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# Bolstering emergency power resilience for hospitals during power outages: How the Los Angeles County Emergency Medical Services Agency initiative offers a blueprint for other jurisdictions

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## Abstract

*This paper describes an initiative launched by the Los Angeles County (LAC) Emergency Medical Services (EMS) Agency to bolster emergency power resilience for hospitals operating in LAC. The multiyear initiative, launched in 2019 and concluded in October 2023, culminated in the publication of the 'Healthcare Facility Emergency Power Resilience Playbook',[1] a heralded resource that introduces innovative protocols to address significant vulnerabilities uncovered during the initiative. These vulnerabilities included seriously outdated generators, facilities with no redundant emergency power and facilities with limited onsite generator fuel storage capacity. New protocols developed to address these gaps include accelerated emergency power threat reporting by hospitals and a first-ever, confidential risk rating of hospital emergency power systems by a government agency. This move is intended to help the LAC EMS Agency maintain closer vigilance of higher-risk facilities during an outage. The new protocols far exceed the federal government's emergency power requirements for hospitals. This paper also outlines the additional steps jurisdictions could consider to build on the LAC EMS Agency's groundbreaking work to achieve even higher levels of emergency power resilience. This article is also included in* ***The Business & Management Collection*** *which can be accessed at https://hstalks.com/business/.*



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## INTRODUCTION

No state has had more wildfires in recent decades than California, and these disasters have become deadlier and more destructive in recent years. The 2018 Camp Fire claimed 86 lives in Northern California's Butte County. Los Angeles County (LAC) in Southern California has also had its share of deadly and destructive wildfires. According to records from the California Department of Forestry and Fire Protection,[2] three of the 20 most deadly California wildfires have occurred in LAC and two of the 20 most destructive fires have occurred in nearby San Diego County.

The growing realisation that a significant number of wildfires were sparked by utility transmission lines led to new legislation in California. This legislation authorised utilities to pre-emptively shut off power in areas where weather conditions posed an elevated risk that utility lines would trigger fires.[3] In the five-year period between 2018 and 2023, Southern California Edison (SCE), the largest utility serving LAC and surrounding areas, implemented a total of 55 shutoffs. These proactive measures, and the warnings of pending Public Safety Power Shutoff (PSPS) events, led many healthcare facilities to test generators ahead of the shutoff, which unfortunately triggered a number of generator failures in hospitals and skilled nursing facilities. These failures, and the broader threat from PSPS events, drew close attention from Terry Crammer, then the Chief of Disaster Services for the LAC Emergency Medical Services (EMS) Agency.

The LAC EMS Agency is charged with helping 80 hospitals in LAC develop and refine disaster response plans while also providing direct support to hospitals experiencing problems during an emergency. During the COVID-19 pandemic, for example, the LAC EMS Agency coordinated support for the county's overwhelmed hospitals, including providing millions of units of personal protective equipment and other COVID-19 supplies.

Several years before PSPS events became a reality, the LAC EMS Agency was focused on the low-probability but high-impact consequences of a catastrophic Southern California earthquake. This deadly event would likely knock power out for weeks, if not longer.[4] Concern over this scenario prompted the LAC EMS Agency to join with the LAC Office of Emergency Management and the cities of Long Beach and Los Angeles to collectively seek Federal Emergency Management Agency (FEMA) funding to purchase a sizeable fleet of temporary generators that could be deployed to hospitals, skilled nursing facilities or other critical infrastructure facilities throughout LAC during an extended outage. FEMA funding enabled these jurisdictions to collectively purchase twelve 800kW generators and 23 200kW generators — sizes well matched to generators used by hospitals and skilled nursing facilities.

The addition of the generator fleet was the starting point of the LAC EMS Agency's plan to boost emergency power resilience in the face of the threats posed by earthquakes and now PSPS events. The agency knew it needed a broader strategy to develop a comprehensive emergency power resilience plan for the county's hospitals and the government agencies charged with helping those hospitals should emergency power fail during an outage.

