NATIONAL RADIO ASTRONOMY OBSERVATORY
Green Bank, West Virginia

Electronics Division Internal Report No. 37

STRIP OF SKY AND LOW FREQUENCY SYSTEMS ON THE 300-FOOT TELESCOPE

Dewey Ross and Yervant Terzian

OCTOBER 1964

NUMBER OF COPIES: 75

THE STRIP OF SKY AND LOW FREQUENCY SYSTEMS ON THE 300-FOOT TELESCOPE

Dewey Ross and Yervant Terzian

I. Introduction

The purpose of this report is to furnish those people involved in the "Strip of Sky", "Normal Galaxy Observations" and "Observations of H II Regions" with a record of equipment used and the specification of that equipment. In this report the individual systems and feeds are discussed as well as the parameters of the beams for each system. Also the difficulties for the first attempt of installing a multifeed system on the 300-foot telescope are discussed.

II. Installation

Installation of the Strip of Sky equipment, which consisted of three 1410 MHz units and one 750 MHz unit, was begun on December 30, 1963 and completed January 2, 1964. The Low Frequency Systems, one 234 MHz unit and one 405 MHz unit, were installed on February 4, 1964. The low frequencies were selected at 405 and 234 MHz from a survey done by S. von Hoerner (Internal Report, NRAO, 1963) on the level of noise and interference between 216 and 420 MHz. The two selected frequency regions had the minimum percentage of interference.

III. Mechanical Mounting of Feeds

The mounting was made with the 750 MHz unit and one 1410 MHz unit located in the center box, while one 1410 MHz unit was mounted NW of the center and one 1410 MHz unit was mounted SE of the center.

The center systems utilize the original frontend box which has been used on all systems mounted in the past at the 300-foot telescope.

The East and West 1410 MHz feeds are attached to the center box by means of a 2-inch aluminum angle. Such mounting enables one to focus all Strip of Sky systems at the same time.

The above-mentioned mounting angles are so made to allow the East and West 1410 MHz feeds to be positioned 2.63, 5.24, 7.88 and 10.52 inches North or South of the center. The East 1410 MHz system is variable between 18.30 and 26.28 inches East of the center, while the West 1410 MHz system is variable between 18.40 and 26.28 inches West of the center. The measurements correspond to beam positions of 5, 10, 15 and 20 minutes of arc North and South and from 35 to 50 minutes of arc East and West.

The East 1410 MHz system beam position was set for 37.6 minutes of arc East and 5 minutes of arc North of center. However, after positions were run it was found to be 37.6 minutes of arc West and 6 minutes of arc North of center.

The Strip of Sky feed positions are shown in Figures 1, 2, and 3.

The two Low Frequency feeds (234 and 405 MHz) are mounted SW and NE of the center feed.

The 234 MHz feed is 21.1 inches East and 28.3 inches North of the center feed. The measured beam position is 55.0 minutes of arc South and 51.3 minutes of arc West of center.

The 405 MHz feed is 24.5 inches West and 24.2 inches South of the center feed. The measured beam position is 50.0 minutes of arc North and 50.0 minutes of arc East of center.

The helical low frequency feeds were originally constructed for 450 and 250 MHz. Due to the fact that helical feeds are broad-banded, the available low frequency feeds were adopted for the present observations. These feeds were not exactly focused because no space was available for their mechanical motion on the 300-foot focus. These two effects had a net result of lowering the beam efficiencies.

Table 2 gives the ratio of T_{cal}/E_b for all systems derived in the way described in section VII. T_{cal} is the antenna temperature of the thermal calibration and E_b is the beam efficiency. The thermal calibrations for the two low frequency systems were measured three times and the results gave 19.00 ± 0.92 degrees for the 405 MHz system and 18.95 ± 0.42 degrees for the 234 MHz system. The beam efficiency at 405 MHz was sixty percent and at 234 MHz fifty percent. Table 1 shows the mean thermal calibrations for the three 1410 and the 750 MHz systems. These latter thermal calibrations have an error of about ±3 degrees. Due to the uncertainty of T_{cal} the measured values were not used directly. To obtain the brightness temperatures of any observed point the ratio of T_{cal}/E_b was computed for each system by observations of standard sources as it is described in section VII.

Table 1 also includes the bandwidths, radiometer temperatures and the measured detector law (α) for each system.

IV. Mechanical Mounting of Frontend Assemblies

The center systems (750 and 1410 MHz) are mounted in the original frontend box which has been used for all frontends previously mounted on the 300-foot telescope.

The East 1410 MHz system is mounted SE of the center box and extends beyond the "catwalk" approximately 6 inches. It is supported by two pieces of 3-inch aluminum channel which are attached to a 2-inch aluminum angle, mounted on the frontend box, by means of four 5/8 inch bolts.

The West 1410 MHz system is mounted NW of the center box in the same manner as the East box.

The low frequency box, which houses both the 234 MHz and the 405 MHz systems is mounted on the "catwalk", near the South feed support leg.

V. Feeds

234 MHz -- A helical feed, which had a VSWR of 1.02:1 at the center frequency and a VSWR of 1.3:1, 2 MHz on each side of center frequency. The feed was tuned by means of a coaxial stub stretcher which was made from RG-9. A drawing is shown in Figure 4.

405 MHz -- A helical feed, which had a VSWR of 1.02:1 at the center frequency and a VSWR of 1.3:1, 2 MHz on each side of center frequency. The feed was tuned by means of a coaxial stub stretcher which was made from RG-9. A drawing of the feed is shown in Figure 4.

750 MHz and 1410 MHz center: The Jasik Type 275, SN 3. At 750 MHz the VSWR is 1.15:1 and less than 1:2 from 690 MHz to 775 MHz.

At 1410 MHz the VSWR is 1.08:1 at the center frequency and less than 1.2:1 from 1365 MHz to 1465 MHz.

1410 MHz East and 1410 MHz West -- Both feeds were built by the NRAO Electronics Division machine shop and have a VSWR of 1.15:1 at the center frequency and less than 1.2:1 between 1390-1425 MHz. A drawing of these feeds is shown in Figure 5.

VI. Electronics

234 MHz -- The 234 MHz system is an RF switched system and uses an argon source fed through a directional coupler and attenuator for calibration. Two calibration levels are made available by the use of coaxial relays.

The mixer is an Empire Devices single-ended mixer and the preamplifier is an LEL IF 31BS which was tuned to a 4 MHz bandpass. The noise temperature of the system including feed cable is 1000 °K.

A block diagram of the system is shown in Figure 6.

405 MHz -- The 405 MHz system is an RF switched system and uses an argon source fed through a directional coupler and attenuator for calibration signal. Two calibration levels are made available by the use of coaxial relays.

An LEL Model UBC-3 mixer-preamplifier, tuned for 4 MHz bandwidth, was used. The system noise temperature, including feed cable is 875 °K.

A block diagram of the system is shown in Figure 6.

750 MHz -- The 750 MHz system is an RF switched system. Two systems were used. The initial system utilized the low noise mixer with a ceramic tube pre-amplifier. (This unit is covered in detail in Electronics Division Internal Report No. 8, "Ceramic Tube - Low Noise Front Ends" by Joe Carter.)

The system noise temperature is 470 °K and the bandwidth is 6 MHz.

On March 12, 1964 this system was removed and a Micro State Electronics tunnel diode amplifier and a LEL Model UCC-3 mixer-preamplifier were installed.

The system temperature is 450 °K and has a bandwidth of 8 MHz.

The calibration system is the "poor man's calibration system" which is covered in Electronics Division Internal Report No. 26 entitled "750 Mc-1400 Mc Receivers at the 300-Foot Telescope" by D. Ross. A block diagram is shown in Figure 7.

1410 MHz center -- The 1410 MHz center system is a RF switched system. The MPC L-band parametric amplifier (covered in Electronics Division Internal Report No. 25 entitled "Microwave Physics Corporation L-Band Parametric Amplifier" by B. Hansson and B. Pasternak) and a LEL Model LAC-3 mixer-preamplifier were used.

The system temperature including feed cable is 190 °K and the bandwidth is 8 MHz.

The calibration system is the "poor man's calibration system". A block diagram is shown in Figure 8.

1410 MHz East -- The 1410 MHz East system is a RF switched system. The AIL Model 2877 parametric amplifier (covered in Electronics Division Internal Report No. 9 entitled "Parametric Amplifier - Airborne Instruments Laboratory" by D. Ross) and a LEL Model LAC-3 mixer-preamplifier were used.

The system noise temperature including the feed cable is 138 °K and the bandwidth is 8 MHz.

The calibration system is the "poor man's calibration system". A block diagram is shown in Figure 9.

1410 West -- The 1410 MHz West system is a RF switched system. The AIL Model 1930A parametric amplifier (covered in Electronics Division Internal Report No. 9) and a LEL Model LAC-3 mixer-preamplifier were used.

The system temperature including the feed cable is 210 °K and the bandwidth is 8 MHz.

The calibration system is the "poor man's calibration system". A block diagram is shown in Figure 10. Figure 11 shows the standard receivers of the multifeed system.

VII. Beam Parameters and Standard Sources

During the course of the observations, the shapes of all the beams were determined, either by making observations of a strong point source day after day at a slightly different declination, or by moving the telescope north and then south successively while a strong source was in transit.

