Professional Engineer - Virginia - #05782
Professional Engineer - Pennsylvania - #20621.E
Professional Engineer - Illinois - #62-32261
Professional Engineer - New Jersey - #12618
Professional Engineer - Kentucky - #11506
Professional Engineer - Alabama - #15408
Professional Engineer - Arizona - #19057
Professional Engineer - Arkansas - #6273
Professional Engineer - Colorado - #23862
Professional Engineer - Connecticut - #14015
Professional Engineer - Delaware - #6957
Professional Engineer - Florida - #0036341
Professional Engineer - Georgia - #15453
Professional Engineer - Idaho - #5272
Professional Engineer - Indiana - #ENE8600628
Professional Engineer - Iowa - #10765 (Retired)
Professional Engineer - Kansas - #10337
Professional Engineer - Massachusetts - #32444
Professional Engineer - Michigan - #31880
Professional Engineer - Minnesota - #17485
Professional Engineer - Mississippi - #9591
Professional Engineer - Missouri - #E-21442
Professional Engineer - Nebraska - #E-6055
Professional Engineer - Nevada - #7162
Professional Engineer - New Hampshire - #6347
Professional Engineer - Wyoming - #5096
Professional Engineer - Ohio - #E-49967
Professional Engineer - Oregon - #13,133
Professional Engineer - Rhode Island - #4832
Professional Engineer - South Carolina - #10437
Professional Engineer - Utah - #7425
Professional Engineer - Vermont - #5193
Professional Engineer - Wisconsin - #E-24060
Professional Engineer - New Mexico - #9598
Professional Engineer - Louisiana - #22119
Professional Engineer - North Carolina - #12902
Professional Engineer - South Dakota - #4222
Professional Engineer - Montana - #ENG08785
Professional Engineer - North Dakota - #PE-3023
Professional Engineer - Washington - #23117
Professional Engineer - Oklahoma - #14540
Professional Engineer - West Virginia - #9901
Professional Engineer - Tennessee - #17,990
Professional Engineer - California - #C 040249
Professional Engineer - Texas - #59573

Certificate of Qualification by the National Engineering Examiners, No. 4003.

Tau Beta Pi Honorary Engineering Society
Certified Fallout Analyst and Protective Construction Analyst, DOD - 2TT0318865

Electronics Industries, Association, TR-34.2 Subcommittee on Earth Station Antennas. TR 14.7 Tower Committee on Communication Towers

Mr. Vlissides' major recent studies and prototype designs include:

Large Tracking Antenna Tower & Foundation Analysis & Design Consideration (July 1968)

Large Tracking Antenna Building & Foundation Earthquake Analysis & Design Considerations (July 1968)

Application of Fiberglass/Plastic to transportable communications systems.

High-gain Antennas Surface Geometry Determination (January 1968)

Optimum Antenna Design for Synchronous Communications Satellites (January 1970)

Original Design of 32-foot Transportable or Fixed Tracking Antennas (April 1971)

Participation in the preparation of Earth Station Antenna Standards for the Electronics Industries Association (EIA) (1969-1971)

Effective low cost methods for equipment shock and vibration isolation (June 1971)

Design of an experimental multibeam antenna system of satellite communications (1971-1972) Comsat Corporation

Analysis, Design & Fabrication Supervision of the Sectionalized Loran-C Transmitting Antenna for Cosmos Engineers, Inc. and the U.S. Coast Guard (1972-1973)

Tall guyed towers with provision of a broken guy condition and secure and easy access to the tower elevator landing directly from the transmitter building. Various applications at WBNS-TV, WJXT-TV, WBTV, WCBD, WXFL-TV and Hill Tower, Inc.

Mr. Vlissides has a B.S. Degree from the Athens, Greece Military Academy; B.C.E. and M.C.E. in Structural Mechanics from the Catholic University of America, where he has been a Doctoral Candidate in Structural Mechanics and Dynamics.

His language capabilities include English and Greek.

