MER

NATIONAL RADIO ASTRONOMY OBSERVATORY

PROGRAM PLAN 1982

N A T I O N A L R A D I O A S T R O N O M Y O B S E R V A T O R Y

CALENDAR YEAR 1982 PROGRAM PLAN

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I. INTRODUCTION

The National Radio Astronomy Observatory is funded by the National Science Foundation under a management contract with Associated Universities, Inc. The role of the Observatory as a center for basic research in radio astronomy is implemented both by the operation of its major telescope systems and by research and development in the fields of advanced technology and data processing.

The NRAO operates four major telescope systems--the 27-element Very Large Array telescope (VLA), the 36-ft millimeter wavelength telescope, the 140-ft telescope, and the 300-ft meridian transit telescope. Except for an anticipated extended summer shutdown for resurfacing the 36-ft telescope, all telescope systems will continue normal operation throughout 1982. Observing pressure continues to remain high as the radio astronomical community responds to the availability of newer low-noise and extended-wavelength receivers. Fully twice as much time is requested on the 36-ft telescope as can be accommodated. Similar pressure on the two Green Bank telescopes has resulted in a subscription backlog in excess of nine months. Experience with all four standard configurations of the fully operational VLA during 1981 has shown a dramatic increase in its user base as non-traditional radio astronomers from other wavelength regimes become initiated in its use. During 1982, approximately 70% of the observing time that is available on the NRAO telescopes will be used by visiting investigators, and their planned research is summarized in Section II of this Program Plan.

Section III of the Plan presents a program for the development of new research instrumentation for use on the telescopes. As in the past, the NRAO is committed to the maintenance of a strong electronics research and receiver development effort in order to ensure the continued growth of the NRAO's technological capability to support forefront radio astronomical research in the foreseeable future. Millimeter-wave technology will continue to receive significant support as techniques and devices for observing at frequencies above 120 GHz will be developed for use on both the present 36-ft telescope, its resurfaced 12-m version and eventually the future 25-m telescope. Modifications and improvements in VLBI techniques will also require more engineering efforts. Continued efforts to construct improved low-noise systems for Green Bank will be maintained as the capabilities of the Green Bank telescopes continually expand. At the VLA new receivers are under development which will reduce system noise and extended low-frequency coverage. The potential of the VLA in the future, however, to a large extent depends on the ongoing efforts to extend and streamline its data-processing capabilities.

Subsequent sections give the detail of the expenditures required for operations and maintenance of the Observatory. A summary of the allocations of funds is given in Section VIII, the Financial Plan.

Appendices to this Plan include a summary of the scientific program of the NRAO permanent staff, a list of the staff and their principal research interests, an organizational chart for the NRAO, and a list of the various committees associated with the NRAO.

II. SCIENTIFIC PROGRAM

Throughout 1982, visiting astronomers proposing to carry out research with NRAO facilities will be submitting detailed requests for observing time, which will subsequently be evaluated for scientific merit by peer review groups advisory to the NRAO scheduling committees. Because the time between proposal receipt and scheduling can be shorter than six months, not all of the 1982 observing programs can be summarized at this time. Nevertheless, the proposals already in hand are a representative group that are undoubtedly typical of the observations that will be made during the entire year. The following summary, by telescope, will aptly serve to outline the type of research projects and the major thrusts to be emphasized by the NRAO's varied clientele.

The VLA - The demand for observing time has been exceedingly heavy during 1981 and promises to continue increasing during 1982. Restrictions on observing time which were imposed by limitations in the data-processing system have gradually been eliminated since much of the map-making and data-processing burden has been transferred to a VAX post-processing system and the DEC model KI asynchronous computer has been upgraded to a model KL. An ever-widening base of users in the astronomical community has gained experience with the full power and versatility of the VLA in all four of its standard configurations. In spite of steady increases in the number of proposals, a general appreciation for the VLA's capabilities and efficiencies has resulted in a decreased oversubscription rate compared with earlier years. Some restrictions still remain for spectral-line work, however.

The VLA will continue to have strong appeal for researchers in nearly every subdiscipline of astronomy. Several groups of solar investigators will continue to rely heavily on high-resolution VLA data in order to correlate radio features with optical features on the solar disk. Spatial images of centimeter bursts in conjunction with X-ray and γ-ray burst observations from the Solar Maximum Mission satellite and the planned Japanese Astro-A satellite will be central to the understanding of the mechanisms responsible for the release of energy during the impulsive phase of solar flare activity and its subsequent conversion to electron acceleration. Basic to these observations will be a critical examination of existing solar flare theories and X-ray flare models with respect to

magnetic field configuration. Observations of several of the planets and their major satellites will also continue, with particular emphasis on the most distant Jovian planets Saturn, Uranus, and Neptune and the thermal and chemical nature of their atmospheres. A novel cometary occultation experiment proposes to examine the number density and spatial distribution of electrons in the comet's ion tail.

More than any other radio telescope, the VLA has expanded research possibilities for stellar sources. Numerous projects taking advantage of the VLA's enormous power and sensitivity have been proposed to survey all classes of early or late-type stars where significant interactions with the stellar environment is evident at other wavelengths. These range from binary X-ray stars and peculiar variable stars to old planetary nebulae and much younger mass-losing stars. Continuing interest is devoted to the structural properties of supernova remnants and their central stellar sources as well as to the dynamics of stellar maser sources. As the spectral-line capabilities of the instrument expand, numerous dynamical studies for galactic objects will be pursued. Attention will focus particularly on HII regions, molecular clouds, and the Galactic Center where both the physics of the object itself and its relationship to overall galactic structure are important.

In the area of extragalactic astronomy, the VLA continues to pour forth great quantities of data on the detailed morphologies, spectral index distributions and variability of many classes of sources. Many of the earlier studies still require further complementary observations with different configurations and frequencies. The attainment of the greatest possible dynamic range is also an oft-sited goal required for the analysis of faint, extended source components critical to the interpretation of the physics involved. Follow-up observations on several extragalactic supernovae and other enigmatic variable sources will add valuable points to their evolving light curves and our subsequent understanding of the emission processes involved. Several studies of the hard to detect faint outer portions of quasars are planned, and the search for other gravitational lens candidates continues. More extensive dynamical studies in normal galaxies, as well as impending work on their molecular content, will remain limited by ongoing developments in the VLA spectral-line capability.

The 36-ft Telescope - Prospects for dramatic improvements in the short wavelength capability of the NRAO millimeter-wave telescope have been strengthened by plans to resurface the dish. During an extended summer shutdown in 1982, a new 70 micrometer (r.m.s.) 12-m dish and improved backup structure will be installed in place of the current dish. The antenna efficiency at 1-mm wavelength should be improved by at least a factor of ten. Pointing accuracy is also expected to improve due to the improved thermal stability of the new backup structure. A large part of the justification for the resurfacing project arises with the completion and installation of a state-of-the-art ^{3}He cooled bolometer for 1-mm and 3-mm continuum observations and a newly completed 230-GHz spectral-line receiver.