To develop that strategy and create a detailed response plan, the agency contracted with Powered for Patients (P4P), a 501c3 non-profit created by Eric Cote to address the lessons learned when Hurricane Sandy shuttered emergency power systems in six New York area hospitals, resulting in four emergency evacuations. Cote is

a subject matter expert in emergency power resilience for hospitals. Prior to being retained by the LAC EMS Agency, Cote had completed a FEMA-funded project for the Rhode Island Emergency Management Agency, which assessed response protocols for emergency power failures in Rhode Island's 15 hospitals.

The LAC EMS Agency worked with Cote to develop a comprehensive plan for a multiphase initiative that would span more than four years, a period extended by the COVID-19 pandemic that sidelined the project for a five-month period. During this time, project management transitioned to Chris Sandoval, LAC EMS Agency's Disaster Program Manager, who worked with P4P to implement the plan. The key phases of the project and their primary activities are described below.

## PHASE I: MAY 2019 THROUGH OCTOBER 2020

Key Phase I activities included:[5]

- Assessment of current emergency power threat reporting protocols used by hospitals during power outages.
- Review of state and county emergency response plans to assess how these plans addressed the responsibilities of government agencies and hospitals when responding to the failure of emergency power during power outages.
- Creation of an up-to-date list of the locations and custodial points of contact for the 12,800kW and 23,200kW generators (purchased with FEMA funds) to determine their locations and custodial points of contact.
- Preliminary evaluation of a representative sample of hospital emergency power systems.
- Enhanced power outage coordination with SCE and the City of Los Angeles Department of Water and Power (LADWP) to accelerate restoration and response to hospitals experiencing emergency power failures.
- Establishment of working relationships with leading generator service, rental and fuel providers.

## PHASE II: AUGUST 2020 THROUGH NOVEMBER 2022

Phase II focused on implementing the recommendations Cote made at the conclusion of his Phase I work, which included:

- Development of a comprehensive Emergency Power Threat Reporting and Response Protocol to include an early warning and status update protocol for hospitals.
- Conducting a census of emergency power systems in the 80 LAC hospitals that participate in the U.S. Department of Health and Human Services (HHS) Hospital Preparedness Program (HPP).
- Creation of a confidential Emergency Power System Risk Calculation for individual hospitals in LAC to help LAC EMS Agency officials maintain closer vigilance of hospitals with emergency power systems considered at higher risk of failure or with systems whose failures were more likely to trigger an emergency evacuation (single-generator hospitals).
- Formalising communications with leading generator service, rental and fuel providers by creating an Emergency Power Industry Working Group.
- Strongly encouraging hospitals to invest in generator rental contracts and install quick connect devices, especially those with single or two-generator emergency power systems.

## Additional detail on key Phase II activities

### *Census of emergency power systems in 80 LAC hospitals reveals seriously outdated generator fleet*

Cote conducted a census of the emergency power systems in 80 LAC hospitals, seeking the following information:

- Number, age, make and size of generators.
- Number of automatic transfer switches (ATS).
- Number and size of fuel tanks.
- Status of multiple feeds from the electric utility.
- Name of generator service, fuel and rental provider(s).
- Status of air conditioning connectivity to emergency power.

To encourage participation in the census, LAC EMS Agency officials assured the 80 hospitals that the information would be kept confidential and would not be shared with regulators or members of the media.

Obtaining responses from all the hospitals took months of follow-up by Cote. In the end, only two of the 80 hospitals failed to submit detailed census data. Nevertheless, Cote was still able to determine that the total number of generators among the 80 hospitals was 271.

Among the census's most significant finding was the number of seriously outdated generators. Eighty-seven of the 271 generators, or 32 per cent, were 30 years old or older (thirty years is considered the expected useful life of a generator[6]). Table 1 provides a detailed breakdown by age grouping among the 271 generators captured in the census.

