Interoffice

ADDITIONAL BASELINE TO INTERFEROMETER NO. 132

National Radio Astronomy Observatory

Green Bank, West Virginia

To: Additional Baseline to Interferometer March 13, 1981

From: Buck Peery, John Ralston, Len Howell, and Fred Crews

Subject: Possible Surplus Antenna

In response to a telephone request from the U.S. Naval Observatory that we investigate the use of an antenna that is to be reported surplus, we visited Goddard Space Flight Center where there is a mate to the antenna that might be available. The reported surplus antenna is located at Goldstone.

Bill Klepczynski (USNO) and the four of us visited with NASA's Joe Kueberth and saw the antenna similar to the one to become surplus. Mr. Kueberth was familiar with the surplus antenna as well, and was very helpful and informative.

I. The following general information was obtained through discussions and observations.

1. These antennas were built in 1963 by Philco Ford.
2. Both antennas have been modified over the years, but not necessarily the same.
3. The antenna is a paraboloid 12.2 meters in diameter, with an F/D of 0.4.
4. The drive system is hydraulic, utilizing a 75 HP motor to develop 3000 psi for operation (i.e. a common system). Some of the hydraulic controls and possibly part of the hydraulic system itself havebeen removed from the surplus antenna for use elsewhere -- just how much had been removed was unknown by Kueberth.
5. A design for DC drives and controls had been made and a prototype developed, but it had not been installed on the surplus antenna and had been misplaced or used for parts. At the request of NASA, Bendix has thoroughly gone over the surplus antenna and determined the costs to put it back into operation. The costs in current dollars were 179K for material and 171K for labor and manpower, totaling 350K. Bendix gave prices for both hydraulic and DC drive, with very little cost difference between the two.
6. The surplus antenna was thought to be prime focus - however, since then it has been determined that it is Cassegrain. In any case it was doubtful that the feed support legs would be adequate for our 1450 lb. load requirement and maintain the required pointing accuracy.

7. The focal point structure would need reworking to house our adjustable feed mount (Sterling Mount). This coupled with findings in Item 6 above would dictate a complete redesign of the feed support structure with possible changes in the back-up structure for adequate support.

8. The back-up structure is a heavy steel structure assembled "on site" with "Huck" rivets. It is not clear how difficult it would be to successfully disassemble and reassemble the structure. The estimated weight at that time was 160 tons. This number has since been revised to be 60 tons.??????

9. The surface is made of framed aluminum skin panels, with an estimated accuracy at .030 inches. (This has since been revised to be .063 inches over 95% of the surface. However, the surface has been changed once, and the exact present condition is not known).

10. The braking system is not fail safe (i.e. power is required to apply the brake). This would have to be changed, and is allowed for in the Bendix generated costs described in Item 5 above. Mechanical stops consist of two hydraulic snubbers on each axis.

11. The antenna is an X/Y configuration which would require modifications in the current interferometer computer programs and possibly the computer interface. (It is realized that even an AZ/EL antenna will require modifications, but this has already been done once for the existing 45-ft).

12. An estimate of the pointing accuracy was not available at the time of the visit. The antenna has been in use most of its life - except for the last couple of years - as a satellite communications antenna (transmit and receive) and has had very little movement over the X and Y axis. This could mean uneven wear or flattening out of bearings.

13. The drive system used two drive motors on each axis for torque biasing or antibacklash control.

14. The X/Y configuration presents a peculiar problem when the upper axis is turned to where the dish is tipped and at mid-travel the dish structure crosses over the other axis. Because of this structural interference, there are two possible notches in the sky coverage. The severity of the notch is determined mainly by the "yoke arm" length. Mr. Kueberth told us that the surplus antenna had an even shorter "yoke arm" distance than the one we were visiting. This could present a problem to the USNO observing demands.

15. A blank copy of our comparison sheet (check list) was given Mr. Kueberth. He has reviewed the list and has collected a reasonable amount of data on the surplus antenna. A copy of these sheets is included, and an evaluation of the discrepancies and NRAO's conclusions for the use of this antenna follows.