VLISSIDES ENTERPRISES, INC.

ENGINEERING STATEMENT

SCRIPPS HOWARD BROADCASTING COMPANY

This engineering statement has been prepared on behalf of Scripps Howard Broadcasting Company ("Scripps"), licensee of WMAR-TV, Channel 2, Baltimore, Maryland in support of its petition to deny the application filed by Four Jacks Broadcasting, Inc. ("FJB"), FCC File No. BPCT-910903KE. The FJB application seeks a construction permit for a new television station to serve Baltimore, Maryland on Channel 2 + (54-60 MHz) with an effected radiated power (ERP) of 100 kW (H&V) and 267 meters antenna height above average terrain. FJB proposes operation from an existing tower currently utilized by WPOC (FM) located at the geographic coordinates:

North Latitude: 39° 17' 13"
West Longitude: 76° 45' 16"

Based on the attached Engineering Study's final conclusion the FJB application should be rejected since the tower, if used as proposed, is unsafe.

STATE OF MARYLAND
MATTHEW JOHN VLISSIDES
NO. 7868
REGISTERED
PROFESSIONAL ENGINEER

5/6/93

Matthew J. Vlissides, P.E.
State of Maryland
Professional Engineer
Registration No. 7868

COMPUTER STRUCTURAL ANALYSIS

TABLE OF CONTENTS

SECTION A

INTRODUCTION

The subject structure is a 666 ft. guyed tower located in Catonsville, Maryland (Coordinates: 39^{o} 17' 13"; 76^{o} 45' 16"). The tower has a triangular cross-section with a face width of 4 ft. It is supported on a hinged base with seven guy levels of three guys each. The tower was designed and manufactured by Utility Tower Company in 1969.

The purpose of this analysis is to investigate the structural capability of the tower to support the Channel 2 TV antenna on top and its one 3-1/8" transmission line, in addition to the existing antennas and transmission lines.

The following assumptions have been made regarding the major characteristics of the structural system employed in the design of the subject tower:

a) Section panels were assumed to be approximately 5 ft. in height.
b) The tower span lengths were estimated to be 93.5 ft., 95.2 ft., 95.2 ft., 95.2 ft. 94.5 ft., 95.2 ft. and 94.4 ft. For spans #1 through #7 respectively.
c) The inner and outer guy anchors were estimated to be at 262 ft. and 402 ft. distances from the tower respectively.
d) The guy cables are E.H.S. cables with estimated diameters of 5/8", 5/8", 3/4", 5/8", 3/4", 7/8" and 1" for guy levels #1 through #7 respectively.
e) The tower legs were assumed to be of 3.5" O.D. with 0.300" wall thickness in the bottom 500 ft. of the tower and 0.216" wall thickness from 500 ft. to top.

f) All the diagonal members were assumed to be solid rods of 5/8" diameter.

g) All the horizontal girts were assumed to be solid rods of 1" diameter.

h) All the tower members were assumed made of 50,000 psi minimum yield strength steel.