Even more concerning was the age of generators among the 14 single-generator hospitals captured in the census. Nine facilities, or 64 per cent, relied on generators over 30 years of age, more than double the percentage of generators over 30 years of age across the entire fleet. Among these nine facilities, three had generators between 50 and 59 years of age, and one relied on a generator over 60 years of age. Table 2 provides a detailed breakdown by generator age among the 14 single-generator facilities.

These findings alarmed LAC EMS Agency officials, who were especially concerned about the outdated generators in the 14 single-generator hospitals. Cote explained that no federal, state or local laws or safety codes limit the age of hospital generators. A generator of any age can continue operating as long as it passes required tests, which include monthly starts and running the generator for a four-hour period every three years. Cote cautioned that these test conditions do not reflect the real-life challenge an older

**Table 1: Age grouping of generators**

| *Age range* | *No. of generators* | *% of total* |
|---|---|---|
| 0–9 years | 47 | 17% |
| 10–19 years | 69 | 26% |
| 20–29 years | 68 | 25.00% |
| 30–39 years | 32 | 12% |
| 40–49 years | 40 | 15% |
| 50–59 years | 9 | 3% |
| 60–69 years | 6 | 2% |

**Table 2: Breakdown of generator age**

| *Age range* | *No. of generators (among 14)* | *% of total* |
|---|---|---|
| 0–9 years | 2 | 14% |
| 10–19 years | 1 | 7% |
| 20–29 years | 2 | 14% |
| 30–39 years | 2 | 14% |
| 40–49 years | 3 | 21% |
| 50–59 years | 3 | 21% |
| 60–69 years | 1 | 7% |
| | Total number of hospitals 14 | |

generator would face if called upon to run continuously for days during an extended power outage.

### *Single-generator hospitals with no redundant emergency power draw closer scrutiny*

To address the elevated risk of an emergency evacuation should a single-generator facility experience a generator failure, the LAC EMS Agency offered funding to these facilities to deploy an advanced generator monitoring technology that provided 24/7 automated real-time notifications to designated individuals any time emergency power was activated or faced a mechanical problem while operating. The system's real-time warning would enable accelerated response by service providers and faster deployment of a government generator should one be needed, both of which can help minimise the risk of an emergency evacuation. As of September 2021, two of the 14 eligible facilities had deployed the P.I.O.N.E.E.R. tool. P.I.O.N.E.E.R. stands for Power Information Needed to Expedite Emergency Response.

Cote informed LAC EMS Agency officials about the feedback he received from facilities that refused the funding. These facilities were hesitant to share automatic reports of real-time generator status with county officials before they had a chance to independently assess the situation with their emergency power system.

### *Additional findings of emergency power system census*

The census highlighted the wide range in emergency power system size across the county's 80 HPP hospitals, not only in the quantity of generators but in the amount of power produced by these generators. This variability is to be expected, considering the diverse range of hospital sizes in terms of licensed beds, intensive care unit (ICU) beds and operating rooms.

The most extensive emergency power system included ten generators with a combined power of 8.59MW, supporting a facility with over 500 beds, including more than 50 ICU beds and 20 operating rooms. In contrast, a smaller 100-bed hospital with five ICU beds and three operating rooms relied on a single 100kW generator for support.

Most hospitals utilised a dual-generator system, which accounts for 24 hospitals (30 per cent). While this setup mitigates the risk of relying on a single generator, it also introduces its own set of potential pitfalls. Typically, if one generator malfunctions in a dual-generator facility, emergency power cannot be seamlessly transferred to the other generator. Consequently, essential hospital operations could be left without a backup power supply.

The second most prevalent size is the single-generator system, present in 14 hospitals (18 per cent). The third most common size is a three-generator system, present in 12 hospitals (15 per cent). Table 3 illustrates the generator fleet sizes as measured in number of generators.

