.

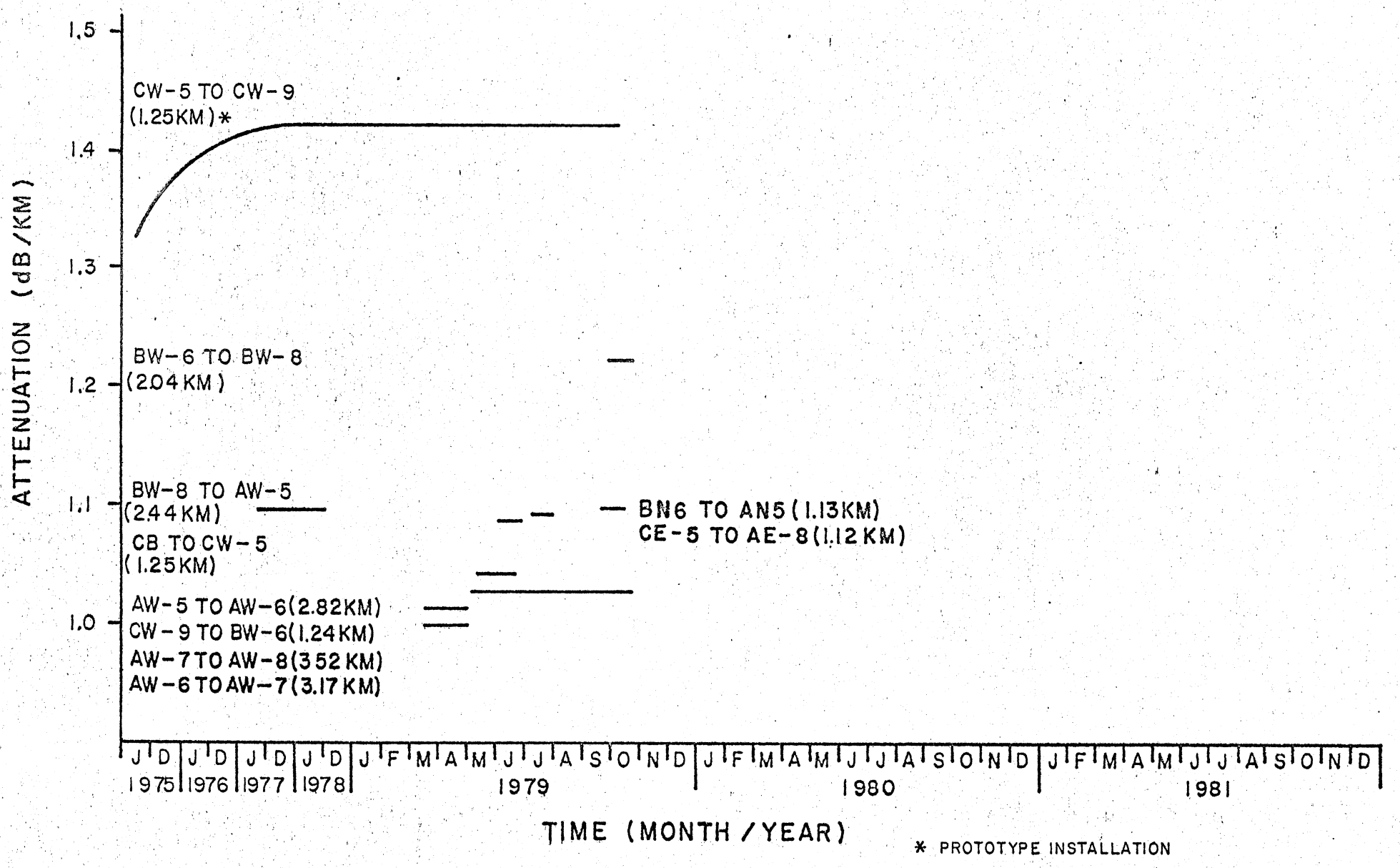
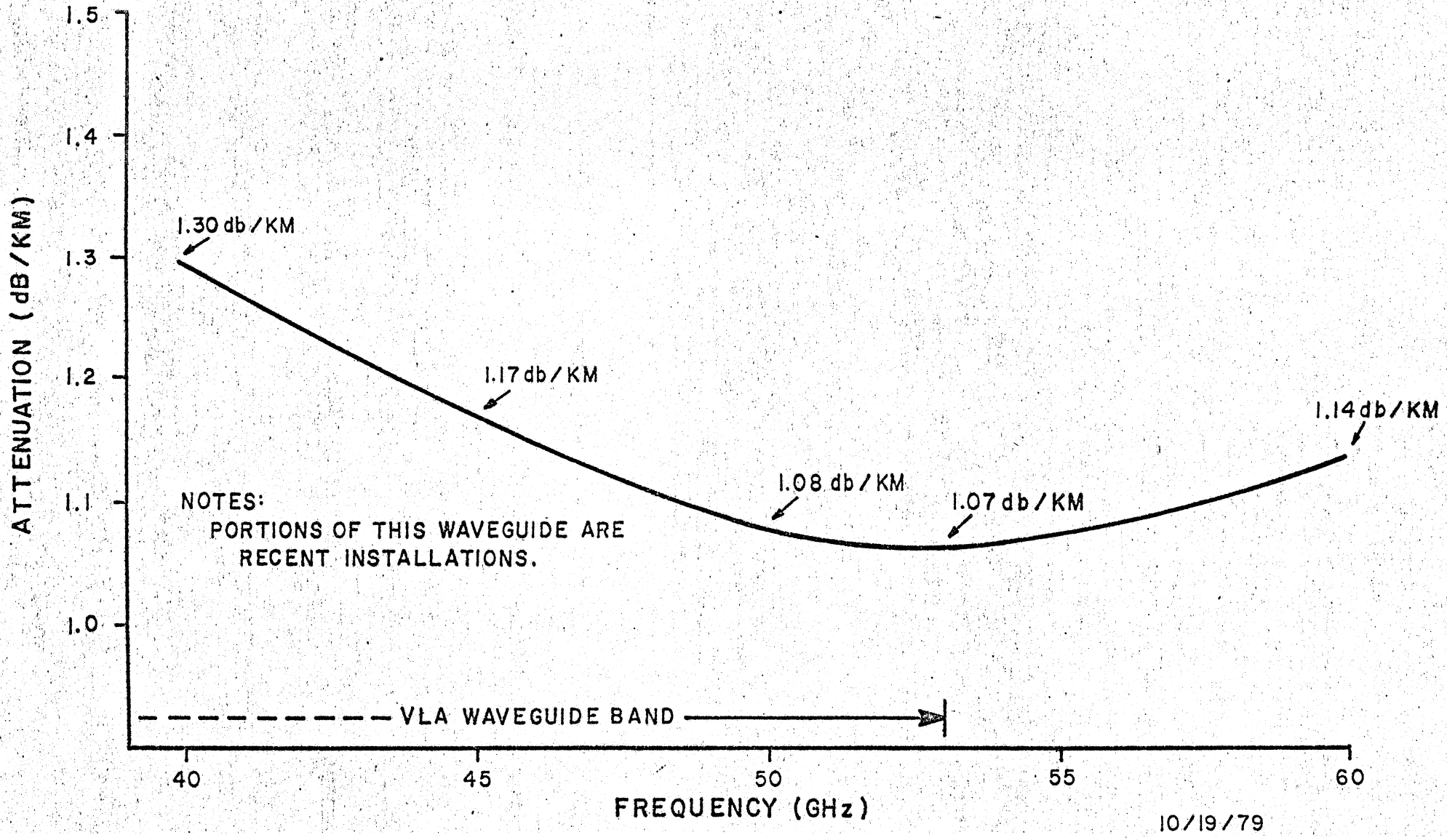

60 MM HELIX WAVEGUIDE
ATTENUATION vs TIME at 50 GHz
ATTENUATION (dB/KM)
1.5
1.4
1.3
1.2
1.1
1.0
CW-5 TO CW-9
(1.25KM)*
BW-6 TO BW-8
(2.04KM)
BW-8 TO AW-5
(2.44KM)
CB TO CW-5
(1.25KM)
AW-5 TO AW-6(2.82KM)
CW-9 TO BW-6(1.24KM)
AW-7 TO AW-8(3.52KM)
AW-6 TO AW-7(3.17KM)
BN6 TO AN5(1.13KM)
CE-5 TO AE-8(1.12KM)
J D J D J D J 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 F M A M J J A S O N D
1975 1976 1977 1978 1979 1980 1981
TIME (MONTH / YEAR)
* PROTOTYPE INSTALLATION

