PRODELIN
CORPORATION

TR-305

1.8m Series 3180 Ka-Band Mechanical Test Report

April 02, 2003

REVISION 00

Prepared By: Prodelin Corporation

Each of the test antennas (2) was comprised of single-piece reflector, feed support, feed rods, tailpiece, feed horn, az/el mount, and reflector support. Also included in testing was a complete non-penetrating mount and a representative pole mount (above ground portion only).

All tests were performed at Prodelin's Newton, North Carolina facility.

This report describes the tests conducted and the results observed or measured as noted.

Description of Tests:

The tests included the following:

1. Antenna Assembly: Prior to assembly, individual components (reflector, az/el assembly, reflector support, tailpiece, feed support, feed rods, feed horn, and hardware kits) were weighed and their weights recorded. The antenna was assembled on a 5.56" o.d. mast pipe. Tools required, hardware accessibility, time to assemble, and any assembly difficulties were recorded.
Results: The antenna assembly was completed without difficulty. All components fit as expected and access to hardware was not an issue. Tools required for assembly included:

- ½" open-end wrench
- 7/16" open-end wrench or socket
- ¾" open-end wrench
- 1-1/8" open-end wrench
- ½" socket and ratchet
- 3/4" socket and ratchet
- 1-1/8" socket and ratchet
- 5/16" wrench or socket (radio attachment)

Weights of the antenna components are shown below.
Antenna Assembly

Component	Weight
Reflector	100 lbs.
Az/El Assembly	57 lbs.
Reflector Support	48 lbs.
Tailpiece	27 lbs.
Elevation Adj. Assembly	3 lbs.
Feed Support Assembly	14 lbs.
Reflector Mounting Hardware	1.5 lbs.
Dither/Scale Kit	6 lbs.
Feed Support Hardware	1 lbs.
Total	**257.5 lbs.**

Non-Penetrating Mount

Component	Weight
Mast Pipe	105 lbs.
Angle Brace	11 lbs. (x 4)
Diagonal Angle	16 lbs. (x 4)
Outer Angle – Type A	12 lbs. (x 4)
Outer Angle – Type B	12 lbs. (x 4)
Inner Angle – Long	17 lbs. (x 4)
Inner Angle – Short (Opt.)	10 lbs. (x 4)
Auxiliary Angle (Opt.)	10 lbs. (x 4)
Hardware	6.5 lbs.
Total	**383.5 lbs. (463.5 lbs. w/optional inner tray)**

Assembly of DVT units at Prodelin demonstrated the following average times (2 man install, no packaging):

Az/El Assembly snug to Mast Pipe:	2 minutes
Reflector Support to Az/El Assembly:	3 minutes
Elev. Adj. Assembly to Refl. Support and Az/El:	3 minutes
Tailpiece to Reflector Support:	2 minutes
Reflector to Az/El Assembly:	5 minutes
Feed Support to Reflector/Tailpiece:	8 minutes
Radio Assembly (Radio Tray) to Feed Support:	3 minutes
Total Time to Assembly:	26 minutes

2. Az/El Kinematics: The test antenna assembly consisted of az/el assembly, reflector, reflector support, tailpiece, feed support, feed rods, and hardware. The assembly was leveled using the (8) set screws provided in the canister and a bubble level. Using the adjustment features of the az/el assembly, range of adjustment as well as ease of adjustment and access to hardware was evaluated. Assessment was made in azimuth axis and elevation axis.
Next, a laser pointer was mounted to the feed support and pointed at grid paper attached to the wall. With all azimuth and elevation locking hardware loose on the az/el, the center of the beam was aligned with a grid intersection and the beam traced on the paper. All locking hardware was tightened and any movement of beam on the paper was identified by labeling the beam's final position.

Results:

Unit #1

(1) Unit 1 was adjusted in azimuth and elevation. The azimuth can be adjusted ±15°, and the elevation can be adjusted from 0° to 91°.
(2) Unit 1 was locked down and tested for angular error according to the test procedure. The lock down of the Az/El produced an error of 0.03°.