The central beams were found to be fairly symmetrical, but each of the 1410 E and 1410 W beams had one pronounced sidelobe. This was expected due to the fact that the feeds of these two systems were off-center. The low frequency beams were slightly asymmetrical since the feeds were also off-center. No sizable sidelobe was present in these cases. The exact orientation of all the beams relative to the central ones is given in Table 1. The half-power beamwidths (HPBW) of the main beams in declination and right ascension were measured from the contour maps of the beams and are given in Table 2. Figure 12 shows the three 1410 MHz beams.

Daily observations of two or more standard sources were observed with each system. A thermal calibration was taken before and after each observation. The standard sources were normalized to the thermal calibrations, and a least square linear fit was put through the points. (These were performed with the cooperation of M. DeJong.) The source 3C 71 was adopted as a standard source for the 1410 C and 750 MHz systems. The source 3C 196 was used for the 1410 E and 1410 W MHz systems, and 3C 353 was used for the low frequency systems. The flux densities of these sources were obtained from Conway, Kellerman, and Long 1963, M.N. 125, 261). Due to changes of the thermal calibration at 750 MHz, three values of the normalized deflections of 3C 71 were obtained. Table 2 includes the values of the normalized deflections of the standard sources D_{st}/D_{cal}, together with the standard deviation of the mean σ_m. The adopted flux densities and the calculated ratios of the calibration temperature T_{cal}, to the beam efficiency E_b are also given in Table 2.

In order to calculate the flux density of an extended source we need to know its brightness temperature distribution. The brightness temperature T_b of any observed point s is

$$T_b = \frac{D_s}{D_{cal}} \frac{T_{cal}}{E_b} . \qquad (1)$$

In the case where standard sources are used, the ratio T_{cal}/E_b can be computed directly with the knowledge of the flux densities and normalized deflections of these sources. The HPBW of the beam must also be known. The flux density of a source S_λ is given by

$$S_\lambda = \frac{2k}{\lambda^2} \int_{source} T_b \, d\Omega \qquad (2)$$

where k is the Boltzmann constant and λ is the wavelength. In terms of the antenna temperature T_a and the beam efficiency E_b, we can write for the flux density

$$S_\lambda = \frac{2k}{\lambda^2} \frac{1}{E_b} \int_{source} T_a \, d\Omega. \qquad (3)$$

Considering a standard point source, its maximum antenna temperature $T_{a,\,st}$ is the normalized peak deflection of the source D_{st}/D_{cal}, times the experimentally measured temperature of the thermal calibration T_{cal}. Hence, the flux density of a standard point source can be written as

$$S_{\lambda,\,st} = \frac{2k}{\lambda^2} \frac{T_{cal}}{E_b} \int_{main\ beam} \frac{D_{st}}{D_{cal}} \, d\Omega \qquad (4)$$

The main beam solid angle can be represented by a Gaussian function, and can be written as $1.133\ \Theta_\alpha \Theta_\delta$, where Θ_α and Θ_δ are the HPBW in right ascension and declination. Therefore, we can write

$$\frac{T_{cal}}{E_b} = \frac{S_{\lambda,\,st}\lambda^2}{2k} \left(\frac{D_{st}}{D_{cal}}\right)^{-1} \frac{1}{1.133\ \Theta_\alpha \Theta_\delta} \qquad (5)$$

The half-power beamwidths of the main beams were measured directly from the contours of the beams. In the case of the two off-center 1410 MHz beams, a correction was made to the half-power beamwidths of the main beams in order to include the contribution of the sidelobes in deriving the flux density of extended sources. By integrating the sidelobes and the main beams separately, the contribution of the sidelobe for the 1410 E system was found to be 4.6 percent, and that of the 1410 W system 3.6 percent. Having calculated T_{cal}/E_b from equation (5) we can then obtain the brightness temperature T_b of any observed point with the knowledge of its normalized deflection from equation (1).

VIII. Summary and Remarks

Installation of the Strip of Sky systems was begun on December 30, 1963 and all systems were made operational on January 2, 1964.

A great deal of observing time was lost during the month of January due to instability of the equipment.

The cause of the instability was never determined. However, on February 1, 1964, the original switch, switch drivers, and gain modulators (switch was an AEL Model SNB-690A, diodes in same direction; switch driver was solid-state driver described in Electronics Division Internal Report No. 27 entitled "400 cps Solid State Switch Driver" by Hermann von Hoerner) were changed to the standard type components (switch was an AEL Model SNB-634A, one diode reversed); switch driver (standard tube type) on the 750 MHz system and the 1410 MHz center system.

The changes eliminated the instability of the two systems mentioned above; however, it still existed, but not as bad as before, on the East and West 1410 MHz systems.

On February 25, 1964, the East and West 1410 MHz systems were modified in the same manner as the 750 MHz and 1410 MHz center system, thus eliminating the instability problems on all systems.

After a series of tests in the lab (insertion loss as a function of frequency; VSWR with the switches locked in one position, then the other; and VSWR with the switch switching at a 400 cycle rate) these same switches, switch drivers, and gain modulators were operated on the Little Big Horn receiver. Both lab and receiver tests have shown that the systems used in the original installation were as good as the standard system, which was used for replacement. Therefore, we can almost, without doubt, say that the instability problems were as a result of either the coupling of switch driver outputs within the cable or ground loops. Steps are being taken to eliminate both problems.

On February 4, 1964, the low frequency systems were installed. During the first week of observations a great deal of time was lost due to interference, some of which was at the signal frequencies and a great deal at the intermediate frequency (30 MHz).

The amount of interference was reduced by installing a high pass filter (200 MHz) in the 234 MHz system and a bandpass filter in the 405 MHz system.

Results of the observations show that 14.60 percent of the total observing time on 234 MHz was lost due to interference while the time lost on the 405 MHz system was 4.02 percent.

A systematic record of the types of interference was taken over a 6-day period (Monday-Saturday) on 234 MHz and 405 MHz. The results are shown below.

Cause of Interference	Percent of Interference Time
Aircraft --------	39
Traffic (ignition)-	29
Lightning -------	3
Unknown --------	29

Direct analog records were made on a 6-channel recorder. Simultaneously, the output was recorded digitally on punched paper tape. Also, a printed record was made at the same time. Six outputs were recorded every 10 seconds, one for each channel.

Table 1

Parameters of the Receivers and Positions of the Antenna Beams

ν (MHz)	λ (cm)	Band-width (MHz)	System tem-perature (°K)	T_{cal} (degrees)	α	Beam Positions Relative to the Central Beams
1410-C	21.3	8	190	7.5	1.69	Central beam (feed-horn)
1410-E	21.3	8	138	6.6	1.74	37.5' W 6.0' N (feed-horn)
1410-W	21.3	8	210	7.6	1.72	37.6' E 10.9' S (feed-horn)
750	40.0	a) 6 b) 8	a) 470 b) 450	9.7	1.7	Central beam (dipole feed)
405	74.1	4	875	19.0	1.72	50.0' E 50.0' N (helical feed)
234	128.2	4	1000	18.9	1.71	51.3' W 55.0' S (helical feed)

Table 2

Parameters of the Beams and Standard Sources

ν (MHz)	$HPBW_\delta$	$HPBW_\alpha$	Standard source	D_{st}/D_{cal} , σ_m	S_ν 10^{-26} Wm^{-2} Hz^{-1}	T_{cal}/E_b (°K)
1410-C	10.0'	10.0'	3C 71	0.613 ± 0.009	5.46	15.23
1410-E	10.8'	10.0'	3C 196	1.652 ± 0.027	14.886	13.64
1410-W	10.2'	12.0'	3C 196	1.407 ± 0.018	14.886	14.29
750	18.8'	18.8'	3C 71	a) 1.232 ± 0.008 (Feb. 2 - Mar. 11) b) 0.973 ± 0.012 (Mar. 11 - Apr. 5) c) 1.460 ± 0.026 (Apr. 5 - Apr. 14)	7.41	a) 10.29 b) 13.03 c) 8.68
405	45'	43'	3C 353	4.396 ± 0.041	130	31.67
234	67'	65'	3C 353	6.901 ± 0.052	184	37.90

