kpff Consulting Engineers

TV and Radio Tower Broadcast Structures
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Madison J. Batt, SE, PE
Director of Tower Engineering

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About Me

Madison J. Batt, PE, SE

•35 years of experience in the field of structural engineering, specifically focused on tower engineering for the last 26 years in the examination, evaluation, analysis, and design of towers and communication sites. I have managed over 1,000 tower projects and have climbed and observed the condition of over 500 towers, ranging in height from 50 to 2,000 feet.

•Licensed in 49 States, Washington D.C., Guam, and Puerto Rico.

A Brief History

Towers For TV and Radio

•First broadcast towers were built for AM radio

•No specific design standard for towers before 1949

•First Standard – RETMA (TR-116) 1949 – Wind Pressure 20/13.3 and 30/20

•EIA/TIA 222 – First issued in 1959 – Wind Pressure varied based on map (30-70)

•EIA/TIA 222-A, B, and C in 1966 to 1976 – Wind Pressure Map (30-85)

•EIA/TIA 222-D, E, and F in 1986 to 1996 – Wind Speed Fastest Mile County listings for wind (70-110) Ice (***Major change to standard***)

•TIA 222-G 2005 to Present- Wind speed 3 Second Gust (***Major change to standard)***

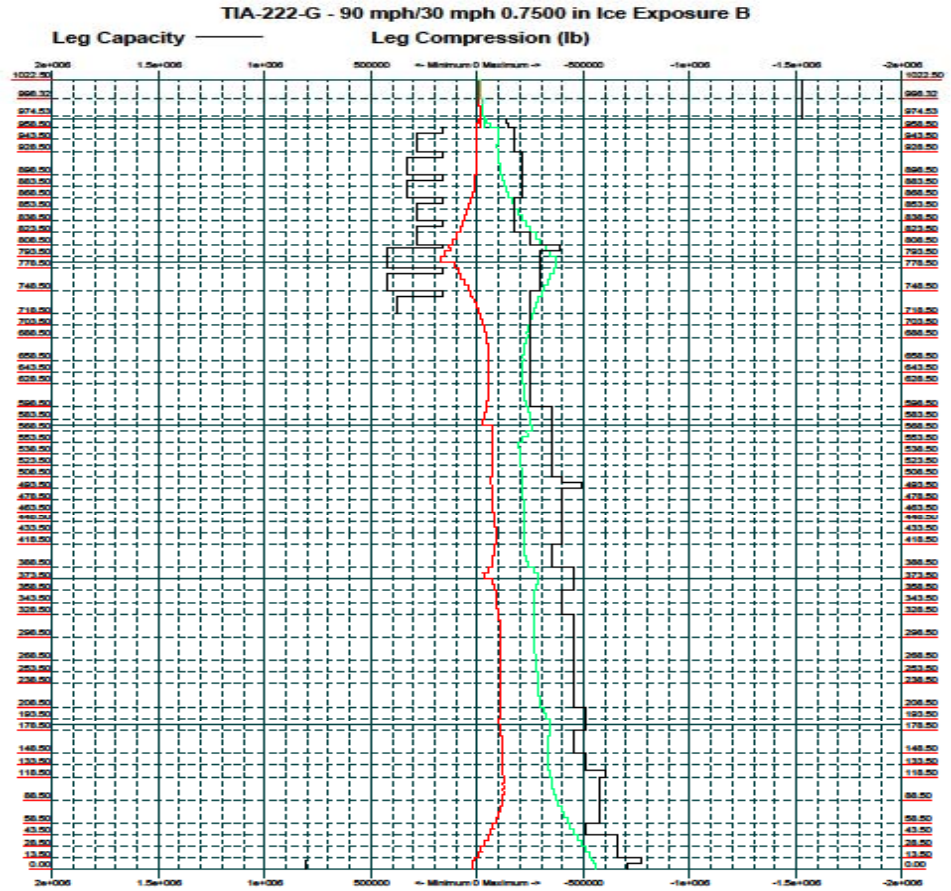
G Standard and impact on Industry

- Mandated by Building Officials (IBC) - Not by industry
- 3 Second gust versus Fastest Mile
- Updated Ice loading
- Exposure categories
- Topographic categories
- Earthquake design
- Importance classification
- Serviceability requirements
- Ref: **http://www.stainlessllc.com/Resources/NAB2007Paper.pdf**

