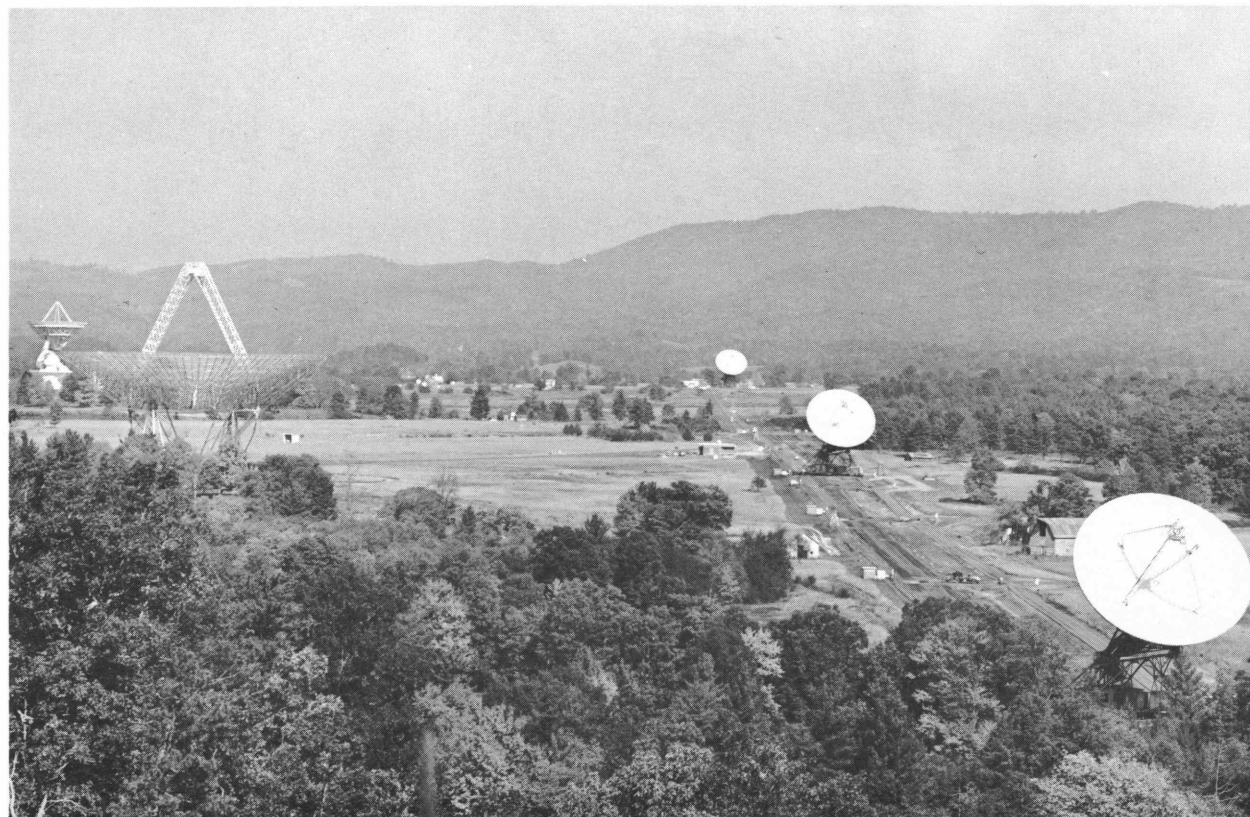


# NATIONAL RADIO ASTRONOMY OBSERVATORY



**STATISTICAL SUMMARY**  
**FEBRUARY 1971**

February 9, 1972

The NRAO Seven-Year Plan for Budget and ManpowerI. PERSONNEL LEVELS

The personnel levels are projections from CY 1972 through CY 1978. The figures for CY 1972 and 1973 are based on budget requests already submitted to the National Science Foundation.

Table I. Seven-Year Plan Personnel Projections by Category of Employees CY 1972-1978

<u>Category</u>	(Actual) Dec. 31, 1971	1972	1973	1974	1975	1976	1977	1978
1. Scientific & Engineering	50	58	60	64	65	65	66	69
2. Technical	73	83	86	88	92	96	98	99
3. Administrative & Clerical	56	58	58	58	60	62	63	63
4. Operations & Maintenance	55	56	56	56	60	61	61	62
Total	234	255	260	266	277	284	288	293
Total Visitor-Users:	175	176	177	178	179	180	181	182

II. SCIENTIFIC RESEARCH: OPERATIONS

The operating budget projection is based on the manpower levels shown in Table I.

Table II. Operating Budget Projections by Calendar Year  
(Figures in thousands of dollars)

<u>Item</u>	<u>Actual 1971</u>	<u>1972</u>	<u>1973</u>	<u>1974</u>	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>
Salaries (1)	2730	3200	3400	3680	4050	4400	4750	5100
Benefits (2)	424	484	540	570	640	700	760	830
Travel (3)	168	190	190	200	240	260	280	330
Other (4)	1402	1651	1790	2250	2150	2300	2500	2700
Subtotal, Operations:	4724	5525	5920	6700	7080	7660	8290	8960

Notes and Assumptions for CY 1975 and beyond:

- (1) Salaries at \$13.84K per man in CY 1974, then increasing at 6% per year, compounded.
- (2) Benefits at 15.5% of salaries in CY 1974, then increasing at 0.2% per year.
- (3) Travel at 6.0% of salaries.
- (4) Computer rent, communications, utilities, building and maintenance, management fee and all other materials, supplies and services and miscellaneous receipts are included here. Assume, according to past experience, 53% of salaries.

From the personnel projections (Table I) and the operating budget summary (Table II), we can derive the operating cost per man in Table IIA.

Table IIA. Operating Cost Per Man CY 1971-1978

<u>Calendar Year</u>	<u>Operating Cost Per Man</u>
1971 Actual	\$ 20,200
1972 Estimated	21,700
1973 "	22,800
1974 "	25,200
1975 "	25,600
1976 "	27,000
1977 "	28,800
1978 "	30,600

### III. SCIENTIFIC RESEARCH: RESEARCH AND OPERATING EQUIPMENT

Table III gives the budget projections for the NRAO research and operating equipment budgets through CY 1978. (Figures in thousands of dollars)

Table III. Research and Operating Equipment Budget Projections CY 1972-1978

<u>Item</u>	<u>Calendar Year</u>	<u>1972</u>	<u>1973</u>	<u>1974</u>	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>
<b>A. <u>RESEARCH EQUIPMENT</u></b>								
Other Observing Equipment		845	900	1150	1220	1300	1370	1450
Electronic Research Equipment		250	250	280	300	310	330	350
Electronic Test Equipment		50	50	70	74	80	85	90
Subtotal		1145	1200	1500	1594	1690	1785	1890
<b>B. <u>OPERATING EQUIPMENT</u></b>								
Maintenance, Shop & Repair Equipment		80	40	60	65	65	70	75
Office & Library Equipment		18	10	15	16	17	18	19
Living Quarters, Furniture & Equipment		2	2	3	5	6	6	6
Building Equipment		26	18	12	15	16	17	18
Scientific Services & Engineering Equipment		24	10	10	11	11	12	13
Subtotal		150	80	100	112	115	123	131
Subtotal, Equipment		1295	1280	1600	1706	1805	1908	2021
Subtotal, Sci. Research		6820	7200	8300	8786	9465	10198	10981

IV. CONSTRUCTION

Table IV gives the budget projections for NRAO construction items through CY 1978. Beyond CY 1974 price increases of approximately 6% per year, compounded, have been applied to estimates of standard items in order to allow for anticipated increased cost of construction and materials.

Table IV. Construction Budget Projections CY 1972-1978  
(in thousands of dollars)

<u>Item</u>	<u>Calendar Year</u>	<u>1972</u>	<u>1973</u>	<u>1974</u>	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>
<b>A. <u>SITE DEVELOPMENT</u></b>								
1. Roads, Green Bank		0	0	0	20	10	10	10
2. Water and Sewer		0	0	0	40	40	20	20
3. Electric Power & Communications		0	0	40	15	16	16	17
4. General Site Improvements		0	0	0	6	10	7	11
Subtotal		0	0	40	81	76	53	58
<b>B. <u>PLANNING, DESIGN AND CONSTRUCTION OF BUILDINGS</u></b>								
1. Green Bank Tourist Center		0	0	20	300	0	0	0
2. Green Bank Activities Center		0	0	0	20	300	0	0
3. Misc. Alterations & Additions		0	0	25	11	12	12	13
4. GB Lab & Residence Hall Extension		0	0	70	700	0	0	0
5. GB, Additional Houses		0	0	0	0	0	60	0
6. GB Indoor-Outdoor Electronics Test Facility		30	0	0	0	0	0	0
7. GB New Works Area Bldg.		0	0	0	0	0	30	400
8. CV Building Extension, Design		50	0	0	0	0	0	0
Subtotal		80	0	115	1031	312	102	413

Table IV - continued

<u>Item</u>	<u>Calendar Year</u>	<u>1972</u>	<u>1973</u>	<u>1974</u>	<u>1975</u>	<u>1976</u>	<u>1977</u>	<u>1978</u>
<b>C. <u>CONSTRUCTION OF RESEARCH FACILITIES</u></b>								
1. Homology Telescope		0	0	10000	0	0	0	0
2. VLA		0	3000	11045	48028	480	480	0
3. Major Alterations to Existing Telescopes		0	0	200 <sup>†</sup>	295	310	320	340
Subtotal		0	3000	21245	48323	790	800	340
Subtotal, Construction		80	3000	21400	49435	1178	955	811
TOTAL BUDGET		6900	10200	29700	58221	10643	11153	11792

<sup>†</sup>New Surface, 36-foot.

After completion of the homology telescope and the VLA, the estimated number of operating personnel and the operating costs are shown in Table V.

Table V

<u>Telescope System</u>	<u>Total Time to Construct</u>	<u>Total Personnel to Operate</u>	<u>Operating Budget (1978 dollars)</u>
1. Homology Antenna	4 years	26	0.72 million
2. VLA	5 years	83 <sup>(1)</sup>	4.26 million <sup>(2)</sup>

Details for the VLA will be found in the VLA Reports.