**Table 3: Generator fleet sizes**

| *Number of generators per hospital fleet* | *Number of hospitals by fleet size* | *Percentage of total* |
|---|---|---|
| 2 | 24 | 30% |
| 1 | 14 | 18% |
| 3 | 12 | 15% |
| 5 | 9 | 11% |
| 6 | 7 | 9% |
| 4 | 5 | 6% |
| 9 | 2 | 3% |
| 7 | 3 | 4% |
| 10 | 2 | 3% |
| 8 | 1 | 1% |

### *Fuel capacity*

The fuel capacity for emergency power systems varies significantly, with many facilities able to operate their generators for a significant number of days before refuelling. The largest emergency power fuel system has a 200,000-gallon capacity, enough fuel to keep the facility operating on emergency power for more than seven consecutive days. At the other end of the spectrum, one hospital only has enough fuel capacity on site to run its generators continuously for 22 hours. The vast differences in fuel capacity will require more frequent refuelling of hospitals with smaller fuel capacity, a process that could become challenged in a severe fuel shortage, underscoring the need for proactive planning and resource management.

### *Heating, ventilation and air conditioning (HVAC) connectivity to emergency power takes on added importance following federal rule update*

The survey revealed a concerning number of hospitals that did not have air conditioning connected to emergency power. In November 2017, the U.S. Department of HHS Center for Medicare and Medicaid Services (CMS) implemented the Emergency Preparedness Rule. Among other mandates, the new rule required hospitals and nursing homes to ensure that temperatures in patient care areas not exceed 81°F during a power outage. This rule was inspired by deadly outcomes in previous hurricanes, such as Hurricane Katrina, which resulted in patient deaths due to escalating indoor air temperatures in hospitals and nursing homes following power outages.

Adhering to this temperature requirement would necessitate connecting significant elements of a facility's air conditioning system to emergency power — a costly step that few hospitals had taken as of August 2024. Hospitals and nursing homes unable to maintain temperatures at 81°F or below during a power outage would be required to evacuate. Additionally, Florida and California implemented stricter rules than the federal requirement regarding air conditioning connectivity to emergency power.

In September 2017, following Hurricane Irma's landfall in Florida (FL), 12 elderly residents of the Hollywood Hills Rehabilitation Center in Hollywood, FL died after indoor air temperatures rose to dangerous levels. A generator at the facility was operational at the time of the deaths but air conditioning was not connected to the generator, and at the time was not required to be. In response to this tragedy, Florida's Governor, Rick Scott, pushed through regulatory and legislative changes that required nursing homes and assisted living facilities (ALFs) to connect air conditioning to emergency power. The effort was challenged by Florida's nursing home association, but an agreement was eventually reached that provided nursing homes and ALFs with additional time to comply.

According to a Florida legislative staff analysis at the time,[7] the mandate was expected to cost US$121,380,545 for the nursing-home industry and US$243,912,720 for the ALFs in the first five years. California has followed Florida's lead in mandating tougher standards for nursing homes. In September 2022, California Assembly Bill (AB) 2511 was passed, requiring skilled nursing facilities (SNFs) to connect air conditioning to a source of emergency power by 1st January, 2024. The California Association of Health Facilities (CAHF), the trade association that represents most SNFs in California, fought the legislation unsuccessfully. Nearly all SNFs in California will have to undergo costly expansions of their emergency power systems.

Among the hospitals in LAC that reported on HVAC connectivity to

emergency power, 18 hospitals (27 per cent) had no air conditioning connection; 50 hospitals (74 per cent) had some portion of their air conditioning connected to emergency power.

For facilities with partial or no air conditioning connected to emergency power, spot coolers connected to electrical outlets supplied by emergency power could be used to maintain safe indoor temperatures during a power outage. This approach, however, may prove difficult in preventing temperatures from rising above 81°F, especially in larger facilities.

### *Creating a confidential emergency power system risk calculation*

As part of Phase II work, Cote and the LAC EMS Agency developed a confidential two-tier emergency power system risk calculation for individual hospitals in LAC. The goal of the risk rating was to help LAC EMS Agency officials maintain closer vigilance of hospitals with emergency power systems considered at higher risk of failure or with systems whose failures were more likely to trigger an emergency evacuation (single-generator hospitals).

