Editor's Letter

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This *JCIP* edition contains articles submitted in response to a Call for Papers on Critical Infrastructures and COVID-19 as well as articles having broader significance for national critical infrastructure (CI) policy. The pandemic is serving as a stress test for each of the Nation's CI sectors[1], and a reminder that when they occur, lower probability events can have enormous impact. COVID-19 has also put issues of community resilience into sharp focus. This includes society's reliance on the full array of infrastructure systems, inter-sectoral dependencies, strategic supply chains, and the professionals and practitioners who operate these complex systems of systems. Perhaps as never before, the need to embed resilience at the community and CI levels is apparent.

When the virus began propagating in early 2020, both privately held and publicly run CIs considered the nature and scope of potential response measures. The Healthcare and Public Health Sector was attuned to pandemic planning owing to preparations for the Swine Flu pandemic and a worldwide H5N1 outbreak. As those of us in the Sector recall, H5N1 had been circulating through Asia, North Africa, and the Middle East for years, achieving global spread in 2008. It had a 60 percent mortality rate for those contracting it.

Fortunately, overseas mortality attributable to that virus ended up being relatively low, and H5N1 dissipated before endangering the U.S. The Swine Flu (like the 1918 Spanish Flu, an H1N1 variant) was declared a pandemic in April 2009, with direct impact on the U.S. Based on these and other outbreaks, there was a major surge of public health planning, vaccine development, and antiviral drug distribution. Techniques that were refined in that period such as Crisis Standards of Care, have been heavily utilized in the COVID-19 response. Despite the earlier events, health professionals could not have predicted the current pandemic's virulence nor lethality. However, over the past decade, public officials have advocated that serious pandemic planning was essential.[2]

1 There are 16 critical infrastructure sectors whose assets, systems, and networks, whether physical or virtual, are considered so vital to the U.S. that their incapacitation or destruction would have a debilitating effect on security, national economic security, national public health or safety, or any combination thereof. Presidential Policy Directive 21 identifies these sectors: Healthcare and Public Health; Energy; Information Technology; Transportation Systems; Communications; Emergency Services; Financial Services; Chemical; Critical Manufacturing; Nuclear Reactors, Materials and Waste; Government Facilities Water and Wastewater Systems; Food and Agriculture; Defense Industrial Base; Dams; Commercial Facilities.

2 "Guidance for Establishing Crisis Standards of Care for Use in Disaster Situations," Institute of Medicine, National Academies Press, 2009.

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While the Healthcare and Public Health Sector and the Emergency Services Sector remain in the forefront, all CI sectors continue to adapt to changing pandemic conditions. In order to ensure continuity of operations for essential functions, in mid-year 2020, the Centers for Disease Control issued guidelines for critical infrastructure employees exposed to COVID-19. This guidance permitted CI employees to continue working following potential exposure, provided they remained asymptomatic and additional precautions were implemented to protect them, their organizations, and the community. Despite significant challenges to their operations and workforce, the Energy Sector did an outstanding job maintaining electric service to Americans adapting their family and work lives to unprecedented conditions.

As 2020 progressed, the Transportation, Food and Agriculture, Commercial Facilities, and other sectors were heavily impacted. Many CI operators reassessed their objectives, adjusting to upward, downward, or erratic service demand. In an unexpected turn, the locus of the pandemic response shifted from the federal to the state and local levels. As governors and mayors know, the geographic sprawl of CI systems often transcends their political jurisdictions, sometimes complicating crisis decision-making.

It will take years to fully unwind the lessons of this pandemic. But it is worth stating the obvious now—that awareness of the most predictable public health catastrophe did not result in pandemic safeguards prior to the event's occurrence.[3] At present, across multiple critical infrastructures, preparedness is far from assured. That is one reason why JCIP includes emergency management within the scope of its interest. Whether natural or human caused—or the result of other factors—cascading failures of CI systems can occur. The Emergency Services Sector and other responders must be prepared and equipped for events of that magnitude.