Figure 8

Figure 9

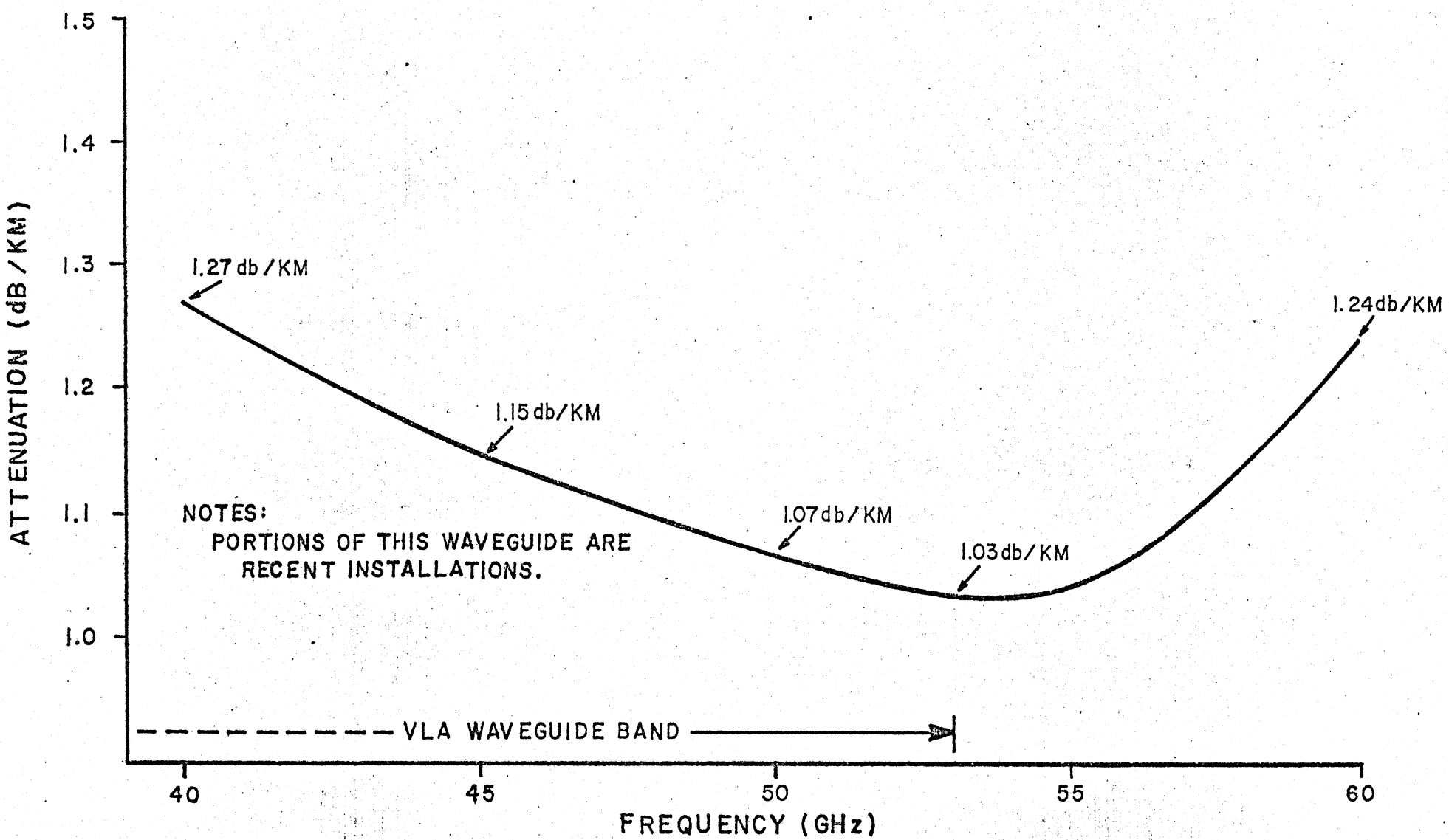
60 MM HELIX WAVEGUIDE

AVERAGE ATTENUATION
14.644 KM EAST ARM
CONTROL BLDG.— AE8



60 MM HELIX WAVEGUIDE

AVERAGE ATTENUATION
4.910 KM NORTH ARM
BN6—AN5 +.883 KM



10/19/79

Figure 10

COMPUTER SYSTEMS

The greatest accomplishment in the area of the on-line programs has been the implementation of the on-line software for the spectrometer system. This is an interim system, designed to accumulate experience leading to a more competent design for the final system. It restricts the product of the number of baselines and the number of channels to about 5000, which can simultaneously be stored in the core memory of a Modcomp computer, greatly simplifying the programming. Some elementary off-line software support has been written; much more must come to make the system scientifically useful.

The PDP-11/70-FPS AP120 B array processor mapmaking system is now supported by a powerful and flexible set of software for making radio images. Much work has gone into the communications between this computer and the DEC-10; the objective has been to make this computer as unobtrusive as possible, and the eventual goal is to make it unnecessary for an astronomer to know that the computer exists. The astronomer will deal only with the DEC-10 and will not have to worry about the fact that actual computation occurs elsewhere.

A start has been made to implement additional functions in this computer system - specifically the CLEAN algorithm and a self-calibration algorithm.

The DEC-10, obviously overloaded under even the current demands, has had additional disk space added and will, early in 1980, have yet more disk space and an additional increment of main memory added. None of this will make the DEC-10 capable of handling the full VLA data processing load, but is done simply to allow it to keep up with those tasks we will retain in the DEC-10 when the main data processing is moved to other processors.

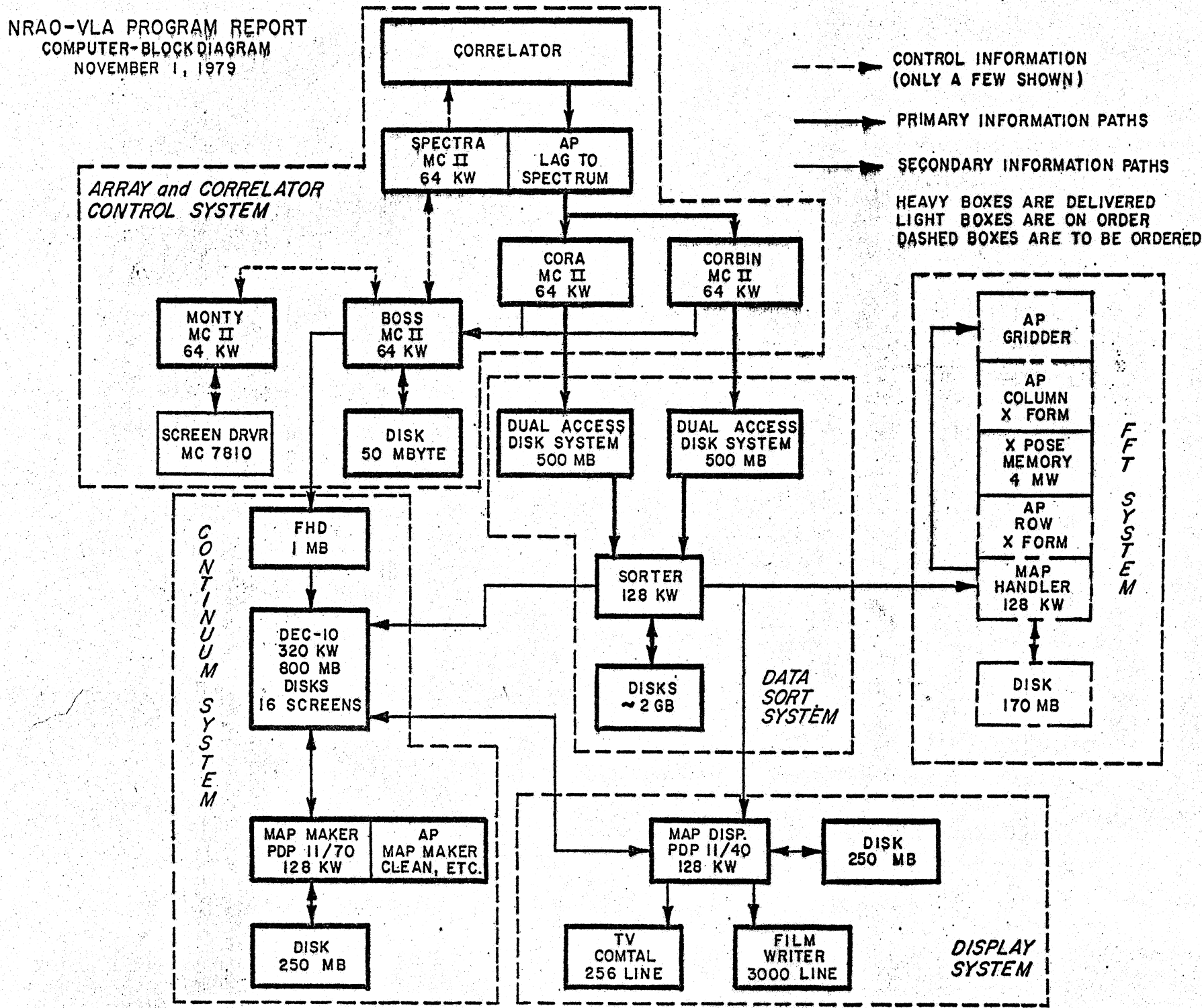
We have had delivered, in 1979, a PDP-11/70 with twelve disk drives, purchased from Century Data Systems, which will provide a total of three GBytes of data storage - enough for 12 hours of full spectral line system data. Four of these drives will be shared with the Modcomp on-line computer system. The interface of the Modcomps is being built here and will be functional by the end of 1979.

Work is continuing on the procurement of the spectral line FFT machine. A 4-million word memory has been ordered, which will hold an image 2000 points on a side. Having a semiconductor memory of this size will allow image making an order of magnitude faster than on the existing PDP-11/70 system. The associated array processors should be on order by the end of the year.

The main thrust of the image processing work has been taken over by the Charlottesville software group. An initial system has been implemented on a Modcomp Classic Computer with an IIS image display device. A DEC VAX-11/780 computer has been delivered to Charlottesville. It will run a software system as nearly identical to the Modcomp as is possible; this VAX system will be sent to the VLA Site about midyear of 1980. The software system is being written, as much as possible, in FORTRAN, so that it can be brought up on as large a variety of systems as possible with minimal effort. It is hoped that many universities will implement the system on their own minicomputers, lessening the strains on the support facilities of the NRAO and providing a more leisurely pace to the observers.

Included as Figure 11 is a Block Diagram of the Computer Systems, dated 01 November 1979, which illustrates those hardware items which are now on hand or under order.

Figure 11


NRAO-VLA PROGRAM REPORT
COMPUTER-BLOCK DIAGRAM
NOVEMBER 1, 1979
CONTROL INFORMATION (ONLY A FEW SHOWN)
PRIMARY INFORMATION PATHS
SECONDARY INFORMATION PATHS
HEAVY BOXES ARE DELIVERED
LIGHT BOXES ARE ON ORDER
DASHED BOXES ARE TO BE ORDERED
CORRELATOR
SPECTRA MC II 64 KW
AP LAG TO SPECTRUM
ARRAY and CORRELATOR CONTROL SYSTEM
CORA MC II 64 KW
CORBIN MC II 64 KW
MONTY MC II 64 KW
BOSS MC II 64 KW
SCREEN DRVR MC 7810
DISK 50 MBYTE
DUAL ACCESS DISK SYSTEM 500 MB
DUAL ACCESS DISK SYSTEM 500 MB
AP GRIDDER
AP COLUMN X FORM
X POSE MEMORY 4 MW
AP ROW X FORM
MAP HANDLER 128 KW
FFT SYSTEM
DISK 170 MB
CONTINUUM SYSTEM
FHD 1 MB
SORTER 128 KW
DEC-10 320 KW 800 MB DISKS 16 SCREENS
DISKS ~2 GB
DATA SORT SYSTEM
MAP MAKER PDP 11/70 128 KW
AP MAP MAKER CLEAN, ETC.
DISK 250 MB
MAP DISP. PDP 11/40 128 KW
DISK 250 MB
TV COMTAL 256 LINE
FILM WRITER 3000 LINE
DISPLAY SYSTEM

SITE AND WYE CONSTRUCTION

During the Fall of 1978 it was determined that a substantial cost benefit would accrue to the Program if the crushed stone ballast required for the wye trackage was procured as a separate item furnished to the construction contractor instead of having the construction contractor furnish it as was done in the Phase I and III subcontracts. Bids for 117,700 cubic yards were solicited 13 November 1978 from twelve vendors. A number of options were included which would permit the VLA to split the commitment between 1979 and 1980 funds in order to increase the available 1979 funds for an adequate Phase V construction contract. On 8 January 1979 a subcontract in the amount of $668,660 was awarded Wheeler Construction Company. Of this, $392,000 was authorized for immediate manufacture, and $276,660 would be authorized when 1980 funds were available.

Phase IV construction, consisting of 21.9 kilometers (13.6 miles) of wye trackage, twenty-one antenna foundations and 11 interchanges and antenna foundation spurs proceeded well during the year. On 1 November 1979 this work was 94% complete, with final completion scheduled in December 1979.

At the end of 1978 it was not clear how the balance of the wye construction should be executed. The reduction of $1,500,000 in planned CY 1979 funding reduced the available Phase V wye construction funds to $1,201,000, which was too low a figure to permit the balance of the work to be accomplished using a single contract. This would require a Phase VI construction contract to be awarded in 1980, and two contracts would result in a much higher total cost, due to mobilization and demobilization expenses, overhead costs, poor interest of prospective bidders, two labor determinations and inefficiencies due to the two contracts. It was estimated that proceeding with two contracts would result in a total cost in excess of $3,400,000.

To avoid the need for two construction contracts, a determined effort was made in January 1979 to make all possible reductions in other elements of the program and to assign contingency funds for immediate wye construction. In this way, the funds available in 1979

for wye construction were increased to $2,200,000. This made it possible to proceed with a single contract which would include a unilateral option covering the work which would be financed with 1980 funds.