<sup>1</sup> 62 on-site and 21 off-site personnel

<sup>2</sup> Site Operations: 2555K  
 Off-Site Operations: 640K  
 Total Operations: 3195K  
 New Equipment: 1065K  
 Total Operating: 4260K  
 (1978 dollars)



# OBSERVING HOURS

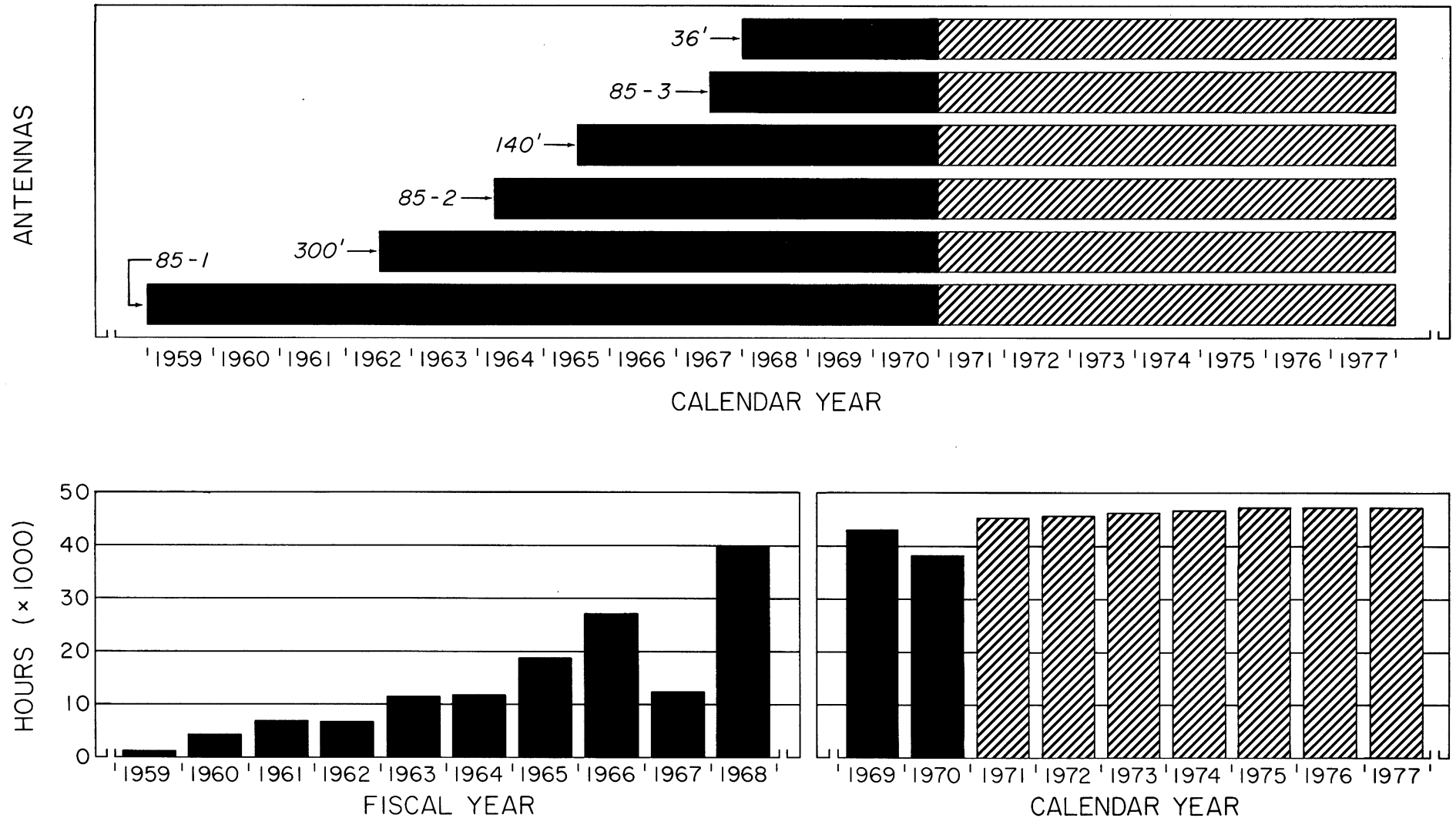


Fig. 1. The upper figure shows the year in which existing (black) or planned (shaded) telescope systems are incorporated into the NRAO observing program. The lower figure shows the total number of hours of observing time during each year. Each telescope contributes separately to the sum.

## OBSERVING TIME DISTRIBUTION

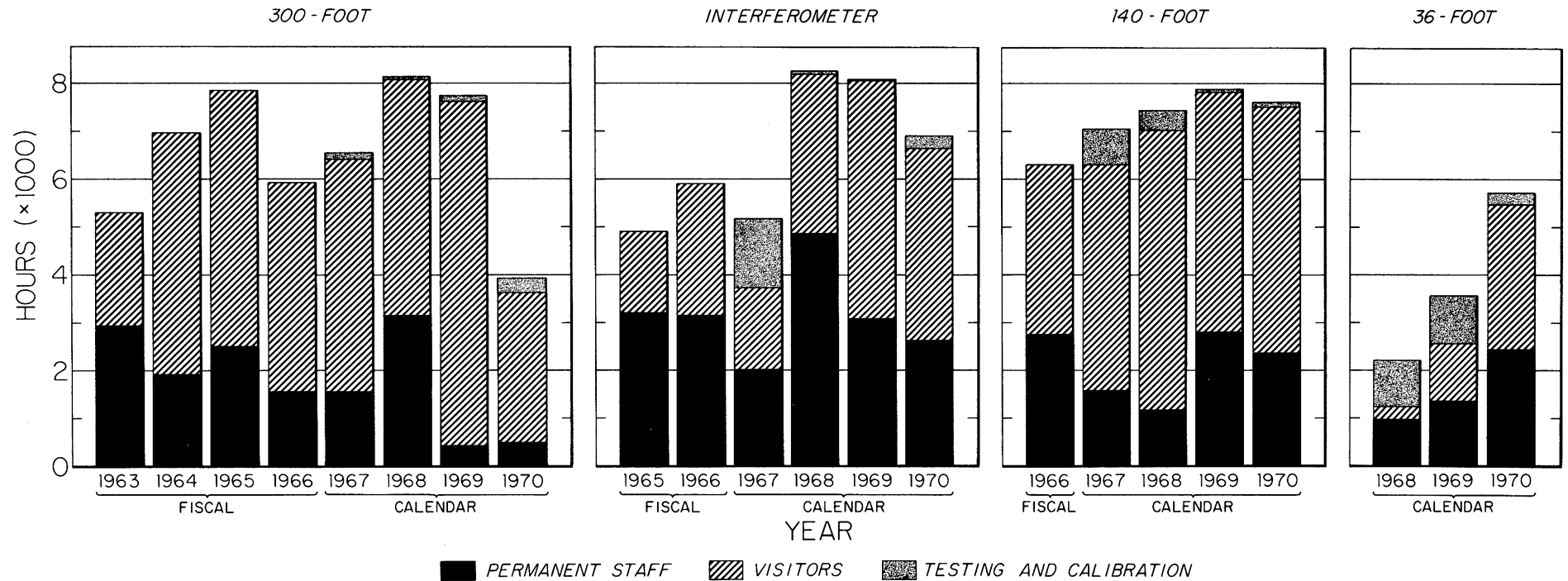


Fig. 2. These graphs show the number of hours devoted to calibration and testing and to observing by NRAO permanent staff members and by visitors on each telescope system during each year the telescope has been operative.

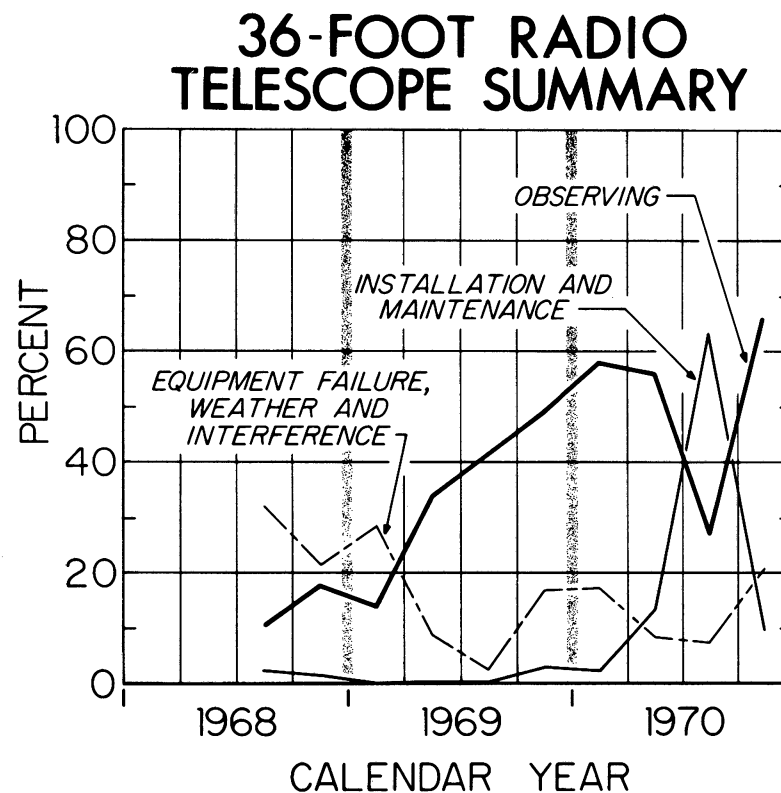


Fig. 3. This summary for each quarter of the calendar year shows the percentage of time the telescope was scheduled for observing, for routine maintenance and installation of new experiments, and the percentage of time lost due to equipment failure, bad weather, and radio interference.