The two risk tiers and the criteria for each were as follows:

- *Tier 1*: The facility has ample emergency power resources and no issues of concern relating to generator age, limited fuel capacity or lack of redundant emergency power.
- *Tier 2*: Facilities meet one or more of the following conditions:
  - Single-generator hospitals (which by definition have no redundant source of emergency power).
  - Hospitals with less than 48 hours of generator run time, based on onsite fuel storage capacity.
  - Hospitals with single or two-generator emergency power systems where one or both generators are in excess of 30 years of age.

Of the 80 hospitals captured in the census, 42 were rated as Tier 1 facilities and 38 were rated as Tier 2 facilities.

### *Development of a comprehensive emergency power threat reporting and response protocol*

Cote and the LAC EMS Agency collaborated to develop a protocol for emergency power threat reporting during power outages, aiming to accelerate reporting without overwhelming hospitals as they responded to the outage's impact on hospital operations.

To facilitate emergency power status reporting, the LAC EMS Agency enhanced its web-based emergency medical communications system that enables two-way, real-time communications between hospitals and the agency about a hospital's operating status during emergencies. The system is called ReddiNet, which was initially developed more than 25 years ago by the Hospital Association of Southern California (HASC). ReddiNet has evolved its technology platform over the years and is used by the LAC EMS Agency and by EMS agencies in 22 other California counties. All 80 HPP hospitals subscribe to ReddiNet, which is supported by a satellite connection to maintain information flow during an outage that disrupts services from traditional communications providers.

The LAC EMS Agency operates a 24/7/365 Medical Alert Center (MAC). Personnel actively monitor a ReddiNet dashboard to assess each hospital's status, including the availability of various clinical services and its capacity to accept patients transported by ambulances responding to 911 calls.

To support the new emergency power status reporting requirement, ReddiNet

added a 'generator' pill to the list of reporting categories (see Figure 1). Once hospital personnel are logged into ReddiNet and click on the generator pill, a newly developed window opens up with four drop-down questions (see Figure 2).

The LAC EMS Agency's new protocol requires hospitals to report generator status within 30 minutes of an outage, unless any of the following scenarios arise:

- Clinical services fall below reduced levels normally available when emergency power is functioning properly.
- Run time is less than 24 hours based on current fuel levels.
- Mechanical problem arises that requires a call to service provider (for Tier 2 facilities only).

Status reporting is achieved when a hospital answers the four questions shown in Figure 2. Based on a facility, the severity of the situation is reflected in the facility's generator pill on the ReddiNet dashboard using a red, orange, yellow or green threat level indicator scale.

If a facility indicates that it has 24 hours or less of remaining generator run time (based on their answer to question 4), their generator pill will be coloured red. These facilities are then required to report on the remaining fuel level every six hours by logging back into ReddiNet and answering the four questions again. This six-hour reporting allows the LAC EMS Agency to maintain close vigilance of a facility running dangerously low on fuel. In such a scenario, county agencies may be able to deploy a fuel truck or assist in expediting the deployment of private fuel.

### *Threat level triggers different EMS agency response actions*

The red, orange, yellow and green threat scale is intended to help MAC personnel identify facilities experiencing serious problems with emergency power and prioritise their response to facilities accordingly. If a generator pill illuminated in red, MAC personnel would contact a hospital official to obtain further situational awareness beyond what is reported through ReddiNet. They would also notify the