Unit #2

(1) Unit 2 was adjusted in azimuth and elevation. The azimuth can be adjusted ±15°, and the elevation can be adjusted from 0° to 91°. Hardware accessibility was acceptable, and the adjustments were smooth.

(2) Unit 2 was locked down and tested for angular error according to the test procedure. The lock down of the Az/El produced an error of 0.03°.

3. Static Load Test: The antenna's maximum force and moment due to wind loading was determined for wind speeds of 50 mph, 100 mph, 125 mph, and 150 mph.

Static wind load tests were performed on the antenna assembly to duplicate each of the wind speed conditions. Two (2) separate static wind load tests were performed. The first test measured the "worst case" reflector movement due to maximum wind force and the second test measured the "worst case" reflector movement due to maximum moment load for each wind speed case.

The antenna was assembled in a horizontal position onto a pole mount 51" long. The antenna consisted of az/el assembly, reflector, tailpiece, feed support, and feed rods. Dial indicators were placed under the reflector and mount to allow deflections to be measured.

50 mph - Measured reflector deflections were compared to 20 GHz and 30 GHz performance curves to determine the signal loss at maximum operational wind speed of 50 mph.

100 mph - When this portion of the test program was completed, the static loads were removed and the "recovery" displacement data was recorded to compare to initial displacement data to determine the amount of permanent set, if any.

125 mph - A load for the 125 mph case was applied to the reflector. The load was removed and the antenna examined for any signs of permanent deformation.

150 mph - A load for the 150 mph case was applied to the reflector. Observation was made for any signs of component failures.
Results: During this test, the antenna system was assembled with the Pole Mount (above ground portion only). The results shown include BPE contributions of the az/el assembly and the Pole Mount. One unit was tested.
Two wind angle load cases were tested. 0° WindAngle and 56° WindAngle. The 0° WindAngle exhibits the worst case Axial force, and the 56° WindAngle exhibits the worst case twisting moment. The windloads were calculated as shown in WindLoad Calc. Attachment.

Table of wind loads for 0° wind angle:					
Item/MPH	35	50	100	125	150
Fa (lbs)	-106.0	39.7	896.9	1539.9	2325.6
Fs (lbs)	0.0	0.0	0.0	0.0	0.0
Mw (ft-lbs)	0.0	0.0	0.0	0.0	0.0

Unit 1 (Reflector, Az/El, & Pole Mount) @ 0° WindAngle showed 0.018° Elevation BPE, 0.00° Azimuth BPE, thus 0.018° Composite El/Az BPE when loads, shown in blue above, were applied.

Table of wind loads for 56° wind angle @center of dish:					
Item/MPH	35	50	100	125	150
Fa (lbs)	-92.0	68.3	1011.2	1718.4	2582.8
Fs (lbs)	17.5	35.7	142.9	223.2	321.5
Mw (ft-lbs)	-46.4	-94.8	-379.2	-592.4	-853.1

Unit 1 (Reflector, Az/El, & Pole Mount) @ 56° WindAngle showed 0.032° Elevation BPE, 0.067° Azimuth BPE, thus 0.074° Composite El/Az BPE when loads, shown in blue above, were applied.

Antenna Radiation patterns were then acquired and dB losses calculated. All losses were calculated at 30GHz or Tx frequency. The following resulting dB losses were determined:

Unit 1 Loss due to 0.018° BPE @ 0° WindAngle: …….. 0.01dB
Unit 1 Loss due to 0.074° BPE @56° WindAngle: …….. 0.43 dB

In this test, the same assemblies of reflector, Az/El, and Pole Mount were loaded to simulated 100mph windloads. The load was placed on the assembly, and left for a cycle of 2 minutes. Only the permanent set or BPE was recorded.

Two wind angle load cases were tested. 0° WindAngle and 56° WindAngle. The 0° WindAngle exhibits the worst case Axial force, and the 56° WindAngle exhibits the

worst case twisting moment. The windloads were calculated as shown in WindLoad Calc. Attachment.