Part II 1

COMPARISON SHEET

Parameters Considered	Specification or Desired	Parameters of Manufacturer's Antenna Under Consideration Mfg.
Diameter of Dish (Meters)	9.15 - 15.25	12.2 (40')
f/D	.36 - .43	0.40
Dish Surface rms	.045"	0.063" 95% OF DISH
Panel Mfg. rms	.018"	NOT AVAILABLE
Dish Shaped or Paraboloid	Paraboloid	PARABOLOID
Panel Adjustments (Number)	4	NO DOCUMENTATION, COULD BE DETERMINED AT SITE
Feed System (P.F./Cassegrain)	Prime Focus	CASSEGRAIN
Type (El/Az)	Pedestal - El/Az	X/Y ON CENTER AXES
Feed System (Wt. supported)	1450#	ORIGINAL QUAD POD SUPPORTED 800LBS
Shadow	15%	WOULD DEPEND ON CONFIGURATION
Panel Separation (Crack)	.125"	0.125"
Axis Orthogonally	18 sec.	± 10 SECONDS OF ARC
Repeatable Pointing Error	3 min.	POINTING ACCURACY ± 60 SECONDS
Non-Repeatable Pointing Error	38 sec.	
Total Pointing Error		
Azimuth Travel	± 270°	(X) AXIS ± 90.0°
Azimuth Drive (Torque Bias)	2 DC-Gear-T.B.	HYDRAULIC DRIVE
Max. Azimuth Speed	20°/min.	(X) 5°/SEC²
Low Azimuth Speed	0 - 15 min/min	N.A.
Elevation Travel	-10° - 90°	Y AXIS ± 83°
Elevation Drive (Torque Bias)	2 DC-Gear-T.B.	HYDRAULIC DRIVE
Max. Elevation Speed	20°/min.	(Y) 5°/SEC²
Low Elevation Speed	0 - 15 min/min	N.A.
Operating Wind Speed	15 mph ± 3	70 MPH
Survival Wind Speed	110 mph	120 MPH
Temperature Range (operate)	- 22° → +123°F	-60° → 130°F
Ice Load	1 cm	1" RADIAL ICE LOAD @ 60 MPH
Snow Load	20#/ft²	24 INCH LOAD (8LBS/CU FT)
Concentrated Load	250#	
Pedestal Construction	Steel	STEEL
Structure Construction	Steel	ALUM
Total Weight		80 TON APPROX
Weight on Elev. Bearings		
Type Pedestal Bearing		TAPERED ROLLER
Mechanical Stops	Yes	HYDRAULIC SNUBBERS
Limit Switches	Yes	YES
Type Brakes	Motor + Disc.	DISC (ELECTRICAL)
Motorized Stow Pins	No	YES
Torque Tube Size		
Weatherproof	Yes	YES
Lightning Protection	Yes	YES
Painting	Yes - Triangle	TRIANGLE 6
Hand Crank		NO
Lubrication System	Oil	OIL
Servo System	No	YES [illegible]
Preassemble before ship	Yes	NO
Special Equipment to Erect	Med - Crane	HEAVY DUTY CRANE 30 TON
Erection Time (Days/No. Men)		30 DAYS 10 MEN
Power Requirements		100 KVA MINIMUM
Drawings	Yes	?
Acceptance Test in Field	Yes	
Maintenance Manual	Yes	YES
Delivery (Months)		

Part II. 2.

FACT SHEET

Items for Estimating

Basic Structure (Hardware including drive motors)	$______
Installation - Erection and Testing	$______
Shipping	$______
Modifications to improve pointing Cassegrain only	$______
Sub Reflector	$______
Feed for Cassegrain	$______
Modifications to improve pointing - Prime Focus with 1450#	$______
Servo Electronics (Not to include position readout equipment)	$______
Other Modifications { Gearing change	$______
	$______
	$______
	$______

THE SYSTEM INCLUDING THE TAPE DRIVE AND SERVO / FEED SYSTEM WAS VALUED AT $100,000 IN 1962

Error Budget

	in. x 10^{-3}
Surface	
Manufacture	______
Gravity	______
Thermal	______
Wind	______
Setting	______
Structure	
Assembly	______
Gravity	______
Thermal	______
Wind	______
Sub Reflector	
Manufacture	______
Gravity	______

Pointing Error Budget

	sec of arc.
Read out	17 Bit GRAY CODE
Servo & Drive	______
Thermal	______
Wind	______
Structure Def.	______

Review Questions

1. Null Band Servo System (as related to minimum speed)
2. Size shaft and space available for inductosyn (10 sec.)
3. Specifications - Servo system, Subreflector, and Feed
4. Antenna Optics NONE

III. Evaluation of performance specifications.

1. The .063 inch rms of the dish is not acceptable for the intended use.

2. Original feed legs supported only 800 lb. load. Feed support structure would not be adequate, and there would be some concern in regard to the structural rigidity of the attaching points due to our load requirement of 1450 lb.

3. The 100 KVA minimum load requirement is unacceptable.

4. It is questionable whether drawings can be furnished. These would be essential.

5. Other supplied specifications in Part II appear to be acceptable.

IV. Conclusions.

1. A new antenna can be purchased, delivered and erected for 445K. An additional 59.3K will be required for the drive and control system, for a total telescope cost of 504.3K.

2. Assuming Bendix figures to update the machinery, applying some estimates based on Micro-T's price/ton to move 85-3 and assuming 60 ton for the surplus antenna:

Machinery update		350K
Disassembly $425/ton x 60	=	25.5K
Shipping $400/ton x 60	=	24K
Erection $900/ton x 60	=	54K
Estimate for new feed legs	=	30K
Total		483.5K

3. The surplus antenna does not meet the dish surface requirement.

4. NRAO would have to dedicate much more engineering and other labor to bring the surplus antenna on line compared to a new antenna.

Based on the above information, other information included in this memo, and various unknowns, the NRAO is opposed to the acquisition of this antenna. Furthermore, we do not feel that it would be in the best interest of the USNO to acquire this antenna. Therefore, we consider the matter satisfactorily investigated and closed.

FC/baw