## 140-FOOT RADIO TELESCOPE SUMMARY

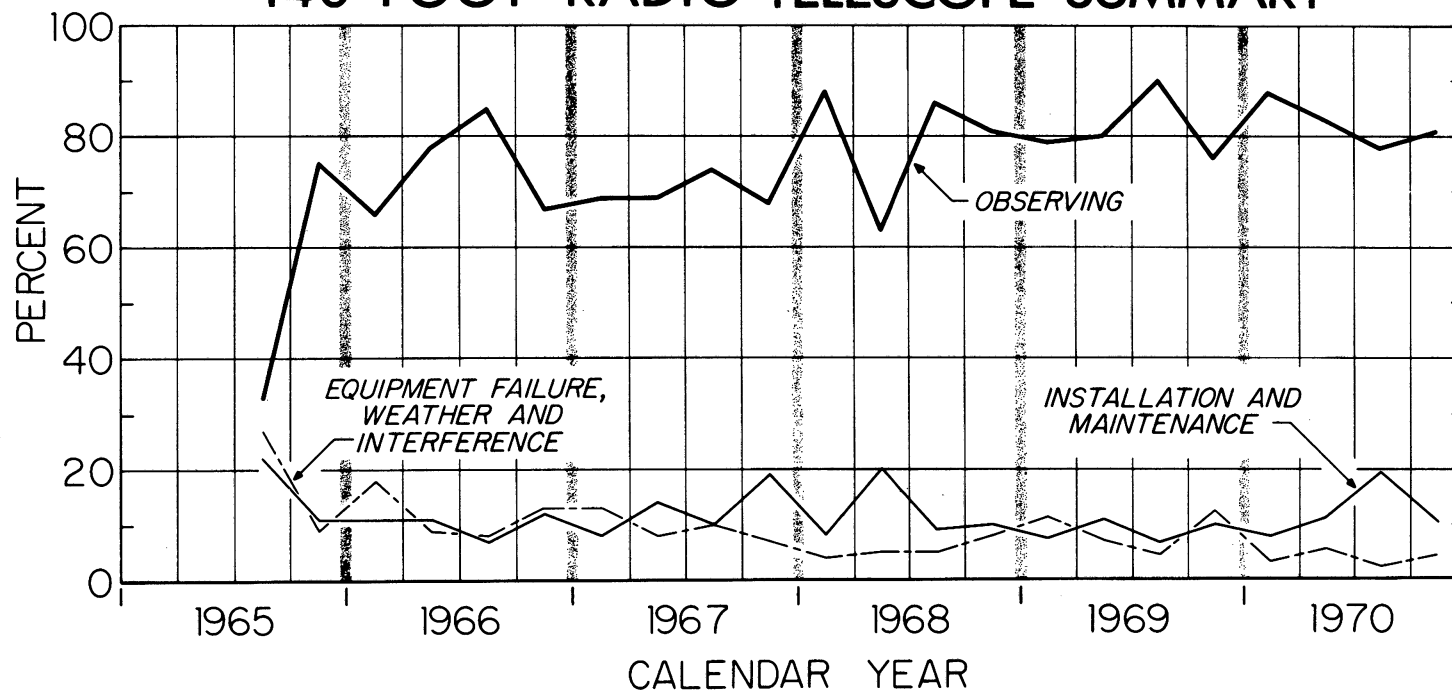


Fig. 4. This summary for each quarter of the calendar year shows the percentage of time the telescope was scheduled for observing, for routine maintenance and installation of new experiments, and the percentage of time lost due to equipment failure, bad weather, and radio interference.

## 300-FOOT RADIO TELESCOPE SUMMARY

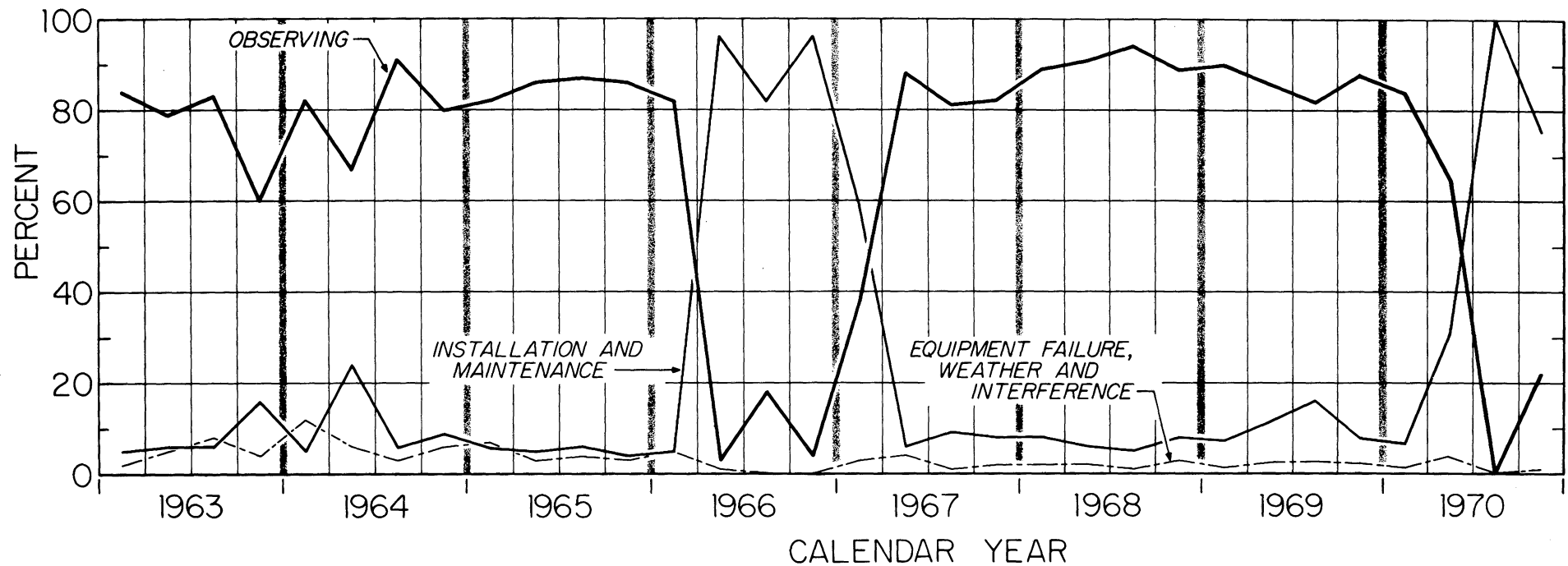


Fig. 5. This summary for each quarter of the calendar year shows the percentage of time the telescope was scheduled for observing, for routine maintenance and installation of new experiments, and the percentage of time lost due to equipment failure, bad weather, and radio interference.

## FULL - TIME PERMANENT EMPLOYEES

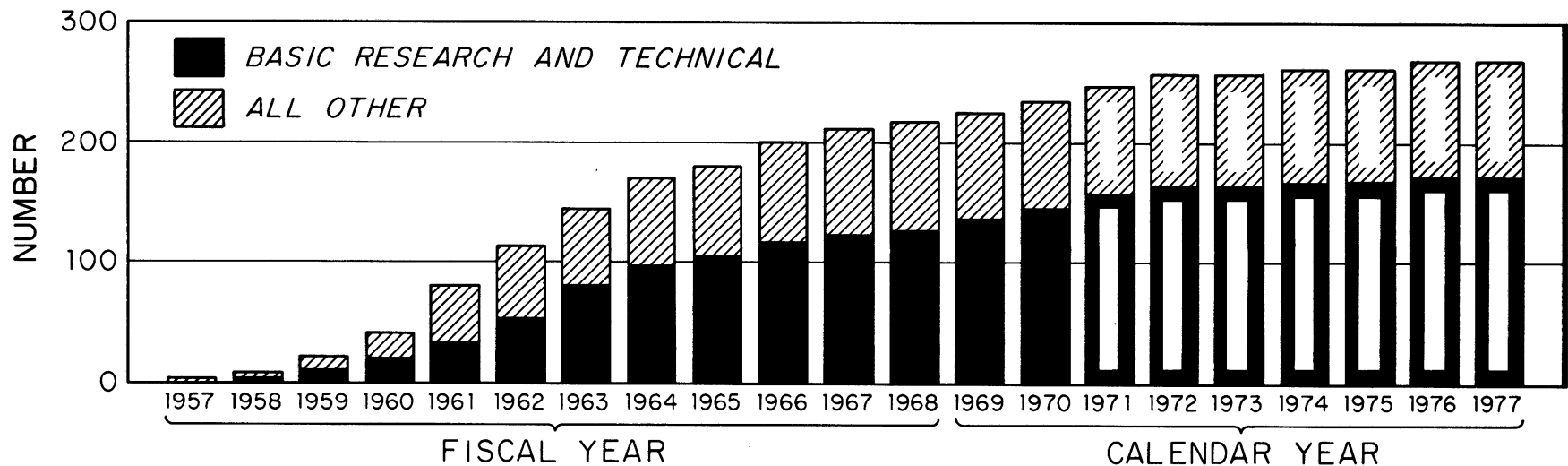
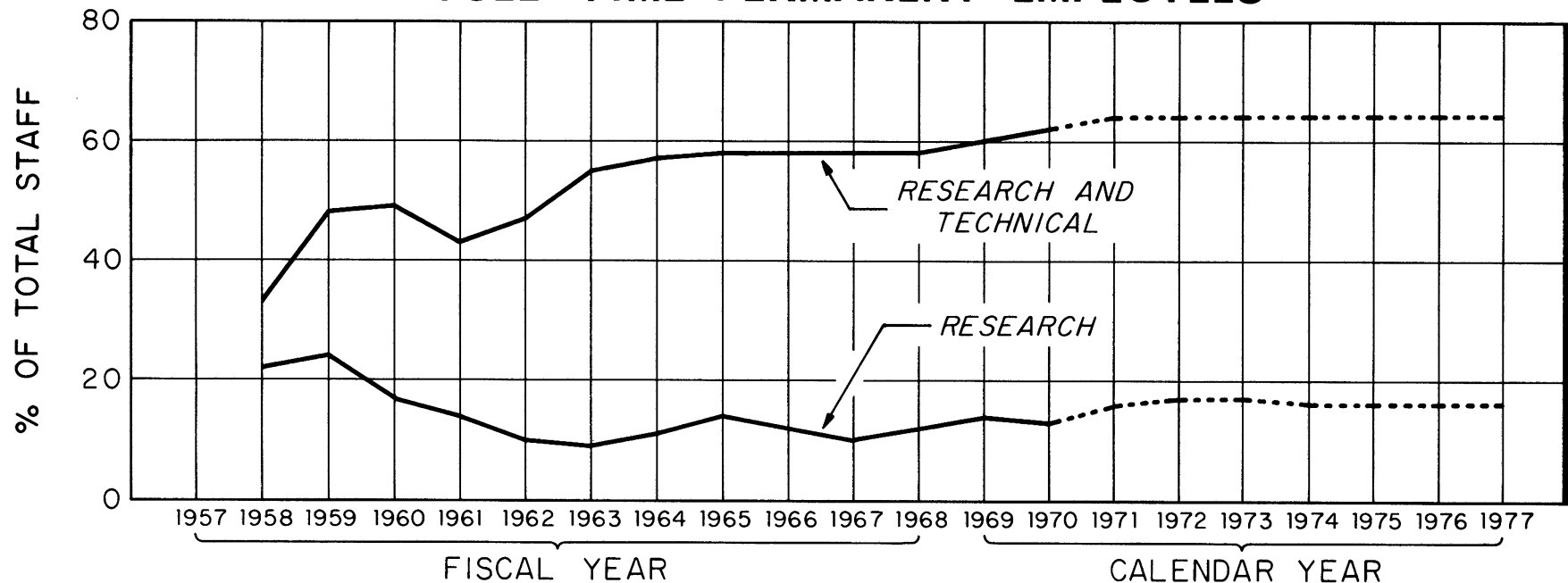


Fig. 6. The lower figure shows the total number of NRAO full-time, permanent employees at the end of each year, projected into the future. The upper figure shows the percentage of these employees each year that are in the basic research staff (lower curve) or who are either research or technical (upper curve).