A Davis-Bacon wage determination was requested from the Department of Labor, supported by complete data and several face-to-face meetings with Department of Labor staff people. On February 14th the wage determination was received and 50 sets of Phase V construction bid documents were sent out. Bids for the 1979 and 1980 portions of the work were received March 27th as follows:

Wm. A. Smith Contracting Co.	$2,820,000
Burn Construction Co.	$2,896,000
Transit Products, Inc.	$3,084,387
Pacific Railroad Constructors	$3,190,000
Peter Kiewit Sons' Co.	$3,270,000
Engineers Estimate	$3,100,000

On March 28th, Burn Construction Co. protested the award to Wm. A. Smith. This protest was rejected March 29th by AUI, and Burn took no further action. The subcontract was fully executed on 26 April 1979. Construction will consist of 25 kilometers (15.5 miles) of wye trackage, with twelve interchanges and antenna foundation spurs. Electrical work consists of 25 kilometers (15.5 miles) of 15 kV primary feeder circuits and antenna power and grounding for 12 antenna foundations. At 1 November this contract was 55% complete and is scheduled for completion in October 1980.

Waveguide installation proceeded throughout the year with the exception of February when the weather was too cold and windy to permit precision placement. It is expected that by the end of the year approximately 16,500 meters will have been installed. Waveguide will then be in place to AW8 on the West arm, AN7 on the North arm and AE8 on the East arm. Details on the measured attenuation of the waveguide in place are given in the Electronics section of this report. In all cases it was far better than the 1.40 dB/km manufacturer's specification at 50 GHz.

The personnel of Site and Wye Division supervise all construction and installation work, with the assistance of monthly visits from the Engineer/Architect.

PROGRAM MANAGEMENT

During the past year, ending 1 November 1979, the Program Management Group has issued over 2,300 subcontracts and purchase orders, having a total value in excess of $8.3 million. Wherever possible, orders have been placed for sufficient quantities to complete the requirements of the Program. Also a number of subcontracts and orders were placed with unilateral options to complete the requirements. These approaches have allowed advantage to be taken of larger quantity orders and the elimination of potential escalation. Currently the most noteworthy options awaiting advanced 1980 funding are:

Phase V Construction Alternate No. 3	$ 530,000
Stone Ballast	$ 276,660
Waveguide Installation	$ 185,000

Thirty-two new employees have been hired to fill vacancies that have occurred and to meet the planned requirements of Program staffing. There has been a continuing effort to help these new employees, as well as transferring NRAO employees, to find housing in the local area.

This past year there have been an estimated 3,000 casual visitors to the site and the number is growing steadily as the VLA becomes better known. There has been a 65% increase in the usage of the Visiting Scientist Quarters. Room day occupancy totaled 1,712 in 1979.

Efforts continue to obtain the remaining required rail material from government excess channels. In the past year small quantities of material have been obtained from Fort Huachuca, Arizona; Eglin Air Force Base, Florida; Mare Island Naval Shipyard, California; The Presideo of San Francisco, California; Fort Leavenworth, Kansas; and Volunteer Arsenal, Tennessee. However, there remains a potential for one or two miles of track needed because of the lower than expected yields from the several locations. Commercial corporations have been located that will be able to supply good used material, if needed.

FISCAL OPERATIONS

During 1979 the Fiscal Office in New Mexico processed more than 5,000 vendor payments which totaled in excess of $6,000,000. In addition, almost 5,000 payroll checks were processed. A number of transfers were made from construction to completed fixed assets. Among these were the prior year's salaries, benefits, travel, miscellaneous materials and portions of the electronics, trackage, antenna foundations, electric system, waveguide and antennas.

PLANNED ACTIVITIES - 1980

GENERAL

Construction activities in 1980 will be gradually drawing to a close with more and more emphasis being placed on Scientific Operations and maintenance of the existing equipment. The year will start with twenty-two antennas which have been declared operational, gradually building up to the full complement of twenty-eight by year's end.

ANTENNA SYSTEMS

Activities scheduled during the period November 1979 through December 1980 include the mechanical and electrical outfitting of Antennas 25 through 28, as well as preventive maintenance and antenna overhaul. All major items for installation by NRAO at outfitting are on hand and it is anticipated that outfitting will be complete by June 1980. Scheduled preventive maintenance on the 24 antennas in service as of November 1979, as well as repair of malfunctioning components, will be performed. It is planned to initiate overhaul, repainting and refurbishing of antennas, with Antenna 1 in late November 1979 after occupation by NRAO of the Antenna Assembly Building. The Assembly Building will be used during February and early March 1980 for assembly and testing of Transporter No. 2. After completion of testing of Transporter No. 2, antenna overhaul will be resumed with a planned interval of six weeks per antenna.

Trial and test assembly of Transporter No. 2 will be completed early in January 1980 with shipment to the VLA Site requiring the balance of the month. Beginning February 1st, the transporter will be assembled under the crane of the Antenna Assembly Building. Final test of the transporter will begin late in March and be completed by April 15th.

Experience over the last few years has shown that the antennas have a pointing problem during periods of bright sunshine. During nighttime and gray days, the antennas easily meet their pointing specification of 15 arc seconds, RSS; however, on bright days this error

approaches 40 arc seconds, peak. Investigations during 1979 seemed to eliminate the yoke, bearing box and base frame as the major contributor of this increased pointing error. Attention is now being directed to the tubular legs of the antenna base. This work will go on during 1980 until the exact cause of the error is determined. It may then be necessary to insulate the members involved, provide sun shields or take other methods to minimize the errors.

ELECTRONICS SYSTEMS

During 1980 all electronics construction will be completed. The electronics systems for Antennas 25-28 will be installed and brought into operation. The three main electronics upgrading programs, the spectral line baseband system, the front end IF system and IF's B and D will be completed, as will the second half of the spectral processor.

The AIL parametric amplifiers problem will have to be resolved early in 1980. If AIL has not solved their problems by the end of 1979, the decision will be made in early 1980 to retrofit second stage paramps with cooled GaAs FETS, thereby freeing up enough paramps to complete construction and replace all Comtech paramps. If this process proves to be necessary, it is unlikely that it can be completed in 1980 and will probably have to be finished in 1981. If, as expected, AIL solves their problems by the end of 1979 and gets back on schedule with their paramp delivery, then the Comtech paramp and CTI cryogenics retrofits will be completed in 1980.

Several minor retrofits are planned for the end of 1980. These all relate to the replacement of isolated components within the electronics system whose reliability has been found to be inadequate. Examples of these components are the subreflector focus/rotation controller, the upconverter pump oscillator and the paramp pump oscillator. By mid-1980, testing of the replacements for these unreliable components will be complete and the retrofit carried out.

As the observing load in spectral line mode increases, it can be expected that more instrumental problems will be discovered which will require investigation. Problems of this type will probably require extended investigation and, as with problems in polarization

and theoretical sensitivity, their solution will extend beyond the end of 1980.

Except for the installation of IF's B and D, most construction should be complete by mid-1980 and more attention will be paid to providing adequate maintenance support for the array. An important aspect of this support will be the improvement of the monitor data reliability and the automatic data checking schemes in the computer. It is hoped that, eventually, computer checks of the monitor data can be used to have the computer automatically initiate maintenance and delete contaminated astronomical data.

COMPUTER SYSTEMS

As shown on the Computer Block Diagram, Figure 11, the great majority of computer hardware has been received and is in place. At the present time procurement is underway to obtain the balance of hardware required for the Fast Fourier Transform System required for Spectral line research. The 4-million word memory is on order and orders for the balance of the equipment will be placed prior to the end of 1979. This equipment will be received and integrated into the overall system by about mid-1980.

During 1980 the on-line software will go through a number of minor revisions to make sure the system operates efficiently with all of the various design features implemented. This will include the provision of a special CPU for terminal handling, some simple graphics capabilities, additional terminals for electronics maintenance with software to drive them, and moving the observing list preparation programs into the DEC-10.

However, the main software effort in the on-line system will be the construction of the final spectral line system.

The main software effort elsewhere in 1980 will be in making the PDP-11/70 sorter system operate effectively on both spectral line and continuum data. Elementary software on the FFT system will be easy to provide; more sophisticated, high-throughput software will be a goal probably not reached by the end of the year.

The main hardware purchases in 1980 will be additional random access storage. If, as hoped, optical disk technology effects an order of magnitude reduction in cost per bit, we shall invest in these devices. If not, we shall have to beef up our conventional storage capabilities to at least cope with the flood of data the spectral line system will release. It will be noted that there is no "mass store" hardware shown on the Computer-Block Diagram. Developing storage techniques will, we anticipate, allow us to distribute massive amounts of storage throughout the system. As optical disk storage technology is now improving at a very fast rate, it is NRAO's intention to hold off on this purchase as long as possible. It is hoped that it will not be necessary to resort to much less capacious conventional magnetic storage equipment.

In late Spring it is expected that the Map/Image Processor system for post-processing of observer data will be moved from Charlottesville to the site and installed in the new VAX addition to the Library-Office Building.

A new approach to Observer data manipulation, to be financed with 1980 funds, is the development of an Interactive Microcomputer System (IMS). This system, based on equipment now being developed for the "home" microcomputer market, has been assigned a budget of $20,000. Procurement of basic equipment will take place late in 1979, with the equipment to be received and installed in the Socorro office in the first months of 1980.

SITE AND WYE

The Site and Wye Group will continue to oversee the construction of the Phase V construction with Wm. A. Smith Contracting Company, Inc. It is expected that this work will be completed during the Fall. This will complete VLA wye work and baselines of 21 kilometers will be available on the Southeast and Southwest arms and the 18.9 kilometer long baseline on the North arm.

High on the priority list of 1980 projects is the water sprinkler fire protection systems for seven small site buildings. The two major buildings, the Control and Cafeteria buildings, are protected by water sprinkler systems but due to cost considerations,

the Technical Services Building, the Warehouse, the Shop Buildings, the Library-Office Building and three Visiting Scientist Quarters are not. Each of these buildings are subject to serious damage or destruction by fire. Replacement costs for building and content would run from about $120,000 in the case of a Visiting Scientist Quarters building to over $600,000 for the Technical Services Building or Warehouse Building. We have trained a fire brigade which should be effective during normal work hours, but this covers only 24% of total hours. The closest volunteer fire department is in Datil, some 20 miles away, and it is very doubtful whether they could be effective during non-normal work hours. Response time would probably be in the vicinity of one hour; about the time the building was burned to the ground. The loss of one of these seven buildings would result in a greater loss to the Government than the cost of water sprinkler systems for all of the seven buildings.

It is intended to obtain competitive quotations for this work in November 1979, and to complete the work early in 1980. Estimated cost is $120,000.

In 1980 it will be necessary to add an 80'-0" extension on the Library-Office Building to house the Map/Image Processing equipment and work offices for the visiting observers. The proposed building will provide 765 square feet for computer hardware, eight offices for scientists and one tape storage room. Construction will be similar to the Library-Office Building, with wood frame construction, faced with slump block veneer. To reduce cost, the building will be fabricated in Albuquerque and trucked to the site. Gross area will be 2,120 square feet and estimated cost, including furniture, $105,000.

Construction bids will be solicited in December 1979 and the building completed and ready for occupancy in May 1980.

