VLA Test Memo #216
Date: 12/4/1998

Transporter emergency procedure

By R.MOLINA

What happens if:

WE LOSE TRANSPORTER POWER?

WE DERAIL?

THE WIND INCREASES?

We need to decide what we are going to do in the event any of these scenarios occur. During the last scheduled moves, June first, 1998, we were at a point where the wind was coming up and we had lost transporter power. The transporter was losing oil and we had to shut down the Cummins engine which furnishes hydraulic power to move the transporter. We were able to fix it enough to return to a foundation. In the past we had an elaborate plan to build foundation pads underneath the antenna. This would require a large amount of railroad ties and some steel pads we have in the salvage yard. We bought three 100 tons hydraulic jacks with pumps, lines, and several thousand feet of 5/8" steel cable. This was about 15- 18 years ago. We crated all but the steel cable in a box. The mice made a hole in the crate and ate the instructions and the cable has disappeared.

In October of 1982, we had an incident at the center of the array with transporter #1. We were going east to west and the track broke. (See L.Temple files) We went about 4' before the transporter came to a stop. The incident happened at 8:35 in the morning and by 12:45 we were able to move back to the east arm to an empty foundation. Some changes have been made to the track and the transporter so it will not happen again. We still felt we had to plan for other things that could go wrong.

At that time the plan to park an antenna on temporary foundations was drawn up. The idea was to stabilize the antenna. We were to secure wire cable to the elevation axle and anchor the wire to the ground. At ground level we would bury anchors and use turnbuckles to tighten the cables. Next we would build temporary foundations out of railroad ties to support the antenna and remove the weight off the transporter. The plan was to drag it out from under the antenna. To do that a new railroad track would have to be built and a second transporter would be used to finish the move. This could take days to do and would be done only if the transporter breaks in half.

Now we would survey the situation and determine where the problem is. If it is a transporter problem, our employees have more years of experience now and most problems we can think of they can fix. If the transporter fails we must fix it and finish the moves. We have had one derailment while transporting an antenna and that was at the center of the (Y). A derailment would be the only thing which would keep us from finishing a move.

According to data from wind tunnel analysis done on 13 June 1974 the antennas can survive 110 MPH wind at -22 F on the antenna pedestal base circle diameter. Jon Thunborg calculated that if one truck on the transporter derails and tilt the antenna 2.5 degrees away from the wind, we could survive winds up to 90 MPH at - 22 F. This would be at the 18' transporter pedestal circle diameter. The bigger the pedestal circle diameter, the higher winds we can withstand. The diameter can be enlarged by blocking the H-beams on the antenna base to the transporter and welding it.

Following is a study by Jon Thonburg called Tipover Analysis. The only thing we need to do is add a third bolt to the pads that hold down the antenna to the transporter. According to Jon's study the weight of the transporter is enough to keep the antenna upright on a derailed transporter in winds over 90mph.

Conclusions: The action planned is to add a third bolt to the mounting pads to increase the tipover wind velocity from 70mph to 90mph. We feel that we can respond to a derailment or transporter failure before the wind is likely to increase from <20 mph to 90mph. Thus, no tie down procedure seems necessary.

VLA ANTENNA - TRANSPORTER TIPOVER ANALYSIS

Wind Load Data From LTV Wind Tunnel Tests
From VLA Yoke and Pedestal Analysis Report - 13 june 1974

Survival Load q = 28.5657 lb/ft^2 (110 MPH wind @ -22 F Antenna Stowed)

Maximum Reactions $q := 28.5657 \cdot \frac{lbf}{ft^2}$

$Fy := 95750 \cdot lbf$

$Fz := 51530 \cdot lbf$

$Mx := 4627130 \cdot lbf \cdot ft$

Using the above data to find the effective antenna area and effective wind reaction point yields:

$Aeff := \frac{Fy}{q}$ $Aeff = 3351.92 \cdot ft^2$ Effective Area

$Heff := \frac{Mx}{Fy}$ $Heff = 48.33 \cdot ft$ Effective Height above base where wind load is applied