Results of Analysis to G Standard

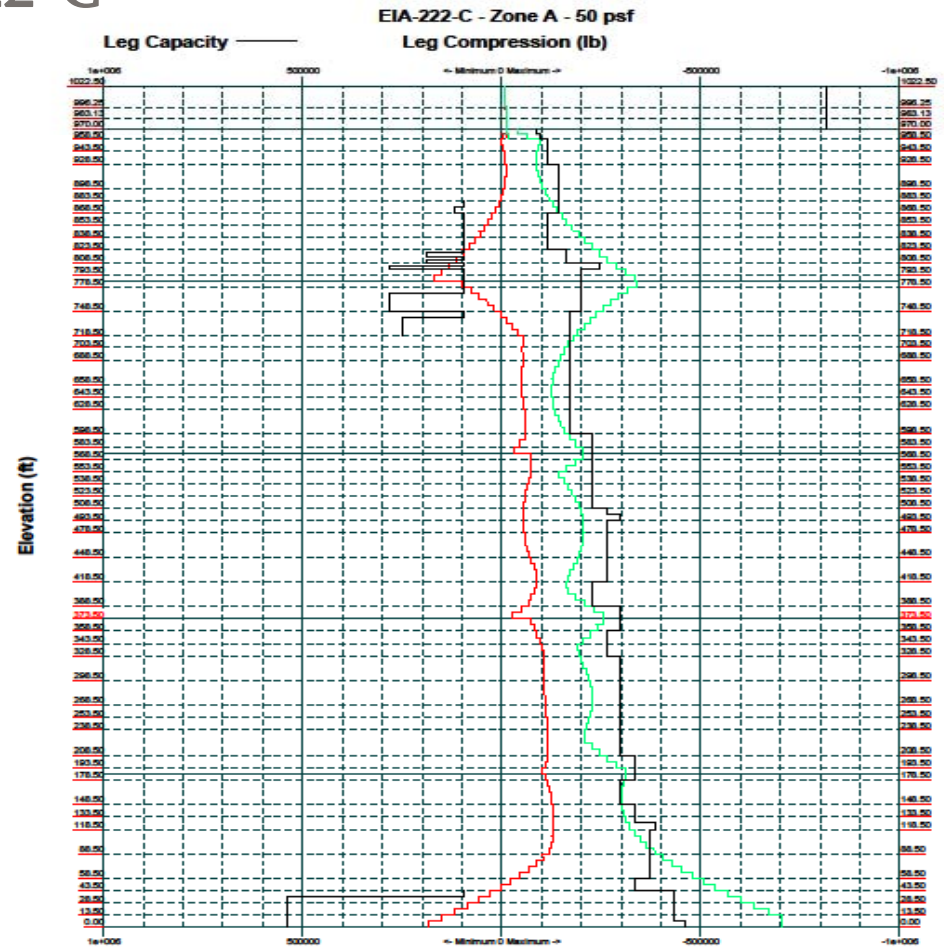
- TIA-222-G adopted by 2007 amendments of IBC
- Most Municipalities will accept TIA-222-G
- Ice Loading is more realistic
- Topographic has large impact on towers on elevated locations
- Towers designed to older standards benefit

TIA-222-G



KPFF Consulting Engineers 1601 Fifth Ave, Suite 1600 Seattle, WA 98101 Phone: (206)926-0508 FAX: (206)622-8130	Job: Proposed Project: 110367 WSOC 1026' GT, Charlotte, NC Client: Cox Enterprises — Drawn by: Madison J. Batt, PE, SE — Appvd: Code: TIA-222-G — Date: 11/15/10 — Scale: NTS Path: — Dwg No. E-3

EIA/TIA-222-C



KPFF Consulting Engineers 1601 Fifth Ave, Suite 1600 Seattle, WA 98101 Phone: (206)926-0508 FAX: (206)622-8130	Job: Existing Condition	
	Project: 110367 WSOC 1026' GT, Charlotte, NC	
	Client: Cox Enterprises	Drawn by: Madison J. Batt, PE, SE
	Code: EIA-222-C	Date: 11/15/10
	Path:	Scale: NTS Dwg No. E-3

Tower Engineering is a Specialization of Structural Work

Engineering

- Electrical Engineers, Communication Engineers, Radio/TV Engineers
- Mechanical Engineers, HVAC, Mechanical Equipment
- Civil Engineers, Structural Engineers, Soils Engineers
- Lots of others Engineer types Chemical, Aeronautical etc.