Table of wind loads for 0° wind angle:					
Item/MPH	35	50	100	125	150
Fa (lbs)	-106.0	39.7	896.9	1539.9	2325.6
Fs (lbs)	0.0	0.0	0.0	0.0	0.0
Mw (ft-lbs)	0.0	0.0	0.0	0.0	0.0

Unit 1 (Reflector, Az/El, & Pole Mount) @ 0° WindAngle showed 0.00° Composite El/Az BPE when loads, shown in blue above, were applied for 2 minutes and removed.

Table of wind loads for 56° wind angle @center of dish:					
Item/MPH	35	50	100	125	150
Fa (lbs)	-92.0	68.3	1011.2	1718.4	2582.8
Fs (lbs)	17.5	35.7	142.9	223.2	321.5
Mw (ft-lbs)	-46.4	-94.8	-379.2	-592.4	-853.1

Unit 1 (Reflector, Az/El, & Pole Mount) @ 56° WindAngle showed 0.002° Composite El/Az BPE when loads, shown in blue above, were applied for 2 minutes and removed.

Consequentially, upon review of 30Ghz radiation patterns taken during DVT testing, .1dB loss = .032°, therefore antenna assembly in configuration tested exhibits passing results with worst case 16.0 FOS.


Play Sand
Play Sand
Play Sand
Play Sand


Play Sand
Play Sand
Play Sand
Play Sand

5. Dynamic Load Test: The antenna assembly with reflector, feed support, feed rods, tailpiece, and az/el assembly was installed onto a non-penetrating mount. A laser pointer was attached, facing outward, at the focal point of the reflector. A sheet of paper with a grid consisting of line spacing representing 0.1 degree spacing based on the distance from mast pipe (rotation point) to wall was attached and the beam of the laser pointer was aligned at an intersection of the grid.

50 mph - Using the Prodelin wind machine (a custom built test apparatus consisting of a trailer mounted, gasoline powered engine with a 6 foot propeller mounted directly onto the flywheel), a wind force of 50mph (maximum) was directed at the reflector. An anemometer was used to measure the wind velocity. The laser's position on the grid paper during wind load was marked. The test was repeated for a wind force directed from the side, back, and at approximately 50° from the feed support.

100 mph - Using the wind machine, a wind force of 100mph (maximum) was directed at the reflector for approximately 2 minutes. An anemometer was used to measure the wind velocity. The laser's location on the grid paper before and after wind load was marked. The test was repeated for a wind force directed from the side, back, and at approximately 50° from the feed support.

125 mph - Using the wind machine, full wind force was directed at the antenna for a minimum of 3 minutes from behind the reflector. The wind machine has a maximum velocity of approximately 120mph so the test will be limited in scope by the limit of the machine. After the test cycle, the components of the antenna system were visually examined for structural damage or failure. The test was repeated for a wind force from the side, and at approximately 50° to the feed support.

Results:

ANGLE	50mph /error	Loss, dB	100mph /error	Loss, dB
SIDE	0.020	0.04	0.00	0.00
FRONT	0.025	0.06	0.011	0.01
BACK	0.039	0.14	0.020	0.04


N
NW
NE
W
E
SW
SE
S
102
MPH
INSIDE
TEMPERATURE
65 °F
BAROMETRIC TREND
DAVIS
Weather Monitor II
TEMP
WIND
WIND CHILL
RAIN
BAR
HUM
DEW
ENTER
UNITS
ALARM
SCAN
TIME
CLEAR
RECL

6. Pole Mount: For this test, a length of 5" (5.56" o.d.) schedule 80 pipe equal to the above ground portion of the pole mount was secured to a test fixture to represent an installed pole mount. The forces used were determined in the static load tests above. The assembled antenna was attached and loaded with amounts equal to the specific wind load.

50 mph - A dial indicator was placed at the top of the mast pipe and opposing the direction of the applied load. An incremental load for the 50 mph case was applied. Mast pipe deflection was observed as a change in dial reading.

100 mph - A dial indicator was placed at the top of the mast pipe and opposing the direction of the applied load. The dial reading was recorded before and after applying the load equal to 100 mph.