It is also worth noting that the impact of major, long-term CI lapses can exceed those of a pandemic in terms of human and economic consequences. For example, if an extended, large footprint power outage were to occur, financial markets would collapse, most strategic supply chains would halt, and the vast majority of hospitals would close following the depletion of backup generator fuel.

But there is also cause for optimism at this stage. Vaccine development during the current crisis vividly demonstrates how quickly a national effort to devise solutions can produce results. During this profound challenge and in its aftermath, it is hoped that a shared experience of this scale will give rise to heightened resilience for the critical infrastructures on which we all depend. The articles in this issue are intended to contribute to that goal.

3 The SARs and MERs coronavirus outbreaks occurred in 2003 and 2012, resp. There were many serious communicable disease outbreaks internationally during the period 2000-2020.

Current Issue

My *Editor's Interview* with PJM President & CEO *Manu Asthana* exemplifies steps taken in the Energy Sector to avert critical worker shortages in the pandemic. PJM is the biggest power grid in North America, and the largest energy market in the world. The strategies implemented by Mr. Asthana and his team could be viewed as a pandemic response model for both privately held and publicly run critical infrastructures. By ensuring worker safety in control rooms, other facilities, and in the field across a 13-state region, continuous electricity was provided to 65 million people and the infrastructures serving them.

The massive Food and Agriculture Sector was heavily impacted by COVID-19 and continues to adjust to its realities. In "Supply Chain Resilience: Push and Pull in Catastrophes," *Phillip Palin* examines how supply chains responded to COVID-19, and the pandemic's impact thus far on grocery and food supply. Following the article's first installment in the Spring/Summer edition[4], Mr. Palin continues to frame his analysis in Washington State's 4.2 million population Puget Sound Region. Based on the COVID-19 experience, he postulates that demand drives and organizes supply, product movement may matter most, and that at any point in time, capacity is essentially fixed. Mr. Palin applies the findings to a future earthquake event in the same region. Washington State is where the first U.S. case of COVID-19 appeared, and the region is also designated as an earthquake "hot zone."

Sherrell Greene, in "How Nuclear Power Can Transform Electric Grid and Critical Infrastructure Resilience," explores Small Modular Reactors (SMR) and how this new nuclear technology could facilitate electric grid resilience. The concept of a resilient nuclear power plant is introduced and the requirements for achieving that capacity assessed. He includes a preliminary, exploratory review of how current SMR designs may assist grid resilience based on criteria suggested by the author. Mr. Greene posits that strategic use of resilient nuclear power plants coupled with resilient critical infrastructure islands could transform electric grid, critical infrastructure, and strategic asset supply chain resilience. He then examines key technical, economic, regulatory, and policy barriers to adopting this new technology for grid resilience, and initial steps that should be taken to deploy SMRs on a widespread basis.

Focusing on the Energy Sector, *Alexander Gilbert* and *Norman Bazilian* analyze the direct and indirect pandemic effects on the operations and resilience of global energy markets and on energy sector resilience. In "*COVID-19 Pandemic: Energy Market Disruption and Resilience*," they note that the pandemic's effects on the sector are occurring during a period of rapid structural change. The pandemic may be a critical juncture for a clean energy transition, as both government di-

4 Palin, Phillip. 2020. "Food and Other Supply Flows in Case of Catastrophe." *Journal of Critical Infrastructure Policy* 1 (1), 51-67.

saster recovery and stimulus measures could influence the trajectory of systemic change—both technologically and socio-economically. Financial resilience of the sector has thus far weathered the pandemic but may become increasingly stressed as the pandemic proceeds. While energy supply and resilience has traditionally been considered a supply issue, the pandemic has made clear that resilience measures must also consider demand disruptions.

Based on work supported by a National Science Foundation grant, *David Mendonça, José Orlando Gomez, Ann-Margaret Esnard, Tracy Kijewski-Correa,* and *Julio Ramirez* examine "COVID-19 Implications for Research and Education on Engineered Structures and Services." They note that despite the fact that the pandemic threat had been well documented, too many of the engineered structures and services supporting institutional health were driven to extreme dysfunction by COVID-19. Applying international observations from the field, the authors conduct a multi-faceted analysis, suggesting that engineering fields should advocate for better (or at least different) social outcomes, and that issues such as social good and equity be incorporated into current engineering paradigms. Specific ways to accomplish that are enumerated in this thought-provoking article.