It was not until both of these receivers were completed that the low efficiency of the 36-ft surface at a 1-mm wavelength was determined.

The new 12-m surface and receiver combinations will attract increased attention to programs already planned for the 1-mm to 3-mm regime. Continuum measurements of Pluto will improve knowledge of the planet's diameter and mass, while observations of spiral galaxies, radio galaxies, compact extragalactic objects, and QSOs will primarily lead to improved models of energy generation.

The energetics and physical processes involved in young star-formation regions continue to play a central role in many investigations. Extended velocity features seen in CO studies of molecular clouds indicate potentially exciting aspects of the interaction between the clouds and young stellar objects. Numerous molecular-line studies of dark clouds have been proposed to probe the chemistry of the interstellar medium.

Several programs are directed to the study of extragalactic molecules. Molecular gas is a major constituent of some spiral galaxies, and attempts are being made to relate the overall structure to the molecular structure of these galaxies in a perspective unavailable to studies of our Galaxy. Other programs will map in barred spirals and irregulars in order to further investigate the conditions for star formation in other galaxies.

The 140-ft Telescope - Visiting scientists continue to exploit the capabilities of the new upconverter maser receiver for the 5-26 GHz range. It's improved sensitivity is the primary reason for a significant increase in the proposal backlog. Outstanding proposals are currently in hand to carry out numerous studies of molecular species under a wide variety of physical conditions. The observations of carbon-chain molecules, for example, serve as a useful diagnostic tool for testing structural and evolutionary models of the temperature and density behavior of molecular clouds. Searches will be made for hydrogen proxide, methyl cyanide, vinyl cyanide, and deuterated formaldehyde. Evidence for excited-state hydroxyl-maser lines will also be sought in several objects.

Neutral hydrogen-line observations will be roughly equally divided between galactic and extragalactic programs. In our galaxy time will be divided among the characteristics of high-velocity clouds and the physics of specific late-type stars undergoing mass loss into a circumstellar shell. Extragalactic-line work will continue to emphasize kinematic studies of a wide variety of galaxies of differing morphological type in addition to a search for highly redshifted molecular absorption lines in quasars. Improved receiver sensitivity also warrants an updated search for the hyperfine transitions of $^3He^+$.

Very Long Baseline Interferometry (VLBI) programs will continue to occupy approximately 25% of the observing time. Continuum observations will concentrate on the mapping of superluminal sources, on the study of compact components in normal and radio galaxies, and on astrometric and geodetic

measurement. The motions of discrete blobs in the jets emitted by the enigmatic source SS 443 will also be followed.

The 300-ft Telescope - Because of its usefulness as primarily a survey instrument, the 300-ft has less flexibility compared with fully steerable antennas and therefore services fewer, but larger, programs. The travelling feed appreciably extends the integrating capability of the telescope-receiver system.

Most of the continuum surveys underway, and those to be initiated, deal with monitoring existing or potentially variable sources with particular spectral characteristics. In some cases, former surveys establish the baseline against which proposed resurveys are to be compared. One planned program at 1400 MHz will completely cover the available sky to the limits of confusion in order to establish a reference catalog for numerous future investigations in a manner similar to its optical wavelength counterpart, the Palomar Sky Survey.

Most of the line work that will be carried out with the 300-ft telescope will involve the 21-cm HI line. HI will be surveyed in galaxies of all different morphological types and in many clusters. Redshifted HI will be sought in bright quasars, and confirmation of a redshifted absorption feature seen at Arecibo in the radio galaxy 3C 293 will be attempted. Particular attention is being given to the HI content of Seyfert and other active galaxies.

Pulsar research will dominate the use of the new low-frequency receiver for the 300-100 MHz range. Several programs have begun which extend pulsar-timing experiments and explore pulsar polarimetry and Faraday rotation in order to gain insight into both the structure of neutron stars and the nature of the propagation medium. Low-frequency observations of interstellar clouds in search of neutral carbon-recombination lines will also be attempted with this receiver.

All proposals for telescope time, whether by visitor or staff, are sent for evaluation to referees who are not on the NRAO staff. The programs that are run on the telescopes represent the best of the proposals. It is anticipated that more than 400 visitors will use the NRAO telescopes during 1982.

The program of the NRAO staff, which comprises about 30% of the total program, is described in greater detail in Appendix A.

III. RESEARCH INSTRUMENTS

The research instruments at the National Radio Astronomy Observatory consist of (1) the 140-ft telescope; (2) the 300-ft telescope; (3) the 36-ft telescope; and (4) the Very Large Array.

The CY 1982 program for new instrumentation has three categories, with budget allocations as follows (in thousands of dollars):

Item 1.	Other Observing Equipment.....	$1,178
Item 2.	Research Equipment.....	225
Item 3.	Test Equipment.....	25
	Total Available.....	$1,428

Item

1. Other Observing Equipment (in thousands of dollars)

	Estimate to Complete (k$)	Estimate Continued Development (k$)	Estimate New Development (k$)
140-ft Telescope			
5-26 GHz receiver	10		
300-ft Telescope			
1-5 GHz receiver		25	
Pulsar signal processor			20
11-cm receiver upgrade		15	
ModComp		25	
36-ft Telescope			
Diode development		25	
SIS development		40	
0.3 K bolometer		15	
New, 1, 2, 3-mm receivers			45
12-m reflector	170		
Inductosyns		30	
Computer upgrade		20	
345-GHz coherent rx			10
VLA Electronics			
300-MHz receiver			15
FET amplifiers, 21 cm			60
FET amplifiers, 2 cm			60
Improvements in antenna pointing		25	

	Estimate to Complete (k$)	Estimate Continued Development (k$)	Estimate New Development (k$)
VLA Computing			
Synchronous computer upgrade		35	
DEC-10 system		135	
Pipeline upgrade		35	50
Image processing system		65	20
VLBI			
MK III projects		200	
Other			
Cooled GASFET development		40	
Data communication			60
Subtotal	180	730	340
+ General + Test Equipment			250
Total			$1,500

A. Other Observing Equipment: Items to Complete

1. 5-26 GHz receiver for the 140-ft telescope. The second channel of this receiver will be completed in 1982.

2. 12-m reflector for the 36-ft telescope. New surface and backup structure for the 36-ft telescope. Objective is 70-μm rms surface accuracy, giving much improved performance in 1-mm window.

B. Other Observing Equipment: Continuing Development Items

1. 1-5 GHz receiver. This receiver will cover 1-5 GHz and will be used on the 140-ft and 300-ft telescopes and have a very low system temperature in this frequency range.

2. 11-cm receiver upgrade. Replacement of parametric amplifiers with GASFET amplifiers will result in improved performance and reliability.

3. ModComp. The old DDP-116 control computer at the 300-ft telescope will be replaced by a ModComp. The resultant increased memory available will increase capabilities of the telescope.

4. Diode development. Contract with the University of Virginia supplies NRAO with all Schottky diodes used in millimeter wave receivers.

5. SIS development. This program covers the development of superconductor-insulator-superconductor junctions suitable for low-noise mixers for future millimeter receivers.