The third Visiting Scientist Quarters will be constructed in 1980, will be a duplicate of number two, and consist of six single rooms. Construction will be of wood frame with a slump block exterior veneer. The building will be constructed in Albuquerque and trucked to the site. When VSQ No. 3 is completed, the site will have 12 single rooms and 4 double rooms, providing 20 beds for visiting personnel. This is the same number of beds which was forecast in 1966 and presented

in the first Limbaugh Report. Recent experience shows that 20 beds is the minimum required. At present, with the VLA operating approximately 50% of the time, the available 10 rooms were full 22 times in the last six months. Stated another way is that in September 1979 the available 10 rooms had an occupancy figure in excess of 80% for 68% of the observing days, and were filled to capacity on 37% of the observing days. As the instrument goes to near 100% uptime and becomes more powerful, observing time assignments will become shorter, which will bring in many more visiting astronomers. The mix between NRAO staff and visiting scientists will change toward more visitors, and hence greater need for housing. Also, visiting scientists will stay longer to take advantage of the vastly improved data reduction facilities.

Construction bids will be solicited in December 1979, along with bids for the Map/Image Processor addition, to take advantage of better pricing. Construction will be completed in May of 1980. Estimated cost, including furniture, is $107,000.

Waveguide installation will proceed throughout the year, with the expectation that the remaining 14.0 km can be placed by December 31st. As waveguide placement is entirely dependent on the weather, it is quite likely that some waveguide will have to be placed in early 1981

Other Site and Wye activities which will take place in 1980, are the design and installation of an improved cathodic system to protect the waveguide system and the grounding network at each antenna station, the improvement of wye roads and the completion of the telephone system.

PROGRAM MANAGEMENT

The efforts of the Program Management Group in 1980 will be similar to activities during 1979. The balance of the needed rail material will either be obtained from government excess or from commercial sources. The procurement effort will be directed toward completing Program requirements. Late in 1980 the personnel people will see to the termination of about 35 employees. Records and completion statements will be prepared for the closeout of the contruction program.

The Program Management Group will keep abreast of the appeal of the favorable New Mexico Gross Receipts Tax decision and render all possible assistance to the U. S. Department of Justice attorneys.

Assistance will also be provided to ensure that the right-of-way over the Bureau of Land Management lands is obtained and that the expected restrictions of use are kept to an acceptable minimum.

An item which will be attempted in 1980 will be to have the New Mexico State Highway Department widen and repair New Mexico Highway 78, which is a portion of the approach road to the site, and to have the Highway Department add an additional seal coat on the 2.4 miles of old U. S. Highway 60 to and through the site.

Since operations began on the arms of the wye, it has been found that maintenance of the antennas, using only the wye railroad system, will be extremely difficult if not impracticable. The Environmental Impact Statement states that the construction roads will not be permanent and that maintenance will be by rail mounted vehicles. The time required for a technician to troubleshoot an antenna can be as much as three to four times longer if a rail vehicle must be used. It is not known whether the main wye roads can be kept in operation after 1980, but every effort must be made to find some way to do this.

FISCAL

With increased emphasis on operations in 1980 and future years, the Fiscal Group will be focusing more attention on the accounting for those funds. The common costs, that is, costs related to both operations and construction, will be accumulated and prorated to operations and construction on the same basis as they were in prior years.

Increasing effort will be expended in transferring completed assets from construction into the various fixed asset accounts.

Other areas of concentration during 1980 will include review of the existing procedures and internal controls and making improvements or changes where necessary. Other areas would include inventories, property, and any special requests or projects requested by management.

FINANCIAL PLANNING

This section of the CY 1980 Program Plan will present the various budget estimates and other schedules necessary for the proper financial planning of the program. Presented are the following:

VLA FINANCIAL STATUS REPORT - Program summary report (Figure 12) which details the financial condition of the program from the standpoint of the original program ceiling compared to total program outlook.

VLA COST ESTIMATE - 11/01/79 - Shows in summary (Figure 13) and in detail (Figure 14) the current cost estimate for the program and compares the present estimate with that presented in the CY 1979 Program Plan. Notes are included to explain changes in the cost estimates.

BUDGET ANALYSIS BY PROGRAM YEAR - CY 1973 THROUGH CY 1980 - Shows the cost estimate by Program Year (Figure 15).

SUMMARY OF COMMON COST BUDGET - CY 1977 THROUGH CY 1980 - Shows Common Cost Estimate by Program Year (Figure 16).

FINANCIAL PLAN - CY 1980 - The financial plan for CY 1979 and CY 1980 broken down into various categories. For comparison, the actual allocation of CY 1973 through CY 1978 funds has also been included (Figure 17).

CY 1979 REVIEW OF FINANCIAL PLAN - A detailed analysis of the revisions that have been made to the CY 1979 Financial Plan, giving the reasons for the changes (Figure 18).

EXPENDITURES AND COMMITMENTS - CY 1979 CUMULATIVE ACTIVITY - A report in graph form, showing scheduled and actual expenditures and commitments (Figure 19).

EXPENDITURES AND COMMITMENTS - CY 1980 CUMULATIVE ACTIVITY - A graphic presentation, showing planned CY 1979 commitments (Figure 20).

NATIONAL RADIO ASTRONOMY OBSERVATORY
VLA PROGRAM

FINANCIAL STATUS REPORT
(thousands)

As of: February 29, 1980

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
		ALLOCATION TO DATE				OUTLOOK		
ITEM	PROGRAM CEILING	ALLOCATED	EXPENDED AND COMMITTED	ALLOCATED BALANCE	UN-ALLOCATED BALANCE	ESTIMATE TO COMPLETE	ESTIMATE TOTAL	(OVER) UNDER CEILING
Site and Wye	27,860	26,848	26,170	678	1,012	678	26,848	1,012
Antennas	20,400	22,721	22,584	137	(2,321)	137	22,721	(2,321)
Electronics	17,000	17,999	17,039	960	(999)	960	17,999	(999)
Computer	4,850	6,011	4,856	1,155	(1,161)	1,155	6,011	(1,161)
Systems Integration	400	201	201	-	199	-	201	199
Program Management	2,650	2,116	1,925	191	534	191	2,116	534
Common Cost	-	2,100	1,800	300	(2,100)	300	2,100	(2,100)
Subtotal	73,160	77,996	74,575	3,421	(4,836)	3,421	77,996	(4,836)
Contingency	2,840	582	-	582	2,258	582	582	2,258
TOTAL	76,000	78,578	74,575	4,003	(2,578)	4,003	78,578	(2,578)

NOTES: (1) Includes $293K for site acquisition, $15.7K for ECAC Study, and $17.1K for NSF Ad Hoc Advisory Panel. Allocated and Expended includes $11K in assets which were retired in prior years.

(2) Estimate to complete is as of 14 March 1980.

Revised 3/14/80

Figure 12

NATIONAL RADIO ASTRONOMY OBSERVATORY
VLA PROGRAM

FINANCIAL STATUS REPORT
(thousands)
AS OF: September 30, 1979

EXPLANATION TO ACCOMPANYING STATEMENT

COLUMN (2) - ORIGINAL PROGRAM CEILING: Original Estimate as of 10 March 1971.

COLUMN (3) - ALLOCATED: Funded by NSF and included in total funds provided in Contract C-780 and AST 74-13427.

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 Program as originally estimated.

COLUMN (7) - ESTIMATE TO COMPLETE: Original estimate updated to take into account current or known costs.

COLUMN (8) - ESTIMATE TOTAL: Column (4) plus Column (7).

COLUMN (9) - (OVER) UNDER CEILING: Column (2) less Column (8).

NATIONAL RADIO ASTRONOMY OBSERVATORY
VLA PROGRAM

ESTIMATED COST - DESIGN AND CONSTRUCTION ON 03/14/80
(thousands)

ITEM	ORIGINAL CEILING	ESTIMATE 8/1978	REVISION 03/01/79	ESTIMATE 3/1980	CHANGE 3/79 - 3/80
SITE AND WYE	27,860	27,067	26,967	26,848	- 119
ANTENNA SYSTEMS	20,400	22,724	22,699	22,721	+ 22
ELECTRONIC SYSTEMS	17,000	17,640	17,672	17,999	+ 327
COMPUTER SYSTEMS	4,850	6,182	5,719	6,011	+ 292
SYSTEMS INTEGRATION	400	201	201	201	0
PROGRAM MANAGEMENT	2,650	2,102	2,205	2,116	- 89
COMMON COST	0	2,114	2,107	2,100	- 7
SUBTOTAL	73,160	78,030	77,570	77,996	+ 426
CONTINGENCY	2,840	1,000	1,000	582	- 418
TOTAL PROGRAM	76,000	79,030	78,570	78,578	+ 8

Figure 13

11/01/79
Revised 3/14/80

COST ESTIMATE 11/01/79
(thousands)

	1979 PROGRAM PLAN 03/01/79	1980 PROGRAM PLAN 11/01/79	CHANGE	NOTES
ANTENNA SYSTEMS				
Antenna Element Design	230	230	0	
Prototype Antenna	1,623	1,623	0	
Production Antennas	17,539	17,541	+ 2	
Transporter Design	120	120	0	
Transporter Prototype	372	374	+ 2	
Transporter Production Model	800	800	0	
Assembly Structure	413	422	+ 9	
E.D.I.A.	1,602	1,612	+ 10	
TOTAL	22,699	22,722	+ 23	

COST ESTIMATE 11/01/79
(thousands)

	1979 PROGRAM PLAN 03/01/79	1980 PROGRAM PLAN 11/01/79	CHANGE	NOTES
ELECTRONIC SYSTEMS DEVELOPMENT				
Feed System	141	142	+ 1	
Front End System	322	344	+ 22	(1)
Local Oscillator System	133	134	+ 1	
Monitor/Control System	85	85	0	
Waveguide System	263	264	+ 1	
IF Transmission	202	213	+ 11	
Delay/Multiplier System	21	21	0	
Spectral Processor	151	143	- 8	
General Electronics	13	13	0	
E.D.I.A.	701	710	+ 9	
Subtotal Development	2,032	2,069	+ 37	
ELECTRONIC SYSTEMS PRODUCTION				
Feed System	1,304	1,275	- 29	(2)
Front End System	3,336	3,365	+ 29	(3)
Local Oscillator System	1,012	1,009	- 3	
Monitor/Control System	592	627	+ 35	(4)
Waveguide System	433	427	- 6	
IF Transmission System	1,163	1,164	+ 1	
Delay/Multiplier System	302	327	+ 25	(5)
Spectral Processor	1,089	1,214	+ 125	(6)
General Electronics	1,418	1,501	+ 83	(7)
E.D.I.A.	4,975	5,001	+ 26	(8)
Subtotal Production	15,624	15,910	+ 286	
TOTAL ELECTRONIC SYSTEMS	17,656	17,979	+ 323	

Figure 14

Figure 14

COST ESTIMATE 11/01/79

NOTES FOR ELECTRONIC SYSTEMS

(1) Front End Development - Increase $22,000 due to the development of solar attenuation switches on all antennas for the Solar Maximum Year.

(2) Feed System - Decrease $29,000 due to reduced cost of subreflector ($7,000), 18-21 cm Feed ($12,000) and 6 cm Feed ($8,000).

(3) Front Ends - Increase $29,000 due to cost of retrofitting circulators and 26-GHz pumps on parametric amplifiers, and the 3.2 GHz upconverter pump oscillators.

(4) Monitor/Control System - Increase $35,000 due to the need to replace the existing subreflector focus/polarization control mechanism which has proven to be unreliable and subject to spurious noise.

(5) Delay/Multiplier System - Increase $25,000 due to the need to replace the D1 sampler module for the A and C IF channels with the design developed for the B and D channels.