125 mph - A load was applied for the 125 mph case. The load was removed and the mast pipe examined for any signs of permanent deformation.

150 mph – A load was applied for the 150 mph case. Observation was made of any component failures.

Results:

50 mph – 0.020" deflection, 0.022° angular deflection
100mph – No permanent set, return to 0°
125mph – No damage per inspection
150mph – No failures

7. Non-Penetrating Mount: The non-penetrating mount was assembled and verified that all assembly could be accomplished with a wrench of 3/4" size (for 1/2" hardware) and that all hardware was accessible with a standard wrench or socket.

The forces used were determined in the static load tests above. Sufficient ballast was applied to resist the test loads being applied. (Test surface was concrete, coefficient of friction = 0.6) Loads were applied at the top and perpendicular to the mast pipe and from two directions: diagonal to the base and perpendicular to the base for static load testing. See the dynamic test section above for results of antenna and non-penetrating mount under dynamic wind loads.

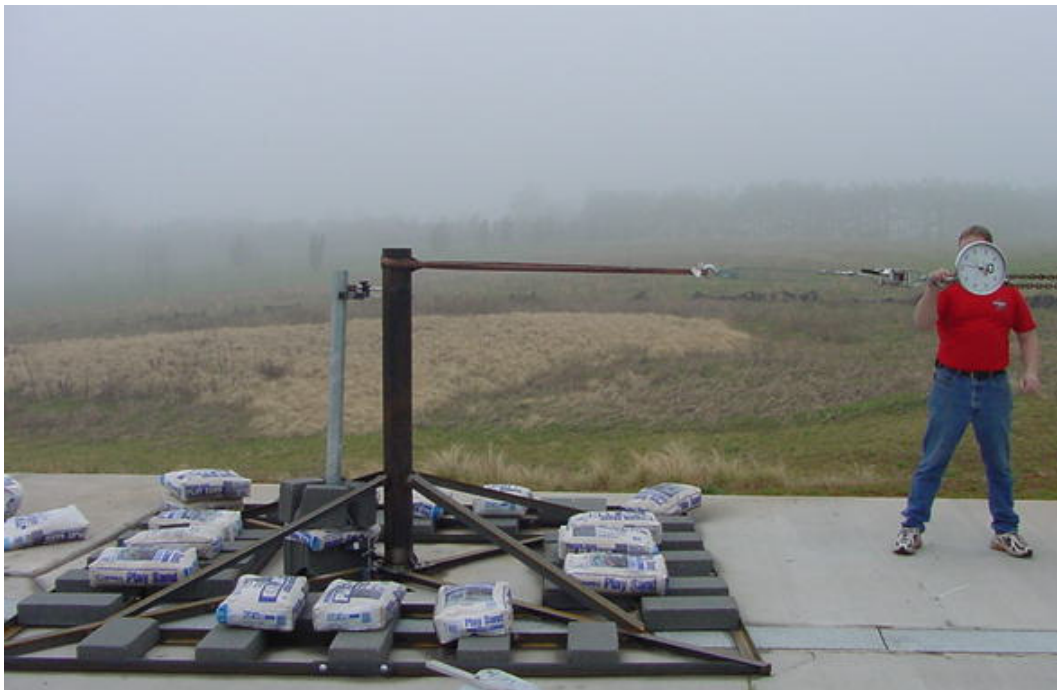
50 mph - A dial indicator was placed at the top of the mast pipe and opposing the direction of the applied load. An incremental load was applied for the 50 mph case via a winch and dynamometer. Mast pipe deflections were recorded by a change in dial reading. The test was repeated for the second direction.

100 mph – A dial indicator was placed at the top of the mast pipe and opposing the direction of the applied load. A load equal to 100 mph was applied. The reading on the dial indicator was recorded before and after load applied. The test was repeated for the second direction.

125 mph - A load was applied for the 125 mph case. The load was removed and the mount examined for any signs of permanent deformation. The test was repeated for the second direction.

