Classification of Tower Structures per ANSI/TIA-222-G, IBC and ASCE 7

Preface

Application of ANSI/TIA-222-G structure classes to communication tower design and analysis is frequently misapprehended. Risk categorization established within ASCE 7 and IBC are historically related to building occupancy among other factors has inconsistent correlation to communication tower use and function. Furthermore, the comprehensive application of Class III categorization to communication towers with the intention of increasing the reliability of wireless networks during emergency situations frequently fails to achieve the desired result and does not match the intent of the ANSI/TIA-222 Standard, as accepted by the IBC.

This white paper explains structure classification relationships between ANSI/TIA-222-G, *Structural Standard for Antenna Supporting Structures and Antennas, the International Building Code*, and ASCE 7, *Minimum Design Loads for Buildings and Other Structures*. It identifies the variables involved in structure classification and further defines how those requirements are to be applied per requirements with ANSI/TIA-222-G.

Definition of Structure Class – ANSI/TIA-222-G

The definition of Structure Class, per ANSI/TIA-222-G, with additional commentary by the authors, is provided below:

ANSI/TIA-222-G Definitions:

Structure Class I:
Structures that due to height, use or location represent a low hazard to human life and damage to property in the event of a failure and/or used for services that are

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optional and/or where a delay in returning the services would be acceptable.

Section A.2.2 further defines Class I structures: Structures used for services that are optional or where a delay in returning the services would be acceptable such as: residential wireless and conventional two-way radio communications; television, radio and scanner reception; wireless cable; amateur and CB radio communications.

Nextel Cellsite in Cuiritiba, South of Brazil
230 Ft (70M) triangular self-support tower
Photographer: Paulo Abreu, Seccional Brasil S/A

Commentary: Failure of the structure defined as Structure Class I typically only affects the owner, although services provided may affect other users. Human life is essentially not at risk and the public well-being is largely unaffected by the tower failure.

Structure Class II:
Structures that due to height, use or location, represent a significant hazard to human life and/or damage to property in the event of failure and/or used for services that may be provided by other means.

ANSI/TIA-222-G, Addendum 2 Annex A Section A.2.2 further defines Class II structures based on reliability criteria: Structures used for services that may be provided by other means such as: commercial wireless communications; television and radio broadcasting; cellular, PCS, CATV, and microwave communications.

Guy tower constructed by Mercury Communications, Inc.
Photographer: Trisha Fribis, Mercury Communications Inc.

Commentary: Failure of a structure defined as Structure Class II presents significant hazard to human life and/or property if a tower fails. Significant with respect to human life means failure of the structure could result in injury or casualties, but it's very limited in practicality or exposure to more than a few individuals (e.g. Significant with respect to property means property surrounding the tower could be damaged or destroyed. With respect to reliability, the phrase "Used for services that may be provided by other means" signifies redundancy exists within the network to support temporary loss of service due to a specific site. This redundancy is present in almost all public wireless service, including E911 networks.

Structure Class III:
Structures that due to height, use or location represent a substantial hazard to human life and/or damage to property in the event of failure and/or used primarily for essential communications.

ANSI/TIA-222-G, Addendum 2 Annex A Section A.2.2 further defines Class III structures based on reliability criteria: Structures used primarily for essential communications such as civil or national defense, emergency, rescue, or disaster operations, military and navigation facilities.

Monopole with cloud
East St. Louis, Illionois
Photographer: Steve Jones, US Tower Services, Inc.

Commentary: With respect to reliability, Class III structures represent towers for which the owner/provider cannot tolerate any loss of the network/signal, due to either types of services provided or zero redundancy existing in the network. Beyond zero redundancy, failure could also potentially impact other services, such as power, water, transportation, etc. that are considered essential to human life. Finally, Structure Class III can be quantified when a high risk to life/safety exists in the event of a failure of the structure. The risk is exemplified when the public venue is not mobile (e.g. hospital, school, large public emergency gathering facility).

Definition of Risk Category – ASCE 7-10 & IBC

The ASCE 7 Standard, *Minimum Design Loads for Buildings and Other Structures* provides the basis for structural load calculation for both TIA-222 and the International Building Code. The most recent published edition is ASCE 7-10, which dictates classification of buildings and other structures by assignment of a Risk Category. ASCE7-10 provides four Risk Categories (I, II, III, IV), with each higher number placing greater significance of risk to the public. The Risk Categories are generally based on the risk to human life, health, and welfare associated with damage or failure by nature of occupancy or use. Once Risk Category is established, importance factors are to be applied based on ASCE 7-10, Table 1.5-2. These importance factors are included in the derivation of design loads for flood, wind, snow, earthquake, and ice applied to the structure during design and analysis. The different Risk Categories can be paraphrased/commented as follows:

Risk Category I: Failure results in low hazard to the public.