Tower Engineering (Subset of Structural and Civil)

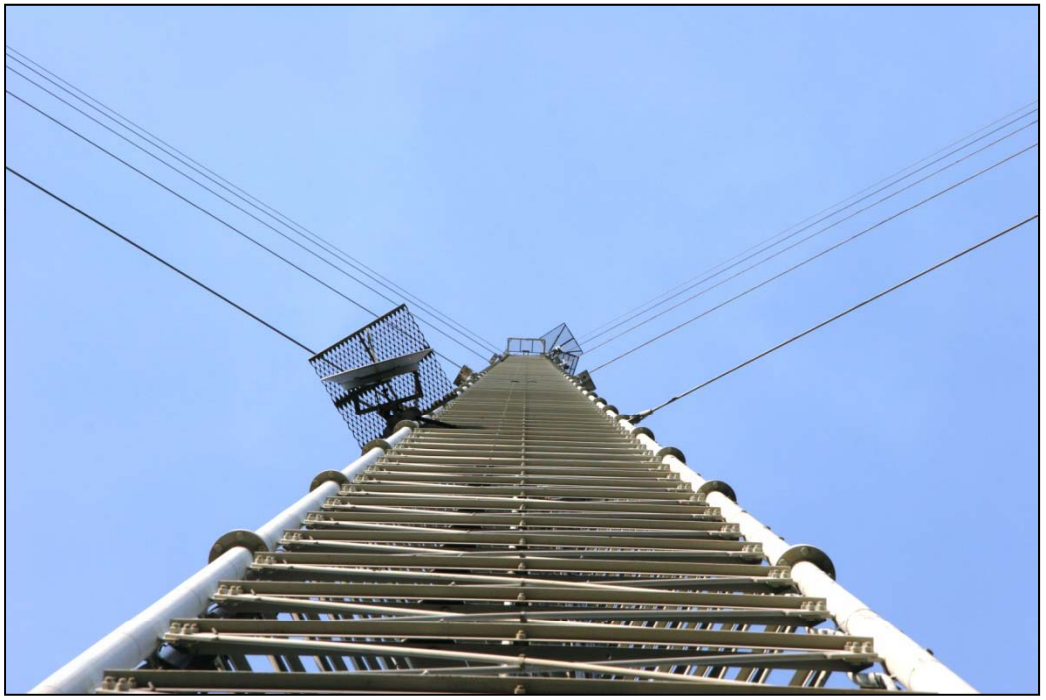
- Wind and Ice (Seismic too)
- Pure structure
- Field Inspections
- Analysis
- Retrofit Design
- Reports
- New Towers
- Construction

Guyed Towers Inspections

Guyed Towers

- Tallest Structures Globally

- Exception: Burj Khalifa, Dubai - Tallest Building (tallest structure in the world)