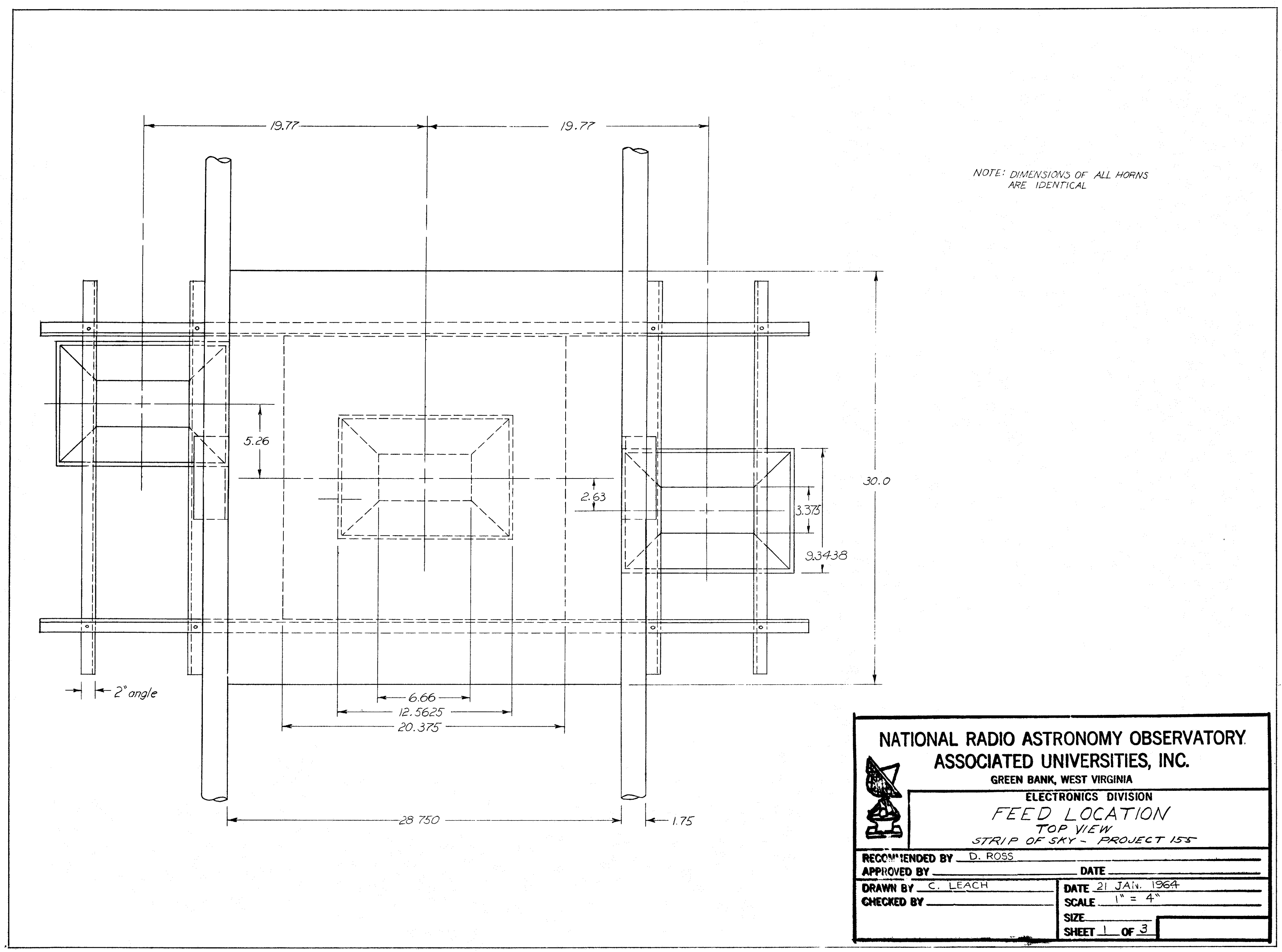
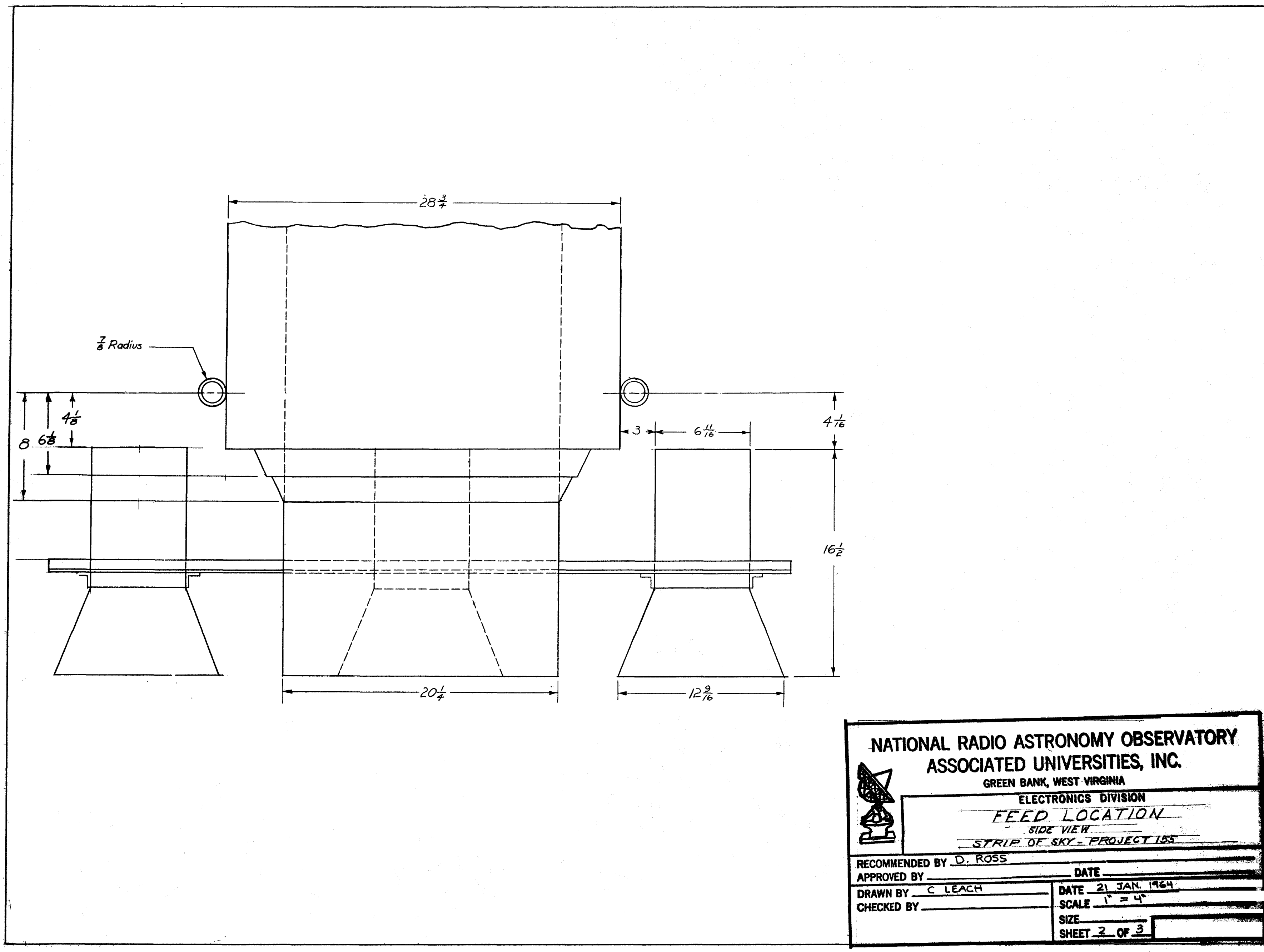
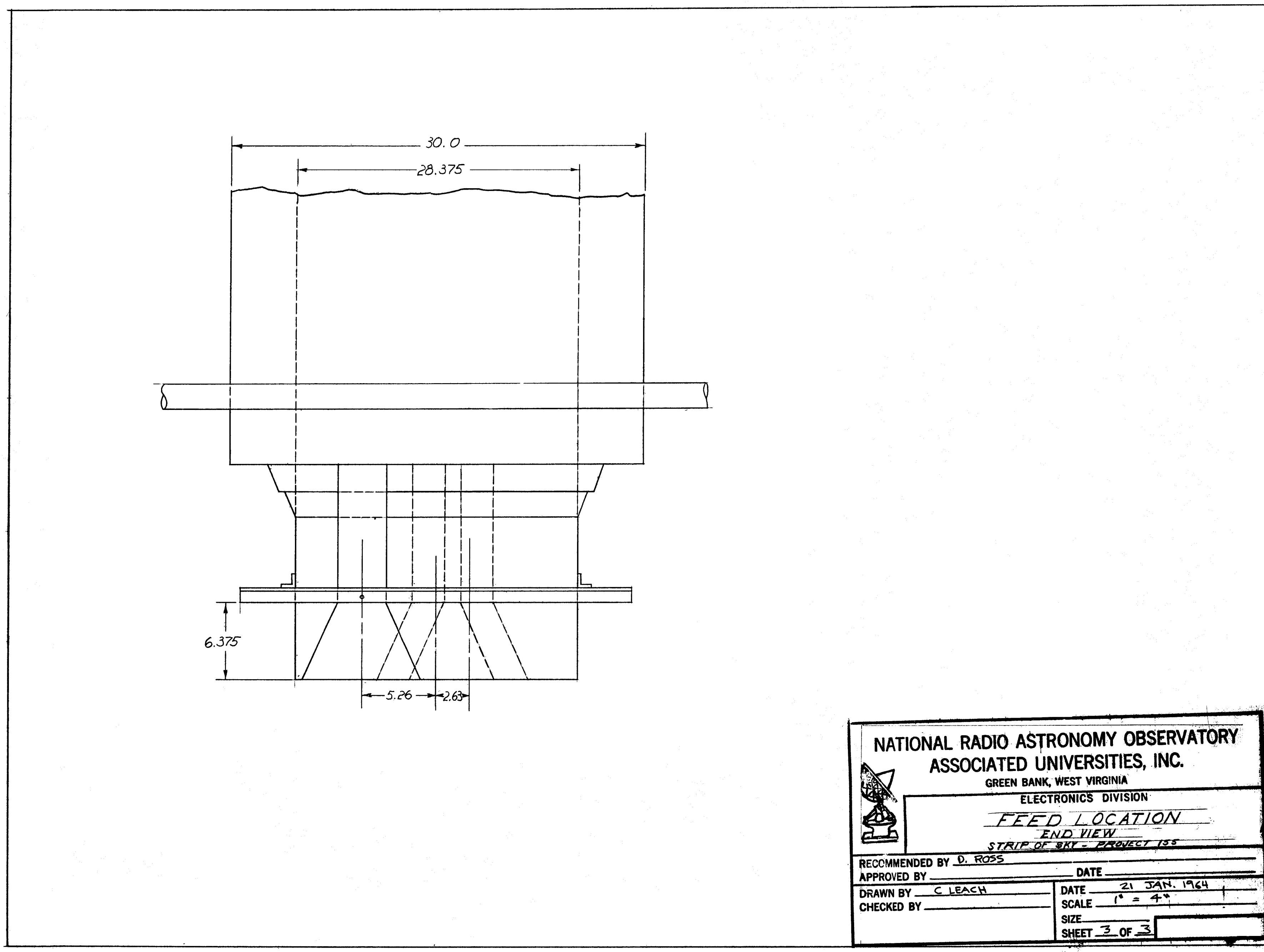