6. 0.3 K bolometer receiver. Continuum receiver for the 1, 2, and 3-mm atmospheric windows. Composite Germanium bolometer cooled to 0.36 K using ^{3}He.

7. Inductosyns. Replacement of encoders by inductosyns at the 36-ft telescope for improved accuracy and reliability.

8. Computer upgrade. Upgrade of DEC-11/40 control computer by DEC-11/44.

9. Improvements in antenna pointing. Modifications to VLA antennas to improve pointing.

10. Synchronous computer upgrade. Upgrade critical items on on-line system to enhance performance and replace some non-maintainable components.

11. DEC-10 system. Improve the overall through-put of the DEC-10 by enhancing communications capability and peripheral equipment.

12. Pipeline upgrade. Additional hardware to aid in development of pipeline, especially in the area of spectral-line mapping.

13. Image Processing System. Addition of new features and facilities to existing image processing system at Charlottesville and the VLA site.

14. MK-III projects. Plan is to purchase hydrogen maser frequency standard for VLA site.

15. Cooled GASFET development. Project covers development of cooled GASFET amplifiers for frequencies to 22 GHz for all NRAO sites.

C. New Development Items

1. Pulsar signal processor. Multifrequency-channel back-end capable of sampling faster than once per microsecond for pulsar observing.

2. New 1, 2, 3-mm receivers. New 1, 2, and 3-mm cooled mixer receivers for the resurfaced 36-ft telescope.

3. 345-GHz coherent receiver. Cooled mixer receiver for resurfaced 36-ft telescope for evaluation of surface at 345 GHz.

4. 300-MHz receiver. 300-MHz prime focus receivers for the VLA.

5. FET amplifiers, 21 cm. Cooled GASFET amplifiers will replace the VLA upconverters for better performance and reliability.

6. FET amplifiers, 2 cm. Cooled GASFET amplifiers precede the cooled mixers for improved system performance at the VLA.

7. Data displays. Interactive displays of the pipeline data.

8. Data communications. System of modems, multiplexers to permit site-to-site communication.

IV. EQUIPMENT

No major equipment acquisitions are planned for 1982. The distribution of funds (in thousands of dollars) in the various equipment accounts is as follows:

1.	Maintenance, Shop and Repair Equipment.....	$ 5.0
2.	Office and Library Furnishings and Equipment...	85.0
3.	Living Quarters Furniture.....	2.0
4.	Building Equipment.....	3.0
5.	Scientific Services and Engineering Equipment..	5.0
6.	Other Equipment.....	50.0
	Total.....	$150.0

Item

1. Maintenance, Shop and Repair Equipment

Funds planned in this account provide for the replacement and/or acquisition of items for the shops and maintenance divisions. Items included in this account are: tractors and mowers, replacement trucks and other vehicles, machine shop equipment, and several auxiliary items and accessories to be used with existing equipment.

2. Office and Library Furnishings and Equipment

These funds provide for replacement, updating and acquisition of typewriters, adding machines, desk calculators, desks, chairs, and other office furnishings.

3. Living Quarters Furnishings

These funds provide for replacement of household appliances and furnishings, such as beds, tables, lamps, draperies, carpets, etc., used in the residences at the sites.

4. Building Equipment

These funds provide for items that are generally attached to and become a part of the buildings. Included are such items as small air conditioners, small heating units, water heaters, etc.

5. Scientific Services and Engineering Equipment

These funds provide for small equipment additions in the darkroom, Public Education, and Engineering Divisions. Items such as cameras, film processing units, projectors, measuring equipment, etc., are included in this amount.

6. Other Equipment

An amount of $50,000 is estimated for general equipment items at the various operating sites.

V. OPERATIONS AND MAINTENANCE

The activities at the NRAO group naturally into six operation units which reflect both the individual operations at its three observing sites and the integrated operations which encompass all four geographic locations. The estimated costs of these major operation units are presented below.

I. General and Administration - Included in this unit are the Director's Office, Fiscal Office, and the Business Office, with a total MS&S budget of $124k. Rent and maintenance of the Charlottesville buildings, including communications and utilities, will require $364k. The management fee will be $295k.

II. Research Support - The NRAO scientific research staff, composed of staff scientists and students (co-operative, and Ph.D.), engages in independent research and competes for observing time on an equal basis with visiting scientists. They are expected to carry out research of the highest calibre while at the same time assisting visiting astronomers in gaining familiarity with the NRAO instruments and facilities. Because they are at the forefront of research in their individual areas of expertise, they are an invaluable asset to the NRAO in posing new problems and stimulating new approaches to observational problems. The staff advises the technical divisions about modifications to equipment or the design of new equipment and participates in the checkout and calibration of instrumentation. Included with the research scientists and students in Research Support are the support persons at the Charlottesville headquarters who maintain the central library and the technical illustration and drafting services. These latter services will require a Material and Supply (M&S) budget for 1982 of $102k.

III. Technical Services - Observatory-wide technical support and development responsibilities in three main areas are focussed in Charlottesville. At the Central Development Laboratory ongoing research is underway on improved radiometers and on state-of-the-art techniques for expanding wavelength capabilities. A subgroup is also involved in the development of VLBI techniques and correlator improvements. The Computer Division operates the central computer and the VLB MK II processor and assists in the development of programs for computers at the telescopes. An integral part of the Computer Division is responsible for coordinating the VLA post-processing effort. Each of the NRAO operating sites receives engineering assistance for the design of new facilities and telescopes from the Engineering Division.

The Materials, Supplies and Services (MS&S) budgets for the Central Lab, Computer Division, and Engineering Division are $55k, $380k (includes computer rent), and $20k, respectively.

IV. Green Bank Operations - Activities at the Green Bank site are coordinated through six basic divisions. These divisions are responsible for maintaining and operating the 300-ft telescope, the 140-ft telescope, and the four-element interferometer (for the USNO). New instrumentation specifically for the single dishes is developed on site. These divisions and their 1982 M&S budgets are: Telescope Services ($122k), Electronics ($125k), Shops ($21k), Plant Maintenance ($110k), Administrative Services ($114k), and Scientific Services ($15k). Communications and utilities require an additional $270k. Miscellaneous revenues, primarily from food service and housing, is estimated to be $70k. An allowance for a credit of $527k from the USNO for the operation of the four-element interferometer is made to the total Green Bank Operations budget.

V. Tucson Operations - This group maintains and operates the 36-ft millimeter wavelength telescope at Kitt Peak and develops new instrumentation for the telescope. Important aspects of the current work of this group involve the development and installation of a new surface for the 36-foot (12-meter) telescope as well as a modernization and consolidation of the on-site computer capability. The two Tucson subgroups will require the following M&S budgets for 1981: Operations and Maintenance ($188k) and Electronics ($120k).