# NUMBER OF PEOPLE ENGAGED IN RESEARCH AT NRAO

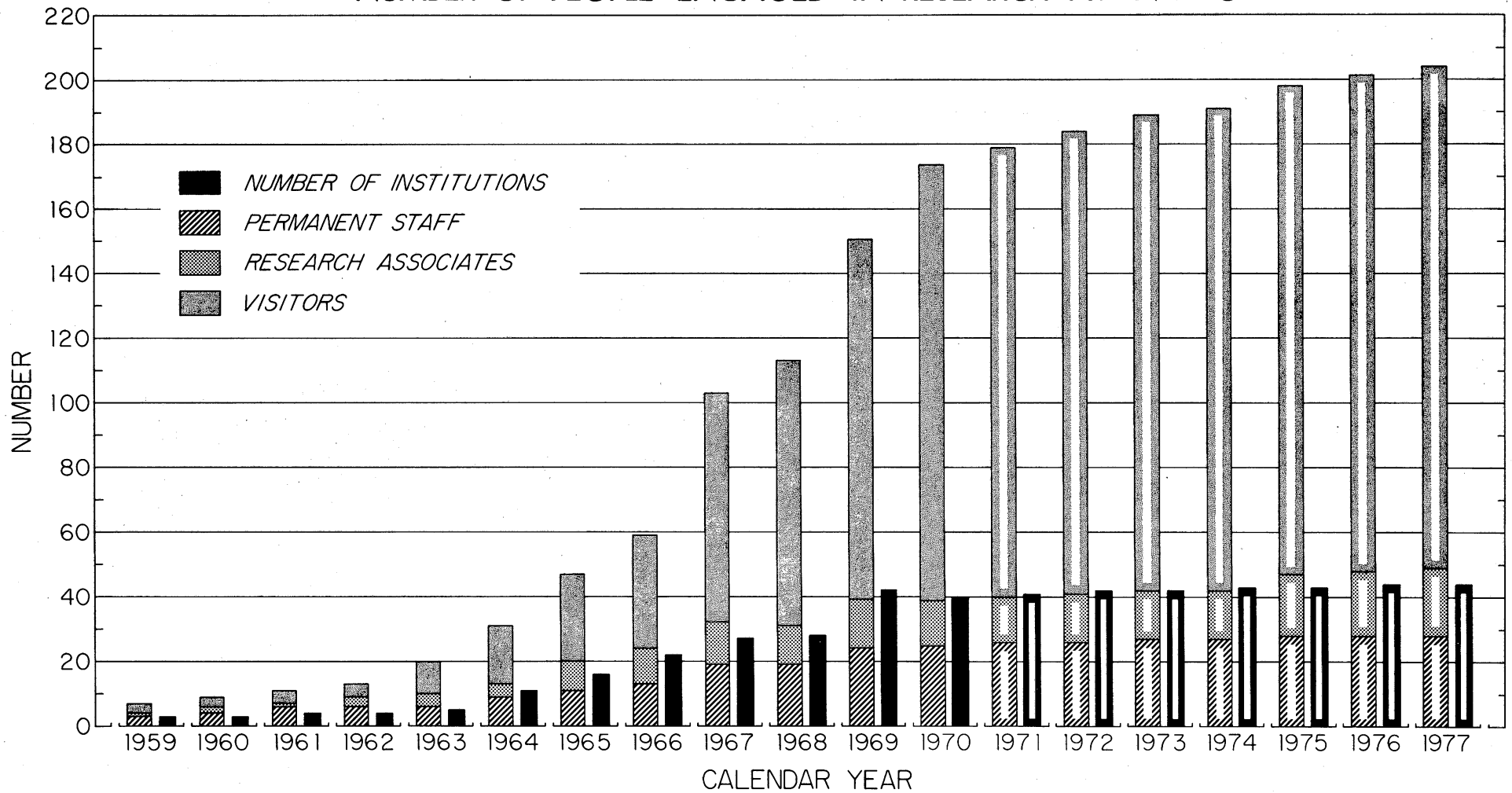


Fig. 7. This bar chart shows for each calendar year the size of the NRAO permanent research staff and the number of research associates on one or two year appointments. In addition it shows the total number of visitor-users of NRAO telescopes and the number of institutions from which the NRAO visitors come.

# RESIDENT SCIENTISTS

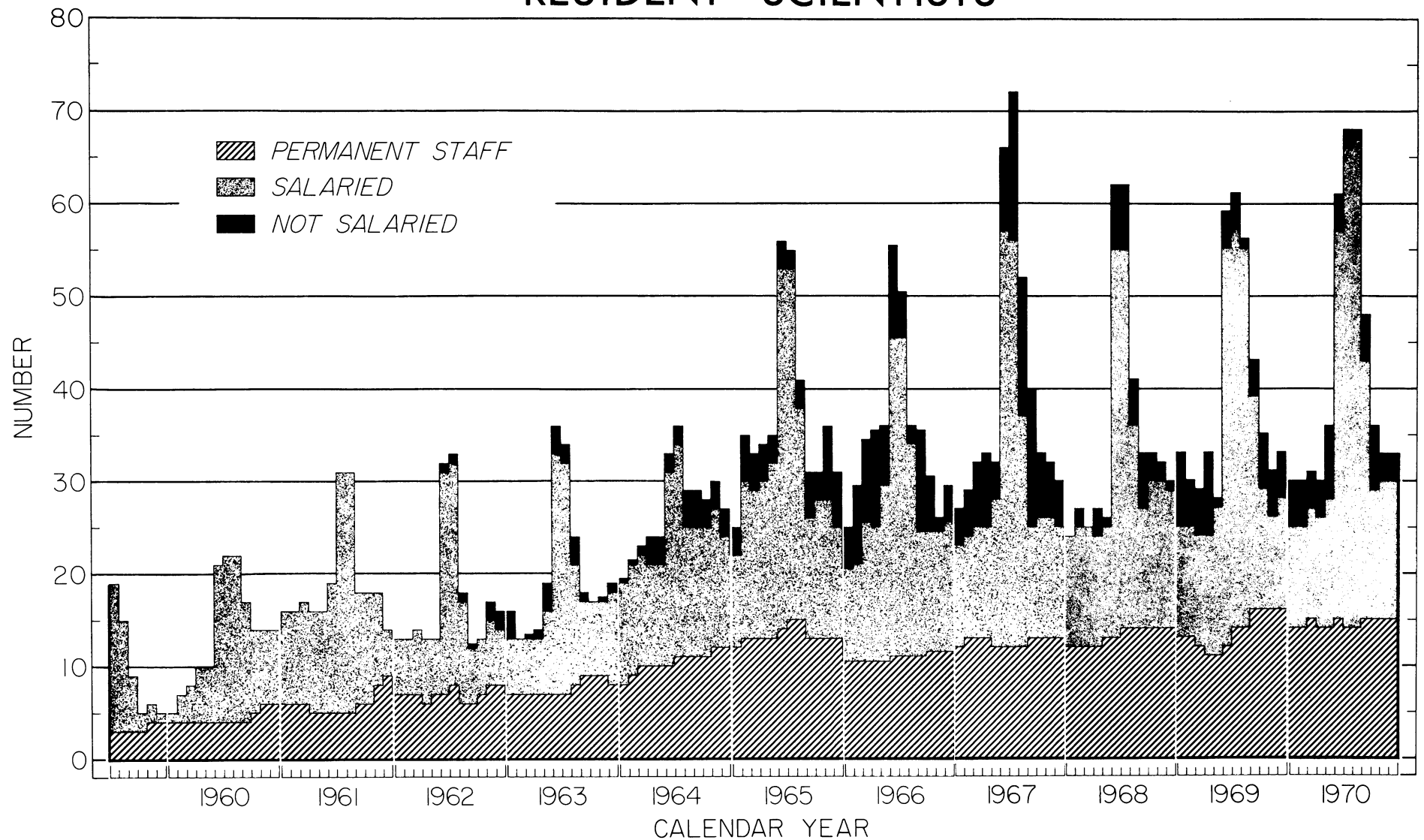


Fig. 8. This bar chart shows, month-by-month, the size of the NRAO permanent staff and the number of salaried and non-salaried visitors who spent approximately one week or more at the NRAO (all sites) during the month. Included among the visitors are Ph.D. students, summer graduate and undergraduate students, and co-op students, as well as telescope users.



