National Radio Astronomy Observatory
VLB Array Program
VLB Array Electronics Memorandum No. 126

WIND SPEED TEST AT PIETOWN VLBA ANTENNA

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I. INTRODUCTION: Tests of wind speed at various locations and under various conditions were performed during an electronics day in spring of 1991. This report is an attempt to explain the results of those tests, suggest further testing, and suggest possible improvements to the system. The weather station uses a model 2030 anemometer made by Qualimetrics. The portable anemometer was a Turbo Meter made by Davis.

II. Antenna Structure Tests: In the first series of tests we measured wind speed at various points on the telescope and compared the readings to the fixed location anemometer at the weather station. The telescope was stowed during this test. The wind speed at the station was around 15 mph with consistent gusts to 24 mph. The telescope readings recorded were taken during gusts also, ie to compare to the 24 mph. Winds on the base platform read 17 mph. On the catwalk, near the back of the dish structure, wind speed was 21 mph. In the surface of the disk, near the feed cone, wind speed read 15 mph. At the apex the reading was 25 mph. We had expected that the catwalk readings would be higher due to the lower surface of the dish amplifying the wind. My guess is that the backup structure attenuates the effect of the curved dish surface. The apex is around 95 feet in the air. The station anemometer is around 35 feet in the air. The close comparison between the apex reading and the station reading implies to me that a higher tower is not necessary for most sites. Peter Napier mentioned that the Hancock, New Hampshire station was surrounded by tall trees which might block the 30 foot tower mounted anemometer. Thomas Baldwin, Station Tech at Hancock, did some level sighting off the structure of the dish and estimated that the tree tops were between 55 to 60 feet in height. Some pines to the north were somewhat taller (estimated at 90-100 feet) but were set back quite a ways from the station. Rohn makes towers, similar to ours, that have standard heights of 48, 58, and 68 feet. We should investigate placing one of these at the Hancock Station. I presume that the original tower was selected to provide a weather bureau standard height of 10 meters. See appendix A for more information on wind tower height and placement. This is a copy of a page out of the Model 2030 instruction manual.

III. Blocking tests: The second set of tests were to try to determine the extent of blocking that the dish structure would have on the station anemometer. Wind warning alarms from the weather station anemometer are used by the antenna ACU to stow that antenna for safety purposes. For this reason we would like the station anemometer reading to represent the wind striking the antenna itself. Figure 1 shows a sketch of the Pietown station layout. Readings were taken at four locations around the dish. The first was on the side toward the wind direction, and the other three at 90 degree intervals around the dish. As it happened, the

270 degree position was close to the weather station. The readings were taken around 45 feet from the outside of the track. This was as far as we could go without running into the fence. We used a step ladder to get the Turbo Meter about 10 feet off the ground. The first readings were taken with the dish in stow, elevation equal to 90 degree. Readings at all four locations were 18 mph while that station reading was around 23 mph. The elevation was dropped to 2.5 degrees and the front of the dish pointed toward the 0 degree station. Both the 0 degree and 180 degree station wind speed readings dropped to around 10 mph while the 90 degree and 270 degree readings stayed up in the 18 to 20 mph area. We then moved the azimuth so that the front of the dish pointed toward the 180 degree station. The 180 degree reading stayed around 10 mph while the 0, 90, and 270 degree readings were in the 18 to 20 mph area. Finally we moved the azimuth so that the front of the dish pointed toward the 270 degree station. The 180 degree readings stayed low, around 10 mph, while the other three stayed up to the normal level. At this point, the wind speed started dropping so we ended the test session.

IV. Test Conclusion: For low elevation there is significant blocking of the wind by the structure of the dish. Further tests could be run to determine the magnitude and angular size of this blockage, ie versus elevation, azimuth, and anemometer height. I would not recommend much further testing since safety is the concern here and any blockage is a problem.

V. Recommendations: We cannot satisfy all of the conditions described in Appendix A but I think we can provide an adequate set of readings to provide for safe operation of the scope. Placing another anemometer about 90 degrees away from the current tower would appear to be a possible solution. The output would have to be fed to the weather station where it could be "or"ed with the current alarm. This would require considerable expense and labor. Towers cost around $1500. A second anemometer costs around $500. A concrete pad and conduit would have to be installed. Electronics would be added to the weather panel. When I started this exercise it was my understanding that installation of anemometers on the dish structure was not possible because maintenance considerations. The VLA type installation would require two anemometers mounted at the lip of the dish on gimbals. I think Bob Stidstone has been rethinking this and may have some ideas as to how this could be done. If this were practical it would be considered as an attractive alternative. Logic would have to be added somewhere in the vertex room and a cable run from there to the ACU in the pedestal room. I am not sure if there are any extra inputs to the ACU. We might eliminate one of the wind warn signals from the current station and replace it with this alarm from the vertex. This might also require reprogramming of the ACU. Further discussions should take place before deciding which way to go. I will check with Bob Stidstone about mounting anemometers at the lip of the dish. Lou Serna will be consulted about the impact on the ACU and I will check with Jess Landers about the anemometers and mounting used on the VLA antenna. If dish mounting looks practical I would suggest going that way.

Interoffice

National Radio Astronomy Observatory

New Mexico
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To: Distribution

From: Betty Trujillo

Subject: VLB Array Electronics Memorandum No. 126

Please attach Appendix A and Figure 1 to VLBA Electronics Memo No. 126 - Wind Speed Test at Pie Town VLBA Antenna.