VI. VLA Operations - The VLA Site Director and his staff of Systems Scientists will require an M&S budget of $64k. The Computer, Electronics, Array Operations, and Antenna Maintenance Divisions which are most critical to the mechanical functioning and data collecting capabilities of the telescope will require M&S budgets of $318k, $118k, $8k, and $100k, respectively. Other services related to the efficient functioning of the operation and the M&S budgets include: Plant Maintenance ($165k), Administrative Services ($225k), and Accounting ($6k). Communications, utilities, and building rent (in Socorro) will amount to $655k, while miscellaneous revenue of $75k is expected.

A summary of the CY 1981 budget for these operations units is provided in the following table:

CY 1982 Budget - Operation Units
($ thousands)

	Operation Unit	Personnel Ceiling	Salaries, Wages & Benefits	Material, Supply, Service	Travel	Total
I.	General and Administration	$ 22	$ 724.0	$ 976.0	$ 75.0	$ 1,775.0
II.	Research Support	38	1,522.0	102.0	284.0	1,908.0
III.	Technical Support	45	1,524.0	441.0	70.0	2,035.0
IV.	Green Bank Operations	94	2,484.0	707.0	29.0	3,220.0
V.	Tucson Operations	22	697.0	308.0	25.0	1,030.0
VI.	Socorro Operations	111	2,914.0	1,584.0	79.0	4,577.0
	Total Operations	$332	$9,865.0	$4,118.0	$562.0	$14,545.0

Notes: 1. Does not include commitments carried forward from 1981.
2. General and Administrative includes $93k carried over for special severance pay and $295K for management fee.
3. Green Bank Operations includes $527k for USNO interferometer support.

VI. INTERFEROMETER OPERATIONS

Under a Memorandum of Understanding between the National Science Foundation and the U.S. Naval Observatory (dated September 26, 1978), the NRAO will continue to operate the four-element interferometer in Green Bank through 1982. The agreement may be extended for successive one-year terms at the mutual agreement of the parties.

VII. PERSONNEL

Personnel Services and Benefits (Level = Full time at December 31)

Category	1981 Level	1981 Salaries	1981 Benefits	1982 Level	1982 Salaries	1982 Benefits
Operations						
Scientific & Engineering	97	$2,918.0	$ 589.6	102	$3,281.0	$ 734.8
Technical	117	2,184.4	441.3	111	2,233.0	500.1
Administrative & Clerical	75	1,731.5	349.8	69	1,730.0	387.4
Operations & Maintenance	54	840.4	169.8	50	816.0	182.7
Total Operations	343	$7,674.3	$1,550.5	332	$8,060.0	$1,805.0
VLA Construction	2	95.0	20.4	-	6.0	2.0
Total Personnel	345	$7,769.9	$1,570.9	332	$8,066.0	$1,807.0

Personnel levels include approximately 10 man-years charged to Interferometer Operations.

IX. PRELIMINARY FINANCIAL PLAN - 1982
(in thousands)

	1980	1981	1982				
	Actual Exp.	Actual Exp.	New Funds 1982	Uncomm. Funds From 1981	Avail. for Comm. 1982	Comm. From 1981	Avail. for Exp. 1982
1. Operations							
Personnel Compensation	$ 6,413.2	$ 7,674.9	$ 8,060.0		$ 8,060.0		$ 8,060.0
Personnel Benefits	1,334.3	1,550.5	1,805.0		1,805.0		1,805.0
Travel	516.1	538.0	562.0		562.0		562.0
Material & Supply	3,548.6	3,550.9	3,730.0		3,730.0	$ 233.0	3,963.0
Subtotal	$11,812.2	$13,314.3	$14,157.0		$14,157.0	$ 233.0	$14,390.0
Management Fee	$ 220.0	$ 235.0	$ 295.0		295.0		$ 295.0
Special Insurance Credit	-	(107.7)	-		-		-
Special Severance Pay	-	307.9		$ 93.0	93.0		93.0
Total Operations	$12,032.2	$13,749.5	$14,452.0	$ 93.0	$14,545.0	$ 233.0	$14,778.0
2. Equipment							
Research Equipment	$ 896.5	$ 1,172.9	$ 715.0	$ 471.5	$ 1,186.5	$ 266.4	$ 1,452.9
12-m Resurface	-	21.0	50.0	191.8	241.8	237.2	479.0
Operating Equipment	137.9	264.6	150.0		150.0	80.8	230.8
Total Equipment	$ 1,034.4	$ 1,458.5	$ 915.0	$ 663.3	$ 1,578.3	$ 584.4	$ 2,162.7
3. Construction							
Very Large Array	$ 6,609.5	$ 1,913.1	-	$ 49.7	$ 49.7	$ 204.1	$ 253.8
Interferometer Expansion	-	39.9	$ 800.0	163.7	963.7	616.8	1,580.5
Total Construction	$ 6,609.5	$ 1,953.0	$ 800.0	$ 213.4	$ 1,013.4	$ 820.9	$ 1,834.3
Total NRAO	$19,676.1	$17,161.0	$16,167.0*	969.7	$17,136.7	$1,638.3	$18,775.0

*Includes 527 K for Interf.

1982 Financial Plan
Operating Costs
(Expenditures and Commitments: by Major Function)

	1980	1981	1982				
	Actual Exp.	Actual Exp.	New Funds 1982	Uncomm. Funds From 1981	Avail. for Comm. 1982	Comm. From 1981	Avail. for Exp. 1982
Operations							
General & Administrative	$ 1,199.5	$ 1,331.6	$ 1,387.0	$ 93.0	$ 1,480.0	$ 5.1	$ 1,485.1
Research Support	1,482.7	1,589.3	1,935.0		1,935.0	34.9	1,969.9
Technical Support	1,832.6	1,981.3	2,035.0		2,035.0	7.0	2,042.0
Green Bank Operations	3,162.8	3,541.6	3,220.0		3,220.0	67.7	3,287.7
Tucson Operations	1,072.1	994.8	1,030.0		1,030.0	11.7	1,041.7
Socorro Operations	3,062.5	4,183.6	4,550.0		4,550.0	106.6	4,656.6
Subtotal	$11,812.2	$13,622.2	$14,157.0	$ 93.0	$14,250.0	$ 233.0	$14,483.0
Management Fee	220.0	235.0	295.0		295.0		295.0
Special Insurance Credit	-	(107.7)	-		-		-
Total Operations	$12,032.2	$13,749.5	$14,452.0	$ 93.0	$14,545.0	$ 233.0	$14,778.0

APPENDIX A

RESEARCH PROGRAMS FOR THE NRAO SCIENTIFIC STAFF

During 1982 the permanent staff of the NRAO will be working in a number of research areas as described below. Some of the research will be done in collaboration with visiting scientists.

A. Galactic Studies

1. The Structure of the Milky Way and the Galactic Center

An atlas of the galactic plane as seen in 21-cm absorption spectra is in preparation which will incorporate about 100 new low-latitude spectra ($|b| < 10°$) taken at the VLA, using novel interferometric techniques. This tenfold increase in the number of accurate low-latitude absorption spectra will facilitate a much improved analysis in order to establish a large-scale picture of the temperature distribution of the galactic interstellar neutral hydrogen. The structure of the cold HI within and between spiral arms will be accessible, and the vertical temperature distribution may also be revealed. The same technique should also make Zeeman splitting measurements possible, with the goal of obtaining magnetic field strength measurements in several new directions.