Risk Category II: Structures that do not fall within Risk Categories I, III and IV.

Risk Category III: Failure results in a substantial risk to the public. These structures can be thought of as being needed during times of emergency (e.g. hospitals, police stations, water treatment facilities) or supporting large population centers (e.g. malls, schools). Failure, while creating significant problems to the public, can be remediated. These structures can be considered as an essential facility.

Risk Category IV: Failure results in substantial hazard to the public. Failure of these structures typically means harm to the public extends well beyond the site of the failure. Often remediation cannot be completed due to the nature of the failure (e.g. nuclear facility). Failure of these structures also typically ensures failure of additional multiple systems critical to the public (e.g. loss of power results in loss of water and transportation). These structures can be considered as an essential facility.

Previous versions of the ACSE-7 used a parameter called Occupancy Category to define the appropriate risk category of a building or other structure. Occupancy Category, as used within the building codes, relates primarily to issues associated with life, safety, and fire protection across a number of building systems, like electrical, mechanical, etc. This use has caused some confusion as Risk Category's purpose is to appropriately derive the expected reoccurrence of environmental loads (wind, earthquake, ice, etc.) and the risks associated with structural failure.

Chapter 16 of the International Building Code addresses Risk Category within section 1604.5. The section is brief and relies on interpretation of the nature of occupancy in order to assign the appropriate risk cate-

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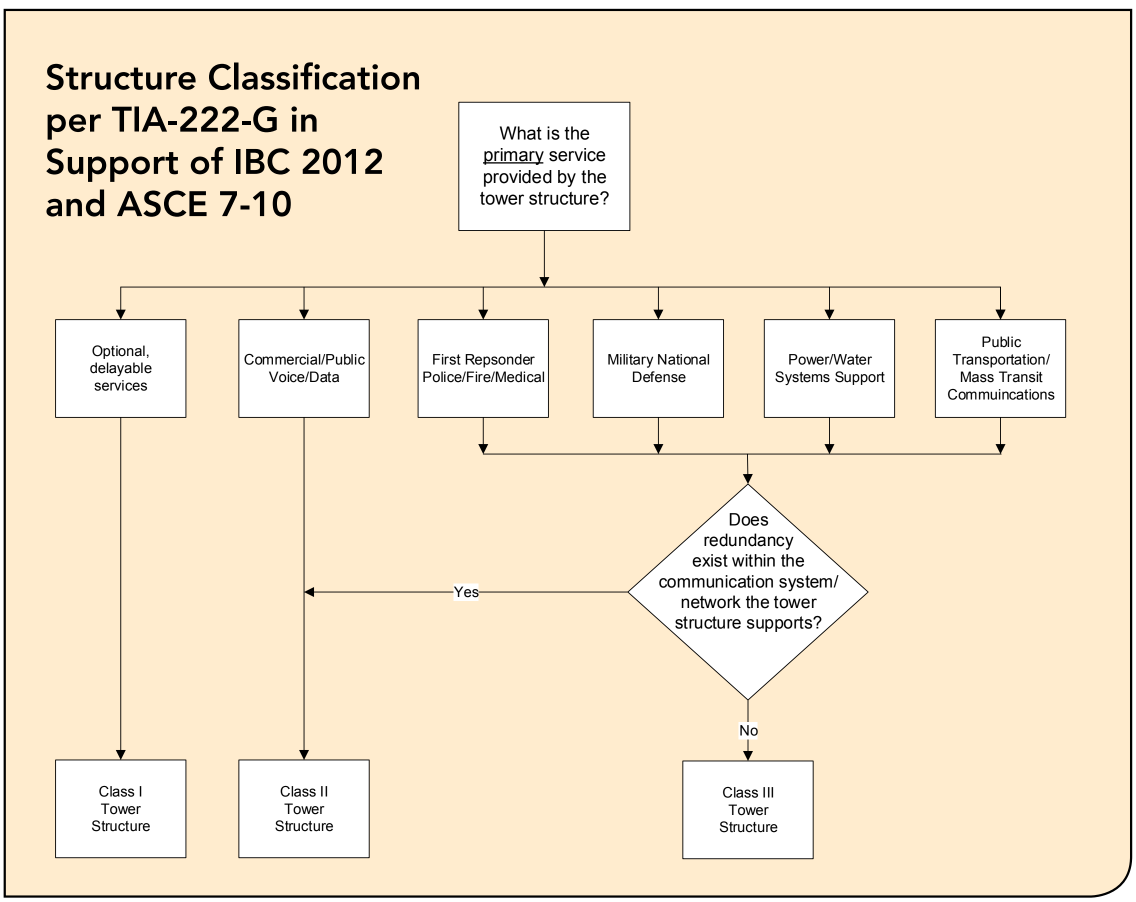
gory for design and analysis. IBC risk categories closely parallel ASCE 7-10. IBC further includes certain specific building types, contents, and occupancies within its risk category definitions for the sake of direct examples. Wireless telecommunication towers are not listed within Class III or Class IV Risk Categories.