# PAPERS BASED ON OBSERVATIONS MADE WITHIN U.S.A.

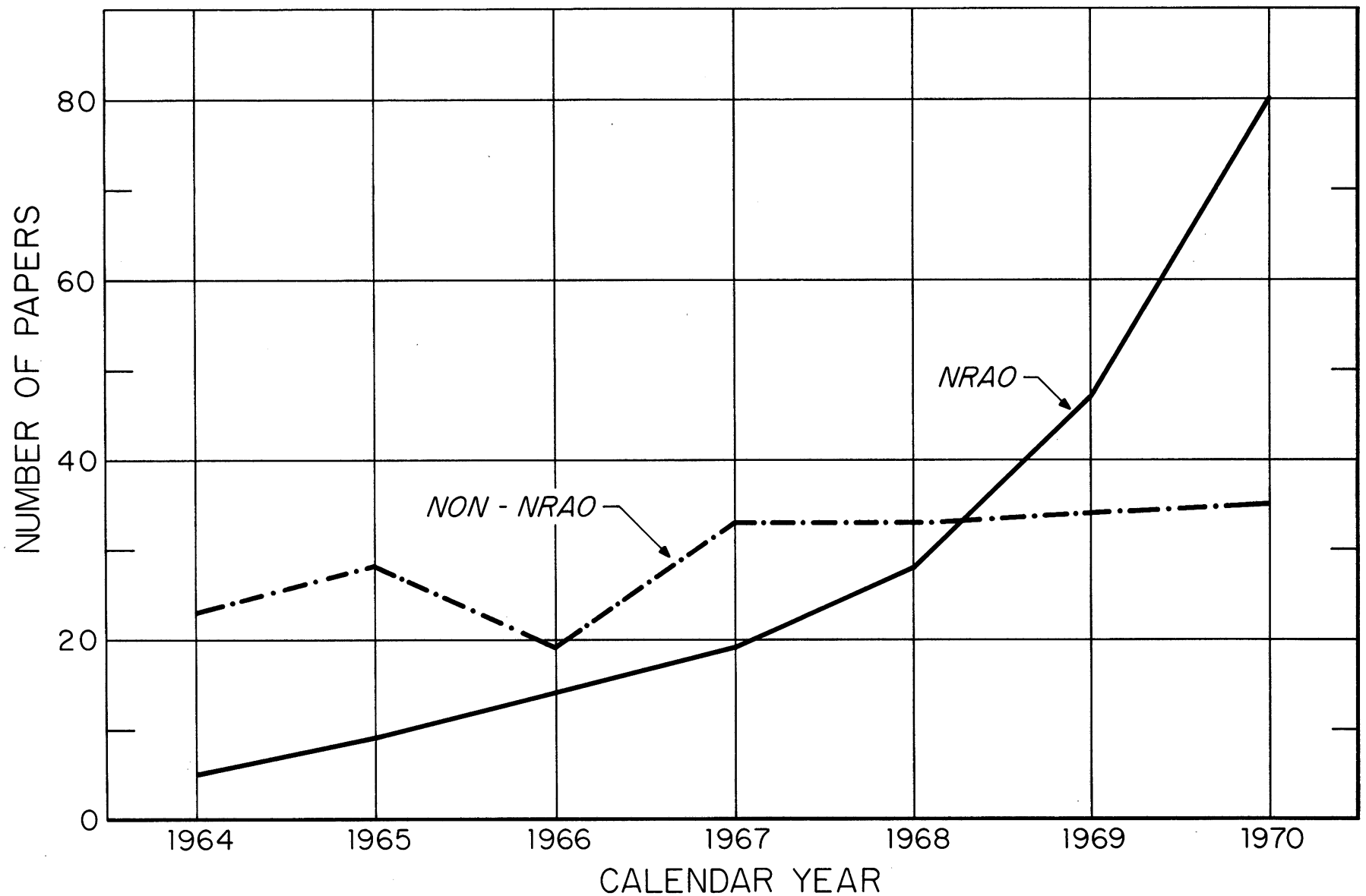


Fig. 9. This graph shows the number of NRAO-based and non-NRAO-based scientific papers in the Astrophysical Journal, Astronomical Journal, Astrophysical Letters and Astronomy and Astrophysics as a function of calendar year, from 1964 through 1970.

### DOCTORAL THESES FOR WHICH MAJOR WORK WAS DONE AT NRAO

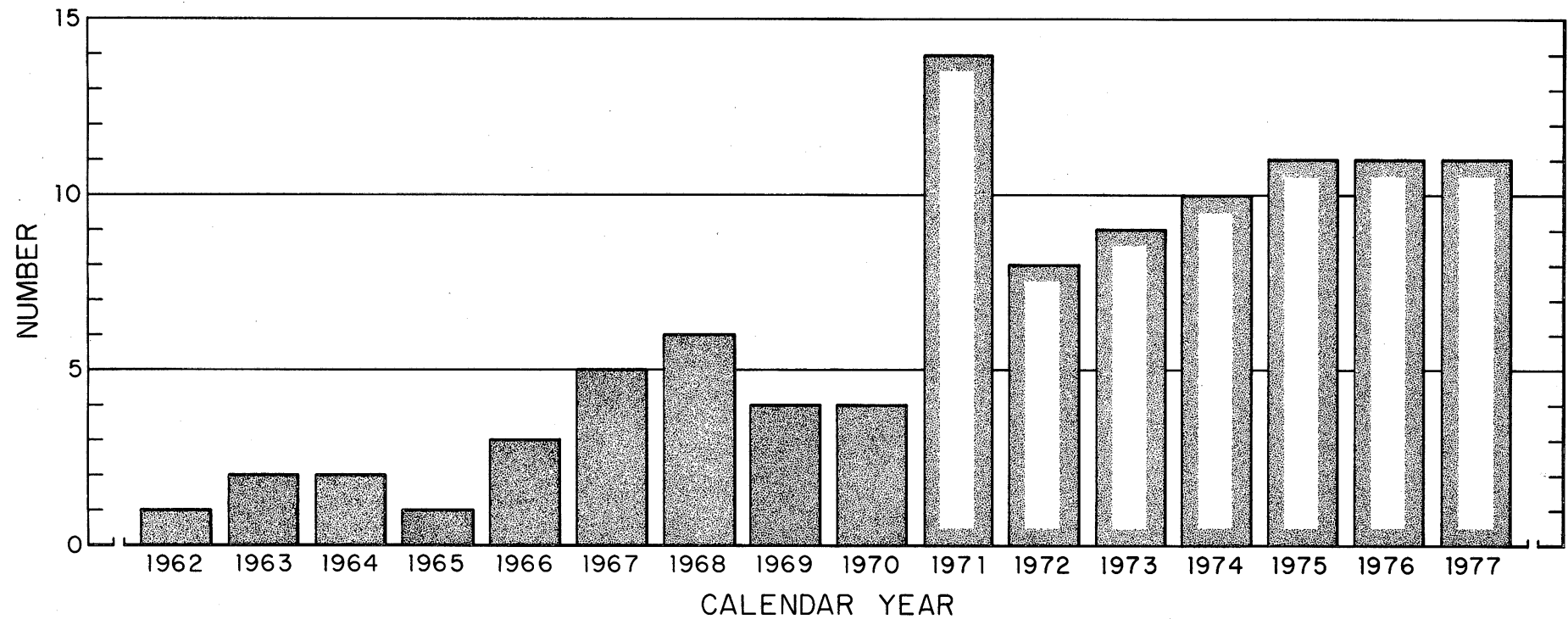


Fig. 10. This bar chart shows the number of doctoral dissertations produced each calendar year by Ph.D. students where the major work on the theses was done at the NRAO.

# NRAO STUDENT PROGRAM

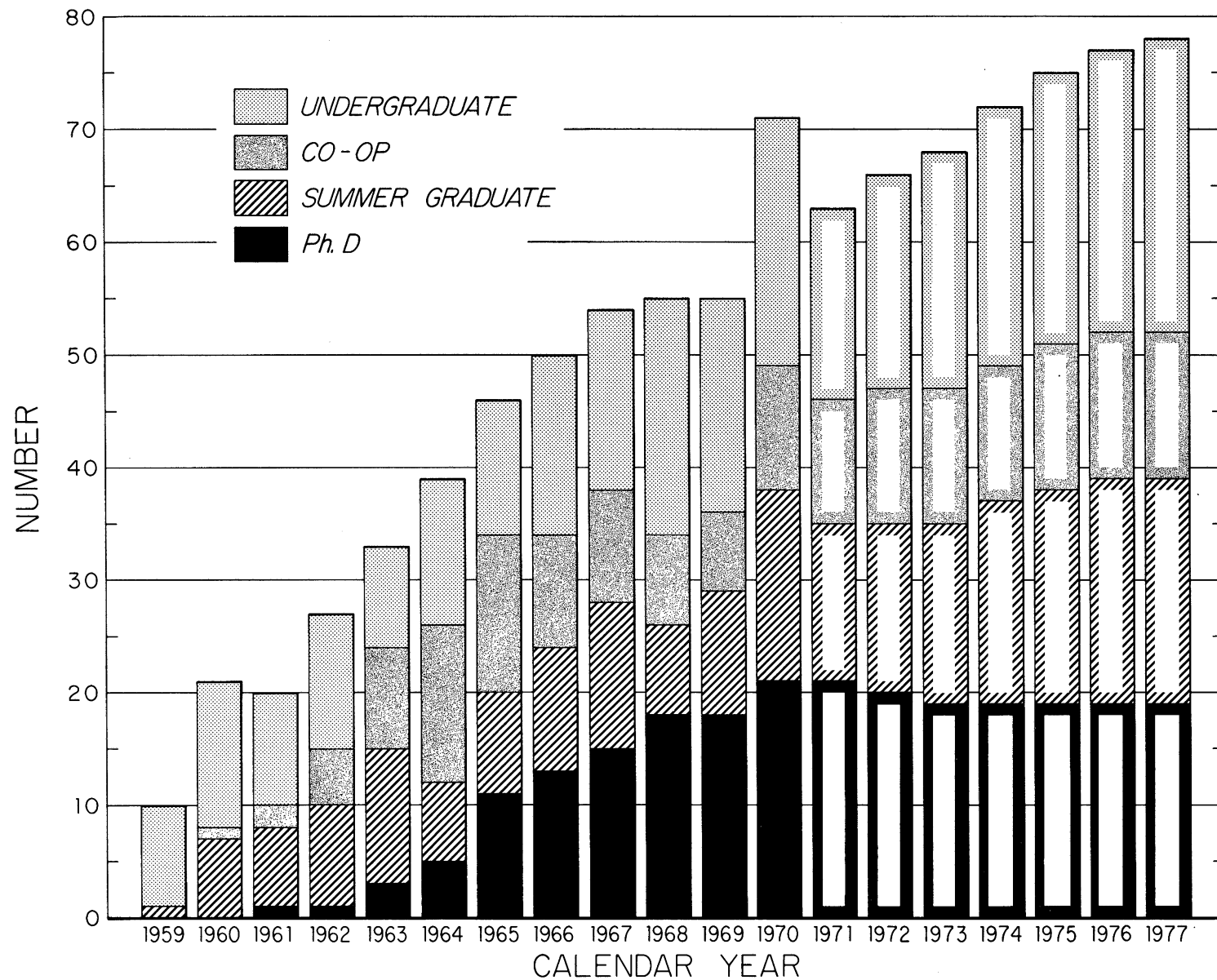
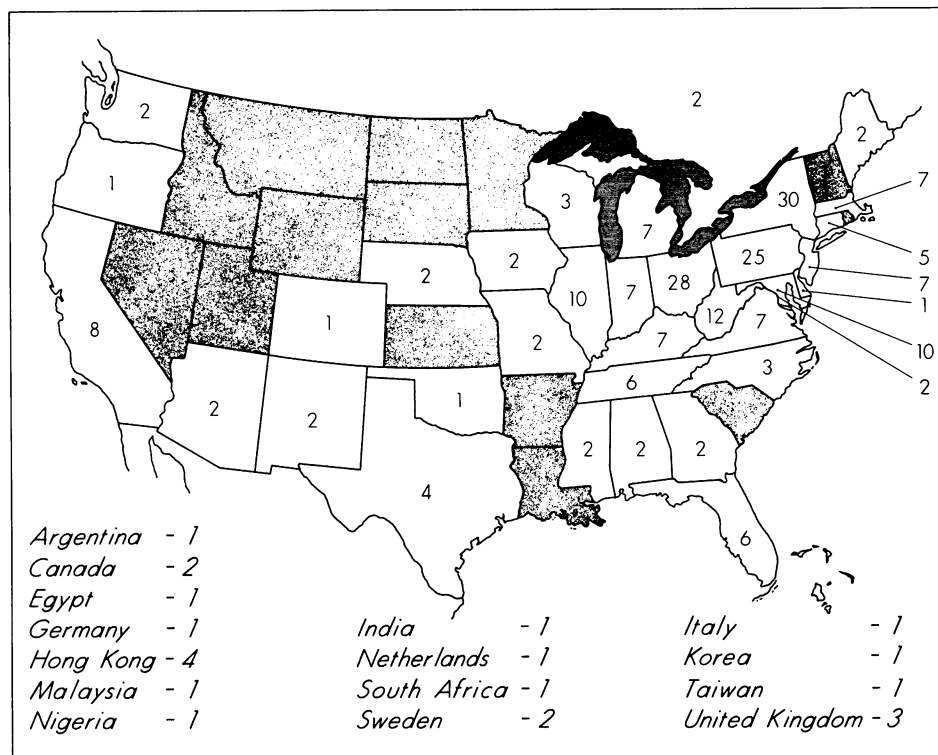
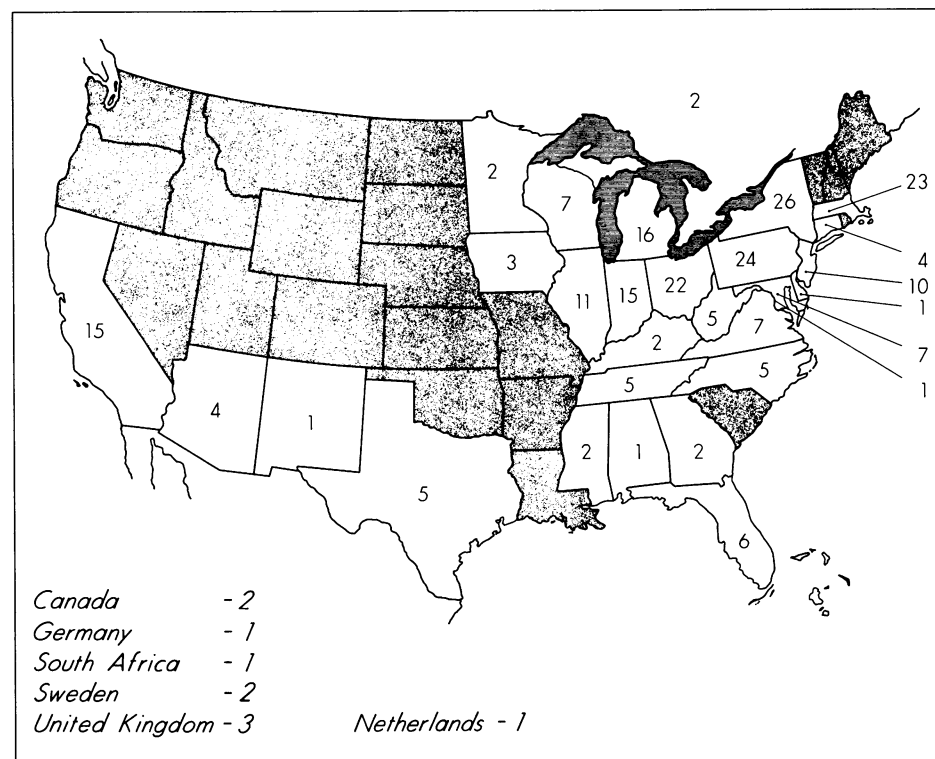