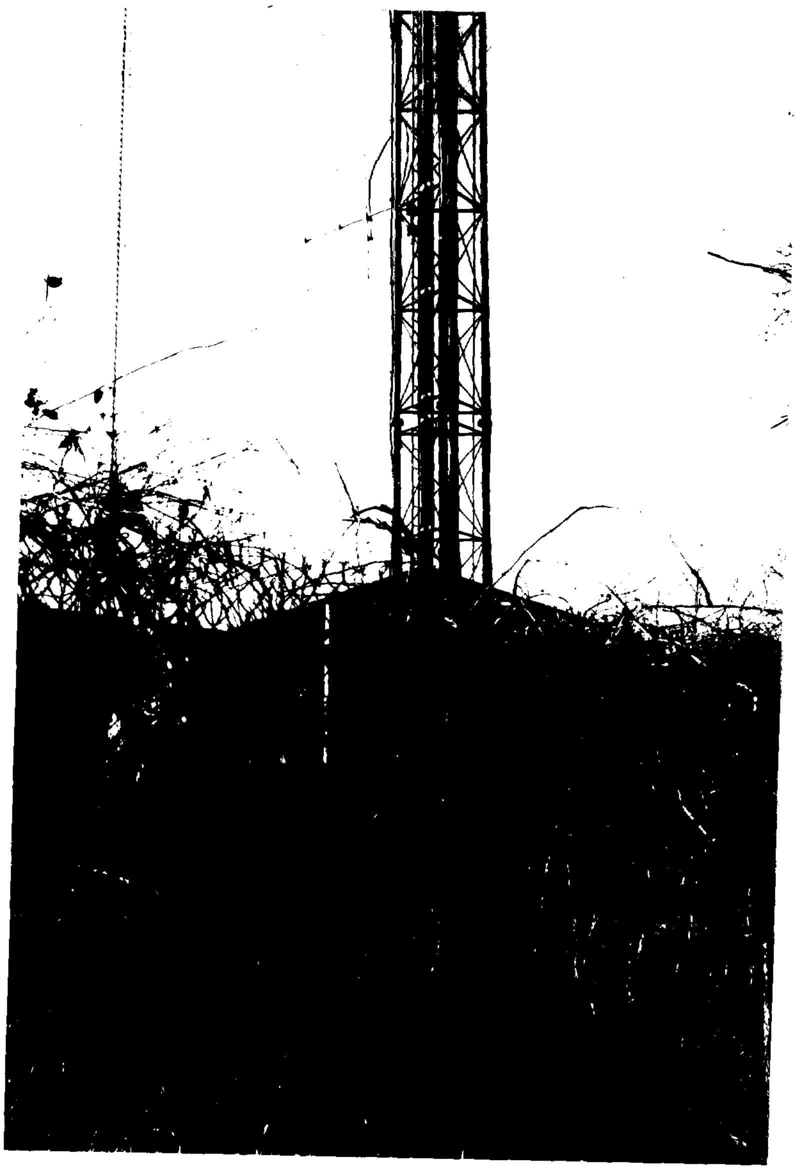
i) The tower sections are of all welded construction and are bolted together through round splice plates on each leg.

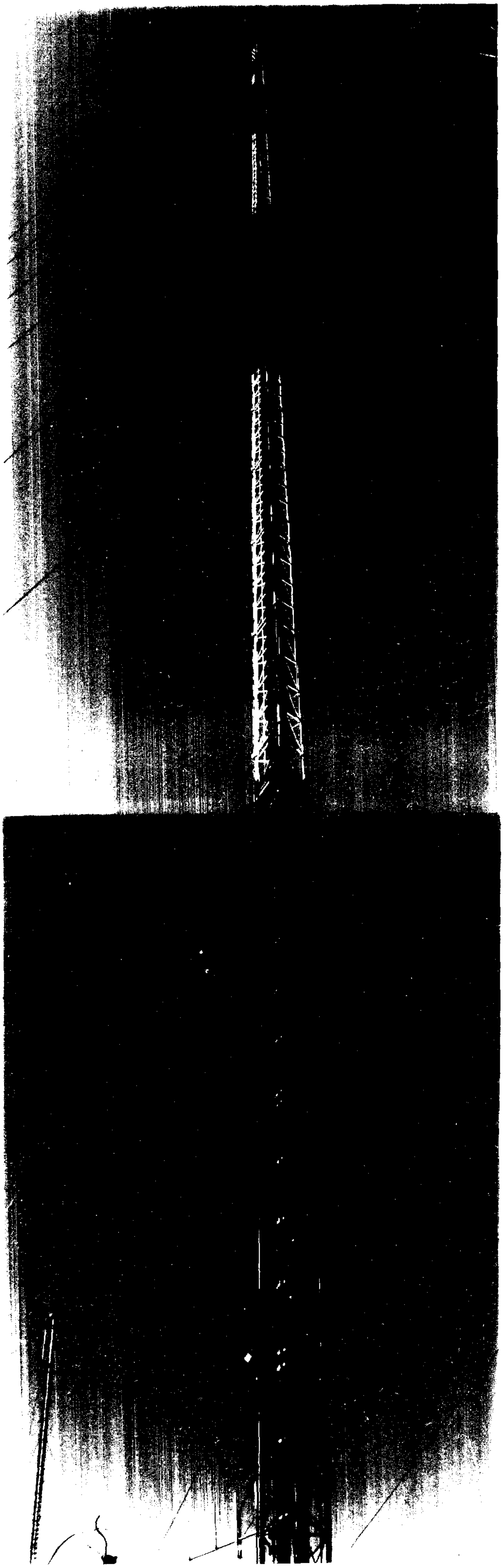
j) The tower color banding is in accordance with the FAA Advisory Circular 70/7460-1H for towers under 700 ft. height.

