S76-22

IBC: TABLE 1604.5

Proposed Change as Submitted

Proponents: David Bonowitz, representing FEMA-ATC Seismic Code Support Committee (dbonowitz@att.net); Kelly Cobeen, representing Federal Emergency Management Agency/Applied Technology Council - Seismic Code Support Committee (kcobeen@wje.com); Michael Mahoney, representing FEMA (mike.mahoney@fema.dhs.gov)

2021 International Building Code

Revise as follows:

TABLE 1604.5 RISK CATEGORY OF BUILDINGS AND OTHER STRUCTURES

RISK CATEGORY	NATURE OF OCCUPANCY
I	Buildings and other structures that represent a low hazard to human life in the event of failure, including but not limited to: Agricultural facilities. Certain temporary facilities. Minor storage facilities.
II	Buildings and other structures except those listed in Risk Categories I, III and IV.
III	Buildings and other structures that represent a substantial hazard to human life in the event of failure, including but not limited to: Buildings and other structures whose primary occupancy is public assembly with an occupant load greater than 300. Buildings and other structures containing one or more public assembly spaces, each having an occupant load greater than 300 and a cumulative occupant load of these public assembly spaces of greater than 2,500. Buildings and other structures containing Group E or Group I-4 occupancies or combination therof, with an occupant load greater than 250. Buildings and other structures containing educational occupancies for students above the 12th grade with an occupant load greater than 500. Group I-2, Condition 1 occupancies with 50 or more care recipients. Group I-2, Condition 2 occupancies not having emergency surgery or emergency treatment facilities. Group I-3 occupancies. Any other occupancy with an occupant load greater than 5,000.[a] ~~Power-generating stations, water treatment facilities for potable water, wastewater treatment facilities and other public~~ Public utility facilities not included in Risk Category IV. Buildings and other structures not included in Risk Category IV containing quantities of toxic or explosive materials that: Exceed maximum allowable quantities per control area as given in Table 307.1(1) or 307.1(2) or per outdoor control area in accordance with the *International Fire Code* ; and Are sufficient to pose a threat to the public if released.[b]
IV	Buildings and other structures designated as essential facilities and buildings where loss of function represents a substantial hazard to occupants or users, including but not limited to: Group I-2, Condition 2 occupancies having emergency surgery or emergency treatment facilities. Ambulatory care facilities having emergency surgery or emergency treatment facilities. Fire, rescue, ambulance and police stations and emergency vehicle garages Designated earthquake, hurricane or other emergency shelters. Designated emergency preparedness, communications and operations centers and other facilities required for emergency response. Public utility facilities providing power generation, potable water treatment, or wastewater treatment. Power-generating stations and other public utility facilities required as emergency backup facilities for *Risk Category* IV structures. Buildings and other structures containing quantities of highly toxic materials that: Exceed maximum allowable quantities per control area as given in Table 307.1(2) or per outdoor control area in accordance with the *International Fire Code* ; and

	Are sufficient to pose a threat to the public if released.[b] Aviation control towers, air traffic control centers and emergency aircraft hangars. Buildings and other structures having critical national defense functions. Water storage facilities and pump structures required to maintain water pressure for fire suppression.

a. For purposes of occupant load calculation, occupancies required by Table 1004.5 to use gross floor area calculations shall be permitted to use net floor areas to determine the total occupant load.

b. Where approved by the building official, the classification of buildings and other structures as Risk Category III or IV based on their quantities of toxic, highly toxic or explosive materials is permitted to be reduced to Risk Category II, provided that it can be demonstrated by a hazard assessment in accordance with Section 1.5.3 of ASCE 7 that a release of the toxic, highly toxic or explosive materials is not sufficient to pose a threat to the public.

Reason: This proposal improves consistency in the assignment of risk categories. It applies current thinking from IBC Chapters 3 and 4 to the risk category assignments in Table 1604.5. The logic of the proposal is as follows:

1. **Risk Category IV is the IBC's main tool to provide functional facilities** soon after a natural hazard event (earthquake, flood, snow, or wind). In terms of post-event functionality, there is a wide gap between RC II-III facilities (which have identical requirements for nonstructural systems) and RC IV facilities. The difference in expected recovery time can be on the order of weeks or months.
2. The performance gap between RC II-III and RC IV is most acute for occupancies that depend on functional nonstructural systems and special design provisions to serve vulnerable users.
3. Because these facilities are rare and specially designed, their services and occupants cannot be quickly relocated to other buildings.
4. Therefore, facilities with special design features and vulnerable users should be strong candidates for Risk Category IV.

Following this logic, this proposal expands the scope of RC IV from just "essential facilities" to include "buildings where loss of function represents a substantial hazard." **This "substantial hazard" can even be life threatening** where, for example, a 24-hour medical facility, residential care facility, public water or power utility, detention center with impeded egress, or critical supply chain facility is out of service for weeks. The code defines *essential facilities* as those that need to "remain operational" through and after an "extreme" earthquake, flood, wind, or snow event. The additional facilities described by the logic above and considered in this proposal might not require continuous operation, but **prolonged downtime – which can be expected from RC II design criteria – can give rise to a similar risk for vulnerable users**, if not on Day 1 after the event, then possibly by Day 3, 10, or 30.

This proposal addresses buildings that support the operations of public utilities. Under the current code, utility buildings that support power generation and water treatment are mostly assigned to RC III even though their value and function is closely linked to the performance of specialized nonstructural components. Only those that provide "emergency backup facilities" for other RC IV facilities are themselves assigned to RC IV.

Instead of drawing a line between normal operations and "emergency backup," this proposal makes the distinction between public utilities (typically designated not by the code but by a state or local commission) and other utilities. If housing, schools, offices, shops, and all the other normal buildings assigned to RC II are to be unusable for prolonged periods after a major storm or earthquake, it should not be because of a failure at a public water or power utility. On the contrary, a policy that expects people to "shelter in place" for weeks or longer in damaged but occupiable buildings should, at the very least, supply those buildings with water and power within at most a few days.

Further, those who would argue that RC IV design for more buildings should be voluntary must acknowledge that no developer would do that voluntary work until reliable utility services are in place. Otherwise, the voluntary work would be wasted as long as a utility outage continues.

Therefore, this proposal makes the key distinction between public water and power utilities and other utilities as follows:

- It maintains the "emergency backup" utilities in RC IV, with no change to the current code.
- It moves public utility facilities for power generation, potable water, and wastewater from RC III to RC IV.
- It maintains the broad assignment of the remaining public utilities to RC III, essentially as in the current code. In some jurisdictions, these "other public utilities" (in the current code's phrasing) might include communications or public transit facilities, but it is the fact that they are designated as public utilities that qualifies them for design consideration beyond RC II.

Despite this reassignment, this proposal is measured in its scope. **It does NOT affect** any non-public utility or any utility supply chain facility not already included in the current RC III provision.

(The current wording of Table 1604.5 regarding utilities is unclear in several ways, but clarifying or correcting it is outside the scope of this proposal. Examples of unclear wording include: Is it assumed that all power generation and water treatment facilities *are* public utilities? Is a solar installation that returns power to the grid considered "power generation"? Are power distribution facilities included with "power generating stations"? What "other" utility functions does the code expect to be assigned to RC III? Why would public utilities be considered *backup* for private facilities, rather than the primary service? And if there is no backup, shouldn't the primary service be assigned to RC IV as well? How many public utilities serve only RC IV facilities, but not the broader community? Etc.)

This proposal is consistent with current IBC principles. This proposal extends the current scope of Risk Category IV, but it does so consistent with the purpose, philosophy, and normative goals the IBC already represents.

Even if you think of the IBC as strictly a "life safety" code, safety is more than mere survival, and safety can be at risk even after the rain, snow, or ground shaking has stopped. If building damage affects the safety of vulnerable users in the following days or weeks, it is consistent with even a safety-based code to manage those risks through design.

But the IBC's purpose is broader than just "life safety." Section 101.3 states that the purpose of the IBC is to provide a "reasonable level of safety, **health and general welfare.**" So a focus on the health and welfare of vulnerable building users, even where their building provides immediate safety, is both "reasonable" and completely consistent with the purpose of the code.

With its definition of *essential facilities* and its use of Risk Category IV to ensure they "remain operational," the IBC is already more than a safety code. It is, in fact, already a basic "functional recovery" code; the only question is which building uses, and users, we decide should qualify for a designed recovery. Where RC II or RC III is not reliable enough, it is consistent with the purpose and scope of the IBC to assign more building uses to RC IV.

Not all of the IBC's tools are perfectly nuanced. Some involve bright lines and broad categories, and it is sometimes necessary to err on the conservative side. So even if a certain use is not quite as "essential" as a fire station, RC IV might still be a more appropriate choice than RC II or RC III, and in these cases, it is consistent with the code to assign buildings to the higher category. In time, design criteria should evolve to address more specific recovery objectives (FEMA, 2020; FEMA-NIST, 2021). But those nuanced provisions are *at least* a decade away. For now, however, RC IV is the most appropriate tool we have, and we ought to use it. Adapting existing practices to new objectives is entirely consistent with the history of code development.

IBC Chapters 3 and 4 define and provide special requirements to manage fire and egress risks for particular groups of users. Table 1604.5 is meant to do the same for rare natural hazard events. But while Chapters 3 and 4 consider dozens of specific building uses and conditions, Table 1604.5 has only four categories. Changing the scope of Risk Category IV to account for specific building uses that are not adequately served by RC II or RC III criteria is consistent with the detailed, use-specific approach of Chapters 3 and 4.

Table 1604.5 represents public policy about what we desire from our buildings. As such, it has changed over time, along with public expectations. As we consider new or increasing risks related to more frequent natural hazard events, urbanization, the pandemic, or aging populations, it is both appropriate and consistent with past practice for Table 1604.5 to evolve as well.

Bibliography: Almufti, I. et al. (2016). "The resilience-based design of 181 Fremont Tower," *Structure*, June.
Bade, M. (2014). "Mission Bay Block 25 Building – An Exercise in Lean Target Value Design," Presentation to the Lean Construction Institute, Finland, April 12.