The distribution of ionized gas in the Galaxy will be studied by combining existing radio recombination-line data, the results of new surveys being made in Green Bank and in Spain, and optical data for Hα emission. An interpretation of the radio data will reveal the general distribution of ionized gas, its kinematics, scale height, and other characteristics; the optical data will allow an estimate of the amount of absorption by dust in various directions.

With an aim toward understanding observed variations in the rotation curve of the Galaxy for regions progressively more distant from the galactic plane, a program has been initiated to determine the vertical structure of galactic rotation using a combination of Green Bank and Arecibo HI observations. Accurate estimates of the HI density structure at large distances from the galactic plane will also be obtained.

A recent analysis of the Green Bank OH survey has uncovered the presence of widespread, spatially extended, anomalously excited OH in the 1720-MHz satellite line. The peculiar clouds have a size distribution the same as that of giant molecular clouds seen in CO emission. Whereas these GMC's, as observed in CO (and H_2CO), cannot be located with respect to spiral arms, the new OH clouds, when plotted on a longitude-velocity diagram seem to show characteristic patterns (as do HII regions) which locate them in spiral arms. Observations are planned to increase the number of such known clouds and to perform sensitive searches for 1720-MHz emission at certain longitudes and velocities which should be forbidden if

these "GMC's" are truly located in spiral arms. The question of such location is presently of central importance to theories of formation of molecular clouds in the interstellar medium.

The detailed radio structure of the central 1 parsec of the galaxy as revealed by the VLA suggests that material is flowing out from the compact, non-thermal radio source. The flow seems to be confined to two oppositely directed non-relativistic beams reminiscent of SS 433. The implications of this model, particularly with regard to the gas dynamics at the galactic center and the ionization structure of the inner parsec of the galaxy, will be studied.

A measurement of the secular parallax of the galactic center has been started at the VLA. Observations of the 0.005 arcsec/year parallax will be made about once per year for several years to improve on the results of an earlier Green Bank interferometer experiment. The two-dimension motion measured at the VLA could set a limit on peculiar motion of Sgr A (central) relative to the adopted secular parallax and set a limit on the object's mass or the galactic constants.

2. HII Regions, Planetary Nebulae, Mass Loss

An investigation of the thermodynamical properties and ionization structure of a large sample of optically-obscured Galactic HII regions will be conducted using single-dish radio recombination-line observations combined with detailed VLA continuum maps. The VLA maps will be interpreted so as to provide a measure of the distribution of particle density within the nebulae; with this distribution the recombination-line observations will be used to infer the nebular temperature distribution. Correlations among the nebulae will be investigated along with possible systematic variations in temperature or density with galactocentric radius.

Further analysis of the H_2O emission region of the W49N HII region will depend heavily on the VLBI map of the region which has already been obtained. A preliminary statistical analysis has revealed the presence of hyperfine structure but without any characteristic clustering scale size.

A knowledge of the distribution and environment of the hydroxyl and formaldehyde interstellar molecules in the HII regions NGC 7538 and DR 21 has been a result of VLA spectral-line observations. Efforts will be made to extend this type of observation to other HII regions.

A variety of theories suggest that in the earliest stages of formation of a massive star from a dense molecular cloud, the young star should be surrounded by a cavity around which is a dense shell of ionized gas. Such a configuration resembles a "ring" on the sky. Recent observations at very high (0.1 arcsec) resolution with the VLA of ultra-compact thermal continuum sources, chosen on the basis of other VLA observations, have indeed revealed ring structure in three, and perhaps four, of six objects examined. Three different configurations, consistent

with three different theories, were seen. It is planned to observe several more ultracompact objects, recently identified in parallel work, to determine how common are the various predicted forms of shell structure on this very small scale.

There will be an attempt to detect the secondary shell in the Dumb-Bell planetary nebula at 6 cm using the VLA with the goal of determining the amount of ionized gas in the secondary shell in order to study evolution of the planetary nebula.

The mass-loss phenomenon will be further investigated with the high resolution and sensitivity of the VLA in a number of objects. Two bipolar nebulae have recently been mapped at high resolution in the 1667-MHz masering transition of OH. The observed velocity-spatial configuration for the symmetrically-opposed streams of ejected, masering OH reveal a wealth of dynamical information on mass loss in these unusual, evolved stellar objects. For objects in a much younger evolutionary phase, radio emission has now been detected from about 15 Wolf-Rayet stars. Additional observations are required to test for time variability in the mass-loss rate and to determine accurate spectral indices of the emission. The spectral index is a function of the velocity and temperature structure of the stellar wind.

Symbiotic stars, proto-planetary nebulae, and stellar wind sources are among the variety of objects showing thermal emission that will be observed with the VLA in order to study the structure of the radio emission regions. An example is the eruptive variable HM Sge, for which information about the distribution of matter in the shell may be of value in understanding the nature of the star. Observations of α Orionis should help to distinguish between chromospheric, wind, and flare phenomena.

3. Radio Stars, Supernova Remnants

SS 433 will be the focus of continuing monitoring observations at both VLA and VLBI resolutions in order to study the time-dependent evolution of its radio jets in the context of existing jet models. The relationship between the innermost structures and their suggested transmission into the outer portions of the source has yet to be firmly established observationally.

Monitoring of Sco X-1 and other similar X-ray sources will also continue with the VLA in order to search for proper motions of the radio components. More detailed information on the source structures and their evolution with time should improve our understanding of their origins and their possible relationship to SS 433 type structures. Likewise, potential radio structures associated with γ-ray bursters will be investigated.

Observations with the VLA of Kepler's supernova remnant will be completed. The maps should be the first high-quality radio maps of this low-declination source. Comparison of these maps with recent X-ray images

should lead to a better understanding of the dynamics of Type I supernova remnants.

Continued monitoring of the expansion and spectral evolution of the knots in Cas A is planned. Observations at L- and C-bands, in the A and B configurations of the VLA, respectively, were made in 1981, and will serve as the "time-zero" basis. It is expected that these studies will aid in identifying the physical mechanisms operating in the evolution of the fine-scale features of this SN remnant.

Analysis of a large set of HI spectra taken around the Rosette and Monocerous nebulae will give the density and kinematic structure of neutral atomic gas in this area of current star formation. A detailed computer simulation will be used to test several theories of the interaction of supernova remnants with the ISM against these data.

The Cygnus superbubble may have resulted from a nearby supernova, or, if the object is as distant as 2 kpc, from the combined action of the stellar winds of the stars in the Cyg OB2 association. The choice between these alternatives is difficult because of the uncertainty in distance. A review of existing neutral hydrogen and CO data will be made, supplemented by additional observations as needed, with a view towards improving the estimate of the distance of the shell.

The supernova remnant in the irregular galaxy NGC 449 will be monitored for time variability at 6 and 21 cm with the VLA. In addition, an attempt will be made to determine the size and hence age (from optical expansion velocities) of the SNR from VLA observations at 2 cm.