(6) Spectral Processor - Increase $125,000 due to underestimate of the Spectral Line IF System cost ($40,000), necessary modifications to the spectral line equipment ($20,000), escalation of integrated circuits ($22,000), retrofit of high current power supplies ($20,000), and escalation of Control/Interface components ($13,000).

(7) General Electronics - Increase $83,000 due to purchase of additional portable test equipment ($21,000), construction of automatic microcomputer controlled test units to speed maintenance testing ($30,000), escalation of metal parts ($11,000) and to provide for automatic weather stations at the center of the array and at the end of the southwest arm ($21,000).

(8) E.D.I.A. - Increase $26,000 due to a need for additional cryogenic spare parts, control and sampler modules.

COST ESTIMATE 11/01/79
(thousands)

	1979 PROGRAM PLAN 03/01/79	1980 PROGRAM PLAN 11/01/79	CHANGE	NOTES
SITE FACILITIES AND WYE				
Site Acquisition	0	215	+ 215	(1)
Preliminary Design	225	225	0	
Detailed Design	504	503	- 1	
Construction Supervision	138	139	+ 1	
Survey/Soils	328	323	- 5	
Construction Site Preparation	75	76	+ 1	
Computer Site Trailers	42	41	- 1	
Archaeological Preservation	107	107	0	
Construction Facilities	145	145	0	
Equipment/Maintenance Vehicles	160	185	+ 25	(2)
Building Complex	2,581	2,930	+ 349	(3)
Site Work/Utilities	845	897	+ 52	(4)
Wye Construction	14,046	13,352	- 694	(5)
Waveguide Procurement	4,862	4,732	- 130	(6)
Waveguide Installation	1,393	1,462	+ 69	(7)
Waveguide Antenna Stations	415	411	- 4	
E.D.I.A.	808	810	+ 2	
TOTAL	26,674	26,553	- 121	
COMPUTER SYSTEMS				
Synchronous Subsystem	456	457	+ 1	
Asynchronous Subsystem	2,856	2,840	- 16	(1)
Map/Image Processor	465	503	+ 38	(2)
Mass Storage	280	500	+ 220	(3)
Computer Maintenance	152	152	0	
E.D.I.A.	1,510	1,517	+ 7	
TOTAL	5,719	5,969	+ 250	

Figure 14

COST ESTIMATE 11/01/79

NOTES FOR SITE FACILITIES AND WYE

(1) Site Acquisition - Increase $215,000 due to Land Commission recommendation as to the fair value of the easement condemnation across three ranches ($203,000) and allowance for Corps of Engineers expense ($12,000).

(2) Equipment/Maintenance Vehicles - Increase $25,000 due to provision of two additional track mounted maintenance vehicles.

(3) Building Complex - Increase $349,000 due to inclusion of Map/Image Processor addition to the Library-Office Building ($105,000), water sprinkler fire protection systems for seven small buildings ($120,000) and the Visiting Scientists Quarters No. 3 ($107,000).

(4) Site Work/Utilities - Increase $52,000 due to improvement of wye roads ($24,000), landscaping for new buildings ($10,000), utilities for new buildings ($8,000) and additional fuel storage facilities ($8,000).

(5) Wye Construction - Decrease $694,000 due to bidding Phase V and Phase VI wye construction as a single job, excellent bid competition, a very favorable Davis-Bacon wage Determination, lower escallation than expected, and lower telephone cable and installation costs.

(6) Waveguide Procurement - Decrease $130,000 due to lower than estimated loss of waveguide due to manufacturing deficiencies, shipping loss and damage, and installation loss.

(7) Waveguide Installation - Increase $69,000 due to an allowance for a cathodic protection system to protect the $6,200,000 system ($40,000) and funds for final waveguide clean-up which may occur in early 1981 ($25,000).

COST ESTIMATE 11/01/79

NOTES FOR COMPUTER SYSTEMS

(1) Asynchronous Subsystem - Decrease $16,000 due to the addition of additional core and disc capacity for the DEC-10 system (+ $90,000), a reduction in the cost of the Display System (- $32,000), a reduction in the cost of the Spectral Line Sorting/Mapping System (- $85,000), the addition of a microcomputer processor (+ $20,000), and the reduction in the cost of the Interface Equipment (- $9,000).

(2) Map/Image Processor - Increase $38,000 due to a better definition of equipment requirements.

(3) Mass Storage System - Increase of $220,000 due to a partial restoration of the $320,000 cut in this item made in March 1979. This system is now estimated to cost $500,000.

Figure 14

NATIONAL RADIO ASTRONOMY OBSERVATORY
VLA PROGRAM

COST ESTIMATE 11/01/79
(thousands)

	1979 PROGRAM PLAN 03/01/79	1980 PROGRAM PLAN 11/01/79	CHANGE	NOTES
SYSTEMS INTEGRATION				
Personnel Costs	152	152	0	
Material, Services, Supplies	30	30	0	
Travel	19	19	0	
TOTAL	201	201	0	
PROGRAM MANAGEMENT				
Personnel Costs	1,245	1,247	+ 2	
Material, Services, Supplies	629	632	+ 3	
Travel	118	123	+ 5	
Termination Costs	196	96	- 100	(1)
TOTAL	2,188	2,098	- 90	
CONTINGENCY/RESERVE	1,000	593	- 407	
COMMON COST	2,107	2,134	+ 27	(1)
SUBTOTAL PROGRAM	78,244	78,249	+ 5	
Funded directly by NSF	326	326	0	
TOTAL PROGRAM	78,570	78,575	+ 5	

COST ESTIMATE 11/01/79

NOTES FOR PROGRAM MANAGEMENT

(1) Termination Costs - Decrease $100,000 due to a more realistic determination of probable costs.

NOTES FOR COMMON COST

(1) Common Cost - Increase $27,000 due to higher escalation of electric utility costs.

Figure 14

Figure 15

11/01/79
Revised 3/14/80

NATIONAL RADIO ASTRONOMY OBSERVATORY
VLA PROGRAM

BUDGET ANALYSIS BY PROGRAM YEAR
(in thousands)

	1973	1974	1975	1976	1977	1978	1979	1980	Total Program
SITE AND WYE	964	875	4,924	4,869	2,309	5,247	5,471	1,896	26,555
ANTENNA SYSTEMS	315	2,453	2,740	7,717	4,103	3,711	1,549	133	22,721
ELECTRONIC SYSTEMS	816	1,460	2,292	2,511	3,283	3,812	2,741	1,068	17,983
COMPUTER SYSTEMS	29	412	1,289	660	782	562	1,310	967	6,011
SYSTEMS INTEGRATION	-	1	46	79	52	23	-	-	201
PROGRAM MANAGEMENT	158	236	499	679	102	111	120	194	2,099
COMMON COST	-	-	-	-	644	591	488	377	2,100
SUBTOTAL	2,282	5,437	11,790	16,515	11,275	14,057	11,679	4,635	77,670
CONTINGENCY	-	-	-	-	-	-	717	(- 135)	582
TOTAL	2,282	5,437	11,790	16,515	11,275	14,057	12,396	4,500	78,252

Add for cost of ECAC Study (16), Land Acquisition (293), and Ad Hoc Advisory Committee (17), funded directly by NSF and not carried in NRAO costs.	326
	78,578

NATIONAL RADIO ASTRONOMY OBSERVATORY
VLA PROGRAM

11/01/79

SUMMARY OF COMMON COST BUDGET

CY 1977 - CY 1980
(in thousands)

		1977	1978	1979	1980
18910	Salary/Wages	332	367	407	438
18920	Benefits	61	88	96	111
18930	Travel	8	9	12	9
18940	Material, Services, Supplies	118	166	189	213
18942	Power	112	170	265	375
18943	GSA Vehicles	38	48	52	56
18944	Bus Operations/Maintenance	14	7	20	19
18947	Communications	96	70	85	92
18952	Cafeteria/Housing Expense	17	18	29	25
18953	Miscellaneous Income	(21)	(30)	(35)	(34)
	TOTAL - COMMON COST	775	913	1,120	1,304
	Percent to Construction Program	83.1%	64.7%	43.6%	31.5%
	Cost to Construction Program	644	591	488	411

Figure 16

Figure 17

NATIONAL RADIO ASTRONOMY OBSERVATORY
VLA PROGRAM

FINANCIAL PLAN - CY 1980
(thousands)

	ESTIMATE	ACTUAL CY-1973	ACTUAL CY-1974	ACTUAL CY-1975	ACTUAL CY-1976	ACTUAL CY-1977	ACTUAL CY-1978	PLAN CY-1979	PLAN CY-1980
TASK I & V SITE FACILITIES/WYE									
Site Acquisition	215	-	-	-	-	-	-	215	-
Preliminary Design	225	225	-	-	-	-	-	-	-
Detailed Design	503	443	30	-	11	-	9	10	-
Construction Supervision	139	-	30	51	14	-	32	12	-
Survey/Soils	323	223	4	34	27	1	17	10	7
Construction Site Preparation	76	15	33	8	11	2	1	4	2
Construction Facilities	145	-	-	141	4	-	-	-	-
Construction Equipment	185	-	-	16	55	28	6	40	40
Computer/Site Trailers	41	-	-	36	1	-	4	-	-
Archaeological Preservation	107	-	-	-	-	107	-	-	-
Building Complex	2,930	-	-	1,814	397	51	282	29	357
Site Work/Utilities	897	-	-	614	62	92	23	56	50
Wye Construction	13,352	-	616	838	3,465	498	3,553	3,351	1,031
Waveguide Procurement	4,732	-	60	1,114	413	1,100	741	1,284	20
Waveguide Installation	1,462	-	-	116	134	284	383	285	260
Waveguide Antenna Stations	411	-	-	-	121	81	127	42	40
E.D.I.A.	810	58	102	142	154	65	69	133	87
TOTAL SITE FACILITIES/WYE	26,553	964	875	4,924	4,869	2,309	5,247	5,471	1,894

FINANCIAL PLAN - CY 1980
(thousands)

	ESTIMATE	ACTUAL CY-1973	ACTUAL CY-1974	ACTUAL CY-1975	ACTUAL CY-1976	ACTUAL CY-1977	ACTUAL CY-1978	PLAN CY-1979	PLAN CY-1980
TASK II ANTENNA SYSTEMS									
Antenna Element Design	230	225	-	-	-	5	-	-	-
Prototype Antennas	1,623	-	1,623	-	-	-	-	-	-
Production Models	17,541	-	-	2,455	7,465	3,780	3,464	368	9
Transporter Design	120	-	83	-	-	37	-	-	-
Transporter Prototype	374	-	311	5	16	11	8	11	12
Transportation Production Models	800	-	-	-	-	-	-	800	-
Assembly Structure	422	-	312	86	4	-	-	-	20
E.D.I.A.	1,612	90	124	194	232	270	239	370	93
TOTAL ANTENNA SYSTEMS	22,722	315	2,453	2,740	7,717	4,103	3,711	1,549	134
TASK VI SYSTEMS INTEGRATION									
Personnel Costs	152	-	-	33	58	43	18	-	-
Material, Services, Supplies	30	-	-	6	18	2	4	-	-
Travel	19	-	1	7	3	7	1	-	-
TOTAL SYSTEMS INTEGRATION	201	-	1	46	79	52	23	-	-

Figure 17

Figure 17

NATIONAL RADIO ASTRONOMY OBSERVATORY
VLA PROGRAM

FINANCIAL PLAN - CY 1980
(thousands)