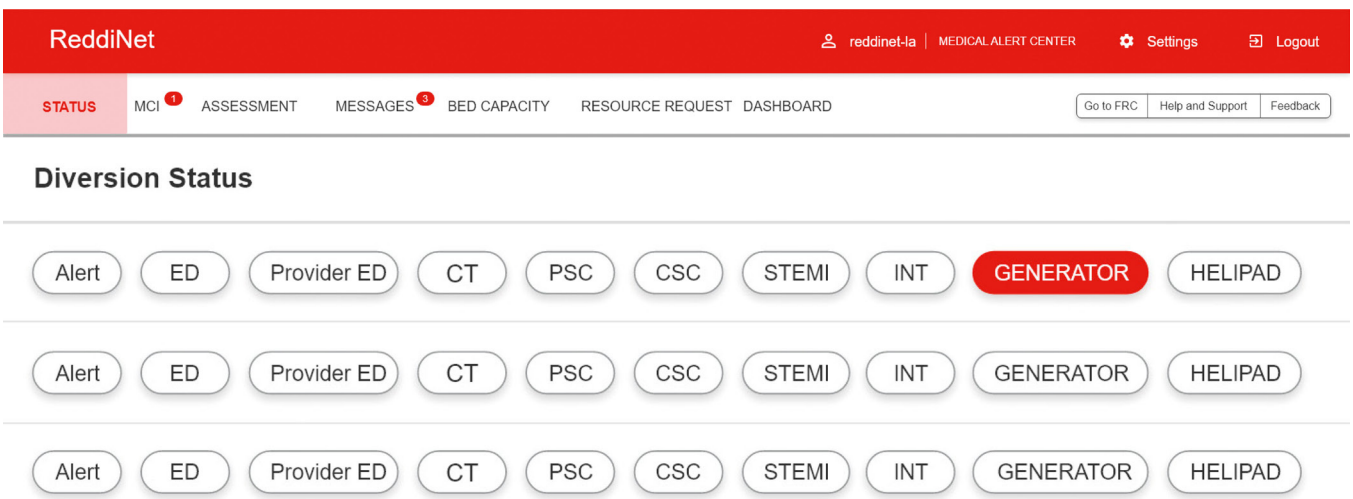


*Figure 1 Generator pill, ReddiNet*

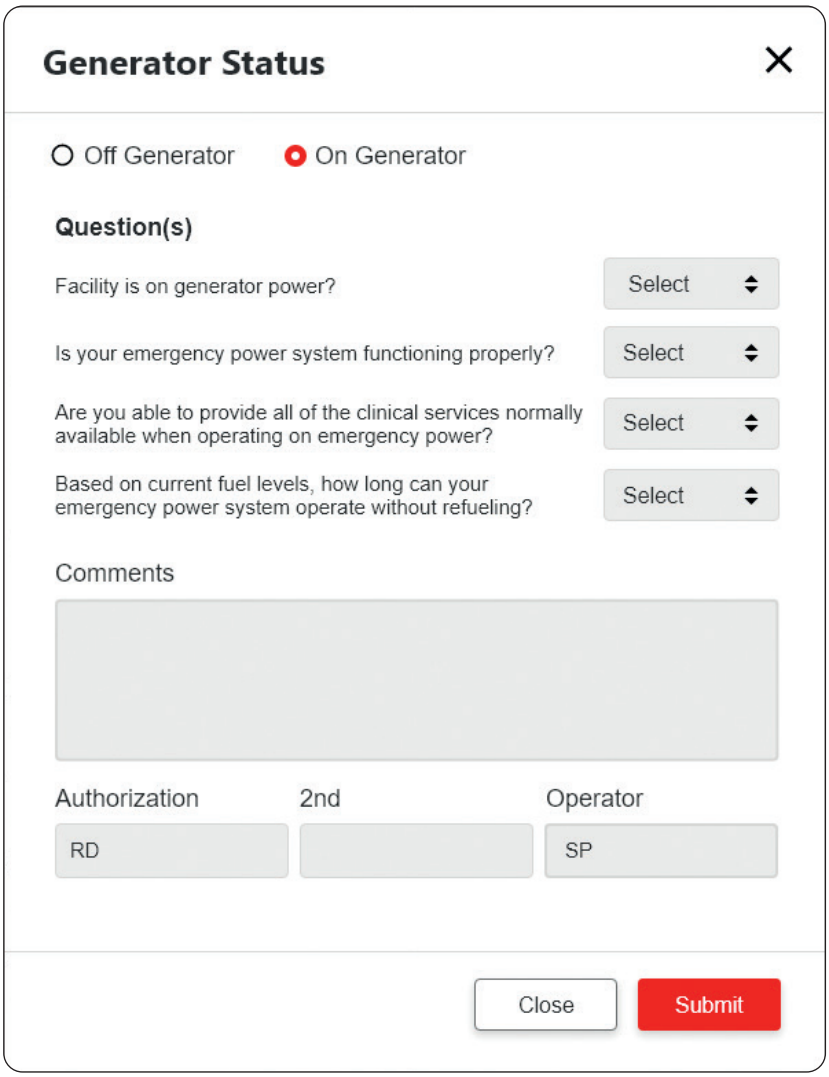


*Figure 2 Generator pill drop-down questions*

EMS Agency's administrator on duty, who would likely establish contact with the facility to assess its need for support. MAC personnel would actively monitor and communicate with this facility until the threat is resolved.

### *Other new protocols developed by the LAC EMS Agency to bolster emergency power resilience*

The LAC EMS Agency developed an Emergency Power System Vulnerability Assessment tool to respond to vulnerabilities identified in the census of hospital emergency power systems. Hospitals are encouraged to utilise the tool to identify vulnerabilities that might have gone unnoticed. The assessment included probing questions about maintenance history, equipment condition and internal communications protocols when emergency power failures arise. It also included a benchmarking component that allowed facilities to compare their emergency power systems to peer facilities based on anonymised data regarding

bed counts and the number, age and size of generators. The vulnerability assessment is available in the appendix of the Healthcare Facility Emergency Power Resilience Playbook.[8]

## PHASE III: NOVEMBER 2022 THROUGH OCTOBER 2023

Phase III was focused exclusively on creating the 'Healthcare Facility Emergency Power Resilience Playbook'.[9] This resource, developed by Cote and the LAC EMS Agency, introduced the new emergency power threat reporting protocols and details other best practices to safeguard emergency power, including those drawn from previous FEMA publications.

## PHASE IV: JULY 2023 THROUGH NOVEMBER 2023

Phase IV ran partially concurrent with Phase III and involved the creation of training resources and the development and implementation of a tabletop exercise to introduce the 'Healthcare Facility Emergency Power Resilience Playbook'[10] to the 80 hospitals in LAC that participate in the HHS HPP.

