NATIONAL RADIO ASTRONOMY OBSERVATORY
Socorro, New Mexico

VLBA Antenna Memo Series No.13

Measurement of VLBA Counterweight Imbalance

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Attachments: Counterweight Measurement Procedure

The VLBA telescopes were designed to be counterweight heavy by at least 15,000 ft-lb. measured at the elevation axle allowing them to seek stow position using gravity in the event of a brake/drive failure. The counterweight imbalance of the antennas (measured by T. Frost and S.Tenorio) listed in Table 1 clearly shows that some of the antennas are lacking sufficient counterweight.

Table 1, VLBA Antenna Counterweight Imbalance

Antenna #	Imbalance (ft-lb.)
PT	24,149
LA	-12,207*
KP	-30,130*
FD	-20,860*
BR	13,752
OV	-39,141*
Average	**-10,740***

* Negative numbers indicate dish heavy

The most convenient location to add additional counterweight is on top of the existing small counterweights which gives us a moment arm of approximately 13 feet. Thus, an average of 2000 lb. of additional counterweight per antenna is needed to meet the original 15000 ft-lb. counterweight heavy specification. A preferable approach might be to reduce the weight of the fixtures and electronics that are located above the axle. Removing 100 lb. at the apex has the same affect as adding 500 lb. of counterweight.

This illustrates the fact that antenna hardware and electronics should be optimized with respect to weight before it is installed on an antenna. The additional weight not only decreases the counterweight imbalance but also degrades the structural performance of the antenna.

L.Serna
2/22/94

VLBA ANTENNA COUNTERWEIGHT TESTS

In all tests, TP-14 on Elevation #2 drive SCR cards has been used to obtain voltage readings. And antenna was driven at 50% full slew speed, using single motor #2.

EQUATION FOR CALCULATING VLBA ANTENNA DRIVE TORQUE IS:

Volts Measured = TP-14 measured with fluke meter (average reading at 20 degrees elevation while antenna is slewing at 50% of slew speed).

amps/volt = 10amps/volt (scale factor for TP-14 SCR cards)

ft.lb/amp = 5.7 ft.lb./10amps (El motor torque constant from Reliance)

Overall gear ratio =25044.4 (elevation overall gear ratio)

Drive Torque = (Volts Measured)(amps/volt)(ft.lb./amp)(gear ratio)

EQUATION USED TO CALCULATE ELEVATION COUNTERWEIGHT (EC):

Drive Torque + Elevation Counterweight + Torque Losses = 0

Or DT+EC+TL = 0

Assuming a counterweight heavy antenna, with antenna driving down,
Then:
|DT(dn)| = |TL + EC|

and with antenna driving up:
|DT(up)| = |TL - EC|

The Elevation Counterweight can be defined as:
2EC = |DT(dn)|-|DT(up)|

Or EC = (|DT(dn)|-|DT(up)|)/2

Elevation Counterweight (EC) in terms of Counterweight at zero degrees elevation is:

EC = ECO (cos(20)) as voltages are taken at 20 deg. Elevation.

Or ECO = EC (1/cos(20))

PIE TOWN ANTENNA COUNTERWEIGHT MEASUREMENTS TAKEN ON 5/15/89

$VMdn := .924 \cdot volt \quad VMup := .727 \cdot volt \qquad |VMdn| - |VMup| = 0.197 \cdot volt$

$$ECO := \left[\frac{(|VMdn| - |VMup|) \cdot \left(\frac{10 \cdot amp}{volt}\right) \cdot \left(\frac{5.7 \cdot ft \cdot lb}{10 \cdot amp}\right) \cdot 25044.4}{2} \right] \cdot \frac{1}{\cos(20 \cdot deg)}$$

$ECO = 14964 \cdot ft \cdot lb$

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CHART FOR ESTIMATING VLBA ANTENNA COUNTERWEIGHT USING TP-14 VOLTAGE READINGS.

$i := -.5, .1 .. 1$

$$f(i) := \left[\frac{(i\cdot volt)\cdot\left(\frac{10\cdot amp}{volt}\right)\cdot\left(\frac{5.7\cdot ft\cdot lb}{10\cdot amp}\right)\cdot 25044.4}{2}\right]\cdot\frac{1}{\cos(20\cdot deg)}$$

Where i= (|Volts Measured dn| - |Volts Measured up|)