Berkowitz, R. (2021). "UCSF Center for Vision Neuroscience," 2021 EERI Annual Meeting, Session 3B, March 24.

CISA, 2020. "Guidance on the Essential Critical Infrastructure Workforce: Ensuring Community and National Resilience in COVID-19 Response (Version 2.0)." U.S. Department of Homeland Security, Cybersecurity & Infrastructure Security Agency, March 28.

FEMA (2020b). *NEHRP Recommended Seismic Provisions for New Buildings and Other Structures, Volume II: Part 3 Resource Papers*, 2020 Edition, FEMA P-2082-2, prepared by the Building Seismic Safety Council of the National Institute of Buildings Sciences for Federal Emergency Management Agency, September.

FEMA-NIST (2021). *Recommended Options for Improving the Built Environment for Post-Earthquake Reoccupancy and Functional Recovery Time*, FEMA P-2090 / NIST SP-1254, Federal Emergency Management Agency and National Institute of Standards and Technology, January.

Mar, D. (2021). "Making Resilience Affordable," 2021 EERI Annual Meeting, Session 3B, March 24.

SEFT Consulting Group (2015). "Beaverton School District Resilience Planning for High School at South Cooper Mountain and Middle School at Timberland," SEFT Consulting Group, July 10.

SFDPH, 2020. "Order of the Health Officer No. C19-07b." City and County of San Francisco, Department of Public Health, March 31, et seq.

Cost Impact: The code change proposal will increase the cost of construction
This proposal will increase the cost of construction for the buildings newly assigned to RC IV. The largest increases will likely be in high seismic areas where assignment to RC IV makes the largest changes to structural and nonstructural design criteria. This does not mean, however, that every RC IV facility will have the same unit cost as a new state-of-the-art hospital. On the contrary, case studies of voluntary RC IV-like seismic design have found a **construction cost premium ranging typically from 0% to 2%** relative to normal RC II designs. (See proposal references by

Almufti, Bade, Berkowitz, Mar, and SEFT.) This estimate stands to reason: Wind, snow, and earthquake loads can already vary significantly within a jurisdiction, but the building designs and unit costs don't change wildly from one side of the county to the other. For example, the seismic design force in Berkeley is about 1.5 times that in downtown San Francisco; so with respect to the structure, any nursing home or grocery store you can build as RC II in Berkeley you can also build as RC IV in San Francisco with no change to the design. The same is likely true for snow design, for example, in Vail v. Boulder and for wind design in Galveston v. the west side of Houston. On the nonstructural side, a facility's nonstructural systems might need more bracing or support when assigned to RC IV, but the number and size of the components themselves don't suddenly look like a hospital just because the risk category has changed.

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Public Hearing Results

Committee Action: **As Modified**

Committee Modification:

TABLE 1604.5 RISK CATEGORY OF BUILDINGS AND OTHER STRUCTURES
Portions of table not shown remain unchanged.

RISK CATEGORY	NATURE OF OCCUPANCY
I	Buildings and other structures that represent a low hazard to human life in the event of failure, including but not limited to: Agricultural facilities. Certain temporary facilities. Minor storage facilities.
II	Buildings and other structures except those listed in Risk Categories I, III and IV.
III	Buildings and other structures that represent a substantial hazard to human life in the event of failure, including but not limited to: Buildings and other structures whose primary occupancy is public assembly with an occupant load greater than 300. Buildings and other structures containing one or more public assembly spaces, each having an occupant load greater than 300 and a cumulative occupant load of these public assembly spaces of greater than 2,500. Buildings and other structures containing Group E or Group I-4 occupancies or combination therof, with an occupant load greater than 250. Buildings and other structures containing educational occupancies for students above the 12th grade with an occupant load greater than 500. Group I-2, Condition 1 occupancies with 50 or more care recipients. Group I-2, Condition 2 occupancies not having emergency surgery or emergency treatment facilities. Group I-3 occupancies. Any other occupancy with an occupant load greater than 5,000.[a] Power-generating stations, water treatment facilities for potable water, wastewater treatment facilities and other public ~~Public~~ utility facilities not included in Risk Category IV. Buildings and other structures not included in Risk Category IV containing quantities of toxic or explosive materials that: Exceed maximum allowable quantities per control area as given in Table 307.1(1) or 307.1(2) or per outdoor control area in accordance with the *International Fire Code* ; and Are sufficient to pose a threat to the public if released.[b]

IV	Buildings and other structures designated as essential facilities and buildings where loss of function represents a substantial hazard to occupants or users, including but not limited to: Group I-2, Condition 2 occupancies having emergency surgery or emergency treatment facilities. Ambulatory care facilities having emergency surgery or emergency treatment facilities. Fire, rescue, ambulance and police stations and emergency vehicle garages Designated earthquake, hurricane or other emergency shelters. Designated emergency preparedness, communications and operations centers and other facilities required for emergency response. Public utility facilities providing power generation, potable water treatment, or wastewater treatment. Power-generating stations and other public utility facilities required as emergency backup facilities for *Risk Category* IV structures. Buildings and other structures containing quantities of highly toxic materials that: Exceed maximum allowable quantities per control area as given in Table 307.1(2) or per outdoor control area in accordance with the *International Fire Code* ; and Are sufficient to pose a threat to the public if released.[b] Aviation control towers, air traffic control centers and emergency aircraft hangars. Buildings and other structures having critical national defense functions. Water storage facilities and pump structures required to maintain water pressure for fire suppression.

a. For purposes of occupant load calculation, occupancies required by Table 1004.5 to use gross floor area calculations shall be permitted to use net floor areas to determine the total occupant load.

b. Where approved by the building official, the classification of buildings and other structures as Risk Category III or IV based on their quantities of toxic, highly toxic or explosive materials is permitted to be reduced to Risk Category II, provided that it can be demonstrated by a hazard assessment in accordance with Section 1.5.3 of ASCE 7 that a release of the toxic, highly toxic or explosive materials is not sufficient to pose a threat to the public.

Committee Reason: Approved as modified as the proposal makes the appropriate distinction between facilities for Risk Category III and IV. For lucidity, the modification restores the current wording for Risk Category III. (Vote: 10-4)

S76-22

Individual Consideration Agenda

Public Comment 1:

Proponents: David Bonowitz, representing Self (dbonowitz@att.net) requests As Modified by Committee

Commenter's Reason: The argument in support of S76 is simple and self-evident: Water and power are vitally important in the hours and days following a damaging earthquake, hurricane, or winter storm. The facilities that provide these services to the public are therefore *essential* and should be assigned to Risk Category IV.
To this obvious truth, the opposition has no response. Instead, they make a number of claims, which we rebut in brief below.

Opposition claim: S76 should be disapproved because it doesn't define "public utility."

Rebuttal in support:

-- "Public utility" is already used in the IBC, and S76 uses it with exactly the same meaning and context.

-- It is a simple exercise for any code user or building official to learn that “public utility” means a provider of certain basic products or services – like water and power – for sale to the general public. But the code cannot, and need not, provide a definition, because it is already defined in state and federal statutes. See the supplemental information in the attached file.

-- At the committee action hearings, opposition to S76 showed a surprising misunderstanding of this quite common term. ICC members and voters can avoid that confusion by reviewing the attached supplemental information.

Opposition claim: S76 should be disapproved because it doesn’t define “power-generating station.”

Rebuttal in support:

-- “Power-generating station” is already used in the IBC, and S76 uses it with exactly the same meaning and context. S76 makes no change at all regarding the meaning of “power-generating station,” so this argument is a red herring.

-- At the committee action hearings, the opposition asked whether certain small PV installations qualify as “power-generating stations,” but that question is moot because S76 applies only to “public utilities.”

-- Proposal S81 can, and does, clarify conditions where PV systems that are *not* public utilities might be properly assigned to RC I or II, making this opposition to S76 moot.

-- The lead opposition to S76 is also the proponent of S79 and S81. As noted in the reason statements for S79 and S81, ASCE 7-16 Section 15.5.4.1 states, “Electrical power-generating facilities are power plants that generate electricity by steam turbines, combustion turbines, diesel generators, or similar turbo machinery.” The S79 and S81 proponents argue that based on this ASCE 7 provision, the term “power-generating stations” as used in Table 1604.5 (and S76) “was never intended to apply to individual PV panel systems.” If this is correct, then S76 will not affect solar, and the opposition disproves its own claim.

Opposition claim: Most PV is designed as RC I and most wind turbines are designed as RC II, so assignment to RC IV is a huge change.

Rebuttal in support:

-- Public utility facilities – that is, the only facilities affected by S76 – are already assigned to RC III, not RC I or II. See the supporting information regarding the use and definition of “public utility”.

-- The fact that PV vendors have convinced building officials to allow RC I based on safety alone (i.e. because ground mounted or short elevated PV systems can’t kill you by falling on you) shows why S76 is needed, because without it, code users completely ignore the public service nature of a public utility that the current RC III assignment is meant to reflect.

-- Proposal S81 can, and does, clarify conditions where safety – as opposed to service to the public – is an appropriate basis for design. So S81 resolves any confusion about the intent of either the current code or S76.

Opposition claim: Even “utility scale” PV is designed as RC I, so S76 emphasis on “public utility” will change that or is at least confusing.

Rebuttal in support:

-- "Public utility” is the term already used in the IBC. S76 doesn’t change that.

-- “Utility scale” is NOT a term used in either the IBC or S76, so this claim is a red herring.

-- “Utility scale” does not imply “public utility.” See the attached supporting information about the meaning of “public utility.” It has nothing to do with scale. In fact, many large power utilities (including many wind and solar installations) are not public utilities at all.

Opposition claim: S76 disproportionately hurts solar and wind, which use the building code for design, and has less effect on older technologies (steam and combustion turbines), which do not.

Rebuttal in support:

-- S76 does not target any specific industries. Rather, it recognizes the importance of post-event water and power, regardless of fuel source. Neither the current Table 1604.5 nor S76 makes a distinction by fuel source.

-- PV and wind installations that routinely use the building code and are permitted by the local building departments are generally NOT public utilities affected by S76. Rather, they are typically private facilities or municipal utilities; see the supporting information.