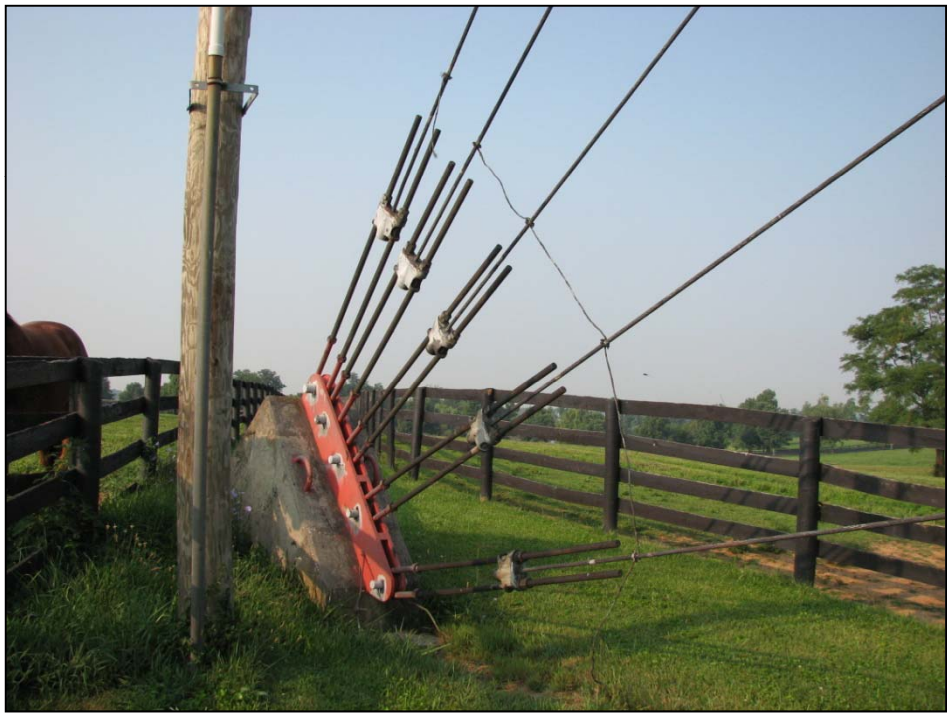
Guyed Towers

Guyed Anchors

- Requires expansive areas of land to secure tower

- Guyed towers commonly located in remote fields, farmland, or mountain tops

- Structural properties demand specialized design and knowledge



Self-Support Towers

Self-Support Towers

Examples of TV and FM Antennas

FM Towers

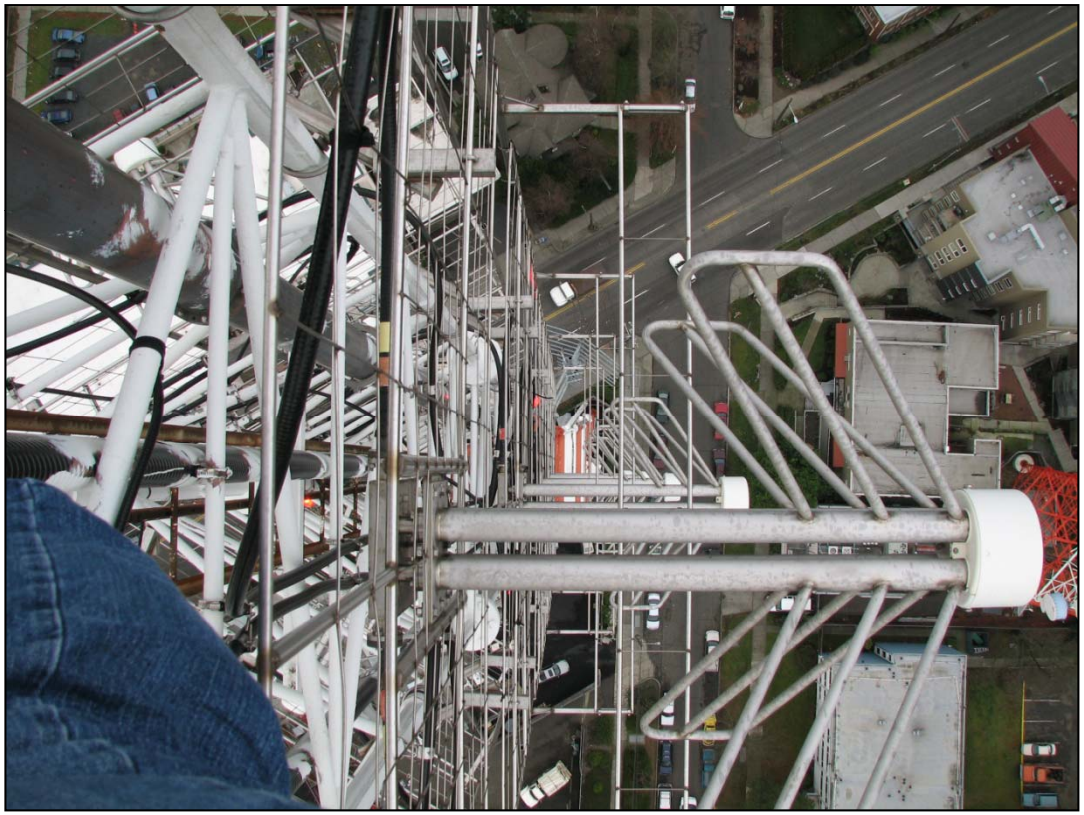
TV Tower (with FM antenna)

Multiple Antenna Mounted Tower

- Top Antenna serves TV
- Side Mounted Antennas serve FM and DTV

TV Tower (with FM antenna)