19.77
19.77
NOTE: DIMENSIONS OF ALL HORNS ARE IDENTICAL
5.26
2.63
3.375
9.3438
30.0
2" angle
6.66
12.5625
20.375
28 750
1.75
NATIONAL RADIO ASTRONOMY OBSERVATORY
ASSOCIATED UNIVERSITIES, INC.
GREEN BANK, WEST VIRGINIA
ELECTRONICS DIVISION
FEED LOCATION
TOP VIEW
STRIP OF SKY - PROJECT 155
RECOMMENDED BY D. ROSS
APPROVED BY
DATE
DRAWN BY C. LEACH
CHECKED BY
DATE 21 JAN. 1964
SCALE 1" = 4"
SIZE
SHEET 1 OF 3

Figure 1



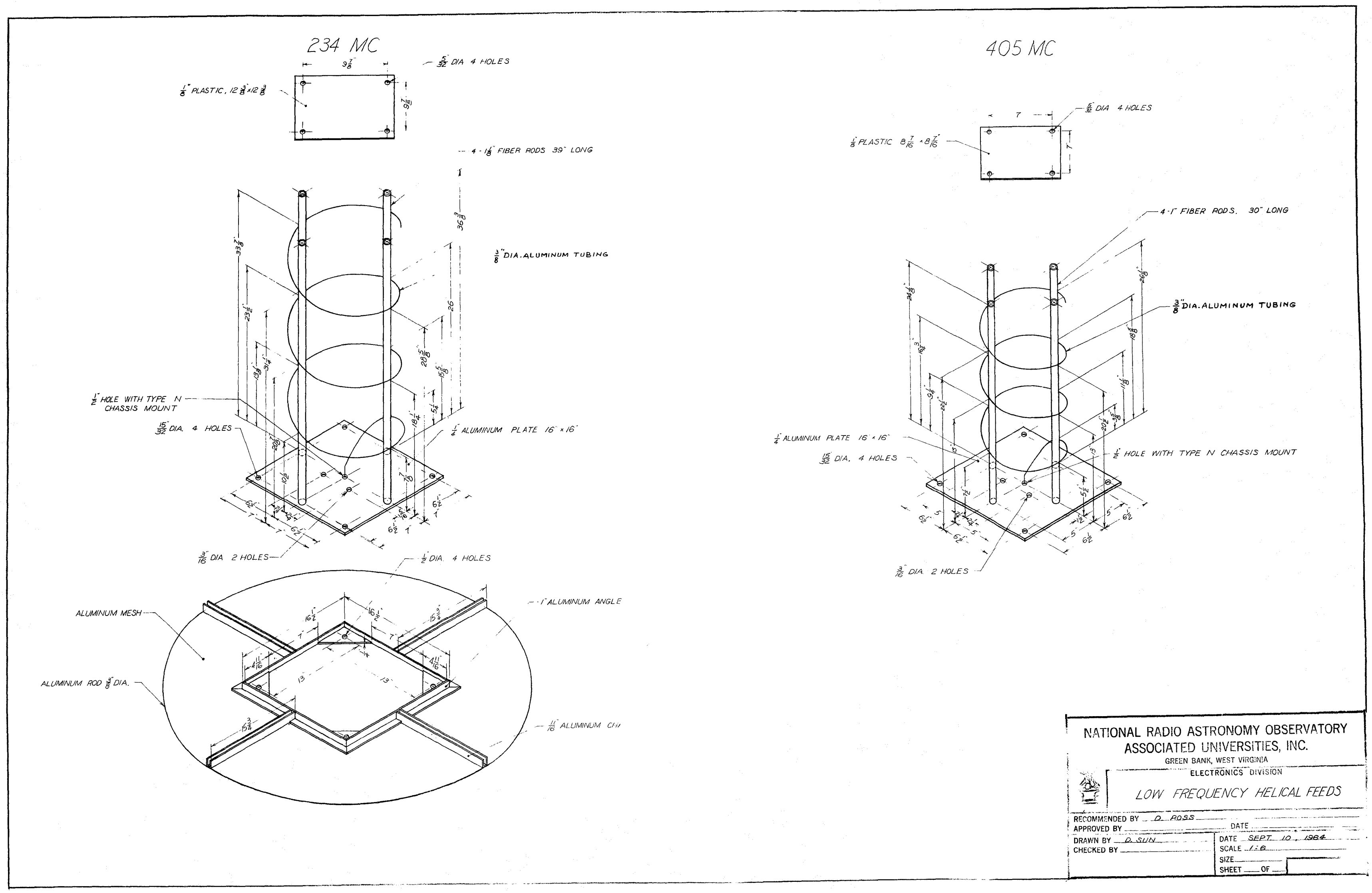
28 3/4
7/8 Radius
4 1/8
6 5/8
8
3
6 11/16
4 1/16
16 1/2
20 1/4
12 9/16
NATIONAL RADIO ASTRONOMY OBSERVATORY
ASSOCIATED UNIVERSITIES, INC.
GREEN BANK, WEST VIRGINIA
ELECTRONICS DIVISION
FEED LOCATION
SIDE VIEW
STRIP OF SKY - PROJECT 155
RECOMMENDED BY D. ROSS
APPROVED BY
DATE
DRAWN BY C LEACH
CHECKED BY
DATE 21 JAN. 1964
SCALE 1" = 4"
SIZE
SHEET 2 OF 3

Figure 2



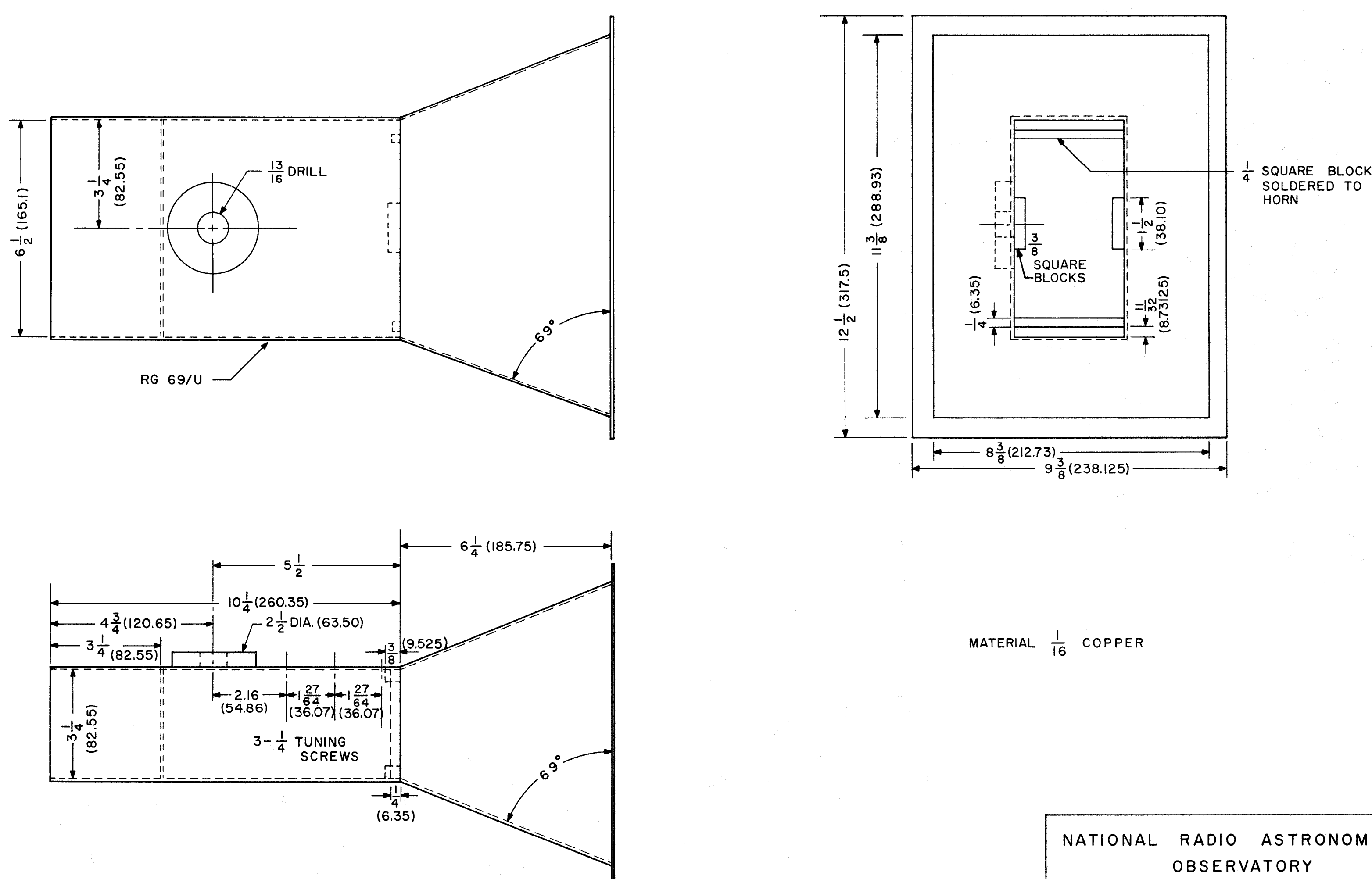
30.0
28.375
6.375
5.26
2.63
NATIONAL RADIO ASTRONOMY OBSERVATORY
ASSOCIATED UNIVERSITIES, INC.
GREEN BANK, WEST VIRGINIA
ELECTRONICS DIVISION
FEED LOCATION
END VIEW
STRIP OF SKY - PROJECT 155
RECOMMENDED BY D. ROSS
APPROVED BY
DATE
DRAWN BY C LEACH
CHECKED BY
DATE 21 JAN. 1964
SCALE 1" = 4"
SIZE
SHEET 3 OF 3