-- It is FALSE that older power plant types don't use the building code. If they are owned by government agencies or independent authorities, they might not receive building permits through the local building official, but they do use the building code and its reference standards (like ASCE 7) as technical design guidance for their buildings and non-building structures. Thus, S76 will influence the design of these facilities as well.

-- At the committee action hearings, the opposition also claimed that public utilities do not use the building code. This is plainly false, likely revealing the opponents' misunderstanding of the term "public utility" – a term already used in the building code, as discussed above and in the supporting information.

-- As noted above, the opposition disproves its own claim by citing (in its reason statements for S79 and S81) a provision from ASCE 7 suggesting that "power-generating stations" excludes PV.

Opposition claim: The design requirements that come with RC IV will increase PV and/or wind system costs so much that they will make those systems impossible or infeasible to build.

Rebuttal in support:

-- This is a far-fetched claim belied by the opponent's own arguments. In testimony on S76 and S81, opponents acknowledged that some PV installations are already assigned to RC III or IV per the current IBC, proving that the RC III and RC IV design criteria is feasible.

-- Outside the code hearings, opponents have claimed that RC IV design criteria will make wind turbine towers so large that they cannot be transported to the site. This, too, is belied by the fact that installations do exist in regions with some of the highest wind and seismic design criteria in the country. If you can transport to these (typically coastal) areas under the current code, then you can transport to any location where RC IV criteria under S76 would still be less than current RC IV criteria in the high-demand locations (such as the Great Plains states).

-- S76 affects only public utility facilities, which the current code already assigns to RC III. Therefore, the appropriate comparison is not between RC I and RC IV but between RC III and RC IV. Our analysis of the IBC and ASCE 7 criteria shows that in high seismic areas, the general increase in design forces would be only 20% (1.5/1.25=1.2). In high wind areas, the increase in design wind pressure would be only 9% throughout the Great Plains states where wind power is most common; in coastal areas, the increase would range from 0% in much of Florida to 14% off the North Carolina coast. In none of these cases is the increase infeasible or impossible.

-- Every industry or user group whose facilities have been assigned to RC IV has made the same objection ... and then has moved forward to develop design criteria and to innovate structural solutions to satisfy the policy goals of Table 1604.5. We have full confidence that the PV and wind energy industries, as well as other power and water infrastructure organizations, can and will do the same.

Opposition claim: Risk Category assignment will not improve grid reliability, which is as much about redundancy and network effects as it is about design of individual components.

Rebuttal in support:

-- Table 1604.5 already addresses these utilities and infrastructure with respect to structural design. S76 does not change that.

-- Table 1604.5 is a policy statement, not a technical provision. It is the one place in the IBC where the *purpose* of a proposed building or structure is considered with respect to severe natural hazards. As such, it is entirely appropriate to set policy guidance in Table 1604.5, with the understanding that technical criteria needed to satisfy the policy goals are set elsewhere.

-- At the committee action hearings, opponents referenced the North American Electric Reliability Corporation (NERC) as the appropriate body to set standards for grid reliability. That's great, as Table 1604.5 and the IBC rely on the existence and maintenance of consensus design standards, such as ASCE 7 and those promulgated by NERC. But those standards are not cited from Section 1604.5. A NERC standard for wind and seismic design would be a great contribution, but its performance goals with respect to extreme wind and seismic events should come from the policy guidance in the building code. Even without such a standard, NERC can (and should) develop a consensus statement about the expected reliability and recovery of existing grids and current PV and wind power designs. By doing so, they might even show that current designs are adequate to the purpose of RC IV and should be deemed to comply with S76. If that's the consensus, NERC should be able to produce such a statement even before the 2024 IBC becomes effective in a couple of years.

Opposition claim: S76 should be disapproved because it was proposed by seismic experts, not energy experts.

Rebuttal in support:

-- The FEMA-ATC committee does include seismic design experts, but it also includes structural experts, experts in nonstructural systems and non-building structures, and building code experts generally.

-- Table 1604.5 is within the scope of the structural committee, not the energy committee.-- S76 is largely a policy statement and will be decided, appropriately, by the ICC Structural Committee, which has already approved it, and by building officials considering the needs of their communities.

https://www.cdpaccess.com/public-comment/3432/27577/files/download/3625/S76%20Public%20Utility%20notes.pdf

Cost Impact: The net effect of the public comment and code change proposal will increase the cost of construction
Same as the original proposal as modified by committee.

Public Comment# 3432

Public Comment 2:

Proponents: Heidi Tremayne, representing Earthquake Engineering Research Institute (heidi@eeri.org) requests As Modified by Committee

Commenter's Reason: I would like to express SUPPORT for the code change proposal S76-22 on behalf of the Earthquake Engineering Research Institute (EERI). This proposal exemplifies EERI's vision by recommending a clear and important action to improve the International Building Code. Once adopted, this code change will improve the seismic performance of new buildings that support operations of public utilities that provide power generation, potable water treatment and wastewater treatment, in alignment with recommendations from EERI's published policy statements. Thank you for considering EERI's position on this important code issue.
EERI's formal support letter can be viewed at: https://www.cdpaccess.com/public-comment/3348/27380/files/download/3613/EERI-SUPPORT-for-ICC-Code-Change-Proposal-S76-22-final-2022-06-17.pdf

Cost Impact: The net effect of the public comment and code change proposal will increase the cost of construction
Same as original proposal.

Public Comment# 3348

Public Comment 3:

Proponents: David Banks, representing CPP Inc (dbanks@cppwind.com) requests Disapprove

Commenter's Reason: I do not believe that requiring most solar to be RC IV will result in improved overall grid resilience, which I believe is the underlying goal of this proposed change, given the proposal's emphasis on electricity availability soon after a natural hazard event. I certainly support this objective, but this proposal is the wrong approach. This is like increasing airplane safety by requiring all planes be too heavily reinforced to take flight. This would have extinguished the industry.
Instead, the aerospace industry ensures high reliability because parts and materials are subject to stringent quality control and strict preventative maintenance schedules, and all failures are subject to intense scrutiny. We should similarly tailor resilience solutions for solar. As an author of SEAOC PV2 and the draft ASCE Solar Manual of Practice, I know it takes time, effort and expertise to ensure resilient design is promoted. More support for such targeted efforts is needed.

As a Principal at CPP wind engineering, I have consulted on hundreds of solar products and projects. I've spent the last 14 years working to understand the risk of wind damage to solar. Using RCIV would not have prevented most of the wind-related failures I have seen. If designers are unaware of a load effect (such as aeroelastic instability or certain companion loads), increasing the magnitude of all the other design loads will, at best, fix the problem by accident.

In the absence of SB76-22 there is nothing to prevent local AHJs and others from requiring RCIII or RCIV speeds as needed for specific solar projects, particularly in places where other electricity sources are very expensive or the impact of a failure is unusually high. This is being done in Puerto Rico right now. Only a small subset of the available racking systems can be built there as a result, though. Unless S81-22 passes, S76-22 would eliminate many current racking systems from consideration and reduce the adoption of solar across the country.

If we are to accept such a cost, the necessity should be a clearly explained as part of the grid reliability guidance from FERC and NERC. I sincerely doubt that requirements in the IBC are the best way to implement their electricity resilience policy. But if IBC changes are indeed the only way, such provisions should reflect consultation with stakeholders to craft something with consideration for potential unintended consequences. I don't expect the transition will be smooth if this proposal passes.

It would be sadly ironic if a measure intended to reduce the impact of ever-increasing natural hazards significantly reduces adoption of solar energy. I recommend this heavy-handed proposal be disapproved.

Bibliography: None.

Cost Impact: The net effect of the public comment and code change proposal will not increase or decrease the cost of construction

As my comment advocates disapproving the code change proposal, there would be no cost impacts if my recommendation was put into effect.

Public Comment# 3269

Public Comment 4:

Proponents: Michael Bergey, representing Distributed Wind Energy Association (mbergey@bergey.com) requests Disapprove

Commenter's Reason: S76-22-BONOWITZ-3 would mandate that "Public utility facilities providing power generation …" be designed under Risk Category IV. The Distributed Wind Energy Association (DWEA) opposes this proposal and recommends that it be disapproved.
Rationale:

· DWEA represents the industry that provides wind turbines for "behind-the-meter" applications. This might be a 5-kW turbine for a rural residence or a 2-MW turbine for an industrial facility. Our members installations require building permits and are typically required to meet the IBC or one of its derivatives.

· DWEA recognizes the beneficial intent of S76 and does not disagree with the proponents that the structures related to critical public services should be designed to more robust standards as a compliment to the more robust standards for critical structures.

· The proponent's intent, as expressed in documents and testimony, is to subject only public utilities to the upgrade to RC IV.

· The term "Public utility facilities", however, is not adequately defined to avoid overly conservative interpretation by code officials. For example:

o Since even a small residential wind turbine will transmit excess power generation to the grid and receive compensation for it, it would be difficult for a homeowner to prove that they were not some form of a public utility.

· Most distributed wind systems are evaluated under RC II and upgrading to RC IV would increase foundation costs significantly (see below) and prohibit the use of standard towers in many coastal zones.

· In the case where a distributed wind system is part of a microgrid system (including energy storage) that serves an RC IV facility we believe the application of RC IV to the wind turbine support structure and foundation is appropriate.

Note: DWEA supports the comments and edits submitted on S79 by the American Clean Power Association (ACPA), which we believe would meet the intent of the S76 proponents without disadvantaging the vast majority of the distributed wind projects.Note: DWEA evaluated residential-scale towers and foundations for self-supporting lattice towers for RC II and RC IV for 110, 120 and 140 mph basic wind speeds per TIA 222-H using the industry standard tnxTower analysis tool. We found that loads increased by an average of 16% and total installed turbine costs increased by an average of 6%. It's worth noting that manufacturers will spend years of research and hundreds of thousands of dollars to shave installed costs a few percent, so a 6% increase is significant. Also, since there has not been a history of tower and foundation failures, the value of stronger foundations to the customer is diminimus. More importantly, our analyses revealed that standard RC II towers would not satisfy TIA-222-H in coastal areas under RC IV. We estimate that the "heavy-duty" towers required would add a further 7% to the installed cost.