Results:

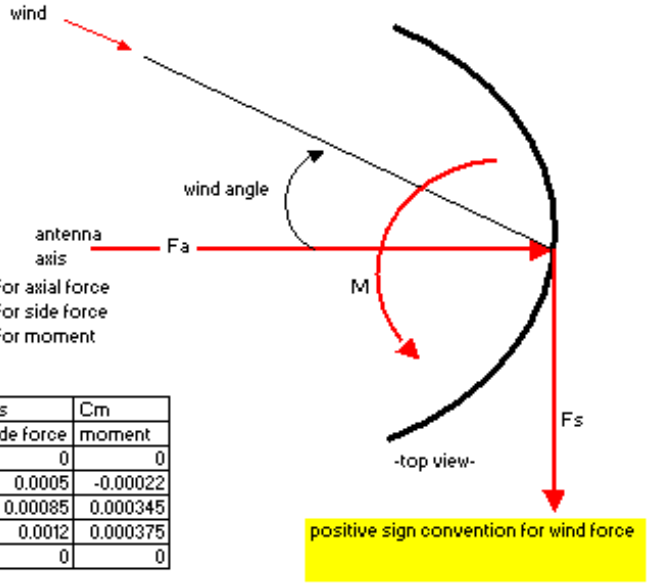
50 mph – 0.042° angular deflection
100mph – .008° permanent set
125mph – No damage per inspection
150mph – N/A



WINDLOAD CALCULATIONS ATTACHMENT

Wind forces and loads produced by parabolic antennas

Wind effects can be separated into two force components and twisting moment as shown below.The axial force, Fa acts along the axis of the antenna, the side foce , Fs, acts perpendicular to the axis of the antenna with its line of action passing through th



Formulas;
Fa=(Ca. A. V^2)-Wt
Fs=(Cs. A. V^2)-Wt
Mw=(Cm.D. A V^2)-Wt
v = wind speed mph
A = area ft^2
D = dia. Ft

Ca= drag coefficient for axial force
Cs= drag coefficient for side force
Cm= drag coefficient for moment

Table of wind coefficients:

	Ca	Cs	Cm
wind angle	axial force	side force	moment
0	0.004	0	0
56	0.0044	0.0005	-0.00022
90	-0.000025	0.00085	0.000345
125	-0.00125	0.0012	0.000375
180	-0.0027	0	0

FOR THE EXISTING **DPC** DISH :
D=(width) 6.032 FT
A= 28.574 FT^2
k, arm from center of dish to center of the mast= 0.67 ft
Wt=weight of dish & azfel when Fa is acting with gravity = 246 lbs

Table of wind loads for 0° wind angle:					
item	35	50	100	125	150
Fa (lbs)	-106.0	39.7	896.9	1539.9	2325.6
Fs (lbs)	0.0	0.0	0.0	0.0	0.0
Mw (ft-lbs)	0.0	0.0	0.0	0.0	0.0

Table of wind loads for 56° wind angle @center of dish:					
item	35	50	100	125	150
Fa (lbs)	-92.0	68.3	1011.2	1718.4	2582.8
Fs (lbs)	17.5	35.7	142.9	223.2	321.5
Mw (ft-lbs)	-46.4	-94.8	-379.2	-592.4	-853.1

Table of wind loads for 90° wind angle @center of dish:					
item	35	50	100	125	150
Fa (lbs)	-246.9	-247.8	-253.1	-257.2	-262.1
Fs (lbs)	29.8	60.7	242.9	379.5	546.5
Mw (ft-lbs)	72.8	148.6	594.6	929.1	1337.8

Table of wind loads for 125° wind angle @center of dish:					
item	35	50	100	125	150
Fa (lbs)	202.2	156.7	-111.2	-312.1	-557.6
Fs (lbs)	42.0	85.7	342.9	535.8	771.5
Mw (ft-lbs)	79.2	161.6	646.3	1009.8	1454.2

Table of wind loads for 180° wind angle @center of dish:					
item	35	50	100	125	150
Fa (lbs)	151.5	53.1	-525.5	-959.4	-1489.8
Fs (lbs)	0.0	0.0	0.0	0.0	0.0
Mw (ft-lbs)	0.0	0.0	0.0	0.0	0.0