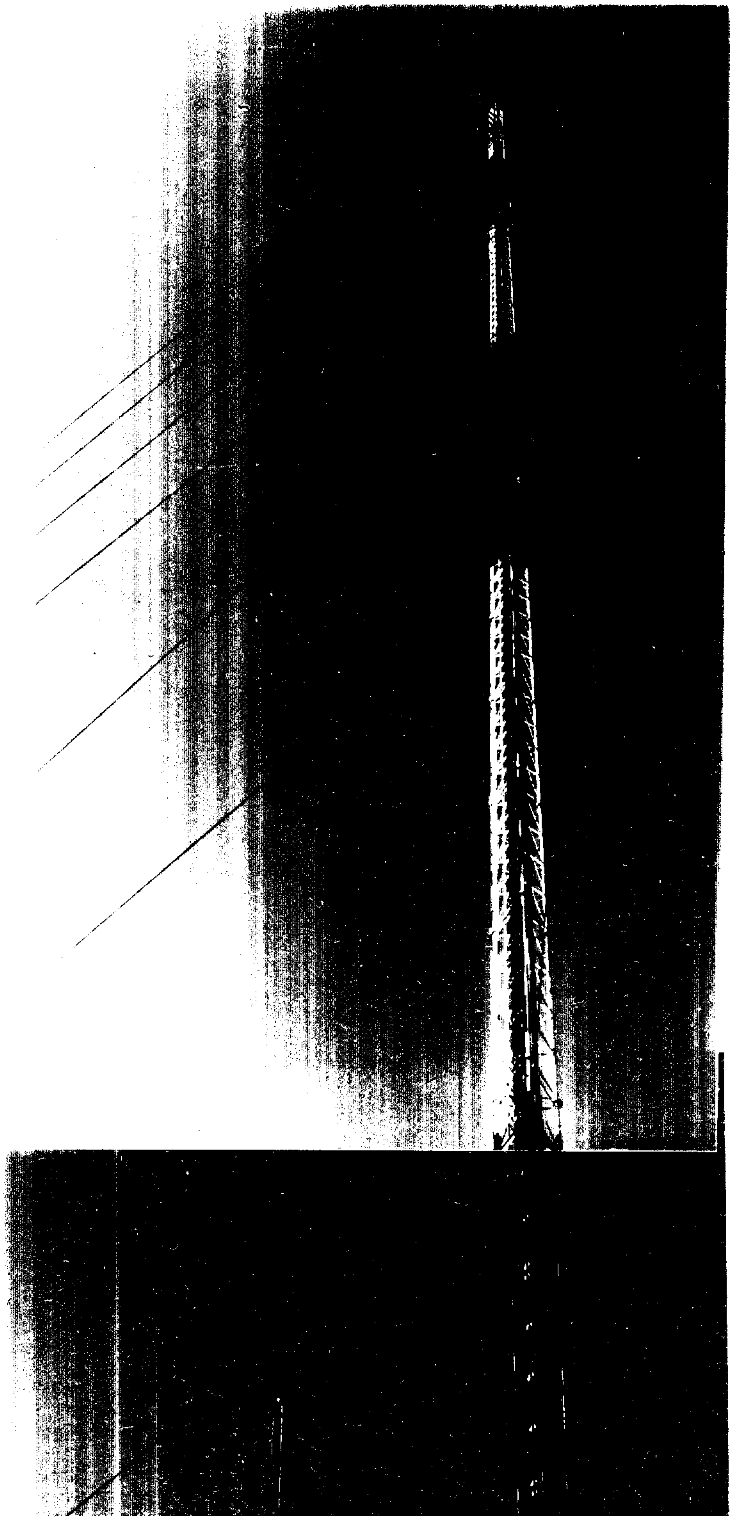
The overall structural system of the tower resists the guy reactions, the wind loads and bending moments by having the legs in tension or compression; the diagonals in tension; and the girts in compression. The structural integrity of the tower depends mainly on the buckling load capacity of the legs and girts and the tension load capacity of the diagonals and guy cables.