Fig. 11. This figure shows for each calendar year the number of Ph.D. students (salaried and non-salaried), co-op students, and summer undergraduate and graduate students who observed or worked at the NRAO during that year.

## NRAO SUMMER STUDENT PROGRAM



Home States



College-University Affiliation

Fig. 12. This figure shows the total number of graduate and undergraduate students by home state or country and by college location who did summer work at the NRAO since the beginning of the summer student program in 1959.

## OPERATING COSTS

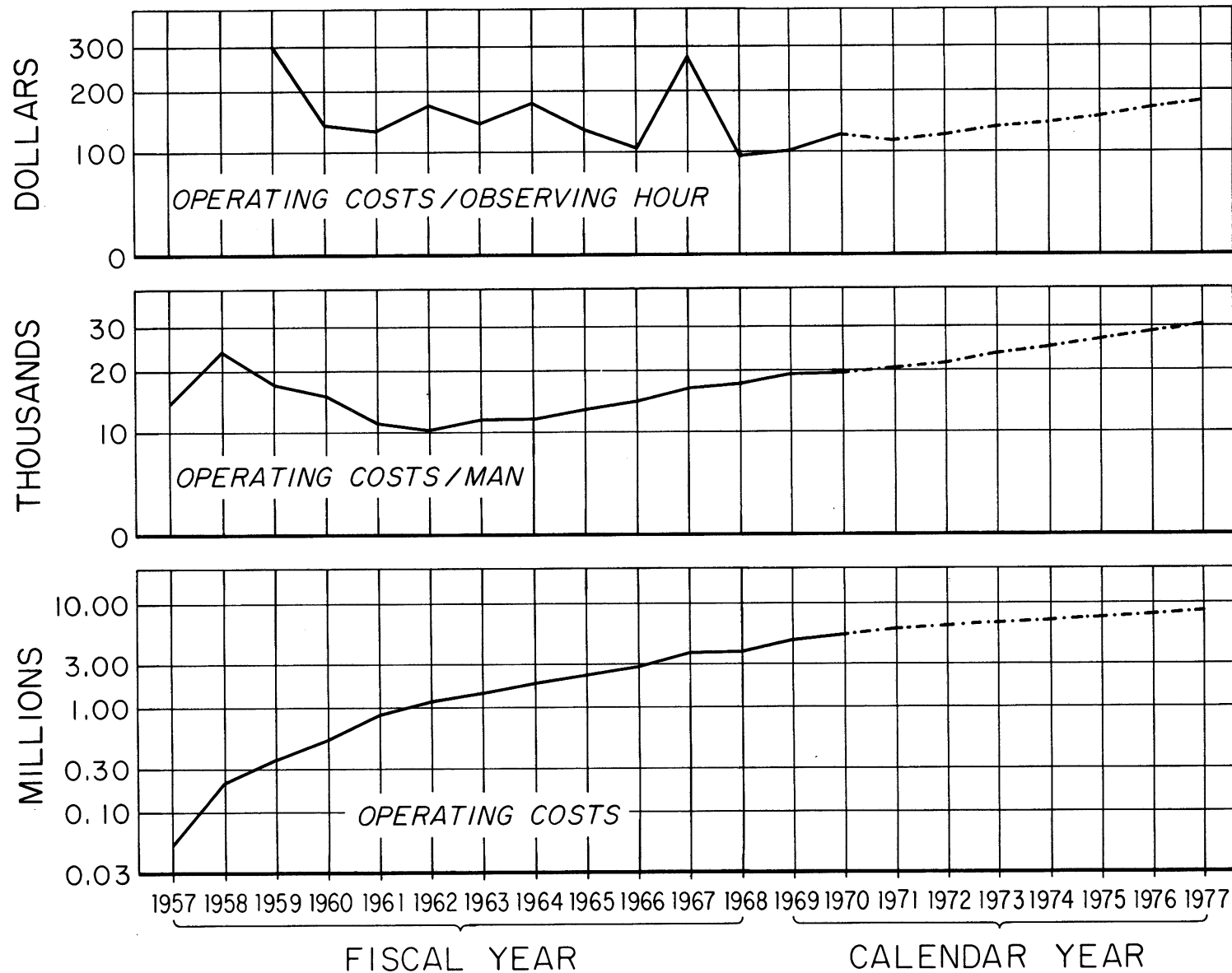


Fig. 13. The total operating cost of the NRAO is shown in the lower graph with actual expenditures shown to the left and projected costs (shaded) to the right. The upper two graphs show the operating cost per observing hour and the operating cost per full-time permanent employee.

## OPERATING BUDGET

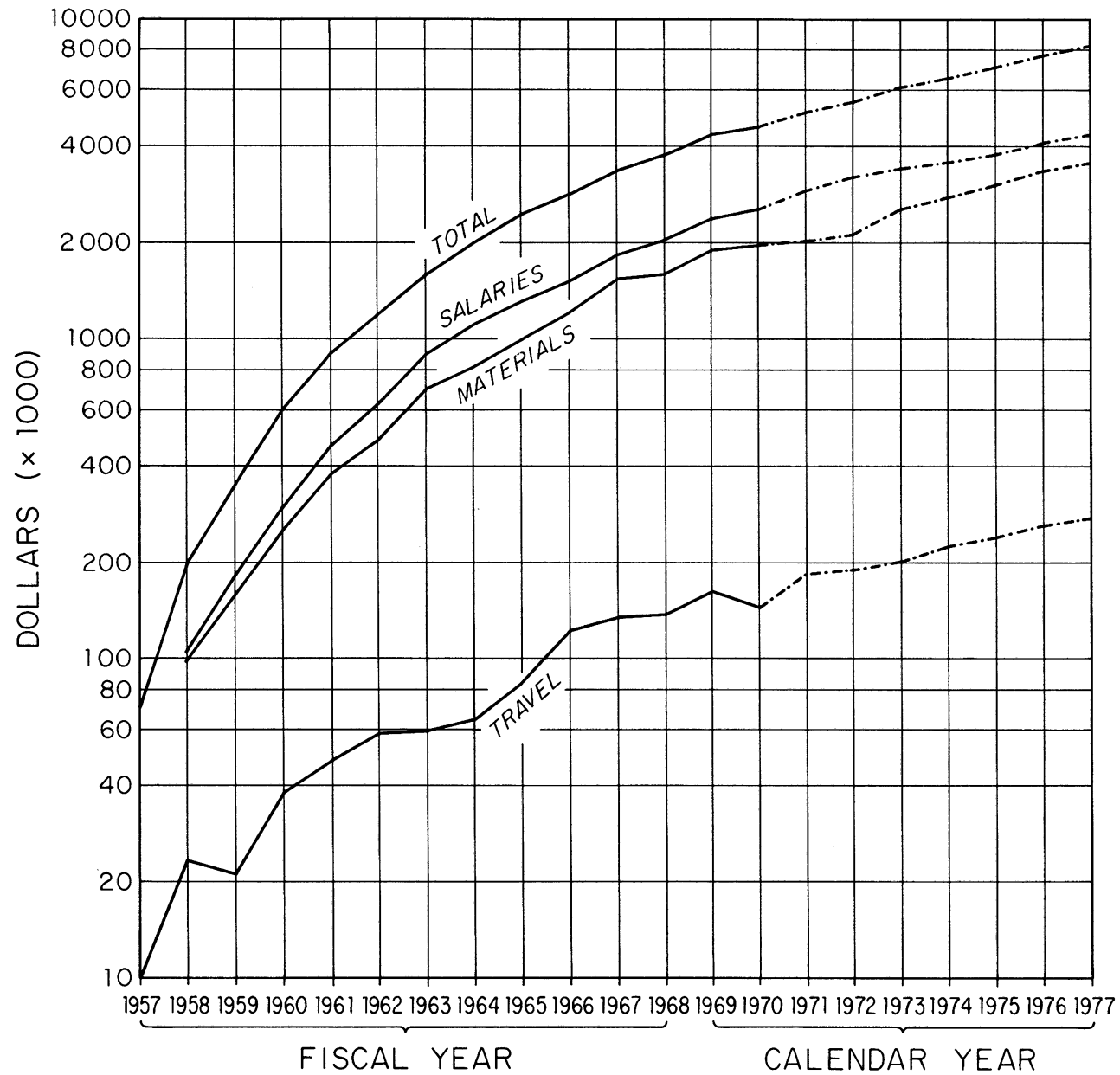


Fig. 14. The NRAO total operating budget is shown on the upper curve with actual expenditures to the left and projected expenditures (shaded) to the right. Below is shown a breakdown of this total by salaries, materials and supplies, and travel.