Figure 3



234 MC
405 MC
5/32" DIA 4 HOLES
1/8" PLASTIC, 12 3/8 x 12 3/8
4 - 1 1/8" FIBER RODS 39" LONG
3/8" DIA. ALUMINUM TUBING
1/2" HOLE WITH TYPE N CHASSIS MOUNT
15/32" DIA. 4 HOLES
1/4" ALUMINUM PLATE 16" x 16"
3/16" DIA 2 HOLES
1/2" DIA. 4 HOLES
ALUMINUM MESH
1" ALUMINUM ANGLE
ALUMINUM ROD 3/8" DIA.
1/8" PLASTIC 8 7/16 x 8 7/16
4 - 1" FIBER RODS. 30" LONG
NATIONAL RADIO ASTRONOMY OBSERVATORY
ASSOCIATED UNIVERSITIES, INC.
GREEN BANK, WEST VIRGINIA
ELECTRONICS DIVISION
LOW FREQUENCY HELICAL FEEDS
RECOMMENDED BY D. ROSS
APPROVED BY
DATE
DRAWN BY D. SUN
CHECKED BY
DATE SEPT. 10, 1964
SCALE 1:8
SIZE
SHEET OF

Figure 4



MATERIAL 1/16 COPPER

NATIONAL RADIO ASTRONOMY OBSERVATORY	
1420 MC WAVEGUIDE HORN	DRAWN BY
	CHECKED BY
	SCALE 1:2
	DATE 8-22-63
	RE-DRAWN BY [illegible]

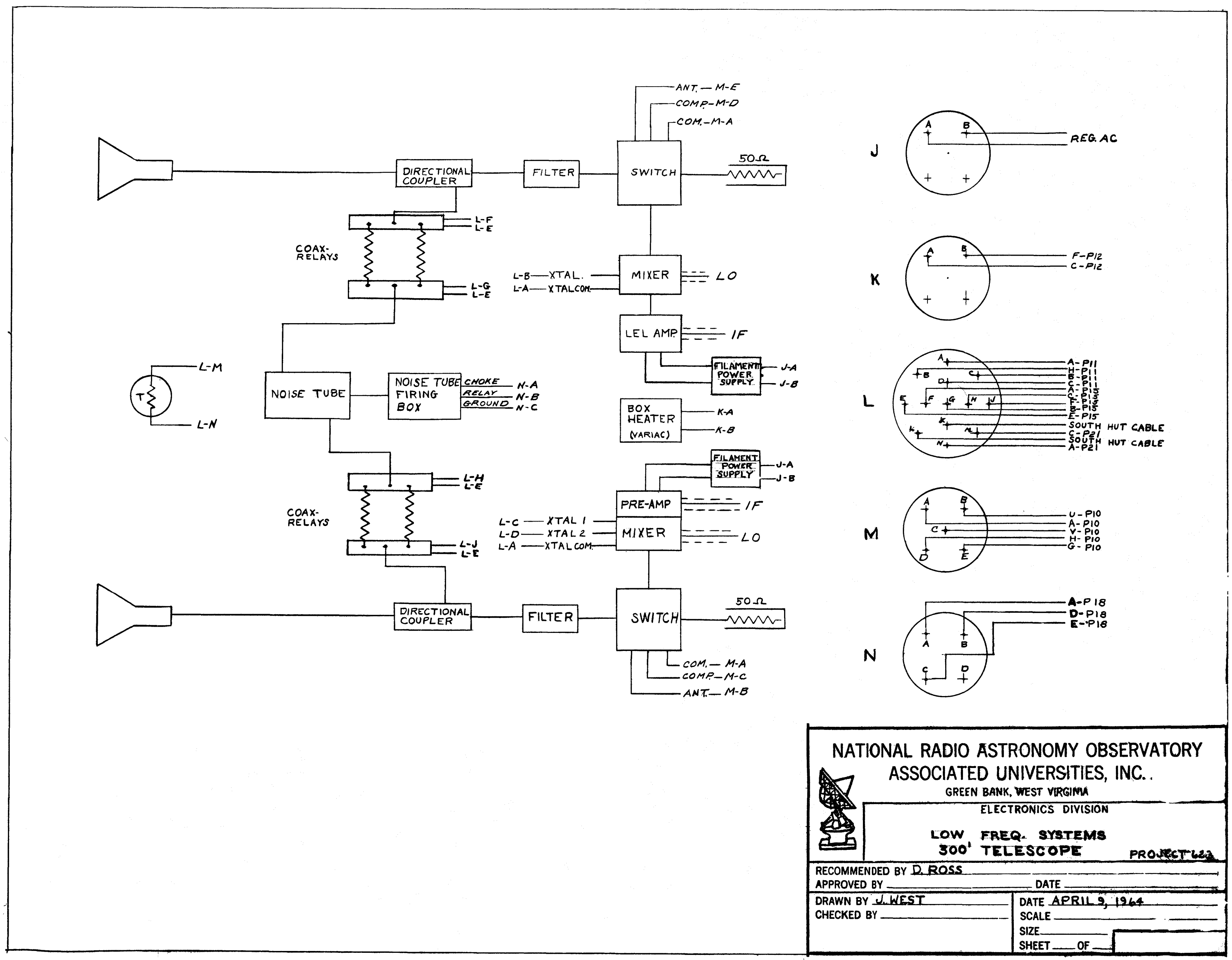
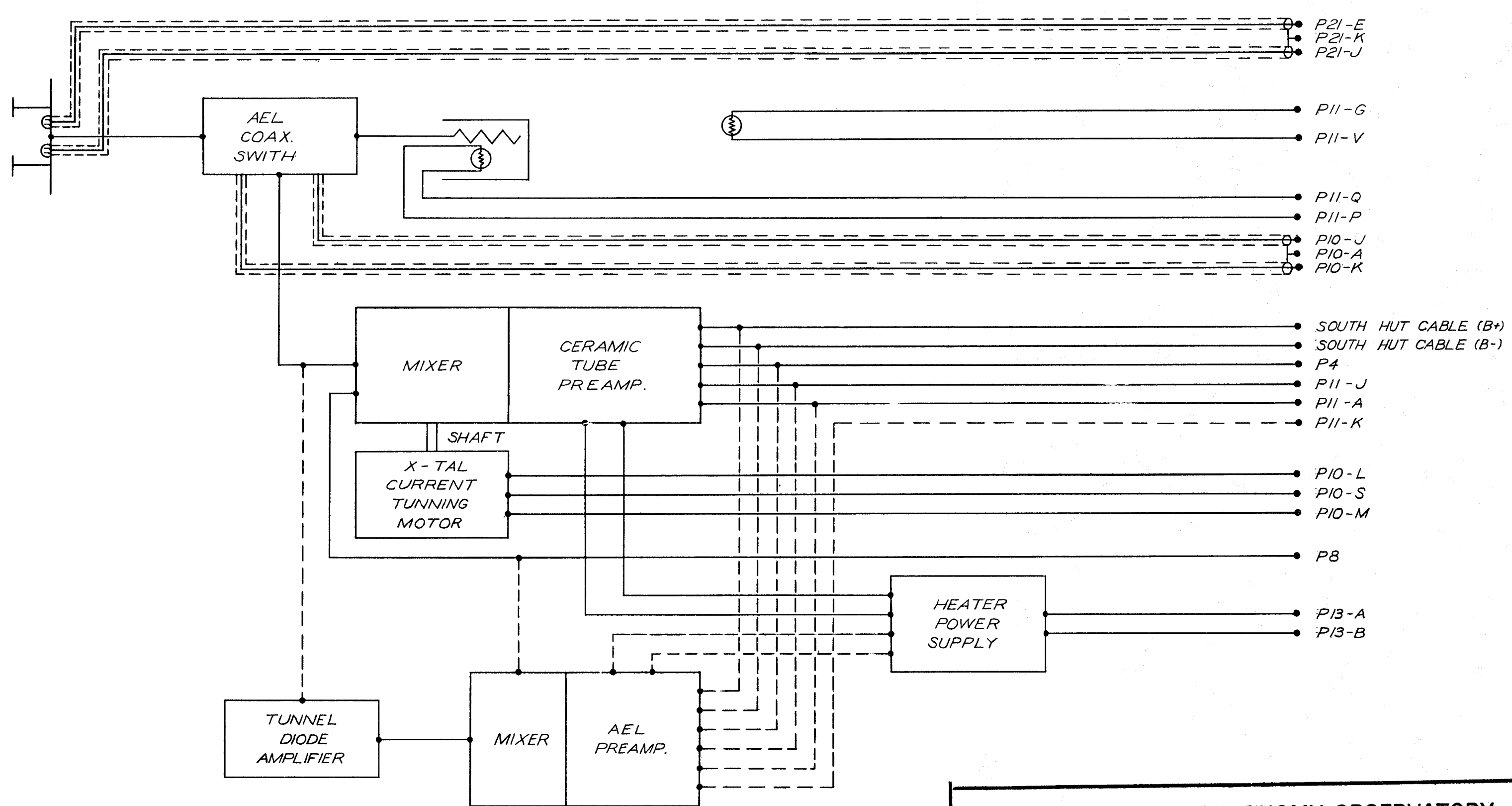