The subject tower was analyzed under a 75 mph basic wind velocity (no ice) in accordance with the EIA/TIA Standard 222-E. The computed wind pressure was applied to all tower members, antennas and ancillary items (transmission lines, ladder, conduits, etc.). No ice loading was considered in this analysis.

PHOTOGRAPHS







ORGANIZATION OF ANALYSIS

1. The following rigorous computer analysis was performed where the tower was analyzed with the use of a high capacity proprietary program, on a Digital VAX-11/730 computer, as beam-column on elastic supports. All secondary effects such as external moments produced by the guys at each level and those produced by beam-column action were taken into consideration. In addition, thermal gradients, wind escalation, wind thrusts on the tower and appurtenances, gravity loads, as well as drag and lift wind forces on the guys, were solved simultaneously by the computer program using the finite element method. The tower was analyzed with the wind direction normal to a tower face (Wind A); normal to a tower apex (Wind B); and parallel to a tower face (Wind C).

   a) Case 1. This was a preliminary analysis to test the relative value of various assumed members and geometry of the Tower, and has been disregarded.

   b) Case 2. Tower in its assumed configuration under a 75 mph basic wind velocity and no ice, in accordance with EIA/TIA Standard 222-E specifications and the following antenna and transmission line loading:

Antenna	Elev. (Ft.)	Transmission Line
Yagi	29 ft.	7/8" Heliax
Whip	98 ft.	7/8" Heliax
Whip	119 ft.	7/8" Heliax
3-Bay Communication	180 ft.	1-5/8" Heliax
8-Element	190 ft.	1-5/8" Heliax
4' Dish w/Radome	230 ft.	1-5/8" Heliax
Whip	289 ft.	7/8" Heliax
Whip	36[illegible] ft.	7/8" Heliax

Whip	375 ft.	7/8" Heliax
Whip	393 ft.	7/8" Heliax
Whip	402 ft.	7/8" Heliax
Whip	403 ft.	7/8" Heliax
Whip	486 ft.	7/8" Heliax
Whip	501 ft.	7/8" Heliax
Whip	511 ft.	7/8" Heliax
Whip	523 ft.	7/8" Heliax
Whip	537 ft.	7/8" Heliax
Long Whip	549 ft. to 629 ft.	1-5/8" Heliax
2-Bay FM	645 ft.	3" Heliax
Whip	650 ft.	7/8" Heliax
	Top	1" Conduit
Alan Dick Superturnstile Channel 2	Top	(2) 3-1/8" Rigid Coax

The type, size, location and number of antennas and transmission lines were taken from sketch of tower prepared by Gerhold, Cross & Etzel, Professional Land Surveyors, Dated 1/20/92. The type of Channel 2 antenna and its transmission lines were assumed. The transmission lines have been taken as are on the tower without any bundling.

c) Case 3. Tower in its assumed configuration under a 75 mph basic wind velocity and no ice, in accordance with EIA/TIA Standard 222-E specifications and the following antenna and transmission line loadings:

Antenna	Elev. (Ft.)	Transmission Line
Yagi	29 ft.	7/8" Heliax
Whip	98 ft.	7/8" Heliax

Whip	119 ft.	7/8" Heliax
3-Bay Communication	180 ft.	1-5/8" Heliax
8-Element	190 ft.	1-5/8" Heliax
4' Dish w?Radome	230 ft.	1-5/8" Heliax
Whip	289 ft.	7/8" Heliax
Whip	363 ft.	7/8" Heliax
Whip	375 ft.	7/8" Heliax
Whip	393 ft.	7/8" Heliax
Whip	402 ft.	7/8" Heliax
Whip	403 ft.	7/8" Heliax
Whip	486 ft.	7/8" Heliax
Whip	501 ft.	7/8" Heliax
Whip	511 ft.	7/8" Heliax
Whip	523 ft.	7/8" Heliax
Whip	537 ft.	7/8" Heliax
Long Whip	549 ft. to 629 ft.	1-5/8" Heliax
2-Bay FM	645 ft.	3" Heliax
Whip	650 ft.	7/8" Heliax
	Top	1" Conduit
Alan Dick Superturnstile Channel 2	Top	(1) 3-1/8" Rigid Coax

The type, size, location and number of antennas were taken from sketch of tower prepared by Gerhold, Cross & Etzel, Professional Land Surveyors, Dated 1/20/92. The existing transmission lines sizes and types were assumed. All the assumed 7/8" and 1-5/8" Heliax transmission lines were considered in three bundles. The type of Channel 2 antenna and its transmission line were assumed.

d) <u>Case 4.</u> Same as in Case 3 above, except all the assumed 7/8" and 1-5/8" Heliax transmission lines were considered in one bundle up the tower.

2. For all computer runs the results are given as follow:

a) Tower loads, kips.

b) Guy weights, kips.

c) Guy unstressed length, feet.

d) Guy forces and reactions, kips.

e) Spring constants for wind and normal to wind directions.

f) Column buckling evaluation parameter for the tower shaft between guy levels.

g) Tower deflections with the tower bending in two directions (if unsymmetrical loads exist) at each tower shaft panel point.

h) Tower reactions, moments and vertical loads for the wind and normal to wind directions.

i) Shears and forces (tension or compression) in all tower structural members.

EIA Standard RS-222-C did not permit the 33% increase of the allowable stresses. In case I did not increase the allowable stresses by 33%, the Four Jacks Broadcasting, Inc. tower would show in the structural analysis on the verge of collapse under the existing antenna and transmission line loads.

b) Allowable Guy Cable Safety Factors: For towers less than 700 ft. in height, in accordance with EIA/TIA Standard 222-E, the guy cable minimum safety factor requirement is 2.00

c) Tower Design Assumptions: All of my assumptions regarding the characteristics of the tower structural system are based on exhaustive study of the structure through personal observations with the use of high power binoculars, high power surveying instruments, large number of photographs taken from short distance with high power lenses, thirty years of experience in dealing with thousands of communications towers' design, analysis, fabrication, installation, inspection and overall construction, and finally, knowledge of the tower designs of the Utility Tower Company. In making my assumptions concerning the characteristics of the tower structural system, I was very careful in giving the opposition every possible advantage.

d) Type of Structural Steel Assumed: I assumed that all structural members on the tower (tower legs, horizontals and diagonals) are made of 50,000 psi high-strength steel, which is very questionable. It is more probable that the steel used for the tower legs is 35,000 psi ASTM A53 pipe and for the diagonals and horizontals ASTM A36 solid bars, which would make the results of the Analysis of the Tower much worse.

e) Tower Antennae Loads: Examining the tower photographs presented in my tower analysis report, it is obvious that at the top of the tower is the skeleton of a ten bay FM antenna without radiating elements or with very small radiating elements. Because I was not very sure about the type of antenna, I totally disregarded this significant antenna load and I did not include it in the tower analysis. All other antennas on the tower were included in the Tower Analysis.