# EXPENDITURES

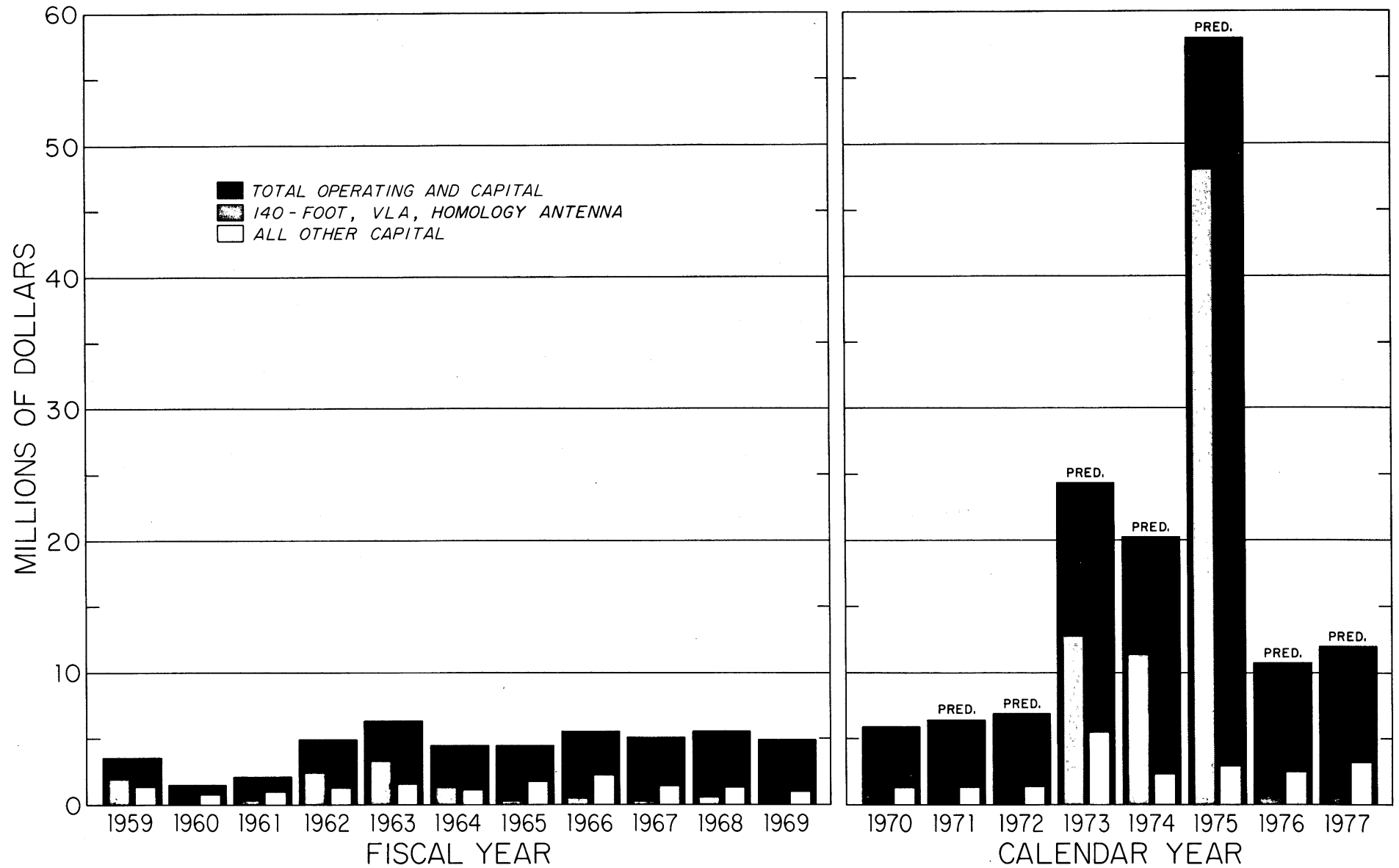


Fig. 15. Actual and projected NRAO expenditures are shown for each year in this chart. Prior to 1965 the shaded bars indicate 140-foot capital expenditures. Beyond 1965, VLA and homology expenditures.

# Telescopes and Receiver Systems

<u><math>\lambda</math> cm</u>	<u>T<sub>system</sub></u> (°K)	<u>Bandwidth</u>	<u>36-ft</u>	<u>140-ft</u>	<u>300-ft</u>	<u>Interf.</u>
0.3	4,000	1 GHz	X			
0.3 - 0.45(line)	4,000	100 MHz	X			
0.95	1,000	400 MHz	X	[X]		
0.95	700	300 MHz	X	[X]		
1.35 (line)	600	50 MHz	(X)	(X)		
1.7 - 2.5 (line)	1,500	200 MHz		X		
1.95	1,200	2 GHz	X	X		
2.1	100	1 GHz	(X)	(X)		
3-6 (line)	400	50 MHz		X		
3	75	300 MHz		X		
3 and 11	100	30 MHz				(X)
6	90	200 MHz		X		
6	70	300 MHz		X		
11 (3 beam)	120	50 MHz			(X)	
7.5 - 30 (line)	100 - 300	45 MHz		X	X	
18 (line)	150	20 MHz		X	X	
18	70	50 MHz		X	X	
21 (line)	120	60 MHz		X	X	
21 (4 beam)	150	60 MHz			X	
21	70	50 MHz		(X)	(X)	
40	500	90 MHz		[X]	X	
50	170	4 MHz		X	X	
75	400	8 MHz		[X]	X	
60 - 150	400	300 MHz			X	
120	400	3 MHz		X	X	
200	400	100 MHz			X	
300 - 30	300 - 600	Octave		X		

Key: X Available  
 (X) On order or planned  
 [X] Available, not optimum

December 1970



NRAO FRONT-END BOX STATUS

Technical Data Sheet  
November 1970

No. 12  
Page 1 of 2

Applicable Telescope	Frequency (MHz)	Amplifier Type	System Temperature	Bandwidth (MHz)	Feed Type	Polarization	Calibration Value	Switching System	Remarks	Person in Charge
Fixed on 300'	234	Transistor	600°	10	Dipole	Linear	10 °K and 100 °K	300° load	Interference limited — use cross dipole feed for dual frequency observations.	Brundage
Fixed on 300'	405	Transistor	600°	10	Dipole	Linear	10 °K and 100 °K	300° load		Brundage
Fixed on 300'	750	Transistor	700°	20	Dipole	Linear	10 °K and 100 °K	300° load	Simultaneous operation with Box 2 (1 beam) is possible with an on-axis feed at both frequencies.	Brundage
Fixed on 300'	100-250 200-500	Transistor	300°	150 MHz (max.) 300 MHz (max.) Can be used with multifilter receivers.	Adjustable Dipoles and 110-200 MHz Broadband	Linear and Circular	Variable and Pulsed	300° load or alternate feed	Receiver designed for pulsar and line work. Will be multichannel for polarization measurements; can be used with NRAO line receivers. Used with traveling feed.	Brundage
300/140'	4 x 1400	Paramp	150°	60	4 Horns	Linear	4 °K and 15 °K	300° load	Line or continuum from control room. Various feed configurations possible.	Brundage
Fixed on 140'	234 256 405	Transistor	400° 400° 400°	4 4 8	Jasik Occ. Feed Dipoles	Linear	≈ 8 °K	300° load	Feed mounting time approximately 1 hour. Interference problems.	Balister
Fixed on 140'	610	Degenerate Paramp	100°	4	Helix	Circular	10 °K	None.	Used for VLB interferometer work. Requires Dicke switch for normal radiometer use.	Vrable
140'	100 to 1000	Transistor	300° to 500°	5%	Tunable Dipole	Dual Linear	50 °K	Frequency	Line work and VLB	Balister
140/300'	1420 and 1600-1730	Paramp	120° and 250°	60 30	1420-1667 Horn	Dual Circular or Linear	10 °K	300° load or frequency switching.	1620-1667 dual system is for line occultations with 234, 256, and 405 MHz. Dual circular or linear at 1667 is used for VLB experiments. Choice of polarization can be made from control room.	Balister
140/300'	1600-1730 Dual Channel	Cooled Paramp	80°	30	Scalar	Linear 2 Circular 2	≈ 10 °K	Normally frequency switched. Uncooled switch can be for load switching.	Can be remotely tuned anywhere in frequency range 1600-1730 MHz. Two channels can be used simultaneously for different polarizations or frequencies.	Balister
140/300'	1000 to 2000	Paramp	270°	30	1-2 GHz Scalar	Linear	10 °K	300° load or frequency switching	Tuning over a 200-400 MHz range is from control room. Larger frequency changes require paramp module change approximately 2 hours. Box, including feed, changed at 2000 MHz. Control room equipment will drive either. Change time approximately 4 hours.	Payne
140/300'	2000 to 4000	Paramp	270° to 350°	30	2-4 GHz Scalar	Linear	10 °K	300° load or frequency switching		Payne
Any	2295	Paramp	100°	50	Horn + x 4 section	Circular	10 °K	None.	Packaged in small temperature-stabilized box. Can be installed on other telescopes with little effort.	Payne
140/300'	3 x 2695	Degenerate Paramp	100°	100 MHz DSB	3 Horns	Circular	10 °K	300° load	Continuum receiver. On-axis horn has paramp on both polarizations. Several feed configurations possible.	Fleming
140/300'	2695	Paramp	200°	40	TRG Scalar	Dual Linear	3 °K	300° load sky horn, other polarization	Choice of switching system from control room.	Behrens