Cost Impact: The net effect of the public comment and code change proposal will not increase or decrease the cost of construction
No change to the code.

Public Comment# 3363

Public Comment 5:

Proponents: Joseph Cain, representing Solar Energy Industries Association (SEIA) (joecainpe@gmail.com) requests Disapprove

Commenter's Reason: The Solar Energy Industries Association (SEIA) is seeking Disapproval of Proposal S76-22 by FEMA-ATC SCSC for multiple reasons.
1. Proposal S76-22 does not solve the problem the proponents are attempting to solve.

2. S76-22 has flawed language that is undefined, ambiguous, and conflicting.

3. S76-22 amplifies the undefined and ambiguous terms "power generating station" and "public utility facility" in a way that many AHJs will be unable to interpret, so many will likely just choose the most restrictive interpretation and require Risk Category IV.

4. S76-22 selectively and disproportionately disadvantages clean, renewable energy.

5. S76-22 could have the opposite effect for the grid – slowing gains in grid reliability.

6. The structural behavior of renewable energy facilities is very different from “conventional” turbine-based power generating stations for which the Risk Category table was written.

7. Reliability of the grid is not within the Scope of the IBC, nor within the responsibility of Structural Engineers or developers of the IBC.

8. The U.S. Department of Energy has spent over a decade working on driving down the cost of renewable energy, along with improving performance; S76-22 by FEMA threatens to drive the cost of renewable energy right back up without improving performance.

Proposal S76-22 does not solve the problem the proponents are attempting to solve.

The proponents of S76-22 seem primarily interested in functional recovery of building structures. We should all be able to agree that we want buildings and communities with greater resilience, and we should all be able to agree that we want our grid to be more reliable.

Proposal S76-22 does not solve or even contribute to any of these goals. It does not solve the problem the proponents are trying to solve. The proponents and supporters mentioned power outages in Texas, California, and from SuperStorm Sandy. The root causes of these power outages have been studied and identified. None of these events would have benefited -- none of these power outages would have been prevented -- by simply imposing the additional cost of higher Risk Categories.

The proponents seem to believe that increasing the risk category – and therefore seismic, wind, snow, ice, and flood loads – of power generators supplying electrons to the grid will have a direct return of a more-reliable supply of electrons to the building structures they are interested in for functional recovery. It will not. As substations, step-up transformers, transmissions towers and high-voltage lines are outside the scope of the IBC, none of these elements will be improved by changes to the RC table.

If the proponents want building structures to have electrical power to remain operational in the event of extreme environmental events or grid outages, the proponents could be much more direct and much more successful advocating for on-site renewable energy systems paired with on-site battery energy storage systems, with equipment and logic to allow these systems to disconnect from the grid and power the building during periods of grid outages. This would be a direct and smart approach to solving the problem.

S76-22 has flawed language that is undefined, ambiguous, and conflicting.

The proponents have elevated the undefined term “public utility facility” as the primary characteristic for assigning RC IV or RC III. The proponents offer no definition in this proposal. In verbal testimony, one proponent offered a verbal suggestion that if a particular facility is under the control of a public utilities commission, then it is a public utility facility. At a different point in testimony, that same proponent offered a different verbal definition, suggesting that "if it serves the public," then it is a public utility facility. Issues of assigning risk category to a project are far too important – and far too impactful – to be left to conflicting verbal “definitions” by one proponent at a code hearing.

In fact, in the As Modified version of S76-22 as approved by the Structural Committee, there is ambiguity and confusion in the language itself. In the As Modified version:

RC III includes: “Power-generating stations … and other public utility facilities … ”

RC IV includes: “Public utility facilities providing power generation …”

How are these different? The language is flawed and must be disapproved.

S76-22 selectively and disproportionately disadvantages clean, renewable energy.

Many renewable energy projects such as solar and wind are developed and constructed by private interests that must apply for permits through a local County building department. County building departments adopt the IBC, so those private developers and their investors must follow the IBC.

However, Investor-Owned Utilities (IOUs) are not subject to County jurisdiction and do not use the IBC or the National Electrical Code. They use the National Electrical Safety Code (NESC), which is not adopted by building departments. Therefore, while renewable energy facilities would be held to using greatly increased structural loads and associated additional expense, the IOUs would not be held to using higher loads for their “conventional” facilities or for their renewable energy development.

The result is that private developers – and their investors – would be selectively disadvantaged, slowing development of renewable energy facilities.

S76-22 could have the opposite effect for the grid – slowing gains in grid reliability.

Distributed renewable energy sources are spread out and less concentrated in one geographic area. By adding these smaller resources at multiple locations, the reliability of the grid is improved. Many smaller distributed facilities are highly unlikely to experience the same extreme environmental loads at the same time. Disadvantaging renewable energy resources will slow deployment and slow these improvements in reliability.

The structural behavior of renewable energy facilities is very different from "conventional" turbine-based power generating stations for which the Risk Category table was written.

ASCE 7-22 Section 15.5.4 states: "Electrical power-generating facilities are power plants that generate electricity by steam turbines, combustion turbines, diesel generators, or similar turbomachinery." The Risk Category table was written for these very large generators, where a power outage represents a major loss of power generating capacity. For example, Diablo Canyon in California has two reactors with total output of 2.55 GigaWatts. If one or both reactors are shut down, that is a massive loss of power generation.

Renewable energy facilities do not behave this way. Where structural damage has occurred the damage has been localized and did not result in the loss of all power production. These facilities are not "switched on" and "switched off" when there is an environmental event. Damage causing the shut-down of one inverter or one wind turbine does not shut down the entire facility. A very recent anecdote was a photo of a missile strike on a ground-mounted PV system in Ukraine. The photo showed localized damage in the vicinity of the crater, and the rest of the PV facility was still standing.

Reliability of the grid is not within the Scope of the IBC, nor within the responsibility of Structural Engineers or developers of the IBC.

Reliability of the grid is the responsibility of the grid experts at the North American Electric Reliability Corporation, which in turn answers to the United States of America Federal Energy Regulatory Commission. There we find grid experts continually working on reliability of the U.S. grid. There is ongoing work on smart grids, microgrids and other strategies for resilience. We are unaware of any study or document from any of these grid experts that suggest a need for increases in RC of renewable power generation.

The U.S. Department of Energy has spent over a decade working on driving down the cost of renewable energy, along with improving performance; S76-22 by FEMA threatens to drive the cost of renewable energy right back up without improving performance.

The DOE has been funding research projects for over a decade to improve performance, lower cost, and increase deployment of clean, renewable energy systems. As PV modules (such as panels) and inverters are the two highest-cost items, much of this research work has been for driving down the "Balance of System" (BOS) cost, which includes rack systems, trackers, and foundations.

The S76-22 proposal by FEMA threatens to counteract the work of the U.S. DOE by driving cost back up without any increase in performance, and without any substantiating study relating to any need for higher risk categories for solar and wind projects. This is not a smart approach or a targeted approach, and it is not supported by any specific research study. It takes only minutes to write a sentence or two in a code change proposal to work against over a decade of progress by the DOE in research partnerships with industry and other experts, including experts from our national laboratories such as the National Renewable Energy Laboratory (NREL).

No problems are solved by simply increasing all seismic loads, wind loads, and snow loads without any consideration of a targeted approach to solving real problems that are known identified risks. For example, if PV modules have come loose, that means we need to focus on module attachment methods – it does not mean we need bigger and deeper foundations.

We respectfully request disapproval of S76-22. It increases cost, slows deployment, and does not solve any problems.

Cost Impact: The net effect of the public comment and code change proposal will not increase or decrease the cost of construction
No change to code.

Public Comment# 3512

Public Comment 6:

Proponents: Gregory Cooper, representing Renewable Energy (gregory.cooper@ge.com) requests Disapprove

Commenter's Reason: On behalf of the GE team working on Department of Energy (DOE) cooperative agreement DE-EE0009059 we oppose the proposal S76-22 due to the unintended consequences on wind turbine tower and foundation designs. We strongly encourage the rejection of the S76-22 proposal.
Background & Justification;

GE has been awarded a grant from the DOE – EERE under DOE cooperative agreement DE-EE0009059, this award funds the development of a new tower technology to economically increase hub height. This proposed change to the IBC risk category for wind turbines would be a significant setback to our goal of improving wind turbine economics and expanding wind markets in the US.

The DOE funding opportunity (A) associated with DE-EE0009059 has two specific objectives;

1. Reduce the levelized cost of energy (LCOE) of land-based wind power by enabling validation of taller tower technology and capturing stronger wind resources
2. Increase wind turbine deployment opportunities in lower wind speed regions across the country where wind energy has previously been more expensive to deploy.

The DOE funding opportunity (A) also references the current economics stating that under current market conditions, technical innovations will be required for land-based tower heights beyond 120 meters to be economical, since the installed cost increases faster than the increased energy production for most sites.

The impact of the changes proposed in S76-22 would be;

1. Reduction in the max economical hub height from 120m to 100m using existing tower technologies on current wind turbines in the market.
2. Increased program cost and development cycle time for the technology development program under DE-EE0009059 due to this change in requirements.
3. Increase in the cost of the commercial tower technology and reducing the economic benefit being developed under DE-EE0009059.
4. Reduced potential market size in the US where this new technology was considered to be a benefit.

Overall this S76-22 proposal would hinder progress of the wind industry and slow the energy transition in the US. We would encourage the proponents to revisit other means to increase the resilience of our energy systems. We are also confident that other energy system integration improvements could meet or exceed the objectives of this proposal without increasing the cost of wind turbine structures.

Thanks for your consideration.

Greg Cooper – GE Technology Integration Leader

Principal Investigator on DE-EE0009059

Bibliography: (A) EERE Funding Opportunity, DE-FOA-0002071 Area of Interest 4 Tall Towers for U.S. Wind Power
https://eere-exchange.energy.gov/Default.aspx?Search=DE-FOA-0002071&SearchType=

Cost Impact: The net effect of the public comment and code change proposal will not increase or decrease the cost of construction
No change to code.