ANT. — M-E
COMP.-M-D
COM.-M-A
SWITCH
50Ω
DIRECTIONAL COUPLER
FILTER
L-F
L-E
COAX-RELAYS
L-G
L-E
L-B — XTAL.
L-A — XTALCOM.
MIXER
LO
LEL AMP.
IF
FILAMENT POWER SUPPLY
J-A
J-B
L-M
L-N
NOISE TUBE
NOISE TUBE FIRING BOX
CHOKE
RELAY
GROUND
N-A
N-B
N-C
BOX HEATER (VARIAC)
K-A
K-B
L-H
L-E
COAX-RELAYS
L-J
L-E
L-C — XTAL 1
L-D — XTAL 2
L-A — XTAL COM.
PRE-AMP
MIXER
IF
LO
COM. — M-A
COMP. — M-C
ANT. — M-B
J
REG. AC
K
F-P12
C-P12
L
A-P11
H-P11
B-P11
C-P11
A-P13
G-P13
F-P13
B-P15
E-P15
SOUTH HUT CABLE
C-P21
SOUTH HUT CABLE
A-P21
M
U-P10
A-P10
V-P10
H-P10
G-P10
N
A-P18
D-P18
E-P18
NATIONAL RADIO ASTRONOMY OBSERVATORY
ASSOCIATED UNIVERSITIES, INC.
GREEN BANK, WEST VIRGINIA
ELECTRONICS DIVISION
LOW FREQ. SYSTEMS
300' TELESCOPE
PROJECT 623
RECOMMENDED BY D. ROSS
APPROVED BY
DATE
DRAWN BY J. WEST
CHECKED BY
DATE APRIL 9, 1964
SCALE
SIZE
SHEET OF

Figure 6

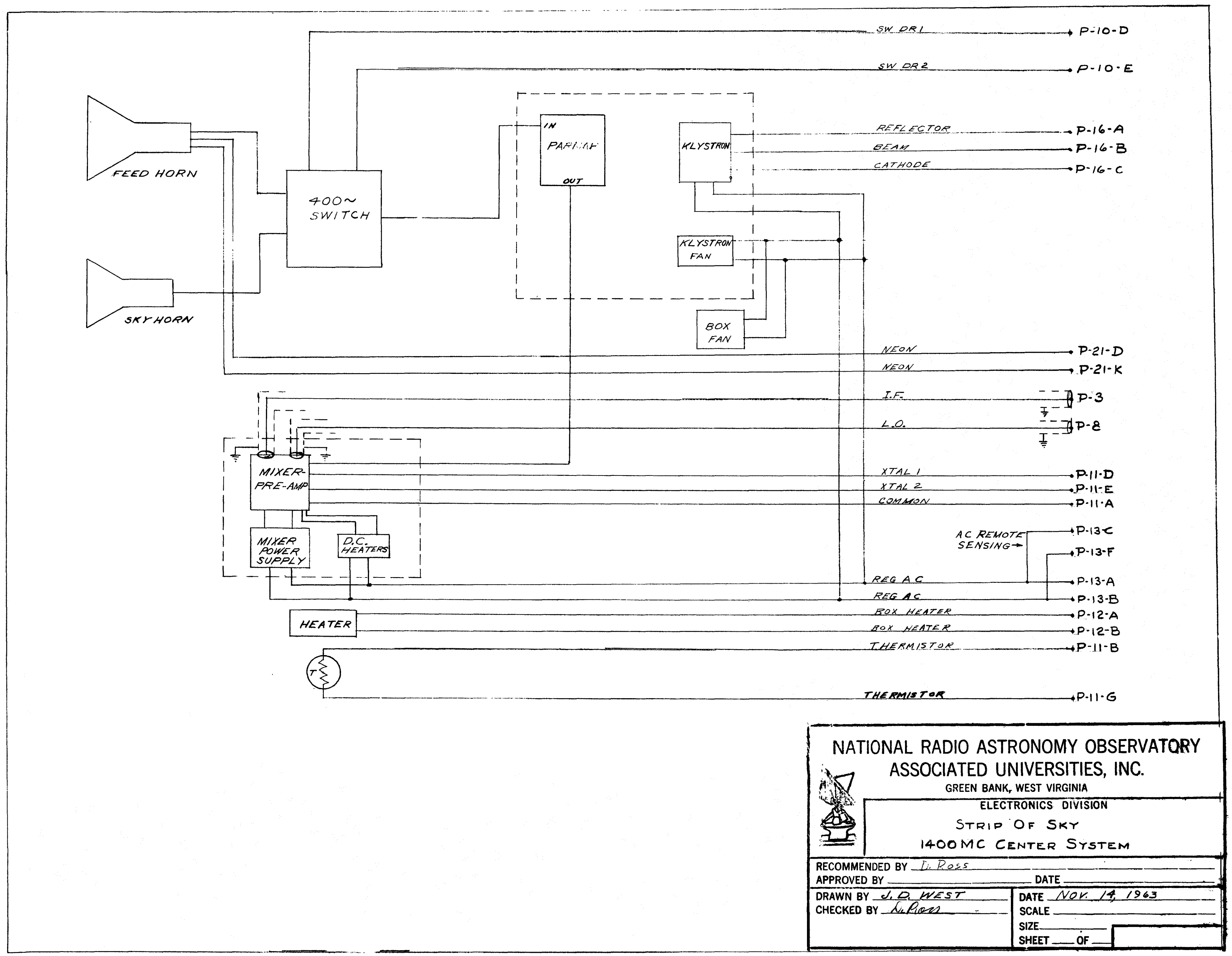


NATIONAL RADIO ASTRONOMY OBSERVATORY
ASSOCIATED UNIVERSITIES, INC.

STRIP OF SKY
750 MC SYSTEM

RECOMMENDED BY D. ROSS
APPROVED BY ____ DATE ____
DRAWN BY D. SUN
CHECKED BY ____
DATE SEPT. 15, 1964
SCALE ____
SIZE ____
SHEET ____ OF ____

Figure 7



FEED HORN
SKY HORN
400~ SWITCH
IN
PARAMP
OUT
KLYSTRON
KLYSTRON FAN
BOX FAN
MIXER-PRE-AMP
MIXER POWER SUPPLY
D.C. HEATERS
HEATER
T
SW DR 1
P-10-D
SW DR 2
P-10-E
REFLECTOR
P-16-A
BEAM
P-16-B
CATHODE
P-16-C
NEON
P-21-D
NEON
P-21-K
I.F.
P-3
L.O.
P-8
XTAL 1
P-11-D
XTAL 2
P-11-E
COMMON
P-11-A
AC REMOTE SENSING→
P-13-C
P-13-F
REG A.C.
P-13-A
REG A.C.
P-13-B
BOX HEATER
P-12-A
BOX HEATER
P-12-B
THERMISTOR
P-11-B
THERMISTOR
P-11-G
NATIONAL RADIO ASTRONOMY OBSERVATORY
ASSOCIATED UNIVERSITIES, INC.
GREEN BANK, WEST VIRGINIA
ELECTRONICS DIVISION
STRIP OF SKY
1400 MC CENTER SYSTEM
RECOMMENDED BY D. Ross
APPROVED BY
DATE
DRAWN BY J. D. WEST
CHECKED BY D. Ross
DATE NOV. 14, 1963
SCALE
SIZE
SHEET OF