# NRAO FRONT-END BOX STATUS

Technical Data Sheet  
November 1970

No. 12  
Page 2 of 2

140'	4995	AIL Cooled Paramp	80° line 135° cont.	225	TRG Scalar or 2 Horns	Dual Linear Orth. Linear	4 °K	Any two of: 60 °K load, sky horn, other beam	Feed change requires 3 hours. Dual horns are used for beam switching. A horn can be mounted off-axis to scalar feed, but beam spacing is high, approximately 30'.	Behrens
140'	4995	TRG Cooled Paramp	70° Scalar Feed 100° Horns	400	2 Horns or Scalar	Orth. Linear	≈ 5 °K	Other beam or 25 °K load	Two feed arrangements available: (1) Scalar and (2) dual horns for beam switching.	Behrens
Any	4995	Paramp	150°	20	Horn	Linear	≈ 10 °K	None.	Packaged in small temperature-controlled box. Can be installed on other telescopes with little effort.	Payne
140'	5.2-10.4 GHz	Paramps	300° to 400°	40	Horn	Linear	≈ 10 °K	Frequency switching	Set of 7 tunable paramps.	Balister
Any	10,695	Paramp	250°	20	Horn	Linear	≈ 10 °K	None.	Packaged in small temperature-controlled box. Can be installed on other telescopes with little effort.	Payne
140'	10,695	TRG Cooled Paramp	100°	300	2 Horns	Orth. Linear	≈ 5 °K	Other beam or 25 °K load	Two feed arrangements available: (1) Scalar and (2) dual horns for beam switching.	Behrens
140'	15,400/ 5000	TDA TDA	1100° 1100°	3 GHz 400	Horns Horns	Linear Linear	17 °K 8 °K	Beam or load switching	Can be installed on 140' telescope in front of exist- ing box in 2 hours. Box may be removed in a similar time, allowing lower frequency programs to continue when weather is too bad for 15 GHz observations.	Dolan
36'	15,375	TDA	1600°	2 GHz	2 Horns	Parallel Linear	5 °K	Other beam or sky horn	Original 2 cm receiver repackaged in 36' box.	Dolan
140'	12.4-18 GHz	TDA's	1000°	50 (1 GHz continuum)	Horn	Orth. Linear	≈ 10 °K	Frequency switching	Contains LO system tunable 12.4 - 18 GHz. Tunnel diode amplifier continuum receiver on orthogonal polarization (used for pointing).	Balister
	14.4-14.9 GHz	Paramp	400°	70				Load switching continuum		
36/140'	22-24 GHz	Degenerate Paramp	600° DSB	100 DSB	Horn	Linear	≈ 20 °K	Load, beam, or frequency	Available January 1971. Stabilized LO system.	Edrich
36'	31.2 GHz	Degenerate Paramp	800° DSB	400	2 Horns	Parallel Linear	15 °K	Other beam or load	Has stabilized LO system for line work.	Albaugh
36'	31.4 GHz	Adtec Mixer	1100° DSB	400	2 Horns	Parallel Linear	28 °K	Other beam or load		Albaugh
36'	45.6 GHz	Degenerate Paramp	600° DSB	1000 MHz DSB	Horn	Linear	10 °K	Beam, load, or frequency	Under development. Estimate completion late 1971.	Edrich
36'	85 GHz	Adtec Mixer	5000° DSB	1 GHz	2 Horns	Variable	28 °K	Other beam or load	Single horn mechanically position modulated or ferrite switch.	Albaugh
36'	85 GHz	Adtec Mixer	3000° SSB	100 MHz	Beam Switch	Linear	30 °K	Beam or frequency	Stabilized LO for line work.	Edrich

February 19, 1971

The NRAO Seven-Year Plan for Budget and ManpowerI. PERSONNEL LEVELS

The personnel levels are projections from CY 1971 through CY 1977. The figures for CY 1971 and 1972 are based on budget requests already submitted to the National Science Foundation.

Table I. Seven-Year Plan Personnel Projections by Category of Employees CY 1971-1977

<u>Category</u>	(Actual) Dec. 31, <u>1970</u>	<u>1971</u>	<u>1972</u>	<u>1973</u>	<u>1974</u>	<u>1975</u>	<u>1976</u>	<u>1977</u>
1. Scientific & Engineering	49	56	63	63	63	64	65	66
2. Technical	75	75	79	79	80	80	83	83
3. Administrative & Clerical	55	57	57	57	57	57	58	58
4. Operations & Maintenance	57	60	60	60	61	61	63	63
Total	236	248	259	259	261	262	269	270
Total Visitor-Users:	135	139	143	147	149	151	153	155

II. SCIENTIFIC RESEARCH; OPERATIONS

The operating budget projection is based on the manpower levels shown in Table I.

Table II. Operating Budget Projections by Calendar Year  
(Figures in thousands of dollars)

<u>Item</u>	<u>Actual</u> <u>1970</u>	<u>1971</u>	<u>1972</u>	<u>1973</u>	<u>1974</u>	<u>1975</u>	<u>1976</u>	<u>1977</u>
Salaries (1)	2549	2900	3200	3400	3573	3787	4137	4385
Benefits (2)	392	441	450	540	554	595	658	706
Travel (3)	146	184	190	200	225	238	261	276
Other (4)	<u>1578</u>	<u>1583</u>	<u>1685</u>	<u>2010</u>	<u>2189</u>	<u>2422</u>	<u>2707</u>	<u>2865</u>
Subtotal, Operations:	4665	5108	5525	6150	6541	7042	7763	8232

Notes and Assumptions for CY 1974 and beyond:

- (1) Salaries at \$13.63K per man in CY 1974, then increasing at 6% per year, compounded.
- (2) Benefits at 15.5% of salaries in CY 1974, then increasing at 0.2% per year.
- (3) Travel at 6.3% of salaries.
- (4) Computer rent, communications, utilities, building and maintenance, management fee and all other materials, supplies and services and miscellaneous receipts are included here.

From the personnel projections (Table I) and the operating budget summary (Table II), we can derive the operating cost per man in Table IIA.

Table IIA. Operating Cost Per Man CY 1970-1977

<u>Calendar Year</u>	<u>Operating Cost Per Man</u>
1970 Actual	19,767
1971 Estimated	20,597
1972       "	21,332
1973       "	23,745
1974       "	24,981
1975       "	26,878
1976       "	28,770
1977       "	30,489

### III. SCIENTIFIC RESEARCH: RESEARCH AND OPERATING EQUIPMENT

Table IV gives the budget projections for the NRAO research and operating equipment budgets through CY 1977.

Table IV. Research and Operating Equipment Budget Projections CY 1971-1977

<u>Item</u>	<u>Calendar Year</u>	<u>1971</u>	<u>1972</u>	<u>1973</u>	<u>1974</u>	<u>1975</u>	<u>1976</u>	<u>1977</u>
<b>A. <u>RESEARCH EQUIPMENT</u></b>								
Other Observing Equipment		897	845	1240	1013	1185	1357	1530
Electronic Research Equipment		250	250	300	325	350	375	400
Electronic Test Equipment		50	50	60	62	65	68	70
Subtotal		1197	1145	1600	1400	1600	1800	2000
<b>B. <u>OPERATING EQUIPMENT</u></b>								
Maintenance, Shop, & Repair Equipment		43	90	50	69	73	77	82
Office & Library Equipment		23	10	17	17	17	18	19
Living Quarters, Furniture & Equipment		6	9	3	7	7	8	8
Building Equipment		5	25	41	30	30	31	32
Scientific Services & Engineering Equipment		18	16	9	11	13	15	16
Subtotal		95	150	120	134	140	149	157
Subtotal, Equipment		1292	1295	1720	1534	1740	1949	2157
Subtotal, Sci. Research		6400	6820	7870	8054	8782	9688	10389

#### IV. CONSTRUCTION

Table IV gives the budget projections for NRAO construction items through CY 1977. Beyond CY 1973 price increases of approximately 6% per year, compounded, have been applied to estimates of standard items in order to allow for anticipated increased cost of construction and materials.

Table IV. Construction Budget Projections CY 1971-1977

(in thousands of dollars)

<u>Item</u>	<u>Calendar Year</u>	<u>1971</u>	<u>1972</u>	<u>1973</u>	<u>1974</u>	<u>1975</u>	<u>1976</u>	<u>1977</u>
<u>A. Site Development</u>								
1. Roads, Green Bank		0	0	0	20	20	10	10
2. Water and Sewer		0	0	0	40	40	20	20
3. Electric Power and Communication		0	0	0	15	15	16	16
4. General Site Improvements		0	0	0	5	6	10	7
Subtotal		0	0	0	80	81	56	53
<u>B. Construction of Buildings</u>								
1. Green Bank Tourist Center		0	0	0	300	0	0	0
2. Green Bank Activities Center		0	0	0	0	300	0	0
3. Misc. Alterations and Additions		0	0	10	11	11	12	12
4. GB Lab & Residence Hall Extensions		0	0	0	0	500	0	0
5. GB, Additional Houses		0	0	0	0	0	60	0
6. GB Indoor-Outdoor Electronics Test Fac.		0	30	0	0	0	0	0
7. GB New Works Area Bldg.		0	0	0	0	0	0	400
Subtotal		0	30	10	311	811	72	412

Table IV - continued

<u>Item</u>	<u>Calendar Year</u>	<u>1971</u>	<u>1972</u>	<u>1973</u>	<u>1974</u>	<u>1975</u>	<u>1976</u>	<u>1977</u>
<u>C. Construction of Research Facilities</u>								
1. Homology Telescope		0	0	10000	0	0	0	0
2. VLA		0	0	2700	11345	48028	480	480
3. Interferometer Expansion		0	0	3700	0	0	0	0
4. Major Alterations to Existing Telescopes		0	0	0	290	295	310	320
Subtotal		0	0	16400	11635	48323	790	800
<u>D. Planning and Design</u>								
1. Green Bank Tourist Center		0	0	20	0	0	0	0
2. Green Bank Activities Center		0	0	0	20	0	0	0
3. CV Building Extension		0	50	0	0	0	0	0
4. GB Lab & Residence Hall Extensions		0	0	0	50	0	0	0
5. GB New Works Area Bldg.		0	0	0	0	0	30	0
6. Planning for New Instruments		0	0	0	0	0	0	300
Subtotal		0	50	20	70	0	30	300
Subtotal, Construction		0	80	16430	12096	49215	948	1565
Total Budget		6400	6900	24300	20150	57997	10643	11954



After completion of the homology telescope and the VLA, the estimated number of operating personnel and the operating costs are shown in Table V.

Table V.

<u>Telescope System</u>	<u>Total Time to Construct</u>	<u>Total Personnel to Operate</u>	<u>Operating Budget (1973 dollars)</u>
1. Homology Antenna	4 years	23	0.55 million
2. VLA	5 years	60	2.4 million

Details for the VLA will be found in the VLA Reports.

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RADIO ASTRONOMY OBSERVATORY  
CHARLOTTEVILLE, VA.

AUG 2 1971