Public Comment# 3229

Public Comment 7:

Proponents: Michael Faraone, representing TerraSmart; James Cormican, representing Terrasmart, Inc. (jcormican@terrasmart.com); Michael Slack, representing Terrasmart (mslack@terrasmart.com) requests Disapprove

Commenter's Reason: My name is Michael Faraone and I disagree with S76-22's proposal which would result in increasing the Risk Category requirement for ground-mounted photovoltaic, PV, arrays. I am the Director of Engineering for TerraSmart, one of the largest PV mounting system manufactures for ground mounted solar in the United States. I have personally worked on almost 4 Gigawatts of PV projects where 97% of them were designed to Risk Category 1. Additionally, my company has worked on a total of 19 Gigawatts of PV arrays where majority are designed to Risk Category 1. The proposed requirement of increasing the Risk Category would result in ground mounts needing to be designed with larger steel structural members, increasing the size and number of foundations. This would result in cost increases to the structure of up to 30% in some cases. For the vast majority of cases, large ground mounted solar PV arrays, Risk Category 1 is appropriate. This can be attributed to design life of the structure, 20-35 years, and the redundant nature of the power arrays having individual strings of solar PV modules spread over acres of land. Most ground mounted solar PV arrays are behind fencing with access only for qualified persons, and no staff on site, representing low risk to human life in the event of a failure. Increasing Risk Category would change the loading calculations, but would not change the solar PV modules themselves, as many would not be rated for higher loading scenarios as required by increased Risk Category, nor would it change the common methods for fastening solar PV modules to the mounting systems. This proposal would add costs that do not improve safety, system reliability, or grid resilience. There are Department of Energy programs working in conjunction with national laboratories such as NREL and others that are specifically targeting solar PV fastener & bolted joint connection performance and reliability. This program and others from ASCE are seeking to improve solar PV safety, reliability, and resilience with targeted efforts involving industry stakeholders. We do not support proposal S76-22 because it is not targeted specifically to ground mounted solar PV, does not involve the input of solar PV industry stakeholders, and ultimately will not achieve the added safety, reliability, and resiliency that I believe the proponents are seeking.

In conclusion myself and TerraSmart oppose S76-22, as this proposal would be detrimental to cost and future viability of PV arrays. Instead of increasing safety, system reliability and grid resiliency, increasing Risk Category would add costs without improving any of those things, reducing new system construction and reducing the number of PV modules available for use in large scale ground mounted solar PV arrays because of significantly higher loading requirements. We oppose this proposal because it would result in the unnecessary overbuilding of the vast majority of ground mounted solar PV arrays, which would mean fewer new arrays being built, and no appreciable improvements to reliability and safety to show for it.

Michael Faraone PH.D., P.E.

Cost Impact: The net effect of the public comment and code change proposal will not increase or decrease the cost of construction
No change to code.

Public Comment# 3463

Public Comment 8:

Proponents: Daniel Fisher, representing Orie2 Engineering requests Disapprove

Commenter's Reason: Ground mount solar should be considered low risk to human life, Risk Category I. For several reasons, the proposal to increase the risk category of ground mount solar systems should not be approved:

1. Solar panel manufacturer's do not manufacture solar panels that provide sufficient wind pressure capacity to meet the required wind demands caused by increasing the risk category. This, at minimum, should cause the code committee to pause consideration of modifying the risk category until it can be confirmed that it can be implemented into the panel itself. If solar panels cannot resist the demand loads, it could pause the entire industry and would not help with building more sustainable energy system and thus would not be helpful in improving the reliability of the power grid.

2. Structural systems of ground mounted solar fields are inherently redundant: a) Larger fields of solar have thousands to hundreds of thousands of pile (or other types) foundations. It is expected that, in reality, the high, rarely occurring wind gust events prescribed by code will be localized and would not happen to the entire site over tens or hundreds of acres. b) if an area of solar were to be damaged, it would not necessarily cause the entire solar field to go down. A study of how solar would be impacted by localized failure should be considered before voting on a general code requirement such as this. Intelligent electrical design of the solar system could allow the remaining undamaged portion of the site to continue operating when localized failure occurs.

3. An increased risk category could have unintended consequences (i.e. electrical, fire, structural, etc. code impacts). A vote on this topic should be considered to be delayed to study all possible impacts.

4. Risk category of the solar field facility itself should be considered low. The typical installation is fenced in with little to no access by the public and considered a low risk to human life. One argument for an increased risk category is that the power may serve essential facilities, however, the solar power itself is not able to be supplied when the sun is not out (at night) and output is lessened when it is cloudy. One could argue that a better strategy to increasing the reliability of power to the grid is to provide additional solar rather than increasing costs and barriers to installing solar that would be associated with higher risk categories. Power outages that we experience in our area of San Diego are typically associated with high winds and fire dangers, which would occur regardless of the source of power.

5. For battery storage, those facilities (battery containers, etc) could be designed at an increased risk category and sometimes are, but not the solar ground mount system. Neither solar nor battery storage should be considered as a constant supply of power, that is not impacted by weather conditions. At night, solar does not generate power. Therefore, power cannot be fed to the battery from the solar at night, directly or indirectly.

6. A more in-depth study of cost impacts should be considered. Based on feedback from other engineers, most engineers disagree with this proposal, yet the proposal has a significant impact on project cost. Structural costs alone could increase more than 10 to 20% making these projects less economically feasible.

7. Any proposals to directly assign risk category to solar, for the reasons above, should be assigning a risk category of RC=I to the ground mount solar.

Cost Impact: The net effect of the public comment and code change proposal will not increase or decrease the cost of construction
No change to code.

Public Comment# 3412

Public Comment 9:

Proponents: Karl Schadlich, representing Signal Energy requests Disapprove

Commenter's Reason: In response to proposal S76-22 I am seeking disapproval for the proposed change for Power-generating station and public utility facilities to be required to be designed to Risk Category IV. As a contractor in the renewable energy industry this proposed change does not consider industry specific applications, uses or implications which results in an inaccurate representation towards the intent of the building risk category structure, and impacts the mission and intent what renewable energy facilities are.

1. Proposal S76-22 presents the argument that increasing the risk categories will bolster recovery time "on the order of weeks to months". It is not clear on what basis this claim is made. Sure, the design would be more conservative and the Mean Recurrence Interval for events will increase, but that doesn't mean that damage won't be sustained, and when damage is sustained, the materials are all sourced from common areas and subject to the same manufacturing timelines (if not longer) than the rest of the industry undergoing new construction.

a. Utility Solar and Wind projects take up very large footprints (+1000 acres) compared to their base load generator counterparts and adverse events that cause damage tend to do so in isolated areas meaning that the entire facility is not necessarily brought offline in the instance of an adverse weather event.

2. Renewable energy facilities rely on the resources they are designed for (i.e., sun, wind) and fundamentally those resources are not constant. This means that renewable energy resources are designed and operated as asynchronous/discontinuous power generators that dispatch power over intermittent periods, and further cannot generate power over a continuous 24-hour period.

a. Power generation facilities are further classified into base load plant and peak load classifications. Peak load facilities are intended to supplement base load generation on an electrical grid, and are not intended, modeled, or capable of the support a base load generator provides.

b. Peak load facilities do not support the total capacity that a base load facility would hold so more are required over any given region to balance the base load facilities capacity.

i. To note 1 a above, with the likelihood of isolated damage and a demand on peak generators capacity to be equivalent to the base load, the probability of not having a renewable energy facility online to support some grid demand is highly unlikely considering adverse events cover relatively smaller areas when compared to the size of the transmission network they support.

3. Solar and Wind facilities are non-occupied facilities designed to be operated by a small handful of operations and maintenance personnel that are only present on-site during periods of maintenance and testing. Therefore, renewable energy facilities do not require 24/7 operations support or facilities and can be operated and controlled remotely. Further, the facilities are designed with security fencing which prevents public access, and they are commonly located in remote areas. In instances where renewable energy facilities are located closer to public areas, the security measures are increased and building risk categories are also generally increased to enhance public safety in extreme events.

a. Solar and Wind facilities are mechanical structures not designed or capable or hosting occupants

b. Solar and Wind facilities do not have operations centers and are commonly controlled remotely via independent power provider or Public Utility operations facilities regionally located.

4. Proposal S76-22 indicates that the proposal would result in cost increases to construction. While the cost of construction would be a definite it's important to note the residual impacts that result from the primary increase to the cost of construction. From a historical project in CA analyzed approximately 2 years ago my team investigated an increase from risk category 1 to risk category 3 resulting in a 40%+ increase to the solar panel racking structure foundation sizing for W6 galvanized I-beams alone. For context, on a 100MW solar project the result was an approximate 1100 ton increase in foundation steel alone. This means that mandating an increase in the building risk category requirements will contribute to:

a. An accelerated increase in carbon emissions

b. An increased burden on public infrastructure, maintenance and reduced overall design life of such public infrastructure (most notably roads and highways).

c. An accelerated depletion in raw materials.A substantial portion to the increase in adverse events correlates directly to global warming, and all the factors described in this section above directly contribute to global warming. It's unreasonable to approach a problem resulting from climate change that will increase contribution to climate change.

The proposed code change would effect the cost of construction through:

1. increased structural material sizing
2. reduction in overall renewable energy projects since products may not support the design requirements by region.
    1. This will likely increase overall cost of energy
3. increase in major equipment pricing
4. increased logistics and transportation pricing
5. increased duration of construction and operation of equipment for larger structures and components (more fasteners, thicker framing, more

concrete, heavier steel all taking longer to install)

Cost Impact: The net effect of the public comment and code change proposal will not increase or decrease the cost of construction
No change to code.