### How could other jurisdictions leverage the investment made by the LAC EMS Agency to bolster emergency power resilience for their hospitals?

Other jurisdictions worldwide interested in bolstering emergency power resilience for their hospitals can look to the LAC project for helpful guidance. Jurisdictions can calibrate the scope of their initiative based on the available resources. The potential approaches are broken into the following categories:

- Least resource-intensive.
- Moderate to significant Investment of personnel time (LAC-like approach).
- Major investment of personnel time (going beyond LAC-like approach).

### Least resource-intensive

Jurisdictions interested in leveraging the LAC project with minimal staff time investment can make immediate use of the many universally applicable appendices in the LAC Playbook. Of the 20 appendices in the Playbook, 13 of them (see below) could be effectively utilised by any jurisdiction and its hospitals with a very modest investment in staff time. The primary staff responsibility would be creating a simple document that introduces the appendix resources to hospitals and explains their purpose, ie bolster emergency power resilience. Hospital personnel receiving the resources would simply need to share them with colleagues, to include the facility director, emergency management officer and an administrator. Hospitals may also want to schedule a discussion to address strategies for incorporating appendix resources into the facility's emergency operations plan. The universally applicable 13 appendices are as follows:

Appendix B — Emergency Power System Assessment and Benchmarking Worksheet for Hospitals
Appendix C — Emergency Power System Assessment Worksheet for Sub-Acute Skilled Nursing Facilities
Appendix D — Outdated Generators: A Risk To Patient Safety
Appendix I — Emergency Power Quick Connects: A Smart Investment for Hospitals and Sub-Acute Skilled Nursing Facilities
Appendix K — Post-Disaster Hotwash Template of Key Questions
Appendix L — Key Emergency Power Contacts Worksheet
Appendix M — Inventory of Key Generator Parts and Fuel Consumption Rates