4. Molecular Line Studies

Based upon new ab initio calculations of the structure and millimeter wavelength frequencies of $HOCO^+$, a tentative identification of this chemically important species has been made for four unidentified lines in the 3-mm wavelength region. A search for additional predicted lines will be made to confirm this identification. Similar calculations have yielded new and more accurately predicted frequencies for two other elusive molecules: $HCNH^+$ and COH^+. Searches will also be made for these at 3-mm wavelength. All of these species play a central role in the ion-molecule picture of interstellar chemistry, but have defied synthesis and microwave measurements in the laboratory.

C. EXTRAGALACTIC STUDIES

1. Normal Galaxies

The nuclei of nearby spiral galaxies are being mapped at 2-cm wavelength at the VLA to study the high-frequency properties of Sgr A-type sources in other spiral galaxies. This may eventually distinguish whether accretion onto a massive compact object is a general phenomenon at the

centers of spirals, or whether intense star-formation bursts which lead to frequent supernovae is the more common mechanism for powering central radio sources in spiral galaxies. The bright spirals with the strongest radio sources will be especially targeted for mapping to determine whether supernova remnants are primarily responsible and, if so, what causes the high supernova rate. For some selected emission-line galaxies, VLA maps, infrared maps and spectrophotometry will be combined in order to understand the nuclear emission in the context of very active star-formation models.

Twenty-one centimeter absorption-line studies of galaxies of different morphological types are now within reach of the VLA spectral-line system, and several galaxies have been selected for detailed studies of the content and dynamics of their interstellar gaseous components.

Other spectral-line studies with the VLA will focus on galaxies that have previously been detected in the main lines of OH. For these galaxies, out to about 68 Mpc, the VLA will be used to synthesize the distribution of OH absorption at high spatial resolution. In NGC 253, for example, a molecular ring-like distribution similar to that in our own Galaxy has been detected and similar distributions will be searched for in other galaxies. Continued studies of the weaker satellite lines of OH in other galaxies will also be carried out with the VLA. Studies at Nancay have already shown these lines to be highly anomalously excited and apparently related to strong nuclear infrared radiation which pumps them.

Continued 36-ft observations of CO in normal galaxies will take place. New galaxies continue to be detected at a rate of ~2 per year, and the maps of stronger ones are being extended and improved. The maps have not yet yielded spiral patterns, and it now appears that, as in our own Galaxy, the contrast ratio of molecular gas in and between arms is much lower than is seen optically. The correlation of CO with other entities, such as IR, nonthermal and thermal continuum strength, OH abundance, morphological type, etc., is of central interest.

Other galaxy programs to be carried out include spirals, ellipticals and irregulars. Observations of clumpy irregular galaxies with the D array at the VLA are required in order to better define the characteristics of the extended component of nonthermal emission. New data from the 36-ft telescope and the NASA IRTF installation will be combined with existing variability data in order to investigate outbursts in the nuclei of some elliptical galaxies. The extended bulge radio source spanning 10 arcminutes of the nucleus of M31 will be studied. Recombination-line VLA observations of M82 and NGC 253 will probe the gas distributions in these galaxies.

Radio emission from extragalactic supernovae in NGC 4321, NGC 6946, and NGC 4536 will be monitored at the VLA to establish for the first time the radio-light curve of a supernova. In addition, supernovae with ages between two and ten years will be observed for radio emission to fill out the later part of the light curve.

Twenty-one centimeter-line observations of the neutral hydrogen content of galaxies located in varying intergalactic environments permit the study of external influences exerted on the interstellar gas, and hence the evolution of galaxies in the different density regimes. In order for the comparison of HI properties among galaxies to be substantive, an understanding of possible observational selection effects must be achieved. In particular, the viewing inclination will affect the observed optical apparent magnitude, measured HI flux, and HI profile width. The latter parameter, when combined with the infrared magnitude, serves in the determination of the Hubble constant via the Tully-Fisher relation. In order both to study inclination effects on the measured quantities and also to determine the intrinsic spread in luminosity (and therefore expected scatter in the Tully-Fisher relation), HI spectra have been obtained for several hundred carefully chosen galaxies, all classified as type Sc.

2. Radio Galaxies and Quasars

Several VLA studies will be aimed at obtaining multi-wavelength high-resolution maps of the various morphological components of different radio galaxies with the prospect of measuring spectral-index distributions, rotation measures, polarization characteristics and both spatial and temporal variations in any of the measured parameters. Observations of the radio-jet galaxies 3C 449 and NGC 6251, as well as the galaxies NGC 1265, 3C 465, 3C 166, and 3C 192, should permit the derivation of magnetic field strengths and geometries and properties of the internal thermal gas in the jets and/or the extended radio lobes. For M87, the scale size of the polarization structure is of interest as are the proper motions of the knots in the jet. VLBI observations will search for relativistic motions in the M87 nucleus as well. Many narrow head-tail source maps will be improved with the VLA in order to better determine what percentage have twin tails and which, if any, are only one-sided jets.

Observations with the VLA of the interstellar medium in the radio galaxy M82 will be completed. Moderate resolution maps of the OH and hydrogen absorption have revealed an interesting ring structure, but are not yet fully reduced. Detailed high-resolution observations of the OH masers found on the moderate-resolution maps are planned.

The VLA, VLBI, and millimeter radio telescopes will be used in an attempt to find compact radio sources in optically selected quasars and in extended radio sources, and to investigate the importance of relativistic beaming on the radio source counts, the luminosty volume test, rapid flux variations, and superluminal motions. For a few selected compact radio sources, it is now apparent that new high-resolution, high-dynamic range VLBI observations will be required in order to decipher the complex superluminal motions that are involved. At the same time, for several steep spectrum compact sources without optical identifications, continuing analysis is planned in order to differentiate opposing models. Currently, the spectra of these sources suggest that if the emission is synchrotron then the high-energy electrons are strongly depleted while the small size and low turn-over frequency suggest abnormally low magnetic field strengths.

Particular attention will also be given to two non-superluminal sources, 4C 39.25 and NGC 1275. The former source has previously shown no internal motion, while in NGC 1275 there is component motion with a velocity only a few tenths the speed of light. Understanding these sources appears crucial in any attempts to understand quasars in terms of a universally applicable beaming model.

A program to measure the absolute motions of features in the superluminal radio sources using VLBI has been started. Most observations to date only show the relative motions of features. The first step in this program is to find suitable reference sources very close to the superluminal sources using the VLA.

A number of low-frequency variable sources will continue to be monitored in a number of wavelength bands from 1.4 to 90 GHz, using the VLA and the 36-ft telescope, in an attempt to confirm the existence of a "centimeter gap" in the radio spectra of low-frequency events. If confirmed, this phenomena provides good evidence for the presence of two emission mechanisms in these sources. An additional program will monitor a complete sample of low-frequency variables composed mainly of QSOs in order to more accurately document the spectral character of the variations.