f) Tower Geometry: The geometry of the tower was carefully measured through surveying instruments and the panel height, type and diameter of the tower leg was verified during these optical measurements.

g) Transmission Lines: Twenty-two transmission lines total are used to feed the various indicated antennas, one conduit for the tower obstruction lights and the tower ladder. All transmission lines do not traverse the tower over the entire distance. In computing the wind load on the transmission lines, I assumed that eight transmission lines, the conduit and the tower ladder have 100% effective projected area to the wind; four transmission lines have 75% effective projected area to the wind; three transmission lines have 50% effective projected area to the wind; six transmission lines have 25% effective projected area to the wind; and the remaining one transmission line has 0% effective projected area to the wind; thus achieving certain transmission line bundling effect even though the actual transmission lines on the tower are not bundled (See Photographs). The above transmission line exposure percentages apply to Case 2 only.

h) Type and Location of Antennas and Transmission Lines: I located the antenna elevations and transmission lines from direct observations and photographs and I verified the antenna elevations by using the land surveyor's report.

i) Ice Loading on the Tower: The tower geographical area is subject to icing conditions, with 0.5 inch radial glaze ice loadings being quite possible. EIA/TIC Standard 222-E leaves the ice loading decision up to the structural tower engineer. Again, being consistent with my previously established policy, I did not use any ice loading in combination with wind. Any significant icing of the tower and its guy cables, in addition to wind loading specified for this geographical area, will put the tower and surrounding area in serious danger.

j) In Cases 2, 3 and 4 of my analysis, I assumed that Four Jacks Broadcasting, Inc. will use the Alan Dick Superturnstile Antenna for Channel 2 and I utilized the published design parameters which were adjusted to EIA/TIA Standard 222-E as follows:

Antenna Design Parameters

Height	Weight Including Base Support Frame	Shear	Overturning Moment
104 ft.	17,000 lbs.	8900 lbs.	393,000 ft.-lbs.

k) The tower height, span lengths, guy anchor distances and the antenna loading were taken from the sketch of tower prepared by Gerhold, Cross & Etzel, Professional Land Surveyors, dated 1/20/92.

FINDINGS & EVALUATION

A structural study of the assumed tower geometry, member sizes and the computer analysis of Cases 2, 3 & 4 indicate the following:

1. Under Case 2. Tower in its assumed configuration and antenna and transmission line loading as described in the Organization of Analysis Section of this Report, under a 75 mph basic wind velocity and no ice in accordance with EIA/TIA Standard 222-E.

   a) The tower legs are overstressed in 60% of the tower by as much as 84%.

   b) The deflection at the top of the tower is too excessive compared to the rest of the tower. This results in uneven distribution of bending moments in the tower and large overstresses in the tower legs.

   c) The column buckling evaluation parameter for the tower shaft between guy levels (PHI) is over 1.5

c) The column buckling evaluation parameter for the tower shaft between guy levels (PHI) is over 1.5 at the two lower spans which indicates possible column instability.

3. Under Case 4. Tower in its assumed configuration and antenna and transmission line loading as described in the Organization of Analysis Section of this Report, under a 75 mph basic wind velocity and no ice in accordance with EIA/TIA Standard 222-E.

a) The tower legs are overstressed in approximately 30% of the tower by as much as 68%.
b) The deflection at the top of the tower is too excessive compared to the rest of the tower. This results in uneven distribution of bending moments in the tower and large overstresses in the tower legs.
c) The column buckling evaluation parameter for the tower shaft between guy levels (PHI) is over 1.5 which indicates possible column instability.