Joseph Weiss, in "Control System Cyber Security," argues for a vigorous national effort to upgrade the cyber security of control systems. Despite major challenges in the threat environment and a recent Presidential Executive Order, there is growing recognition that progress in this area has been insufficient. Examples of major breaches are provided. Among other reasons for control system risk, Mr. Weiss examines a shift that followed the 9/11 attacks, when the cyber security for control system functions moved from the engineering to the information technology components of both privately owned and public critical infrastructures. On a number of fronts, attempts are being made to grapple with the cybersecurity requirements of control systems in a context of both increasing system interconnectedness and heightened cyber risk. It is likely that promising advances will be made in both proactive and adaptive techniques to detect and mitigate control system cyberattacks. To this end, he provides a number of prescriptions to upgrade control system cybersecurity, including technological, organizational, and educational remedies.

In work supported by the Smith Richardson Foundation, *Thomas Popik* and *David Winks,* in "Building Resilience and Recoverability of Electric Grid Communications," note that the telecommunications component for the U.S. electric grid is a subsystem vulnerable to an electromagnetic pulse (EMP). The authors determined equipment and other vulnerabilities and estimate the cost to mitigate these weaknesses. Using engineering analysis, vendor cost data, and publicly available information on facility counts, they calculate the financial resources necessary to provide nationwide EMP resilience. This procedure was repeated for each relevant type of equipment and category of facility. Beyond cost estimation, the study pro-

vides a model for a mass-produced, easily deployed way to protect grid communication systems at 72,000 electric grid facilities across the U.S.

In "Leveraging Public Private Partnerships in Maryland: A COVID-19 Case Study," *Allegra Tartaglia* and *Kyle Overly* present a case study of the Maryland Emergency Management Agency's (MEMA) use of a public-private business partnership in response to the pandemic. The study traces the development and performance of the agency's Maryland Business Emergency Operations Center (MBEOC), clarifying how MEMA and MBEOC responded during the early pandemic challenge. The study provides insights on how a state known for aggressive action on COVID-19 orchestrated its response, how and where state government and private groups interfaced, as well as lessons learned. In addition to examining the leveraging of partnerships for disaster response, the authors call for increased use of community groups in improving consequence management activities and the adoption of the business emergency operations model by other states.

Maggie Davis, Netta Squires, and *Chris Webster* advocate a policy shift in how the U.S. addresses food insecurity during and following a disaster. In "COVID-19 and the Case for a National Food Emergency Stockpile," the authors examine the current basis of improving food security. Local, federal, and state strategies to distribute emergency food are examined in the pandemic context and shortcomings noted. The COVID-19 pandemic has revealed weaknesses in food supply chains that end with Food Assistance Providers (FAPs). FAPs are typically charitable organizations, such as nonprofit food banks, food pantries, sectarian, and other community-based groups that broadly serve those experiencing food insecurity. The existing Strategic National Stockpile and Strategic National Petroleum Reserve models are assessed, as are the requirements for a workable National Food Stockpile. In addition to other criteria, the importance of pre-planned, decentralized, deployable, all hazards approaches are advocated.

Brian Harte and *Umesh Kumar* examine power outages in the U.S. from 2000 to 2020 in "Electric Power Grid Disruptions; A Time Series Examination." The 20-year dataset is maintained in a publicly available and managed Department of Energy (DOE) information system. Electricity providers are required to report the characteristics of power outages, causation, and other factors. The article's findings are presented by outage category and geographically. Over the 2011 through mid-2020 timeframe, the number of power outages increased compared to earlier years, and this trajectory could continue. Notably, the number of outages lasting more than one day has decreased. The authors note that the ability to conduct meaningful policy analysis in this arena requires reliable baseline data. Because of significant database and reporting limitations, they recommend that various reliability improvements occur, including a forensic capacity to examine key occurrences for database integrity. Through their assessment, the authors hope to expand awareness of the DOE database among academic researchers and policy analysts.