Survey programs play an important role in large-scale source identification and variability studies. A first epoch confusion-limited map of the entire sky, which will be sensitive to very extended structures, is now feasible with the 10-arcminute resolution of the 300-ft telescope and its recently improved 1400-MHz four-feed receiver system. VLA survey programs will emphasis more restricted regions of the sky where the instrument's great sensitivity will probe to limiting flux densities many times fainter than previously possible. The faintest sources detected will be crucial to programs aiming to detect optically identified QSOs or to improve radio source statistics. Radio spectra and angular sizes will be combined with X-ray and optical studies to ultimately learn more about the origin and evolution of radio sources as well as their distribution in space.

The search for further examples of highly redshifted 21-cm wavelength HI absorption in the radio spectra of distant quasars will be continued. Since such absorption, when it occurs at a redshift substantially lower than the emission redshift, indicates that a substantial mass (or an entire galaxy) lies along the line of sight one may expect the absorber to act as a gravitational lens and distort the radio image of the background object. High-resolution VLA observations will be obtained to seek such distortions and hence to determine or place limits on the mass of the intervening object.

Several theoretical studies related to the physical mechanisms of radio sources will be pursued in an attempt to explain observational material or to influence future observations. Observed fluctuations in the Stokes parameters, as evidenced in VLA polarization maps, indicate that turbulence plays an important role in some sources. A theoretical

investigation of this phenomenon will be carried out. The astrophysical consequences of Alfven solitons will also be explored in the context of "soliton gas" models for magnetohydrodynamic turbulence in radio sources.

3. Clusters and Groups of Galaxies

Abell clusters which have already been detected with the 300-ft telescope will be surveyed more extensively at 20 cm with the B and C configurations of the VLA. The C array will also be employed for a survey of poor clusters. Galaxies that are identifiable as cluster members will be thoroughly studied in several spectral domains. Special attention will be devoted to the correlation of the radio and X-ray locations and properties of Abell cluster galaxies. For those classical double sources with uncertain membership towards Abell clusters, optical spectra of the central galaxies will be obtained in order to confirm membership. Direct video-camera imaging and spectrosopic analysis of cluster radio galaxies with binary nuclei will continue. Also proposed is a survey for cluster radio galaxies with Hα emission.

The Magellanic Stream, which is currently being mapped with the 140-ft telescope, is a dramatic example of a tidal appendage, fragmented and chaotic in nature by the interaction of the Milky Way and the Magellanic Clouds. Such tidal effects may be common in low-mass aggregates of galaxies and even in our own Local Group where intergalactic hydrogen may evidence past galaxy-galaxy encounters. To study this effect more closely, the extent of the neutral-hydrogen distribution of relatively isolated galaxies will be compared to that of galaxies in compact groups where the effect should increase due to increased collisional cross-sections.

The correct description of "superclusters" is of paramount importance for cosmology as well as for the understanding of the processes of formation and evolution of galaxies and clusters of galaxies. Twenty-one centimeter line observations of a large number of individual galaxies can provide high-quality redshift information, mass distribution and dynamical parameters within the superclusters, and evidence on environment-dependent processes which affect the evolution of galaxies. Current ongoing projects using the 300-ft telescope at Green Bank and the 1000-ft telescope at Arecibo will be continued to collect 21-cm line data on a large sample (> 1500) of galaxies in the Perseus-Pisces, the Hercules-A2199-N5846, the Coma-A1367 and the Lynx-Ursa Major regions. Additionally, both synthesis and filled aperture observations are planned at the VLA and at Arecibo to map the distribution of interstellar gas in cluster galaxies in order to be able to discriminate among different postulated gas removal mechanisms.

D. MISCELLANEOUS

Measurements with the VLA to establish very accurate positions for a large number of unresolved extragalactic sources continue. The main objective is to determine a precise inertial reference frame from the VLA.

Secondary objectives include refinement of precessional, nutational, and geophysical constants.

Astrometric measurements of the largest minor planets continue. The main objectives are a refined location of the vernal equinox and an absolute calibration of the VLA in right ascension. Other astrometric programs with the VLA will attempt to determine absolute parallaxes and proper motions of selected radio binary stars.