	ESTIMATE	ACTUAL CY-1973	ACTUAL CY-1974	ACTUAL CY-1975	ACTUAL CY-1976	ACTUAL CY-1977	ACTUAL CY-1978	PLAN CY-1979	PLAN CY-1980
TASK IV COMPUTER SYSTEMS									
Synchronous Subsystem	457	-	246	-	21	147	1	38	4
Contiuum Asynchronous Subsystem	1,248	-	-	871	118	94	13	115	36
Display I/O Equipment	874	-	-	33	88	59	90	331	273
Spectral Line Sorting/Mapping	1,221	-	-	-	-	212	324	570	115
Mass Store	500	-	-	-	-	-	-	100	400
Computer Maintenance	152	-	-	48	62	19	8	15	-
E.D.I.A.	1,517	29	166	337	371	251	126	141	97
TOTAL COMPUTER SYSTEMS	5,969	29	412	1,289	660	782	562	1,310	925
TASK III ELECTRONIC SYSTEMS DEVELOPMENT									
Feed System	142	-	80	1	49	2	1	5	4
Front End System	344	97	64	81	23	19	14	32	14
Local Oscillator System	134	33	20	4	29	10	2	6	30
Monitor/Control System	85	74	9	2	-	-	-	-	-
Waveguide System	264	83	11	32	56	23	34	21	4
IF Transmission System	213	63	32	94	2	3	6	2	11
Delay/Multiplier System	21	7	14	-	-	-	-	-	-
Spectral Processor	143	-	-	4	25	96	11	4	3
General Electronics	13	-	13	-	-	-	-	-	-
E.D.I.A.	709	35	59	94	105	108	123	120	65
SUBTOTAL DEVELOPMENT	2,068	392	302	312	289	261	191	190	131

NATIONAL RADIO ASTRONOMY OBSERVATORY
VLA PROGRAM

FINANCIAL PLAN - CY 1980
(thousands)

	ESTIMATE	ACTUAL CY-1973	ACTUAL CY-1974	ACTUAL CY-1975	ACTUAL CY-1976	ACTUAL CY-1977	ACTUAL CY-1978	PLAN CY-1979	PLAN CY-1980
TASK III ELECTRONIC SYSTEMS PRODUCTION									
Feed System	1,275	-	105	36	262	276	457	137	2
Front End System	3,365	-	214	384	395	467	997	725	183
Local Oscillator System	1,009	-	80	118	140	316	301	33	21
Monitor/Control System	627	-	15	85	96	133	151	62	85
Waveguide System	427	45	28	21	118	70	89	32	24
IF Transmission System	1,164	-	102	288	208	210	350	6	-
Delay/Multiplier System	327	24	63	122	21	17	10	45	25
Spectral Processor	1,214	-	-	-	3	537	52	572	50
General Electronics	1,501	108	135	254	232	231	333	140	68
E.D.I.A.	5,002	247	416	672	747	765	881	799	475
SUBTOTAL PRODUCTION	15,911	424	1,158	1,980	2,222	3,022	3,621	2,551	933
TOTAL ELECTRONIC SYSTEMS	17,979	816	1,460	2,292	2,511	3,283	3,812	2,741	1,064

Figure 17

Figure 17

NATIONAL RADIO ASTRONOMY OBSERVATORY
VLA PROGRAM

FINANCIAL PLAN - CY 1980
(thousands)

	ESTIMATE	ACTUAL CY-1973	ACTUAL CY-1974	ACTUAL CY-1975	ACTUAL CY-1976	ACTUAL CY-1977	ACTUAL CY-1978	PLAN CY-1979	PLAN CY-1980
TASK VII PROGRAM MANAGEMENT									
Personnel Costs	1,247	128	178	248	334	83	92	99	85
Materials, Services, Supplies	632	17	35	216	328	9	11	12	4
Employees Termination Costs	96	-	-	-	-	-	-	-	96
Travel	123	13	23	35	17	10	8	9	8
TOTAL PROGRAM MANAGEMENT	2,098	158	236	499	679	102	111	120	193
Contingency/Reserve	593							514	79
Common Cost	2,134					644	591	488	411
TOTAL PROGRAM	78,249	2,282	5,437	11,790	16,515	11,275	14,057	12,193	4,700

NATIONAL RADIO ASTRONOMY OBSERVATORY
VLA PROGRAM

CY 1979 REVIEW OF FINANCIAL PLAN
(thousands)

11/01/79

TASK	ITEM	PLAN 03/01/79	ALLOCATION 10/01/79	CHANGE
I & V	Site Facilities and Wye	5,320	5,471	+ 151
II	Antenna Systems	1,549	1,549	0
III	Electronic Systems	2,764	2,741	- 23
IV	Computer Systems	1,392	1,310	- 82
VI	Systems Integration	0	0	0
VII	Program Management	120	120	0
	Common Cost	488	488	0
	Contingency/Reserve	504	514	+ 10
	TOTAL PROGRAM	12,137	12,193(1)	+ 56

(1) Includes $56,000 of prior year commitments cancelled and carried forward to CY 1979.

Figure 18

Figure 18

NATIONAL RADIO ASTRONOMY OBSERVATORY
VLA PROGRAM

CY 1979 REVIEW OF FINANCIAL PLAN
(thousands)

11/01/79

	PLAN 03/01/79	ALLOCATION 10/01/79	CHANGE	NOTES
TASK I & V SITE FACILITIES AND WYE				
Site Acquisition	-	215	+ 215	(1)
Archaeological Preservation	-	-	-	
Engineering - Preliminary	-	-	-	
- Detailed	10	10	0	
Construction Supervision	12	12	0	
Survey/Soils	10	10	0	
Construction Facilities	4	4	0	
Computer/Site Trailers	-	-	-	
Construction Equipment	55	40	- 15	
Building Complex	25	29	+ 4	
Site Work/Utilities	48	56	+ 8	
Wye Construction	3,334	3,351	+ 17	
Waveguide Procurement	1,434	1,284	- 150	(2)
Waveguide Installation	215	285	+ 70	(3)
Waveguide Antenna Stations	42	42	0	
E.D.I.A.	131	133	+ 2	
TOTAL	5,320	5,471	+ 151	

CY 1979 REVIEW OF FINANCIAL PLAN
(thousands)

11/01/79

TASK I & V SITE FACILITIES AND WYE

NOTES:

(1) To provide funds for payment to the U. S. District Court for the increased cost of the condemmed land ($203 k) plus additional payment to the Corps of Engineers for assistance on land acquisition ($12 k).

(2) Loss of waveguide due to manufacturing deficiences, shipping loss and damage and installation damage much less than anticipated. At present all waveguide required is on hand or on firm price order.

(3) It was determined that all shrink sleeves, manholes, and other supplies required for 1980 should be procured with the 1979 purchases for economic reasons.

Figure 18

Figure 18

CY 1979 REVIEW OF FINANCIAL PLAN
(thousands)

11/01/79

	PLAN 03/01/79	ALLOCATION 10/01/79	CHANGE	NOTES
TASK II ANTENNA SYSTEMS				
Production Models	336	338	+ 2	
Field Modifications	28	30	+ 2	
Transporter Assembly/Test/Modifications	811	811	0	
E.D.I.A.	374	370	- 4	
TOTAL	1,549	1,549	0	

CY 1979 REVIEW OF FINANCIAL PLAN
(thousands)
11/01/79

	PLAN 03/01/79	ALLOCATION 10/01/79	CHANGE	NOTES
TASK III ELECTRONIC SYSTEMS				
General Electronics	85	140	+ 55	(1)
Front End System	849	757	- 92	(2)
Local Oscillator System	59	39	- 20	
Waveguide System	71	53	- 18	
IF Transmission System	7	8	+ 1	
Delay/Multiplier System	45	45	0	
Feed System	166	142	- 24	(3)
Monitor/Control System	79	62	- 17	
Spectral Processor	502	576	+ 74	(4)
E.D.I.A.	901	919	+ 18	
TOTAL	2,764	2,741	- 23	

Figure 18

Figure 18

CY 1979 REVIEW OF FINANCIAL PLAN
(thousands)
11/01/79

TASK III ELECTRONIC SYSTEMS

NOTES:

(1) General Electronics, increase $55,000 due to higher cost of test equipment ($11,000), specialized test units for electronic components ($15,000), higher cost of sheet metal components ($11,000), higher cost of D.C. power components ($5,000) and the procurement of a second automatic weather station ($12,000).

(2) Front End Systems, decrease $92,000 due to lower than expected costs for R.F. components ($18,000), Frequency Converters ($32,000) and F.E. Filter Units ($60,000), combined with some increase in a number of other components.

(3) Feed System, decrease $24,000 due to reduction in estimated costs for Feed Mount Deicers ($4,000), 18-21 cm Feeds ($12,000) and 6 cm Feeds ($9,000).

(4) Spectral Processor, increase $74,000 due to increase in material and fabrication costs for the IF System and other small changes.

CY 1979 REVIEW OF FINANCIAL PLAN
(thousands)

11/01/79

	PLAN 03/01/79	ALLOCATION 10/01/79	CHANGE	NOTES
TASK IV COMPUTER SYSTEM				
Synchronous Subsystem	38	38	0	
Asynchronous Subsystem	710	726	+ 16	(1)
Map/Image Processor	290	290	0	
Mass Store	198	100	- 98	(2)
Computer Maintenance	15	15	0	
E.D.I.A.	141	141	0	
TOTAL	1,392	1,310	- 82	

NOTES:

(1) Increase of $16,000 includes additional core and disc capacity for the DEC-10 system ($90,000), a reduction of cost for the Display System ($8,000) and a postponement of procurement of Spectral Line Sorting/Mapping equipment until 1980.

(2) Decrease of $98,000 due to the postponement of procurement of several items until 1980. As shown on other tables, the total Mass Store Equipment is included at $500,000 for the entire system.