Air Density (ρ) Vs TemperatureCalculation: $i := 0..12$ $j := 0..12$

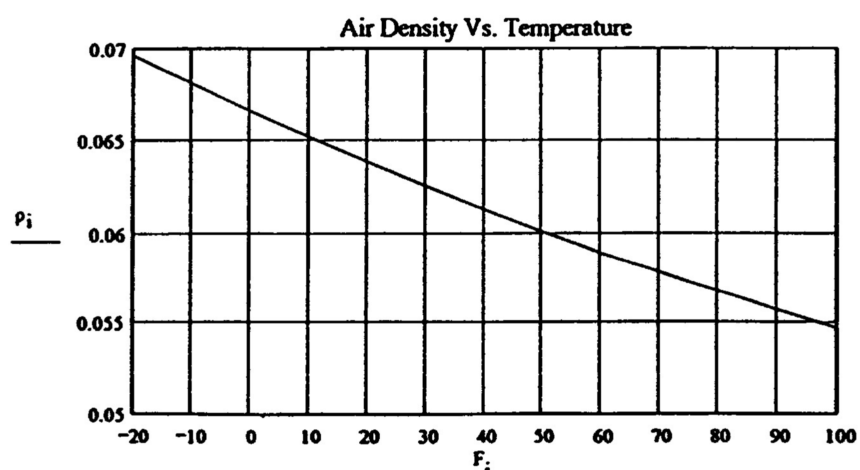
$P := 1633.1$ Standard Pressure (psi) at 7000 ft altitude

$R := 53.35$ Gas Constant ((ft-lb/(lb/r) Dry Air)

$g := 32.152$ Gravitational Constant(ft/sec^2)

$T_i := (459.69 + (i \cdot 10 - 20))$ Temperature (Rankine) $F_i := T_i - 459.69$

$\rho_i := \frac{P}{g \cdot R \cdot T_i} \cdot \frac{slug}{ft^3}$



Dynamic Pressure Vs. Wind Speed:

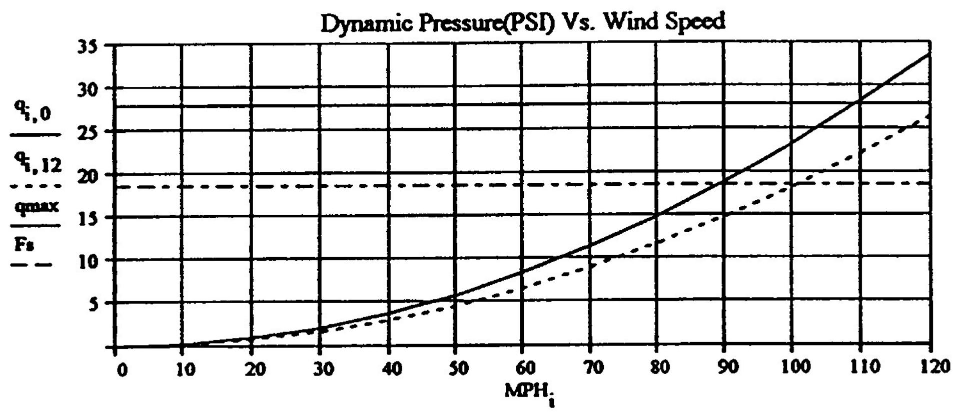
$MPH_i := i \cdot 10$ $\quad FPS_i := MPH_i \cdot \frac{5280}{3600} \cdot \frac{ft}{sec}$ **Wind speed in Feet/ second**

$$q_{i,j} := \frac{\frac{1}{2} \cdot \rho_j \cdot (FPS_i)^2}{g \cdot \frac{ft}{sec^2}}$$ **Dynamic Pressure (lb/ft^2)**

Tipover Analysis

The FEA Model of the VLA antenna Shown on the next page, calculates that an antenna and transporter leaning 2.5 degrees away from the wind due to a derailment will tip over with a wind load of 27.85 lbs/ft^2. The maximum bolt force required to hold the antenna to the transporter is 170,000 lbs.