IBC recognizes that unique structures require specific design and performance criteria. This criterion includes unique application of risk categorization. Telecommunication and broadcast towers are specifically addressed as unique structures within IBC Chapter 35 Referenced Standards and within Section 3108. Section 3108 states specifically that telecommunication and broadcast towers shall be designed and constructed in accordance with the provisions of ANSI/TIA-222.

Application of Structure Class to Towers

Appropriate application of Structure Class I is typically simple to evaluate and is rarely controversial. The misinterpretation primarily occurs with the misapplication of Structure Class III in place of Structure Class II. ANSI/TIA-222-G references the term "essential communications" within Table 2-1 and A.2.2. This reference is to establish a link between ASCE-7 and IBC Risk Category III and IV "essential facility" criteria and structure classification definitions within the ANSI/TIA-222-G Standard. "Essential communications" are defined within ANSI/TIA-222-G Annex A, A.2.2 as structures used primarily in support of civil or national defense, emergency, rescue or disaster operations, military and navigation facilities. On occasion, interpretations have been made based on the terms "emergency" and "rescue" in the above definition as validation of Class III requirements for wireless telecommunication towers, as the expectation is typical personal communication use of a mobile wireless device may be used during an emergency or rescue event, thus mandating the need for the higher classification. This is not the intent of the Standard. To properly apply the correct Structure Class per ANSI/TIA-222-G the term "primarily" must be defined and weighed against the number of lives at risk, as well as purpose and redundancy of the structure, wireless equipment installed, or the network design supported. "Primarily" within the definition above is used to define structures that support wireless telecommunication systems with limited or zero redundancy and hence place large numbers of lives at risk in the event of a failure. It also defines structures whose purpose for installation is to support wireless services used primarily by emergency service providers, military, navigational or mass transit. ANSI/TIA-222-G addresses redundancy of in Table 2-1. The terminology "used for services that may be provided by other means" is the



defined difference between essential communications or Class III structures with limited or zero redundancy and Class II structures that deliver inherent redundancy.

Conclusion

Structure Class definitions have been incorporated into the ANSI/TIA-222 Standard to provide accurate and reasonable classification of tower structures. The IBC specifically recognizes the ANSI/TIA-222 Standard as the guideline for communication tower design and analysis and fundamentally accepts the ANSI/TIA-222 structure classification as the basis required for telecommunication and broadcast towers. Use of the ANSI/TIA-222-G definitions allows for more appropriate application of assessing risk, when considering factors like public safety, service and network redundancy.

Inherent redundancy exists in the vast majority of wireless tower supported networks, including networks that support emergency services such as E911. Because of this redundancy, application of higher structure classes to individual towers typically has little effect on the resiliency of overall network performance. Although a significant total of the population may be potentially (or "be" here) impacted by the loss of service of a wireless provider, the loss of an individual wireless site does not consistently compromise the entire wireless network, nor eliminate the service provided in a specific location. Therefore, the potential impact to the public typically is actually very small, as opposed to what might initially be estimated.

Higher structure classes may be warranted when the failure of the tower implies significant physical consequences to the surrounding area, affects essential services, such as water, power, transportation, etc. or when loss of specific wireless service at a location significantly comprises the overall network or eliminates designated emergency service in a specific geographic location.

In effort to truly enhance the reliability of a wireless site in these scenarios, strengthening of all aspects of the wireless network, including individual antennas, mounts and connections, coax or fiber lines (backhaul for data), back-up power, water intrusion resiliency, and radio cabinet design is likely appropriate. Instituting a Structure Class III requirement only on the tower structure would likely result in a non to minimal improvement in reliability in comparison to the expectation of overall improved network performance and reliability. ■