Public Comment# 3420

Public Comment 10:

Proponents: Brian Skourup, representing EVS, Inc. (bskourup@evs-eng.com) requests Disapprove

Commenter's Reason: The proposed change could re-assign ground-mounted PV panel systems (GMPVPS) to Risk Category III or Risk Category IV, increasing cost, reducing the total amount of solar generation deployed, and thereby reduce power-generation reliability. The following argument demonstrates that GMPVPS are adequately designed on a risk-targeted basis as Risk Category I structures.
GMPVPS should remain assigned to Risk Category I to maintain the most accurate relationship to existing building code-defined target reliabilities and to avoid excessive conservatism and financial penalties commensurate with assignment to Risk Category II. The risk category selection assigns structures to a defined target reliability/probability of failure also accounting for a failure "basis", i.e. – ductile, brittle, or brittle with progressive collapse (Table 1). For seismic design, Risk Category I and II are equivalent in all respects under current code provisions. For wind design, each risk category corresponds to a different reference period (service life) with a targeted constant design event exceedance probability across all risk categories and reference periods.

Table 1. (Reproduced from ASCE/SEI 7-16, p. 2)

Table 1.3-1 Target Reliability (Annual Probability of Failure, P_F) and Associated Reliability Indices (β)[1] for Load Conditions That Do Not Include Earthquake, Tsunami, or Extraordinary Events[2]

Basis	Risk Category I	II	III	IV
Failure that is not sudden and does not lead to widespread progression of damage	$P_F = 1.25 \times 10^{-4}$/yr $\beta = 2.5$	$P_F = 3.0 \times 10^{-5}$/yr $\beta = 3.0$	$P_F = 1.25 \times 10^{-5}$/yr $\beta = 3.25$	$P_F = 5.0 \times 10^{-6}$/yr $\beta = 3.5$
Failure that is either sudden or leads to widespread progression of damage	$P_F = 3.0 \times 10^{-5}$/yr $\beta = 3.0$	$P_F = 5.0 \times 10^{-6}$/yr $\beta = 3.5$	$P_F = 2.0 \times 10^{-6}$/yr $\beta = 3.75$	$P_F = 7.0 \times 10^{-7}$/yr $\beta = 4.0$
Failure that is sudden and results in widespread progression of damage	$P_F = 5.0 \times 10^{-6}$/yr $\beta = 3.5$	$P_F = 7.0 \times 10^{-7}$/yr $\beta = 4.0$	$P_F = 2.5 \times 10^{-7}$/yr $\beta = 4.25$	$P_F = 1.0 \times 10^{-7}$/yr $\beta = 4.5$

[1]The target reliability indices are provided for a 50-year reference period, and the probabilities of failure have been annualized. The equations presented in Section 2.3.6 are based on reliability indices for 50 years because the load combination requirements in Section 2.3.2 are based on the maximum loads for the 50-year reference period.
[2]Commentary to Section 2.5 includes references to publications that describe the historic development of these target reliabilities.

The cumulative probability of exceedance for environmental loads is the basis for structural safety. The formal relationship between the probability of failure, and the probability of exceedance is given below. If *F* is a failure event and *A* is the probability that the design event occurs, the probability of failure, P_f, due to event *A* is given by:

$Pf = P(F|A)P(A)$

Where $P(F|A)$ is the conditional probability of structural failure and $P(A)$ is the probability of exceedance for the design event. See ASCE/SEI 7-16 **C2.5 LOAD COMBINATIONS FOR EXTRAORDINARY EVENTS** (p. 422) for additional commentary. It is clear that $P(F|A) \leq 1.0$ and the upper limit for $P_F = P(A)$. Accordingly, the probability of structural failure cannot exceed the probability of occurrence/exceedance for the design event.For seismic design, the risk-targeted Maximum Considered Earthquake (MCE_R) Ground Motion is defined as, in part, an event with a 2% probability of exceedance within a 50-year period (p. 206 ASCE 7-16). This event corresponds to a mean recurrence interval (MRI) = 2,475 years. The risk category assignment dictates prescriptive detailing requirements and amplified design forces for Risk Categories III and IV. Structures assigned to Risk Categories I and II are treated equivalently under current code provisions.

The risk-targeted design wind speeds are similarly based on a target probability of exceedance within a fixed reference period. However, the reference period and wind speeds vary according to each of the four risk categories. Table 2 illustrates the relationship between risk category, annual probability of exceedance, MRI, and the cumulative probability of exceedance for a structure for each reference period.

The probability of a wind speed exceeding the basic mapped wind speed at least once during the reference period is illustrated below the *Reference Period* title. It should be clear that the target cumulative probability of exceedance is between 5% and 8%, which is relatively constant across the four risk categories and reference periods. These values are presented in **bold** font within the table. However, note that the probability of failure in most cases is less than this value as was previously discussed.

Table 2. Probabilities of Exceeding Wind Loads[1]

Risk Category	*Annual Probability*	*MRI (yrs)*	*Reference Period (years)*			
			25	*50*	*100*	*156*
I	0.003330	300	**8.0%**	15.4%	28.4%	40.6%
III	0.001430	699	3.5%	**6.9%**	13.3%	20.0%
III	0.000588	1701	1.5%	2.9%	**5.7%**	8.8%
IV	0.000333	3003	0.8%	1.7%	3.3%	**5.1%**

1. Expanded form of Table G3.1 in Guide to the Wind Load Provisions of ASCE 7-16.

GMPVPS are typically designed for a 25-year service life based on the PV panel productive life and manufacturer performance warranty. The current design wind speed and target reliability for structures assigned to Risk Category I correspond to a 25-year reference period. Some manufacturers are already extending panel service lives beyond 25 years, but in no case do warranties or service lives meet or exceed 50 years.

GMPVPS with service lives greater than 25 years should be designed for wind speeds corresponding to their expected service life. These design wind speeds can be obtained following the procedure used by the ASCE 7 Wind Load Task Committee described by Vickery, et al (2010). The resulting values for several reference periods are tabulated here (Table 3) for reference. The coefficients in the "V_{ULT}/V_{50}" column can be applied to any MRI 50-year wind speed (V_{50}) obtained from a design map or other reference, such as the ATC Hazards web tool, to obtain risk-targeted design wind speeds at any location for the reference periods shown. Additionally, the risk-targeted design wind speeds can be computed for any reference period and are not limited to the periods shown here.

Table 3. Design Wind Speeds for Several Reference Periods

Risk Category	*Reference Period (yrs)*	*MRI (yrs)*	V_{ULT}/V_{50}	V_{ULT} *(mph)**
I	**25**	**300**	1.179	**106**
	30	371	1.200	108
	35	451	1.220	110
	40	533	1.236	111
II	**50**	**700**	1.264	**114**
III	**100**	**1700**	1.352	**122**
IV	**156**	**3000**	1.409	**127**

**V_{50} = 90 mph*

Table 4 recreates the first three columns of Table 3 but shows the percent error in design wind force for each reference period relative to both Risk Category I and Risk Category II. In the former case, the percentage indicates how much the risk-targeted design wind force is understated for a structure with reference period greater than 25 years while the latter case indicates how much this quantity is overstated. For example, a structure with a 35-year service life assigned to Risk Category I would be under-designed for the risk-targeted wind force by 6.6% while the same structure assigned to Risk Category II would be over-designed for the risk-targeted wind force by 7.4%. In this case, the percentage over-design is also a first-order approximation for the structural cost penalty associated with assigning GMPVPS to Risk Category II.

Table 4. Risk-targeted Wind Forces for Several Reference Periods

Risk Category	*Reference Period (yrs)*	*MRI (yrs)*	*Percentage increase in wind force*	
			*Risk Category I**	*Risk Category II***
I	**25**	**300**	0.0%	14.9%
	30	371	3.5%	10.9%
	35	451	6.6%	7.4%
	40	533	9.1%	4.4%
II	**50**	**700**	13.0%	0.0%

**RC I forces result in understating risk-targeted wind force*

***RC II forces result in overstating risk-targeted wind force*

There is no risk-targeted basis for moving GMPVPS to risk category II, but the change imposes unnecessary inefficiencies and increased costs on all GMPVPS. GMPVPS with extended performance warranties and service lives can either be electively assigned to RC II or designed for wind loads adjusted to the correct reference period. It would be an error to assign all GMPVPS to RC II as the structures are penalized with the burden of excessive design wind forces and increased cost without commensurate benefit. The conclusion being that GMPVPS belong to Risk Category I with the recognition that service lives exceeding 25 years can and should be designed for a risk-targeted wind speed corresponding to an identical reference period.

Bibliography: ASCE. (2016). "Minimum Design Loads for Buildings and Other Structures." *ASCE 7-16.* Reston, VA.
Coulbourne, W. L., and Stafford, T. E. (2020). "Wind Loads - Guide to the Wind Load Provisions of ASCE 7-16." *ASCE Press.* Reston, VA.

Vickery, P. J, Wadhera, D., Galsworthy, J., Peterka, J. A., Irwin P. A., and Griffis, L. A. (2010). “Ultimate Wind Load Design Gust Wind Speeds in the United States for Use in ASCE-7.” *J. Struct. Eng.*, 136(5), 613-625.

Cost Impact: The net effect of the public comment and code change proposal will not increase or decrease the cost of construction
No change to code.

Public Comment# 3429

Public Comment 11:

Proponents: Trevor Taylor, representing Vestas American Wind Technology (trtay@vestas.com); Christof Dittmar, Siemens Gamesa Renewable Energy, representing Siemens Gamesa Renewable Energy; Toby Gillespie, representing GE Renewables North America, LLC (toby.gillespie@ge.com) requests Disapprove

Commenter's Reason: S76-22 proposes to increase the risk category for “public utility facilities providing power generation” to Risk Category IV (RC-IV). Whether “public utility” is locally defined or not, the proposed modifications could readily be interpreted to encompass wind turbine support structures, which introduces significant, unnecessary, and unjustifiable long-term development and permitting risks to future new and repower (turbine upgrade) renewable wind energy projects across the United States. Delays and cancellations of wind energy projects will unfortunately undermine, not enhance, proponent efforts to bolster resiliency and achieve community functional recovery objectives. Accordingly, GE Renewables North America, LLC., Vestas American Wind Technology, and Siemens Gamesa Renewable Energy (collectively, “OEMs”), representing the three largest manufacturers of onshore wind turbines and towers installed in the United States, recommend that S76-22 be disapproved.The primary purpose of this public comment is to provide specialized background information that explains 1) why S76-22 introduces significant but unnecessary risk into the wind energy permitting process, and 2) emphasizes how RC-IV design load levels cannot in most situations be reconciled by OEMs against existing onerous transportation infrastructure restrictions to develop economically viable towers required for projects.
Justification Statement:

WIND TURBINE SUPPORT STRUCTURE PERMITTING

Wind turbine tower and foundation support structures for U.S. wind energy projects are, in virtually all cases, permitted by local building departments and local Authorities Having Jurisdiction (AHJ) in accordance with International Building Code (IBC) and ASCE/SEI 7 load levels corresponding to Risk Category II (RC-II). This standard wind industry practice extends even before December 2011, when a joint committee of interested parties of diverse stakeholders developed through a consensus process *ASCE/AWEA RP2011, Recommended Practice for Compliance of Large Land-based Wind Turbine Support Structures* (RP2011). Section 4.4 of RP2011 provides justification for standard classification under Occupancy Category II of ASCE 7. Although the term “Occupancy Category” has evolved into “Risk Category” in ASCE 7 and the IBC to encompass a broader definition of risks associated with structural failure since RP2011 was published, the general classification and associated “normal/standard structure” building code design load importance factors have remained the same. Wind tower and foundation engineering practitioners and wind energy project permitting AHJ’s continue to reference RC-II load levels for design/verification today as standard industry practice.