4. In Analysis Case 2 I assumed that the proposed channel 2 antenna requires two 3-1/8 inch rigid transmission lines. The Four Jacks Broadcasting, Inc. consultant disputed the need for two 3-1/8 inch rigid transmission lines asserting that one 3-1/8 inch rigid transmission line would be sufficient. Of course, it is easy to see that the only justification for FJB Inc. to plan a low reliability antenna system is to squeeze costs and to support their contention that the tower is safe. However, the FJB's effort to help the tower situation was destined to fail. Below is a comparison of the tower legs overstress levels under Analysis Cases 2, 3 and 4. Under Analysis Case 2 it is assumed

that there are two 3-1/8" rigid transmission lines and no bundling in the balance of twenty-one other transmission lines. Under Analysis Case 3 it is assumed that there is one 3-1/8" rigid transmission line and the balance of the other twenty-one transmission lines are arranged in <u>three</u> bundles. Under Analysis Case 4 it is assumed that there is one 3-1/8" rigid transmission line and the balance of the other twenty-one transmission lines are arranged on <u>one</u> bundle.

<u>Analysis Cases Comparison</u>

Leg Section	Case 2 Two 3-1/8" Lines No Bundling (% overstress)	Case 3 One 3-1/8" Line Three Bundles (% overstress)	Case 4 One 3-1/8" Line One Bundle (% overstress)
1	1.7	*	*
2	6.1	*	*
3	5.8	*	*
4	1.7	*	*
5	21.0	6.4	3.0
6	15.0	1.1	*
*			
9	4.7	*	*
10	19.7	13.4	10.9
11	7.4	2.9	1.2
*			
14	2.3	*	*
15	13.9	6.8	4.9
*			
26	6.2	*	*
27	24.1	*	*
28	54.3	23.1	22.8
29	83.5	48.0	47.2
30	72.4	40.2	39.5

31	57.8	33.3	32.8
32	51.4	40.5	40.2
33	68.3	67.7	67.7

* Where no stress number is shown or where the numbering of tower sections is not consecutive, it means that there is no overstress in those particular tower sections.

Therefore, the plan to use one 3-1/8 inch rigid transmission line and to bundle all small lines in one impractical bundle did not help the tower situation as far as Four Jacks Broadcasting, Inc. is concerned. Still, 30% of the tower leg sections are overstressed from 0.1 to 67.7%. This, coupled with the column buckling evaluation parameter for the tower calculated at over 1.5 renders the subject tower unsafe for installing the Channel 2 antenna and one 3-1/8 inch transmission line.

Final Conclusion

It is my engineering opinion that, due to the large overstresses calculated in the tower legs, the subject tower is not adequately designed to support the Channel 2 antenna and its transmission lines as described in the Organization of Analysis Section of this Report. Thererore, I strongly recommend that the subject tower must not be used for the installation of the Channel 2 Antenna.

NOTES

1. The Findings presented in this section are based on the assumed tower geometry, member sizes and properties, guy cable sizes, and the antenna and transmission line loading described herein.
2. The Computer Analysis Results show the safety factors of the guys and the deflection curve for the tower under Cases 2, 3 and 4. The Computer Analysis Results also list the maximum leg and diagonal loads per tower section.

REPLACEMENT TOWER

The engineering estimate to build a new tower 666 ft. in height on the same site to support the Channel 2 antenna, in accordance with EIA/TIA Standard 222-E, is $350,000.00.

Due to the nature of this Engineering Investigation, I disclaim any liability arising from original design, geometry, material, fabrication and erection deficiencies or the "As Built" condition of the tower. Furthermore, the information and conclusions contained in this Report were determined by application of the current "state-of-the-art" engineering and analysis procedures and formulae, and Vlissides Enterprise, Inc. (Matthew J. Vlissides, P.E.) assumes no obligations to revise any of the information or conclusions contained in this Report in the event that such engineering and analysis procedures and formulae are hereafter modified or revised. In addition, under no circumstances will Vlissides Enterprises, Inc. (Matthew J. Vlissides, P.E.) have any obligations, responsibility or liability whatsoever for or on account of consequential or incidental damages sustained by any person, firm or organization as a result of any information or conclusions contained in this Report.

I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge.

STATE OF MARYLAND MATTHEW JOHN VLISSIDES

P.E.