Figure 8

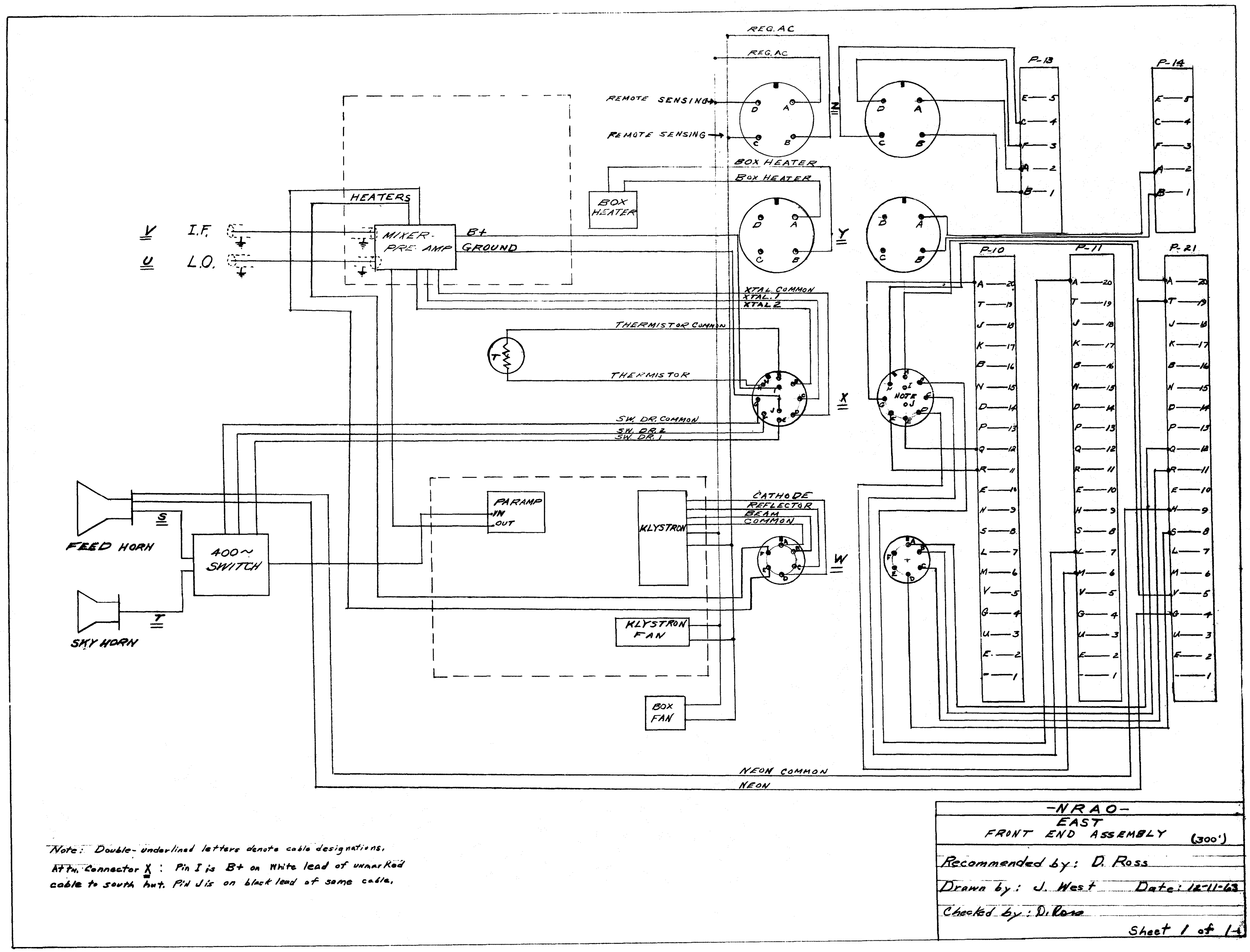

REG. AC
REG. AC
REMOTE SENSING
REMOTE SENSING
BOX HEATER
BOX HEATER
BOX HEATER
HEATERS
MIXER-PRE AMP
B+
GROUND
V I.F.
U L.O.
XTAL COMMON
XTAL 1
XTAL 2
THERMISTOR COMMON
THERMISTOR
SW. DR. COMMON
SW. DR. 2
SW. DR. 1
FEED HORN
SKY HORN
S
T
400~ SWITCH
PARAMP
IN
OUT
KLYSTRON
CATHODE
REFLECTOR
BEAM
COMMON
KLYSTRON FAN
BOX FAN
Z
Y
X
W
NOTE
P-13
P-14
P-10
P-11
P-21
NEON COMMON
NEON
Note: Double-underlined letters denote cable designations.
Attn. Connector X : Pin I is B+ on White lead of unmarked cable to south hut. Pin J is on black lead of same cable.
-NRAO-
EAST
FRONT END ASSEMBLY (300')
Recommended by: D. Ross
Drawn by: J. West Date: 12-11-63
Checked by: D. Ross
Sheet 1 of 1

Figure 9

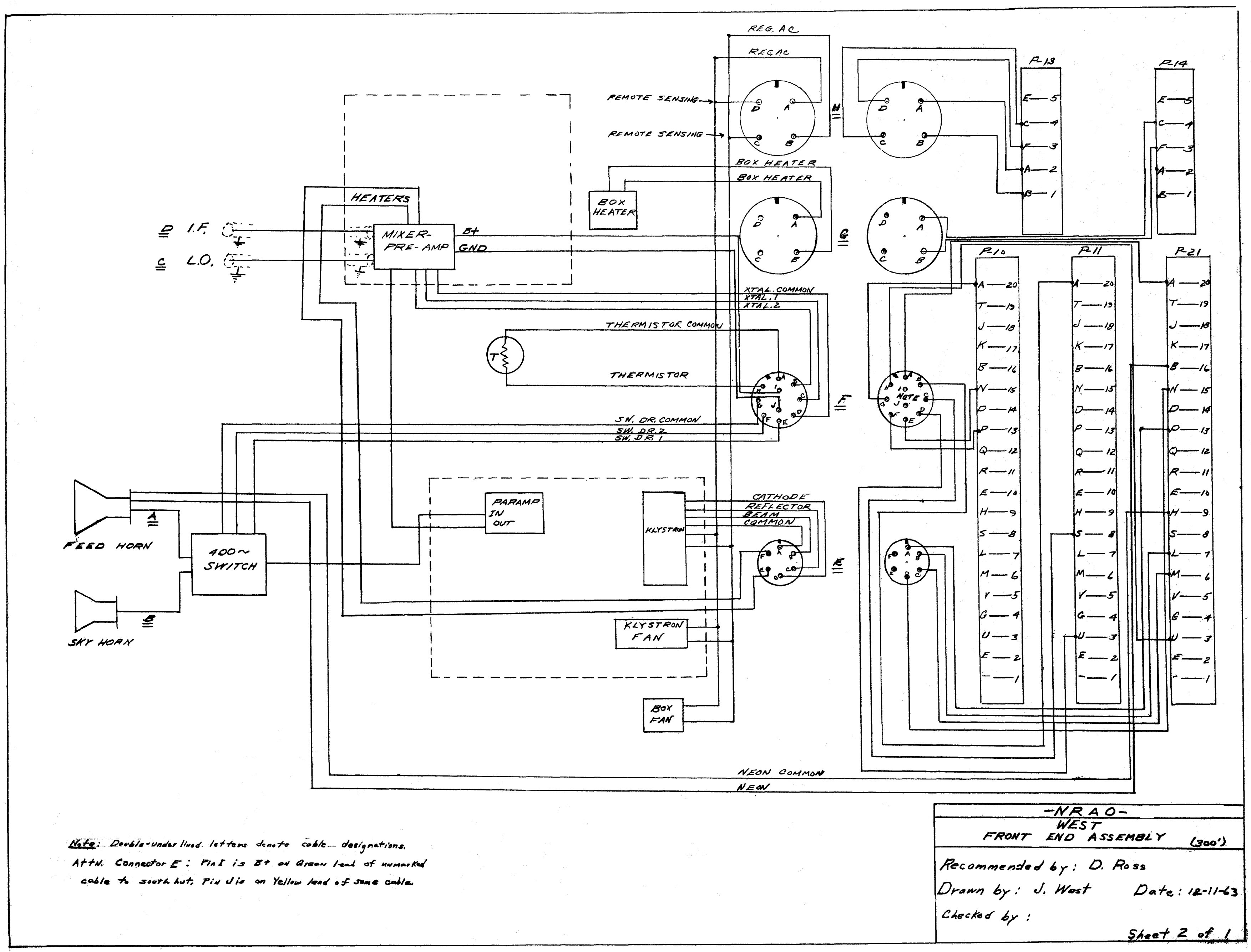
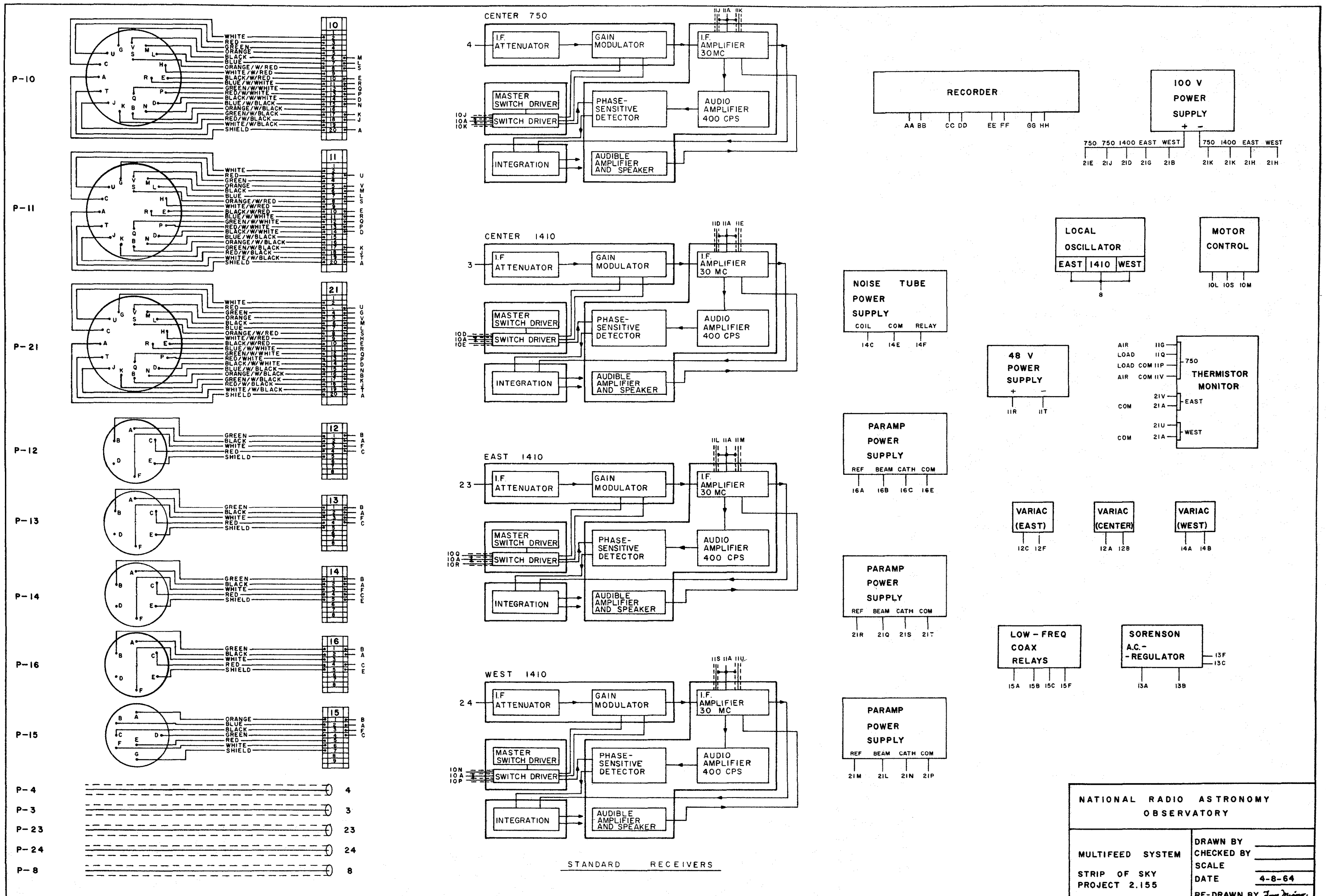