NATIONAL RADIO ASTRONOMY OBSERVATORY
VLA PROGRAM

CY 1979 REVIEW OF FINANCIAL PLAN
(thousands)

11/01/79

	PLAN 03/01/79	ALLOCATION 10/01/79	CHANGE	NOTES
TASK VII PROGRAM MANAGEMENT				
Personnel Costs	104	99	- 5	
Materials, Services, Supplies	10	12	+ 2	
Travel	6	9	+ 3	
TOTAL	120	120	0	
COMMON COST	488	488	0	
CONTINGENCY/RESERVE	504	514	+ 10	

CY 1979 REVIEW OF FINANCIAL PLAN
(thousands)

11/01/79

	PLAN 03/01/79	ALLOCATION 10/01/79	CHANGE	NOTES
COMMON COST				
Personnel Costs	503	503	0	
Travel	8	12	+ 4	
Materials, Services, Supplies	199	189	- 10	
Power	260	265	+ 5	
Vehicles and Buses	68	72	+ 4	
Communications	91	85	- 6	
Cafeteria and Housing (net)	(9)	(6)	+ 3	
TOTAL	1,120	1,120	0	
PORTION TO CONSTRUCTION	488	488	0	

Figure 18

PROGRAM REPORT
EXPENDITURES AND COMMITMENTS
CY-1979 CUMULATIVE ACTIVITY
NOVEMBER 1, 1979

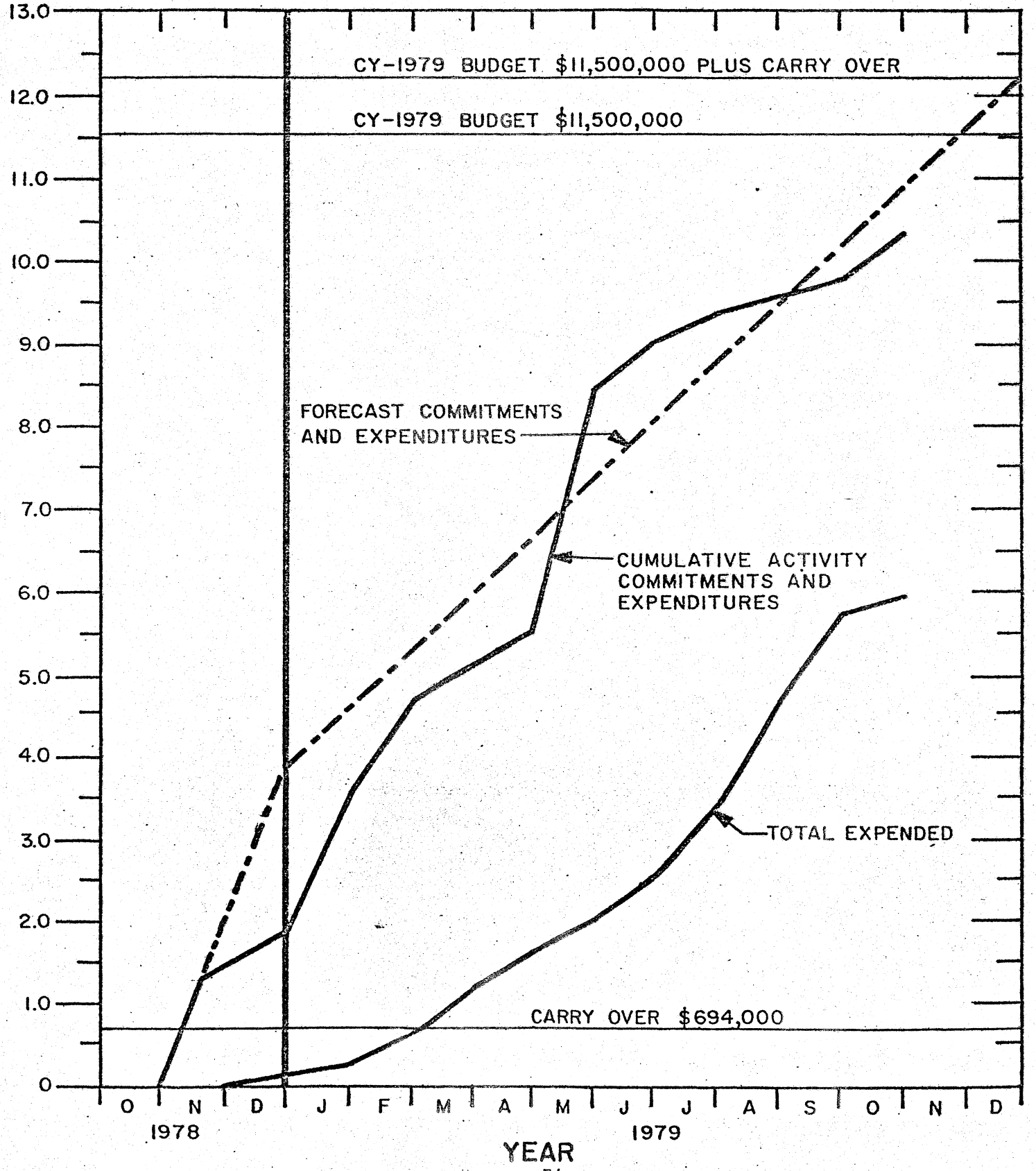


Figure 19

NRAO VLA
PROGRAM REPORT
EXPENDITURES AND COMMITMENTS
CY-1980 CUMULATIVE ACTIVITY

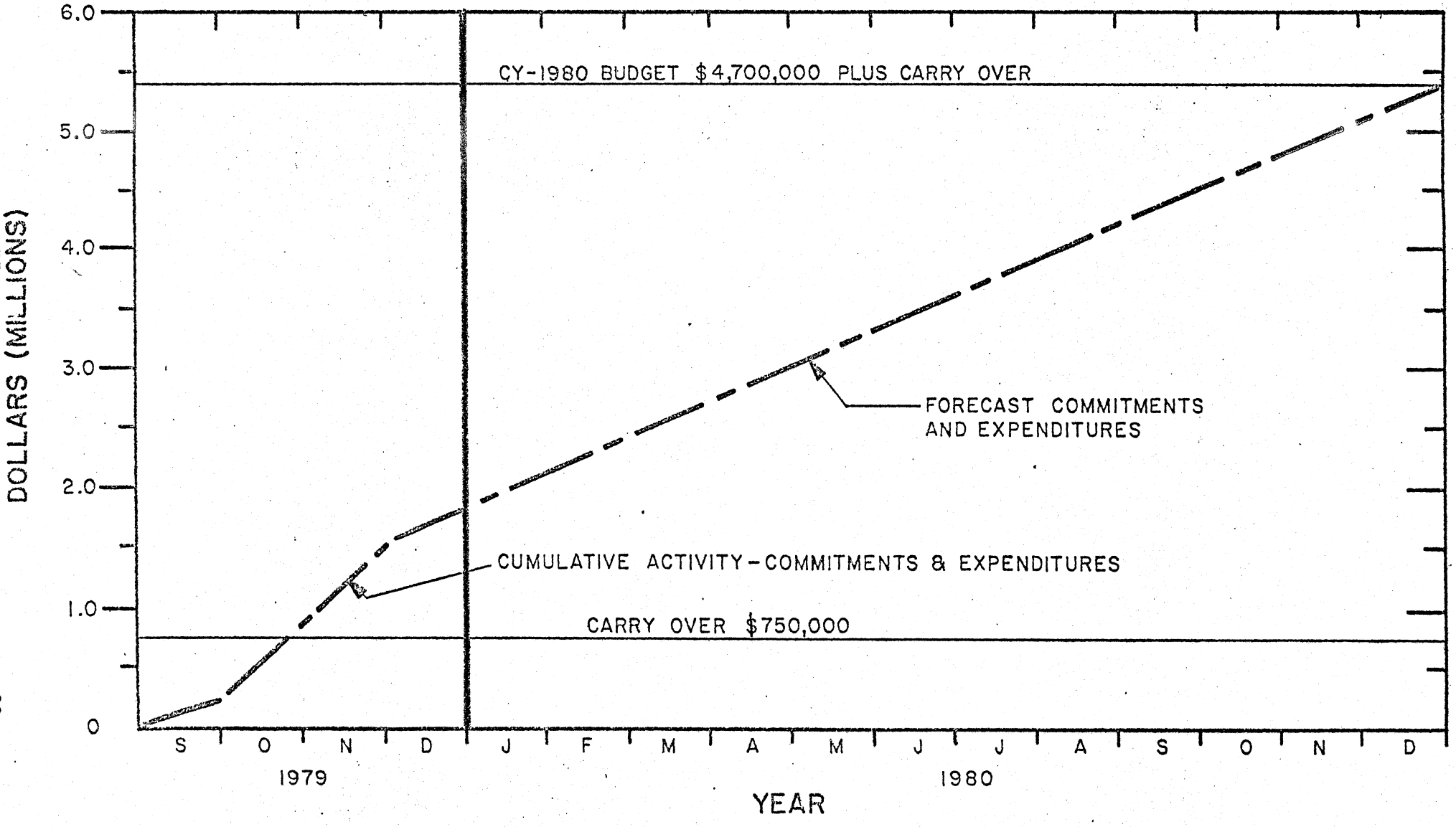


Figure 20

DESIRED ITEMS

In any major scientific program as large and diversified as the VLA, there are many items which would improve the technical capabilities of the instrument, make operations more efficient or less expensive. These items may not be vital for initial operation, and so are usually postponed to the end of a program where they may be financed from remaining funds. The VLA is no exception, and through the years a number of deferred and alternate items have been set forth in the various Program Plans. A number of these items could be financed from any remaining balances and contingency funds.

At this time a list of these items is:

Dichroic Reflector for Simultaneous Operation at 6 and 2 cm Wavelengths

It was the intention of NRAO to include within the construction program a dichroic reflector over the 2 cm feed and an ellipsoidal reflector over the 6 cm feed on all antennas so that simultaneous observation could be made using two IF bands for each frequency. This system has been installed on Antennas 1 and 2 and has been proven in operation. Its estimated cost for a complete automatic system is $350,000.

Visitors Center

Covers the construction of a 2,400 square foot building, 30'-0" by 80'-0" in size, to house exhibits, a forty-five seat auditorium, toilet rooms, and auxiliary spaces. The building would be of prefabricated wood stud construction, built in Albuquerque and trucked to the site. In design it would look like the Control and the Cafeteria buildings, with slump block brick exterior, flat roof, and stucco facia. It would be constructed just off the main access road, old U. S. 60, adjacent to the driveway to the Control Building. Site work would include access driveways, parking area

for about twelve automobiles and two buses, concrete patio and walkways. It would be connected to the site water, sanitary sewer, electric and telephone systems.

Its purpose is to exhibit various displays concerning astronomy and the VLA, which will reduce the amount of staff time now utilized for visitors, the use of toilet facilities in the main buildings, and the pressure of visitors who wish to enter the main buildings for inspection purposes. It would be the start of a self-guided tour of the central VLA site area. A self-activated film or slide show would be set up in the auditorium, or it could be used for a talk to a busload of a specific organization.

In the past year over 3,000 casual visitors stopped at the site, in addition to an organized bus trip for senior citizens, which came about six times during the year. There are no directional signs to the site and it is difficult for the tourist to find his way in. To date, we have been successful in keeping the site off the New Mexico road maps because it is under construction. The New Mexico Department of Development has requested in the past that the VLA be shown and will in the future. In addition, the Director of the Albuquerque Chamber of Commerce wishes to have organized bus tours of the VLA, which they would market to potential tourists on an international basis. The VLA is on one of the few transcontinental U. S. highways and one can expect a very large increase in visitors over the years. The article in the "Smithsonian" magazine, the syndicated New York Times and Washington Post stories, the past TV programs, and the forthcoming "Reader's Digest" and "National Geographic" articles, plus a series of CBS and other TV programs will interest a great many people in the VLA and add greatly to the visitor load.

Estimated cost of the Visitors Center is as follows:

Building, Foundation, Brick		$96,000
Site Work		26,000
Utility Connections		23,000
Initial Exhibits		20,000
	Total	$165,000

Map/Image Processor No. 3

As the VLA goes into full operation, it can be expected that the need for observer interactive data manipulation equipment will increase tremendously. NRAO is constructing the first Observer Processor for use in Charlottesville, the second is being constructed using VLA funds and will be placed at the VLA Site. It seems clear that a third unit will be required in the near future. Space for unit three has been included within the addition to the site Library-Office addition which will be constructed in 1980. Estimated cost is $465,000.

Site Road Resurfacing

The site road network was constructed in 1975 and at the end of 1980 will have been in use nearly six years. These have been hard years on the roads due to the very large number of heavy trucks which have traversed them. Consideration must be given to resurfacing the main roads and perhaps the parking areas. If this is not done, yearly maintenance costs will be high throughout future years, which will absorb needed operating funds. Estimated cost of the roadwork and parking areas, if a cooperative arrangement with the State Highway Department can be worked out, would be $92,000. It would cost $135,000 if a separate special contract had to be awarded to a construction company. Cost of doing only the roads would be $64,000 or $94,000 under the same conditions.