It is reasonable and logical under closer scrutiny for wind energy engineering stakeholders to continue referencing RC-II load levels in the future.

Unfortunately, proposed S76-22 introduces uncertainty in wind turbine support structure Risk Category classification for which reasonable and expeditious project permitting depends. S76-22 attempts to establish a well-intended but insufficiently detailed policy declaration that all “public utility facilities providing power generation” shall be considered Risk Category IV. This declaration appears without underlying study that makes any attempt to distinguish critical and highly consequential differences in failure risk profiles between individual renewable energy “power generation” structures that provide incrementally beneficial contributions to the electric grid, and conventional large-scale power plants.

MAJOR WIND PROJECT VIABILITY RISKS ASSOCIATED WITH S76-22

Current and future wind energy development depends on use of increasingly larger turbine rotors with longer blades (to capture a larger windswept area) and taller towers to not only accommodate the longer blades, but to best position the rotor to capture faster moving (higher energy) and less-turbulent (more predictable) wind. The overall economic objective is typically to maximize energy production value against wind turbine support structure costs, both of which tend to increase with height.

Unfortunately, existing transportation infrastructure currently restricts full optimization of conventional tubular steel wind towers, even under current RC-II code design loads. Tower engineers from every OEM are routinely challenged to design cost-effective tower sections that can be fabricated at the factory and transported by ship, rail and/or road to installation site, while respecting onerous transportation constraints such as roadway weight limits, road and rail height clearances from overpasses and tunnels that effectively limit external tower diameters, and road & rail curves that restrict tower section lengths. The segmenting of towers into additional tower sections to accommodate transport restrictions must be balanced against the high cost of additional splice flanges and bolts and additional erection costs. In some cases, an economical solution simply does not exist.

Unlike building structures and many industrial facilities, wind turbine towers are not readily scalable to accommodate increased design loads due to the transportation infrastructure restrictions. With S76-22 classifying wind turbine support structures as RC-IV, building code extreme wind design loads would increase a minimum of 22% compared to standard RC-II load levels across the continental U.S. This does not account for local tornado design loads, which will be required to be factored into the design load envelope for RC-IV and RC-III structures upon adoption of ASCE/SEI 7-22. The only plausible support structure solution that could accommodate the technical demand of such a large design load increase would not only entail a significant cost increase to the tower and foundation (roughly estimated at a combined +30%), but would necessitate a major reduction in tower height. The associated loss in energy value itself due to the reduced height is easily enough to render such projects economically unviable. This would have major implications for wind energy projects across all regions of the United States.

As for projects in regions of high seismic hazard where RC-II seismic design loads govern contemporary wind turbine support structure design, the 50% increase in seismic design loads attributable to RC-IV load levels preclude the technical development of any suitable tower from any OEM. This would have profound adverse implications for plans to replace or repower any of the thousands of existing obsolete wind turbines in dense wind energy sites in California like Altamont Pass, Riverside County/Palm Springs, and Tehachapi/Mojave.

Other public comments also in opposition to S76-22, and particularly the comment from the American Clean Power Association (ACP), provide detail on key points, including:

1) Electrical grid reliability and resiliency are inherently enhanced by policies that support the installation of multiple structurally independent and geographically distributed wind turbines,

2) Hypothetical failure of one or even multiple wind turbine support structures in a major disaster will not cause the adverse community impacts for which RC-IV categorization is intended to avoid,

3) Structural failures following actual extreme wind and seismic events due to perceived lack of structural integrity associated with RC-II level building code design loads for wind turbine tower and foundation support structures have been exceptionally rare, and

4) There is a lack of evidence that increasing building code design loads on individual wind turbine support structures commensurate with RC-IV levels would minimize power outages or avoid other adverse post-disaster community impacts.

The OEMs support these points.

The change in assignment of Risk Category for wind turbines as proposed by S76-22 will be cost and logistically prohibitive for wind energy in many cases without providing any measurable benefits in terms of resilience and recovery. The OEMs recommend that S76-22 be disapproved.

Bibliography: *ASCE/AWEA Recommended Practice for Compliance of Large Land-based Wind Turbine Support Structures* (ASCE/AWEA RP2011), American Wind Energy Association, December 2011.

Cost Impact: The net effect of the public comment and code change proposal will not increase or decrease the cost of construction
No change to code.

Public Comment# 3458

Public Comment 12:

Proponents: Jeroen van Dam, representing NREL (jeroen.van.dam@nrel.gov) requests Disapprove

Commenter's Reason: The National Renewable Energy Laboratory (NREL) opposes S-76-22 for the following reasons:

- The proposed change though simple in its implementation has broad impacts that are not well thought through. This includes significant impacts on the deployment of renewable energy.
- The proposed change is made with the argument of increasing grid resilience: it will not accomplish this and may in fact have the opposite effect.
- This proposal will increase costs and thus reduce the implementation of renewables on the grid. Renewables like Wind and PV solar are distributed in nature and deploying them on the grid will have a positive effect on grid reliability as it is less likely that an entire plant or all plants in an area will be impacted by a natural disaster. This was demonstrated in the case of hurricane Maria where the Punta Lima wind plant was impacted by the hurricane, yet the Santa Isabel wind plant located within 50 miles survived.
- Renewable Energy power plants are much smaller in capacity in comparison to traditional thermal plants and have built-in redundancy (PV plants have multiple strings with individual inverters, wind power plants consist of many individual wind turbines).
- Studies have shown that new generation needs to be built to keep up with increasing demands on the grid to maintain reliability. Renewables

like PV and Wind have both shown to be quickly deployable in comparison to coal, natural gas and nuclear plants. This proposal will reduce the implementation of wind energy as the relative cost increase due to the move from RC II to RC IV is more significant for wind energy as compared to other power generation.

- NREL is not aware of existing data that show that if wind plants would have been designed to Risk Category IV the grid would have stayed on line or recovered quicker in the wake of natural disasters. There are several articles showing no damage to wind turbines as a result of the hurricane Sandy: https://www.windpowermonthly.com/article/1158013/wind-farm-withstood-hurricane-sandy
- https://cleanenergy.org/blog/sandy-is-gone-wind-power-is-on/
- The proposal will negatively impact grid reliability as the proposal will drive developers to procuring less but more expensive wind turbines designed to RC IV instead of more, but less expensive, wind turbines designed to RC II. More wind turbines by definition provide more grid resilience and reliability through redundancy.
- A cursory cost analysis shows that the impact of the proposed change will increase the cost of Wind energy substantially more than the 2% listed by FEMA. This will significantly impact the economic viability of wind projects in earthquake, hurricane or tornado-prone regions. NREL plans to perform a more detailed independent cost analysis.
- The increase in costs will inadvertently jeopardize the renewable energy deployment goals of our federal government.
- Renewable energy is crucial in curbing climate change and its resulting increase in extreme weather events.

Jeroen van Dam

Principal Engineer

National Wind Technology

National Renewable Energy Laboratory

IEC TC 88 (Wind Energy Generation System) Chair

Cost Impact: The net effect of the public comment and code change proposal will not increase or decrease the cost of construction
This comment opposes the proposed change S76-22 which would increase the cost of wind energy beyond the stated "<2%" impact. By opposing S76-22 we can maintain the status quo and further help reduce the cost of energy for the public through deployment of renewable energy technology.

Public Comment# 3309

Public Comment 13:

Proponents: Scott Van Pelt, representing myself (scott.vanpelt@gamechangesolar.com) requests Disapprove

Commenter's Reason: The reason statement dictates that power generation facilities are "mostly assigned to RC III". This is not true for utility scale solar power plants. In excess of 90% of the utility scale solar power plants installed in the U.S. today are designed to RC I. S76-22 does not sufficiently address the dramatic effect of changing the required assignment of utility solar power plants from RC I to RC IV. The proposed change will cause climatic loads in many jurisdictions to exceed the mechanical ratings of most PV modules currently commercially available and therefore cause projects in these jurisdictions to be technically infeasible.

Cost Impact: The net effect of the public comment and code change proposal will not increase or decrease the cost of construction
No change to code.

Public Comment# 3294

Public Comment 14:

Proponents: Tom Vinson, representing American Clean Power Association (tvinson@cleanpower.org) requests Disapprove

Commenter's Reason: Summary:
S76-22 proposes to increase the risk category (RC) for power generation, including wind turbines, to RC IV. The American Clean Power Association (ACP) recommends S76-22 be disapproved. In summary, ACP's concerns are:S76-22 is based on two faulty premises:

(1) Power outages are caused by inadequate structural integrity of power generation facilities and, therefore, vastly increasing the minimum design load criteria will solve the problem.

However, per reports from grid reliability regulators and peer review studies: (1) outages are generally driven by transmission and distribution damage, not wind and solar generation facility damage and (2) wind and solar energy facilities have largely not suffered significant damage because of natural disasters.