New Antenna Installation



AM Towers

AM Towers

Example of a “Hot” Tower – Entire tower radiates active waves

AM Towers

- Oldest Towers in Service
- Narrowest Face Widths
- Commonly designed and constructed as a guyed structure
- Design patterns vary

AM Towers

- Isolated Tower Base
- Tower is unsafe to touch

Antenna Installation

ENG Antenna Installation

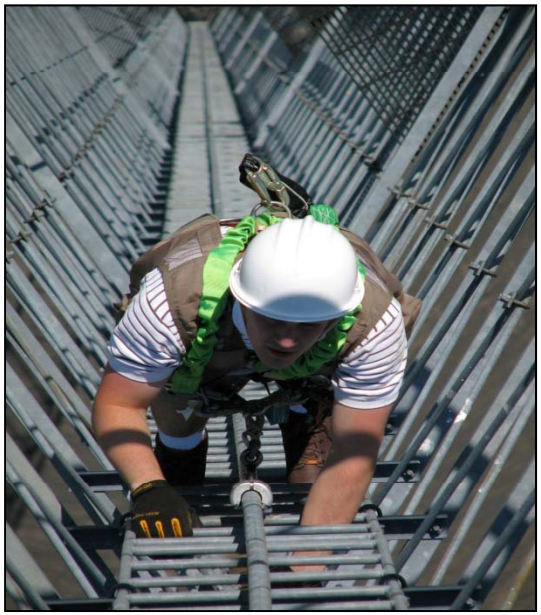
Antenna Installations

New Towers

KRKO - Foundation Construction - Everett

Tower Inspections

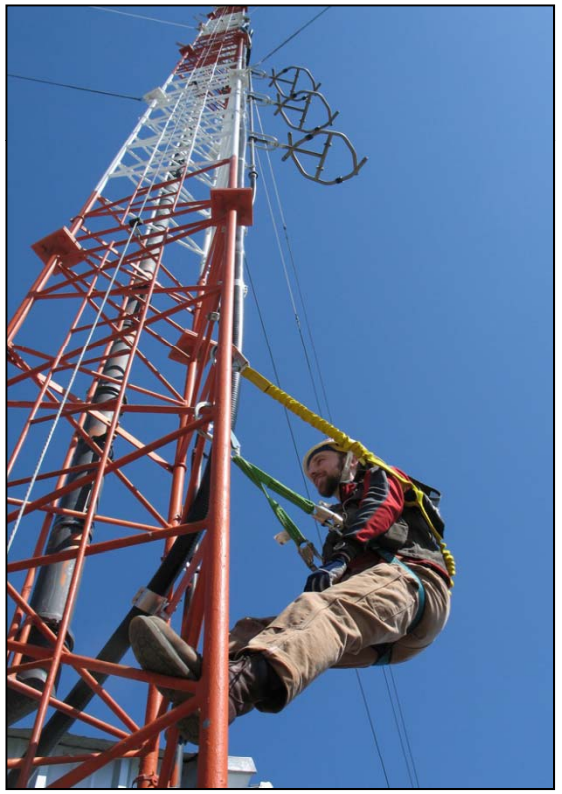
Tower Inspections



Tower inspections are laborious and dangerous:

- Engineers are required to complete extensive safety training
- Engineers must be in very good physical condition

Tower Inspections



Tower Inspections

- Adverse Conditions
- Ice Loads

Inspections - After Disasters

Ten days after Hurricane Katrina – New Orleans, Louisiana

Tower Inspections – After Disasters

- View from tower showing water around building
- Water had been 8 feet higher swamping equipment in transmitter building

Failed Towers

Failed Towers - Collapse

- Experience leads to other areas
- Expert on failure investigation
- Expert witness

Tower Failures

- Failed anchor rods at rod to plate forging

- Fatigue failure

Tower Failures

Magnetic particle testing of rods

Failed Towers - Collapse

Failed Towers - Collapse

Failed Towers - Collapse

Failed Towers - Collapse

Guyed Tower failure

Tower Failures

It appears poor welding of antenna to base of antenna caused failure

Digital TV Trends

•In Most Markets, Broadcasters are adding one or more secondary channels

•Majority of Stations have finalized DTV transition

•There are, however, numerous Stations with Analog antennas still on the tower

•When antennas are removed, a tower study should be done to make sure tower is not overstressed by the removal of antenna (Especially on Guyed towers)