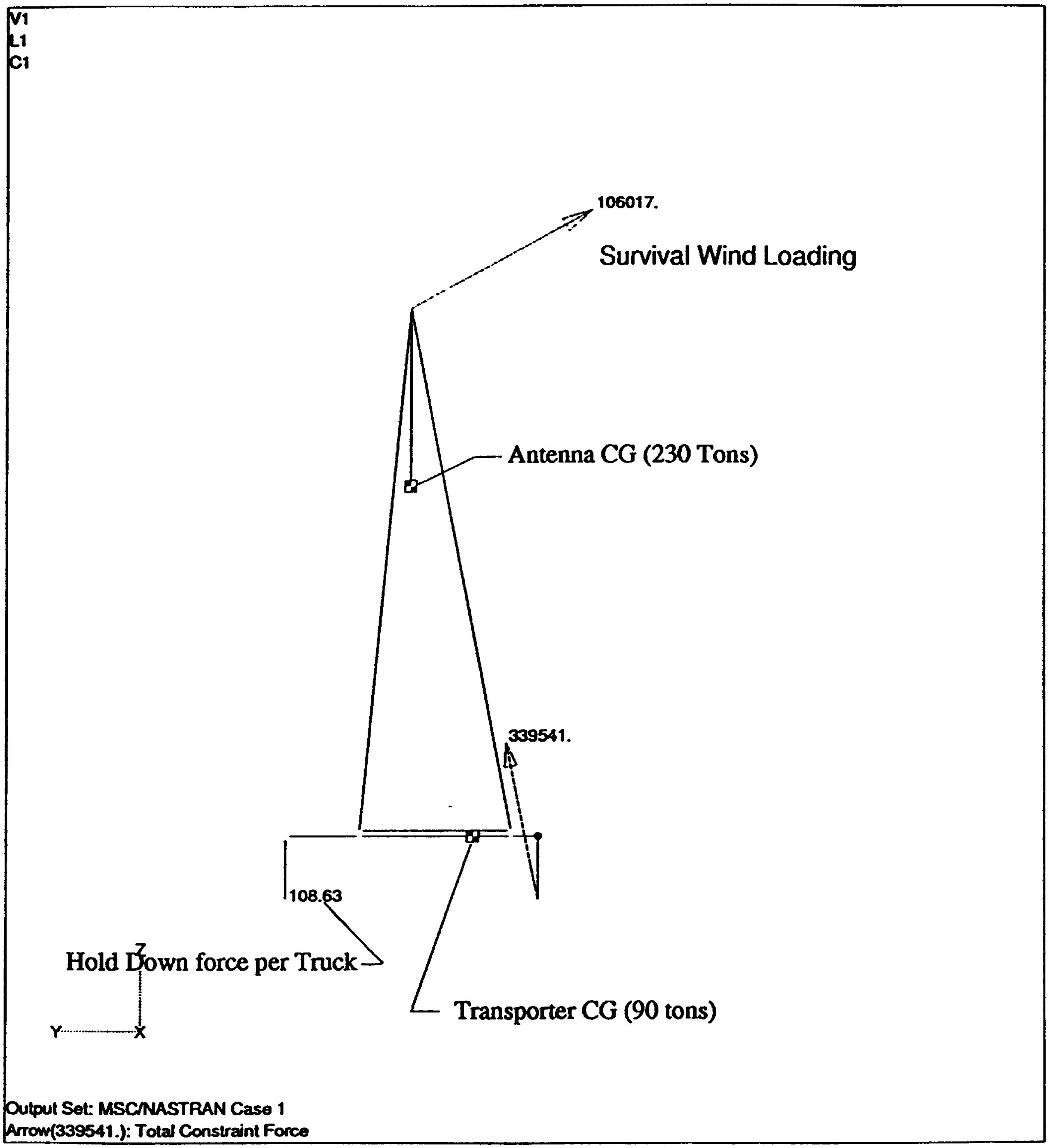
qmax := 27.85
Fs := 18.57



—— PRESSURE @ -20F
- - - - PRESSURE @ 100F
—— TIPOVER POINT
— — TIPOVER POINT WITH FACTOR OF SAFETY OF 1.5

The above graph shows that a 230 ton VLA antenna attatched to a 90 ton transporter will not blow over, even if it is leaning 2.5 degrees away from the wind, unless the wind velocity exceeds 90 MPH. Winds speeds above 90 MPH are extremely rare at the VLA site. The likelyhood of this kind of wind occuring while the transporter is derailed is highly improbable.

Another possibility is that the antenna will blow off the transporter in a high wind. The antenna is currently held to the transporter with two 3/4" socket head cap screws. These bolts will fail in tension at 75,000 lbs each. This gives us a maximum hold down load of 150,000 lbs. Just short of the 170,000 lbs required for survival conditions. Therefore a third 3/4" bolt will be required. Giving us a hold down strength of 225,000 lbs.


V1
L1
C1
106017.
Survival Wind Loading
Antenna CG (230 Tons)
339541.
108.63
Hold Down force per Truck
Z
Y
X
Transporter CG (90 tons)
Output Set: MSC/NASTRAN Case 1
Arrow(339541.): Total Constraint Force