Further, tens of thousands of wind turbines approved by authorities having jurisdiction (AHJs) under a RC II rating for wind turbines pursuant to ASCE/AWEA 2011 *Recommended Practice for Compliance of Large Land-based Wind Turbine Support Structures* have been structurally sound and available to generate power for communities during and after natural disasters, so the increase to RC IV as proposed in S76-22 is unnecessary and burdensome.

(2) Communities have power generation dedicated to serving their load and that power generation needs to be structurally stronger to support resilience recovery.

Except in communities that are electrically isolated from the broader power grid (such as villages in Alaska), the electrons from power generation of all types flows through the bulk electric system down to the distribution level based on physics. Generation is not dedicated to a particular community. Rather, grid operators instantaneously balance generation from various generation facilities in their region to match demand, including ramping up other generation in response to generator outages.

In that context, geographically dispersed power generation like wind and solar energy improve grid resilience, reliability, and functional recovery because (1) If an entire wind farm or solar facility ceases operation, which is rare, geographically diverse wind and solar farms elsewhere across the state or region are still putting electrons on the grid for delivery to homes and businesses and (2) even with a failure at an individual wind turbine(s) or solar panel section(s), the rest of the facility can continue to generate power.

Therefore, S76-22, which will make it more difficult to impossible to build additional facilities in at least some regions will inadvertently undermine reliability and resilience.

ACP also recommends disapproval of S76-22 because:

- By increasing the minimum building code design load criteria by up to 50% for wind turbines, S76-22 will be cost and logistically prohibitive to deploy wind energy in many cases without providing any measurable benefits in terms of resilience and recovery.
- By potentially making wind energy development impossible at least in certain regions and, at a minimum, more expensive everywhere, thus slowing deployment, S76-22 will inadvertently undermine reliability and safety.

Reason Statement:

While ACP understands the sponsor's concerns about power outages and supports the intent to make communities more resilient, adding utility-scale power generation to Risk Category IV (RC IV) in Table 1604.5 as proposed in S76-22 will not have the effect intended by its authors. And, in fact, by potentially making renewable energy development impossible at least in certain regions and, at a minimum, more expensive everywhere, thus slowing deployment, S76-22 will inadvertently undermine grid reliability and recovery and, therefore, public health and safety. Further, the fact that S76-22 is drafted as applying to only "public utility facilities" does not materially change ACP's concerns about the proposal given the uncertainty about how it will be interpreted in thousands of individual jurisdictions.

For more than a decade, wind turbine generators have been classified as Occupancy Category II, per the *Recommended Practice for Compliance of Large Land-based Wind Turbine Support Structures* (ASCE/AWEA RP2011). This document was co-designated by the American Society of Civil Engineers (ASCE) and the American Wind Energy Association (AWEA), and is used when classifying wind turbines. In 2012 the ICC changed from using Occupancy Category to Risk Category. Classifying a wind turbine as Risk Category II is now equivalent to the previous classification as Occupancy Category II.

AHJs have approved the construction of tens of thousands of wind turbines using this standard over the last eleven years. ACP is not aware of any increase in grid failure rates, including related to natural disasters and extreme weather, which would justify the significant change in the ratings for grid-connected wind turbines from RC II to RC IV. No specific evidence is presented by the proponents of S76-22 on wind turbines that explains why the existing RC II rating is inadequate to support resilience and functional recovery.

Moreover, S76-22 will make the transportation of wind towers potentially impossible in many parts of the country, given the added steel, weight, and size necessary to meet the new load requirements. Such significant changes to the design as proposed by S76-22 will mean the larger wind turbine tower sections will exceed many road, rail, and bridge height, weight and/or turn radii limits in the U.S.

The premise of S76-22 appears to be that power outages are caused by inadequate structural integrity of power generation facilities and, therefore, vastly increasing the minimum building code design load criteria by up to 50% will solve the problem. This premise is incorrect.

Various reports on generation outages over the last two decades by grid reliability regulators, the Federal Energy Regulatory Commission (FERC) and the North American Electric Reliability Corporation (NERC), have not identified the structural integrity of power generation as important factors.

- The U.S.-Canada Power Outage System Task Force Final Report on the August 14, 2003, Blackout in the Eastern United States and Canada identified four major causes all related to improper operation and maintenance of the transmission system by a utility in Ohio.
- A joint FERC-NERC staff report on blackouts in Arizona and Southern California on September 8, 2011, found the grid operator failed to maintain the transmission system within its system operation limits, which contributed to cascading outages.
- NERC's report on Hurricane Sandy, which made landfall on October 29, 2012, indicated "no damage was reported" to wind turbines in the impact area.
- NERC's report on Hurricane Harvey, which made landfall on August 25, 2017, found "only minimal damage" was reported at wind energy facilities and facilities other than one that were offline came back online on the next day or the day after on August 26 or 27.
- More recently, FERC-NERC issued a joint report on the February 2021 extreme cold and freeze event that led to multiple days of outages in Texas and more limited challenges in other states that identified two major causes: (1) power generation and natural gas pipelines were not adequately winterized which led to frozen equipment and systems and (2) inadequate supplies of natural gas meant there was insufficient gas for power generation as it was being used for home heating.

In response to all the above cases, FERC and NERC have adopted various federal rules and reliability standards to address the concerns that were identified.

Even the longest power outage in U.S. history in Puerto Rico after Hurricanes Irma and Maria in September 2017 was due primarily to 80% of the transmission and distribution network being inoperable and difficult to repair given mountainous topography, rather than power generation facilities being inoperable. As a peer reviewed article in the February 2019 *IEEE Power and Energy Technology Systems Journal* found, "damage to the conventional electric power generation infrastructure was relatively minor…". A 95 MW wind farm, Puerto Rico's largest, suffered "no damage" while at the other wind farm, located near Maria's landfall, the turbine blades were damaged, but only one turbine support structure failed. Of the five utility-scale solar facilities operating at the time, one was "practically undamaged," three experienced only "light to moderate" damage, and only one, in certain sections of the facility near Maria's landfall, suffered more significant damage.

S76-22 is essentially a proposed solution to a problem – inadequate structural integrity of power generation facilities – that largely does not exist and is not contributing to blackouts.

Geographically dispersed power generation like wind and solar energy improve grid resilience, reliability, and functional recovery. If an entire wind farm or solar facility ceases operation, which is rare, geographically diverse wind and solar farms elsewhere across the state or region are still putting electrons on the grid for delivery to homes and businesses.

Further, the failure at an individual wind turbine does not mean an entire wind farm stops operating. The remaining turbines can continue to generate power if the substation and transmission to the grid remains up and running. The same feature is true with respect to solar generation.

A premise of S76-22 also appears to be that communities have power generation dedicated to serving their load and that power generation needs to be structurally stronger. That also is largely incorrect.

Except in communities that are electrically isolated from the broader power grid (such as villages in Alaska), the electrons from power generation of all types flows through the grid based on physics, the generation is not dedicated to a particular community. Rather, grid operators instantaneously balance generation from various power facilities in their area to match demand. As a part of this balancing, the grid operators account for generation or transmission that is offline for maintenance, intermittent by design, or forced offline by a component or system failure or weather. In the U.S., the grid is largely operated on a regional basis, meaning grid operators ramp up and down generation over a geographically diverse area that is not impacted by a weather system the same way. Adding the geographic diversity of wind and solar, with the broad operating areas of the grid operators, supports resilience and recovery.

Further, grid operators require excess generation capacity that is well-beyond (15% or more) demand peaks (i.e. "reserve margins") to facilitate the ability to ramp up generation to meet demand and to address generator outages (both planned an unplanned).Finally, modern utility-scale wind and solar facilities support reliability, resilience, and recovery through providing essential reliability services to the power grid like frequency support, ramping, and voltage control as documented by the U.S. Department of Energy and other grid experts.

Cost Impact: The net effect of the public comment and code change proposal will not increase or decrease the cost of construction
Disapproving S76-22 as ACP recommends will retain the status quo for construction costs.

The proponents of S76-22 estimated an increase in construction costs of only 0-2%. However, this estimate significantly underestimates the cost for wind and solar energy compliance, and potential other facilities. FEMA acknowledges as much in their January 2021 joint report with NIST (FEMA P-2090/NIST SP-1254). Table 7-4 (page 70) in the report identifies the cost of Recommendation 4 to "mandate the Design of New and Upgrade of Existing Lifeline Infrastructure Systems to Meet Recovery-Based Objectives" is "high" with feasibility rated as "difficult" and the implementation timeline identified as "intermediate to long." Recommendation 4 is conceptually like S76-22. Yet, S76-22 seeks to impose this requirement now. The proponents do not acknowledge the "high" cost impact of S76-22 to the construction of wind and solar facilities.

The 0-2% cost increase estimated by proponents is based on the increase in design load for a building frame. A building frame is a smaller percentage of the overall cost of a building than the foundation and tower are for a wind turbine which are directly impacted by S76-22.

The change in assignment of Risk Category for wind turbines as proposed by S76-22 will hence be cost and logistically prohibitive for wind energy in many cases without providing any measurable benefits in terms of resilience and recovery.

Public Comment# 3292

Public Comment 15:

Proponents: John Williams, representing Committee on Healthcare (ahc@iccsafe.org) requests Disapprove

Commenter's Reason: The scope of the Healthcare committee is for healthcare facilities, such as ambulatory care facilities, clinics, nursing homes and hospitals. Therefore, this public comment is limited to the effect of the new language to the description of Risk Category IV and how it would effect the 1st and 2nd item in the list.

- Group I-2, Condition 2 occupancies having emergency surgery or emergency treatment facilities.
- Ambulatory care facilities having emergency surgery or emergency treatment facilities.

The added language in the description for Risk Category IV could be read that any of the current occupancies in this list could sustain loss of function as long as that damage did not represent a substantial hazard to the occupants. These are a list of essential facilities that <u>must</u> be operational after an event for the safety and recovery of the entire community. Hospitals that have emergency surgery or emergency treatment facilities need to be operational after an emergency. There could be a lot of damage to the building that would not be a substantial hazard to occupants, but would stop the emergency room from functioning.

Cost Impact: The net effect of the public comment and code change proposal will not increase or decrease the cost of construction
No change to code.

Public Comment# 3058