REG. AC
REG AC
REMOTE SENSING
REMOTE SENSING
BOX HEATER
BOX HEATER
BOX HEATER
HEATERS
D I.F.
C L.O.
MIXER-PRE-AMP
B+
GND
XTAL COMMON
XTAL 1
XTAL 2
THERMISTOR COMMON
THERMISTOR
T
SW. DR. COMMON
SW. DR. 2
SW. DR. 1
PARAMP IN OUT
KLYSTRON
CATHODE
REFLECTOR
BEAM
COMMON
KLYSTRON FAN
BOX FAN
400~ SWITCH
A
FEED HORN
B
SKY HORN
H
G
F
E
NOTE
P-13
P-14
P-10
P-11
P-21
NEON COMMON
NEON
Note: Double-under lined letters denote cable designations.
Attn. Connector E: Pin I is B+ on Green lead of unmarked cable to south hut; Pin J is on Yellow lead of same cable.
-NRAO-
WEST
FRONT END ASSEMBLY (300')
Recommended by: D. Ross
Drawn by: J. West
Date: 12-11-63
Checked by:
Sheet 2 of 1

Figure 10



P-10
P-11
P-21
P-12
P-13
P-14
P-16
P-15
P-4
P-3
P-23
P-24
P-8
CENTER 750
CENTER 1410
EAST 1410
WEST 1410
I.F. ATTENUATOR
GAIN MODULATOR
I.F. AMPLIFIER 30 MC
MASTER SWITCH DRIVER
SWITCH DRIVER
PHASE-SENSITIVE DETECTOR
AUDIO AMPLIFIER 400 CPS
INTEGRATION
AUDIBLE AMPLIFIER AND SPEAKER
STANDARD RECEIVERS
RECORDER
100 V POWER SUPPLY
LOCAL OSCILLATOR
EAST 1410 WEST
MOTOR CONTROL
NOISE TUBE POWER SUPPLY
48 V POWER SUPPLY
THERMISTOR MONITOR
PARAMP POWER SUPPLY
VARIAC (EAST)
VARIAC (CENTER)
VARIAC (WEST)
LOW-FREQ COAX RELAYS
SORENSON A.C.-REGULATOR
NATIONAL RADIO ASTRONOMY OBSERVATORY
MULTIFEED SYSTEM
STRIP OF SKY
PROJECT 2.155
DRAWN BY
CHECKED BY
SCALE
DATE 4-8-64
RE-DRAWN BY

Figure 11

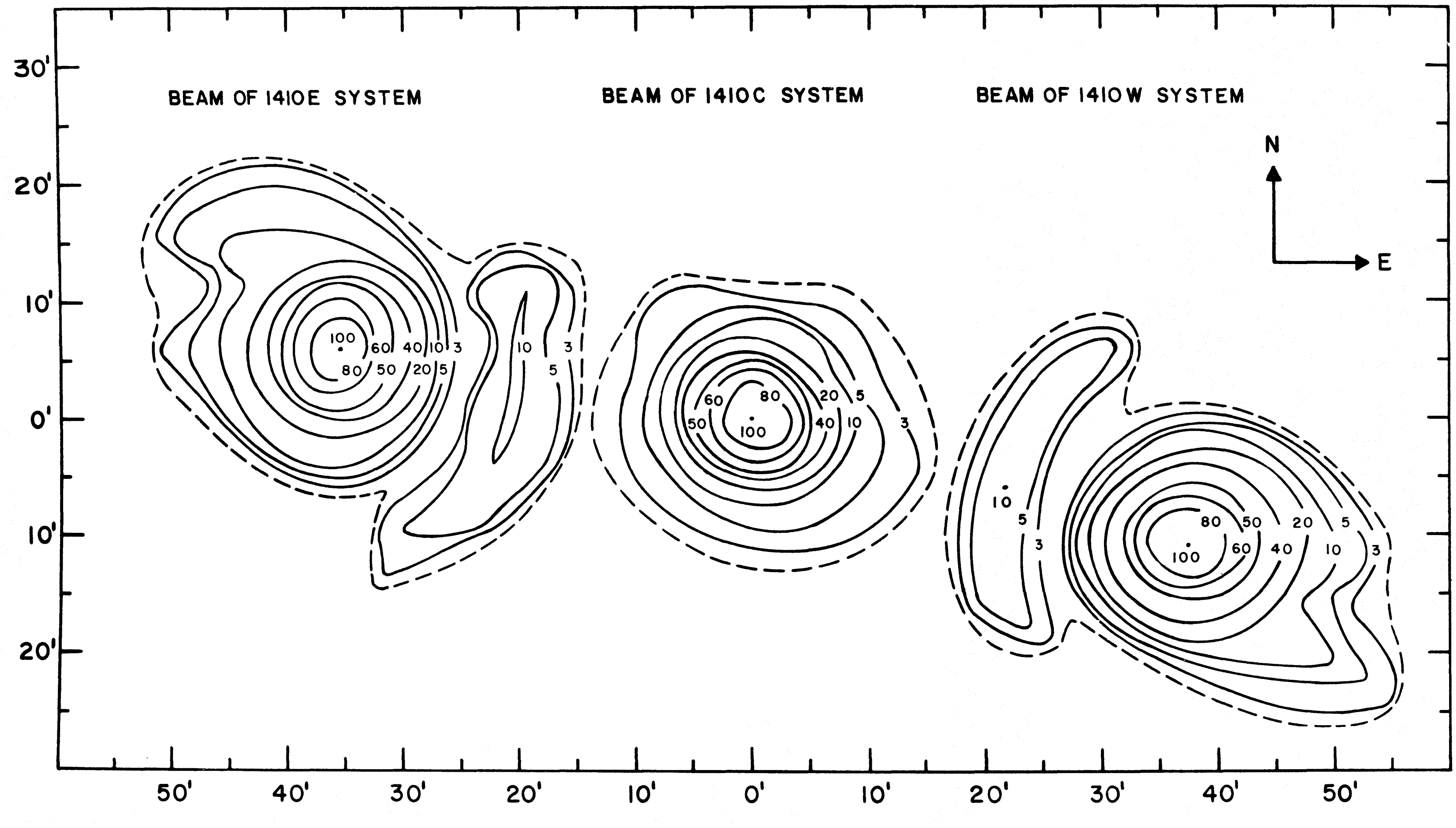

BEAM OF 1410E SYSTEM
BEAM OF 1410C SYSTEM
BEAM OF 1410W SYSTEM
N
E
30'
20'
10'
0'
10'
20'
50'
40'
30'
20'
10'
0'
10'
20'
30'
40'
50'
100
80
60
50
40
20
10
5
3

Figure 12