3.6 Site Selection: Location of the sensor is critical for accurate wind measurements. The standard exposure of an anemometer or vane over open, level terrain is 10 meters above the ground. Open, level terrain is defined as level ground with no obstruction within 300 m. In locations where obstructions are not large (e.g., residential) and are distributed more or less evenly, the sensor can be placed at an effective height of h + 10 meters, where h is the approximate height (in meters) of the various obstacles. As an example, in a location where trees and buildings reach to about 5 meters high, the sensors must be placed on a 15 meter mast to avoid erroneous results.

3.7 In areas where large obstructions do exist within 300 meters of the sensor, the following table can be used to calculate the proper height of the sensor (h is the height of the obstruction).

Distance of obstruction	Minimum height above ground level of anemometers
h	1.75h to 2.25h
5h	1.67h
10h	1.50h
20h	1.25h
25h	1.13h
30h	h

TABLE 3.1[1]

1. Handbook of Meteorological Instruments, 2nd Edition. Measurement of Surface Wind, Volume 4. London, HMSO: 1981

Thus if there is a building 10 meters high and 50 meters away, the anemometer should be at least 16.7 meters above the ground; but if the same building is 200 meters away the sensor could be lowered to 12.5 meters.

3.8 When the sensor is mounted on a building, the building itself disturbs the wind flow and must be taken into account before installation. For large buildings, except things such as lighthouses, and skyscrapers, the sensor must be mounted as far away from the building edge as possible and at a height at least 3/4 the height of the building. Thus with a large building 28 meters high, a roof top tower at least 21 meters should be used for mounting.

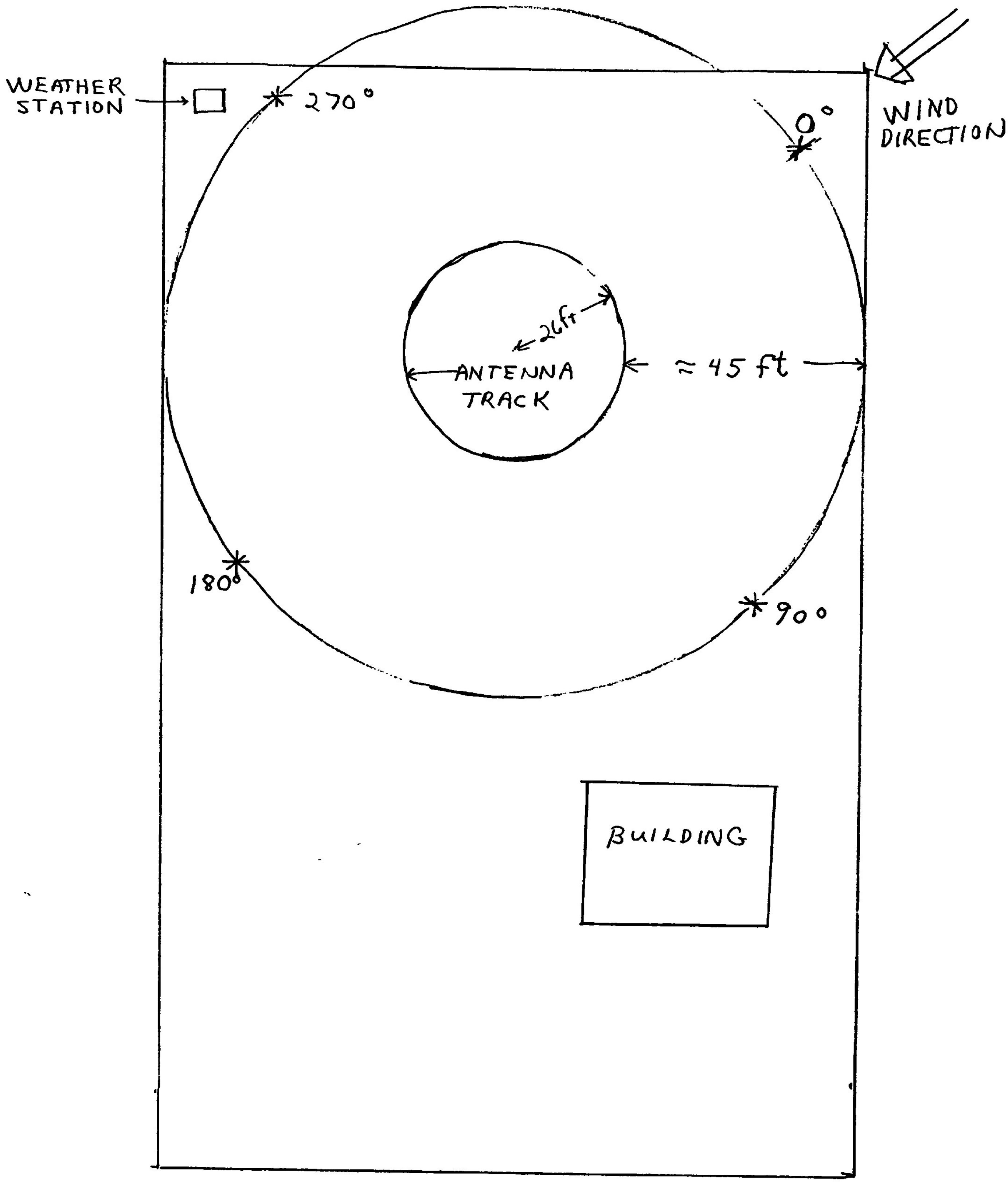

FIGURE 1

PIETOWN SITE LAYOUT
NOT TO SCALE