•A good reference
http://www.stainlessllc.com/Resources/Tower_Effects_Presentation.pdf

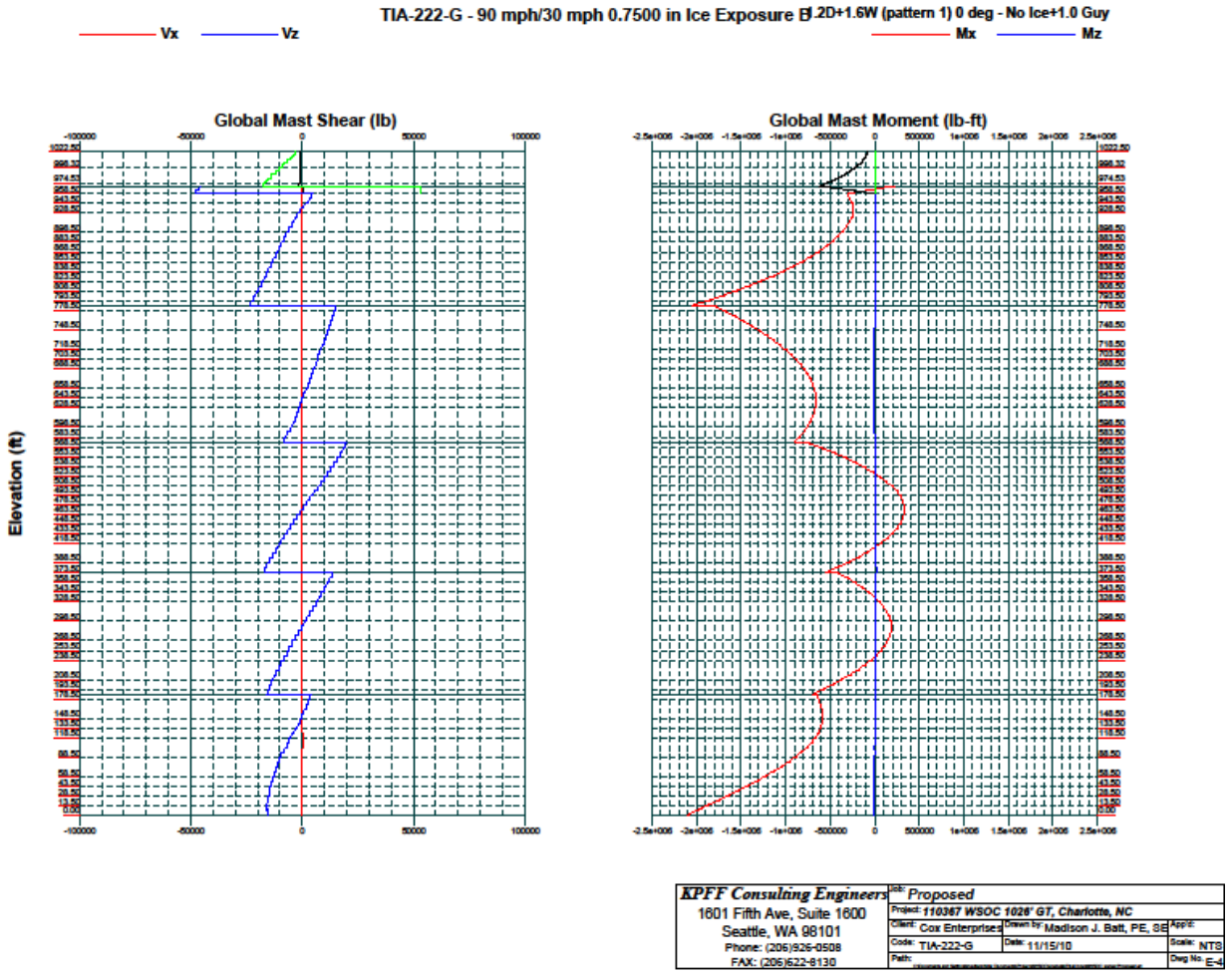
Guyed Tower with Large Antennas to be Removed

- Removal of large side-mounted or top-mounted antenna has impact on adjacent span(s)

- Guy wires sized for large wind loads from antennas will overstress legs and bracing and cause an imbalance in the guy system