APPENDIX B

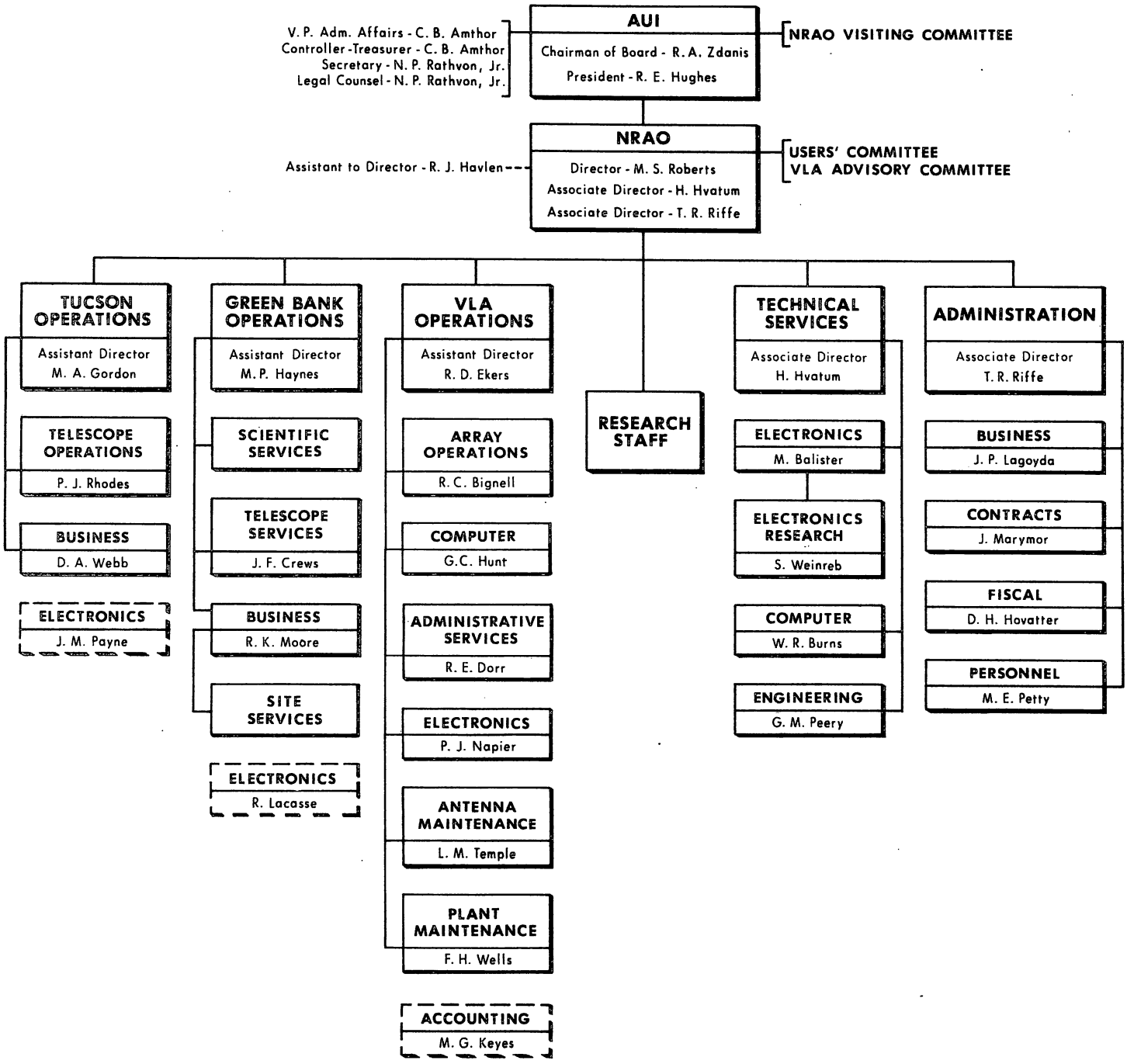
NRAO PERMANENT SCIENTIFIC STAFF, WITH MAJOR SCIENTIFIC INTERESTS

Benson, J. M.	Stellar OH Masers; Compact Galactic Sources
Bignell, R. C.	Polarization and Mapping of Extragalactic Radio Sources; Solar System
Brown, R. L.	Theoretical Astrophysics; Interstellar Medium
Clark, B. G.	VLA Development; VLB; Interferometry
Condon, J. J.	QSOs; Normal Galaxies; Extragalactic Radio Sources
Cotton, W. D.	Extragalactic Radio Sources; VLBI; VLA Development
Dickey, J. M.	Interstellar Medium; Galactic Structure; Intergalactic Hydrogen; Normal Galaxies
Ekers, R. D.	Radio Galaxies; Instrumental Techniques
Findlay, J. W.	Absolute Flux Density Measurements; Telescope Design
Fomalont, E. B.	Interferometry; Extragalactic Radio Sources; Relativity Tests
Gordon, M. A.	CO; Galactic Structure
Greisen, E. W.	Structure of Interstellar Medium; Computer Analysis of Astronomical Data
Havlen, R. J.	Galactic Structure; Clusters of Galaxies
Haynes, M. P.	Normal Galaxies; Clusters of Galaxies; Intergalactic Medium
Heeschen, D. S.	Variable Radio Sources; Normal Galaxies; QSOs
Hjellming, R. M.	Radio Stars; VLA Development
Hogg, D. E.	Radio Stars and Stellar Winds; Extragalactic Radio Sources
Jaffe, W. J.	Radio Galaxies; Clusters of Galaxies
Kellermann, K. I.	Extragalactic Astronomy; VLBI
Liszt, H. S.	Molecular Lines; Galactic Structure

Lockman, F. J.	Galactic Structure; Interstellar Medium; HII Regions
Owen, F. N.	Clusters of Galaxies; QSOs; Radio Stars
Perley, R. A.	Radio Galaxies; QSOs; Interferometric Techniques
Roberts, M. S.	Properties and Kinematics of Galaxies
Rots, A. H.	Extragalactic Research; Spectral Line Interferometry
Spangler, S. R.	Scintillations; Extragalactic Radio Sources
Sramek, R. A.	Normal Galaxies; Quasars; Astrometry
Turner, B. E.	Galactic and Extragalactic Interstellar Molecules; Interstellar Chemistry; Galactic Structure
von Hoerner, S.	Cosmology; Star Clusters; Antenna Design
Wade, C. M.	Astrometry; Interferometry; VLA Development
Walker, R. C.	VLBI Studies of Galactic and Extragalactic Sources

NATIONAL RADIO ASTRONOMY OBSERVATORY
ORGANIZATION CHART

January 1, 1982



APPENDIX D

NRAO COMMITTEES

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.

The current membership of the Committee is:

Boesgaard, A. M.	University of Hawaii
Hewish, A.	University of Cambridge, England
Kronberg, P. P.	University of Toronto, Canada
Leighton, R. B.	California Institute of Technology
Richards, P. L.	University of California, Berkeley
Shapiro, I. I.	Massachusetts Institute of Technology
Taylor, J. H.	University of Massachusetts
Vanden Bout, P. A.	University of Texas

NRAO Users' Committee

This Committee consists of users and potential users of NRAO facilities from throughout the scientific community. It advises the Director and the 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 Director and meets twice a year.

The present membership of this Committee is:

Berge, G. L.	California Institute of Technology
Blitz, L.	University of Maryland
Bridle, A. H.	Queen's University, Canada
Briggs, F. H.	University of Pittsburgh
Churchwell, E. B.	University of Wisconsin
Cordes, J. M.	Cornell University
Dennison, B. K.	Virginia Polytechnic Institute and State University
Dulk, G. A.	University of Colorado
Giovanelli, R.	Arecibo Observatory
Goldstein, S. J.	University of Virginia
Helfand, D. J.	Columbia University
Ho, P. T. P.	University of California, Berkeley
Lada, C. J.	University of Arizona
Linke, R. A.	Bell Telephone Laboratories

Lovas, F. J.	National Bureau of Standards
Marscher, A. P.	Boston University
Moran, J. M.	Smithsonian Astrophysical Observatory
Mutel, R. L.	University of Iowa
Myers, P. C.	Massachusetts Institute of Technology
Partridge, R. B.	Haverford College
Phillips, R. B.	Haystack Observatory
Price, R. M.	University of New Mexico
Reid, M. J.	Smithsonian Center for Astrophysics
Rudnick, L.	University of Minnesota
Schwartz, P. R.	U. S. Naval Research Laboratory
Scoville, N. Z.	University of Massachusetts
Shaffer, D. B.	Goddard Space Flight Center
Welch, W. J.	University of California, Berkeley
Wilson, A. S.	University of Maryland
Zirin, H.	California Institute of Technology

VLA Advisory Committee

The VLA Advisory Committee periodically reviews the status and operation of the VLA. Its particular concern is with the broad elements of the operation and especially those that directly influence the scientific capabilities and performance characteristics of the array. It advises on broad aspects of design, scientific emphasis, and priorities to assist the Director and the staff in assuring that the scientific and technical specifications are met and that the VLA is responsive to the needs of radio astronomy. This group may also advise on the observing programs to be carried out.

The Committee is appointed by the NRAO Director. It is composed of non-NRAO scientists whose interests encompass all areas of radio astronomy and technology of concern to the VLA. An attempt is also made to maintain in the membership reasonable geographic distribution and representation of the major radio astronomy centers. The Committee meets once a year.

The current membership of the Committee is:

Brouw, W. N.	Dwingeloo, The Netherlands
Johnston, K. J.	U.S. Naval Research Laboratory
Kronberg, P. P.	University of Toronto, Canada
Moffet, A. T.	California Institute of Technology
Palmer, P. E.	University of Chicago
Rogstad, D. H.	Jet Propulsion Laboratory
Rudnick, L.	University of Minnesota
Zirin, H.	California Institute of Technology