PROGRAM SCHEDULES

Figure 21 is a VLA ACTIVITY SCHEDULE Bar Chart dated 11/01/79, which is time-scaled to provide a concise, overall view of the entire Program. This chart is revised monthly to indicate the current status of the Program and is revised annually or at other times when major schedule changes occur.

The schedule as planned requires near maximum effort and facility utilization in many principal work areas, Charlottesville equipment construction, antenna outfitting, and on-site maintenance, assembly, test, installation, and upgrading activity. New construction and installation proceed at a uniform rate which results in the well defined milestone of "first fringes" being achieved on Antenna 28 at the end of June 1980.

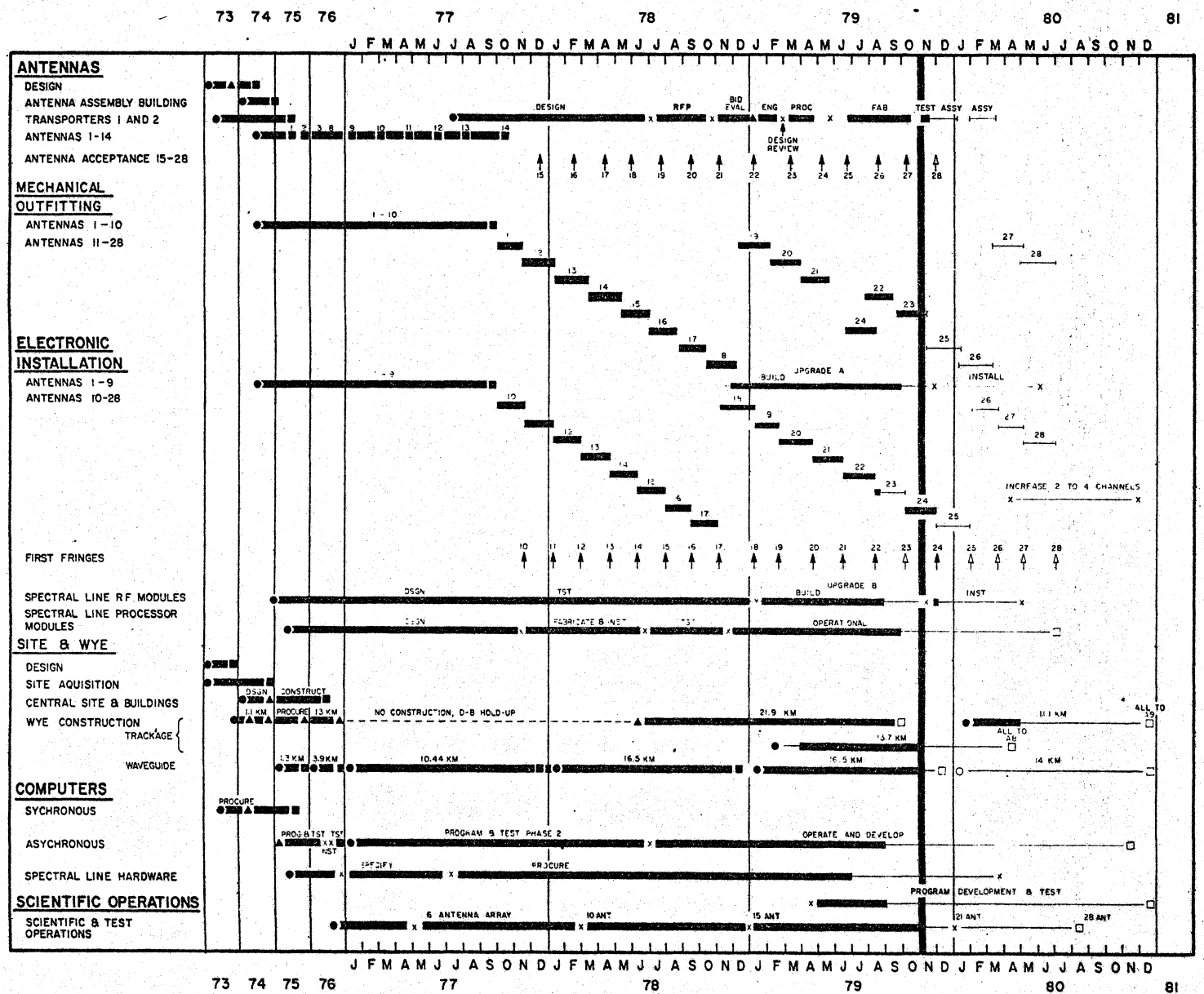
By following this schedule, the final six months of CY 1980 are available for testing of the full 27-element array and upgrading

Figure 21

NATIONAL RADIO ASTRONOMY OBSERVATORY

VLA ACTIVITY SCHEDULE

UPDATE DATE: 11/01/79



TASKS

UPGRADE A	RECEIVER FRONT-END FILTERS, MODULES F4, F7, F8. INSTALL 5 ANT/MO. (25 MODULES)
UPGRADE B	SPECTRAL LINE IF MODULES T3, T4, T5, T6. INSTALL 4 SYSTEMS (24 MODULES) PER MONTH.
INCREASE 2 TO 4 CHANNELS	ADDITIONAL MODULES OF ABOVE TYPES. TOTAL 224. INSTALL 36 PER MONTH.

ABBREVIATIONS

DSGN — DESIGN	TST — TEST
LAB — LABORATORY	PRELM — PRELIMINARY
INST — INSTALL	OPNS — OPERATIONS
ANT — ANTENNA(S)	

SYMBOLS

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

REV. NO.	REV DATE	DESCRIPTION
1	12/1/78	UPDATE PROGRAM PLAN '79
2	11/1/79	UPDATE PROGRAM PLAN '80

APPENDIX A

NRAO COMMITTEES

There will be four major committees involved with the VLA - the NRAO Visiting Committee, the NRAO Users Committee, the VLA Advisory Committee, and the VLA Post-Processing Committee. The first of these provides the AUI Board of Trustees with an independent appraisal of NRAO performance, including the VLA. The Users Committee and the Advisory Committee provide broad overall review and guidance. These two committees furnish scientific input and are the Program's liaison with the scientific community, thus assuring broad participation in the Program. The Post-Processing Committee is responsible for more detailed reviews and advice on the processing of scientific data. In previous years a VLA Steering Committee has been used for the continuous review of technical designs. This committee completed its work and was disbanded in 1979.

The Visiting Committee and the Users Committee have been in existence for many years and both have been involved with the VLA since its early design stages. The VLA Post-Processing Committee was formed in March of 1979.

In addition to the above standing committees, various ad hoc committees will be appointed as needed for specific tasks.

NRAO VISITING COMMITTEE

This committee is appointed by the AUI Board of Trustees and formally reports to the AUI Board on an annual basis. Its function is to review the performance of the Observatory and advise the trustees on how well it is carrying out its function as a national center, the quality of the scientific work, and the adequacy of its instrumentation and facilities. A thorough review of the VLA Program will be conducted

by this committee each year. The current membership of the committee is:

A. M. Boesgaard	University of Hawaii
W. A. Fowler	California Institute of Technology
P. P. Kronberg	University of Toronto, Canada
R. B. Leighton	California Institute of Technology
J. M. Moran	Smithsonian Astrophysical Observatory
J. P. Ostriker	Princeton University Observatory
J. H. Taylor, Jr.	University of Massachusetts
R. W. Wilson	Bell Telephone Laboratories

NRAO USERS COMMITTEE

This committee consists of users, and potential users, of NRAO facilities from throughout the scientific community. It advises the Director and Observatory staff on all aspects of Observatory activities that affect the users of the telescopes - development of radiometers and auxiliary instrumentation, operation of the telescopes, the computer and other support facilities, and major new instruments. This committee is appointed by the NRAO Director. It meets twice a year, and a broad review and discussion of the VLA will be a principal item for these meetings throughout the life of the Program. The present membership of this committee is:

D. C. Backer	University of California, Berkeley
B. Balick	University of Washington
A. H. Barrett	Massachusetts Institute of Technology
J. H. Broderick	Virginia Polytechnic Institute
B. F. Burke	Massachusetts Institute of Technology
W. B. Burton	University of Minnesota
E. J. Chaisson	Center for Astrophysics, Harvard
F. O. Clark	University of Kentucky
T. A. Clark	NASA - Goddard Space Center
J. R. Dickel	University of Illinois

D. M. Gibson	New Mexico Institute of Mining & Technology
S. J. Goldstein	University of Virginia
S. Gottesman	University of Florida
C. E. Heiles	University of California, Berkeley
R. W. Hobbs	NASA - Goddard Space Center
D. R. Johnson	National Bureau of Standards
K. J. Johnston	Naval Research Lab
F. J. Kerr	University of Maryland
G. R. Knapp	California Institute of Technology
M. R. Kundu	University of Maryland
M. L. Kutner	Rensselaer Polytechnic Institute
R. A. Linke	Bell Telephone Labs (Crawford Hill)
J. M. Moran	Smithsonian Astrophysical Observatory
P. Palmer	University of Chicago
L. E. Snyder	University of Illinois Observatory
P. Solomon	State University of New York (Stony Brook)
J. H. Taylor	University of Massachusetts
P. Thaddeus	Institute for Space Studies of New York
N. Thonnard	DTM, Carnegie Institution of Washington
P. A. Vanden Bout	University of Texas
J. F. C. Wardle	Brandeis University
B. Zuckerman	University of Maryland

VLA ADVISOTRY COMMITTEE

The Advisory Committee will periodically review the status and progress of the VLA. Its particular concern is with the broad elements of the Program, and especially those that directly influence the scientific capabilities and performance characteristics of the Array. It will advise on broad aspects of design, scientific emphasis, and priorities, as well as on general progress, to assist the Director and the Program staff in assuring that the scientific and technical specifications are met and that the VLA will be as responsive to the needs of radio astronomy as is possible. When scientific observing commences, this group may advise also on general observing programs to be carried out.

The committee is appointed by the NRAO Director. It is composed of scientists whose interests encompass all areas of radio astronomy and technology of concern to the VLA. An attempt is made also to maintain, in the membership, reasonable geographic distribution and representation of the major radio astronomy centers. The committee generally meets twice a year, depending on the nature of current Program activities and their rate of progress. The current membership of the committee is:

B. Balick	University of Washington
B. F. Burke	Massachusetts Institute of Technology
R. E. Ekers	Kapteyn Laboratory
C. E. Heiles	University of California, Berkeley
P. P. Kronberg	University of Toronto, Canada
A. T. Moffet	California Institute of Technology
D. H. Rogstad	California Institute of Technology
G. W. Swenson	University of Illinois
H. Zirin	California Institute of Technology

VLA POST-PROCESSING COMMITTEE

The Post-Processing Committee oversees the VLA post-processing development work within NRAO. The principal function of the committee is to review past progress and future plans of the Post-Processing Group and to report its findings to the Director.

The Committee was appointed by the NRAO Director. It principally consists of NRAO scientists who are thoroughly familiar with the scientific requirements and development of the VLA, as well as VLA post-processing requirements.

The current committee membership is:

R. C. Bignell	F. N. Owen
R. L. Brown	M. J. Reid
B. G. Clark	L. Rudnick
R. M. Hjellming	R. A. Sramek
W. Jaffe	C. M. Wade