- Transmission line loading can cause greater stress on tower than antenna

Tower Mast Moment Curve With Antenna removed



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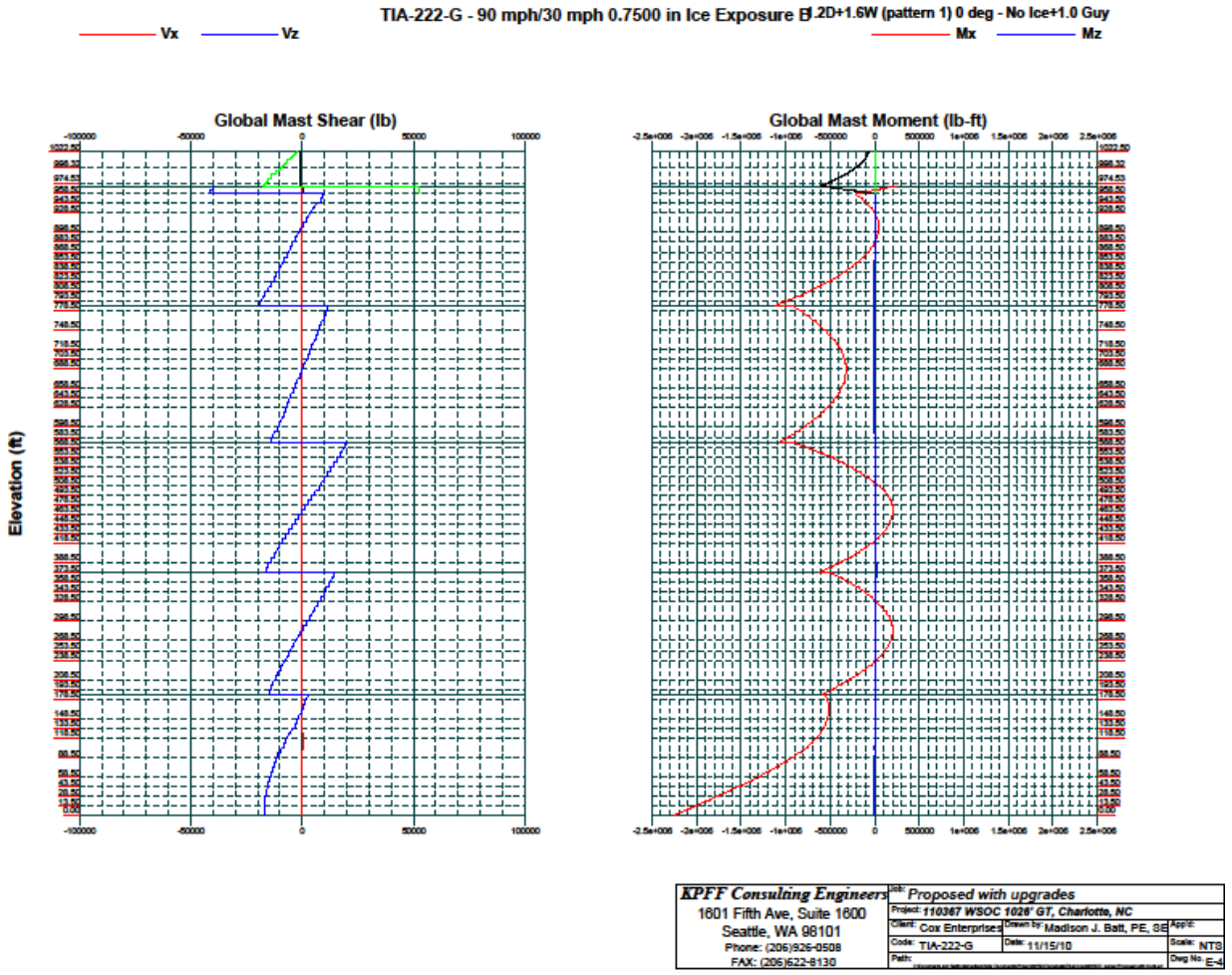
Mast Moment with Guy wire Modifications



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Whats Next

- Is Mobile TV the next big move?
- Antennas are being installed on towers with big V-polarization for Mobile TV reception
- Will consumers go to this?
- Is there a trend for consumers to drop cable and satellite for over-the-air broadcast, Netflix and Internet TV?
- Are consumers buying FM Digital Radios for their homes and cars?

QUESTIONS?

THANK YOU!

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