Appendix N — FEMA D-1 Checklist for Emergency Power Planning Prior to Power Outage
Appendix O — FEMA D-2 Checklist for Emergency Power Planning During Power Outage
Appendix P — FEMA D-3 Checklist for Emergency Power Planning Following Power Outage
Appendix Q — Los Angeles County EMS Agency Medical and Health Resource Request Form
Appendix R — The 10 Most Common Causes of Generator Failure
Appendix S — Generator Fuel Consumption Rate Chart

### Moderate to significant investment of personnel time (LAC-like approach)

The LAC EMS Agency initiative is believed to represent the most advanced work by an EMS agency or health department in the US regarding safeguarding hospital emergency power during outages. Jurisdictions are encouraged to tackle as many elements of the LAC project as resources allow. The key elements of the LAC initiative, in sequential order, were as follows:

- Assessment of current emergency power threat reporting protocols used by hospitals during power outages.
- Review of state and county emergency response plans to assess how these plans addressed the responsibilities of government agencies and hospitals when responding to the failure of emergency power during power outages.
- Creation of an up-to-date list of the locations and custodial points of contact for any temporary emergency power assets that could be deployed to hospitals or other critical facilities experiencing an emergency power failure during a power outage.
- Preliminary evaluation of a representative sample of hospital emergency power systems.
- Enhanced power outage coordination with the jurisdiction's electric utilities. A focal point for discussion is whether enhanced coordination and information sharing can accelerate prioritised restoration for hospitals experiencing an emergency power failure during an outage. Utilities often own temporary emergency power assets, so conversations with utilities can determine whether this applies and, if so, what circumstances would warrant the deployment of utility-owned emergency power assets to hospitals during an outage.
- Establishment of working relationships with leading generator service, rental and fuel providers.
- Development of a comprehensive Emergency Power Threat Reporting and Response Protocol to include an early warning and status update protocol for hospitals.
- Conducting a census of emergency power systems in the jurisdiction's hospitals.
- Creation of a confidential Emergency Power System Risk Calculation for individual hospitals to help officials maintain closer vigilance of hospitals with emergency power systems considered at higher risk of failure or with systems whose failures were more likely to trigger an emergency evacuation (single-generator hospitals).
- Creation of an Emergency Power Industry Working Group.
- Develop a localised version of the LAC 'Healthcare Facility Emergency Power Resilience Playbook'. This should incorporate any new protocols implemented by the jurisdiction relating to emergency power status reporting. Additionally, it should include best practices outlined in the LAC Playbook,

ie encouraging hospitals to invest in generator rental contracts and the installation of quick connect devices, especially those with single or dual-generator emergency power systems.
- Develop training resources, including a tabletop exercise to help socialise the Playbook and its new protocols with hospital personnel to include facility directors, emergency management officers and administrators.

### Major investment of personnel time (going beyond LAC-like approach)

For jurisdictions that want to go even further than the LAC EMS Agency initiative, undertaking one or more of the following steps would advance emergency power resilience to even higher levels.

#### *Step 1: Support hospitals in developing fuel conservation plans based on load shedding*

Hospitals should be encouraged to develop a detailed emergency power load-shedding plan for fuel conservation purposes. This would prove useful in an extended and widespread power outage that triggers fuel rationing. A facility would need to assess its ability to shut off emergency power to less-critical operations so they could throttle back emergency power while still delivering sufficient power to higher-priority areas, ie shutting off emergency power for surgical suites but maintaining it for the emergency department. This process would be easier for larger hospitals with multiple generators and more challenging for smaller ones, including those with only one generator.

The ideal outcome of this planning would be a spreadsheet showing what services can still be provided when emergency power is operating at various capacities with the corresponding fuel consumption for each generator output level, ie full capacity, 3/4 capacity, 1/2 capacity, 1/3 capacity. The spreadsheet would help officials weigh the value of fuel conservation against the loss of certain services at specific hospitals.

As a reference point, Table 4 shows the actual diesel fuel consumption across the 271 generators captured in the census of 80 hospitals at various output levels over a four-day period.

#### *Step 2: Develop contingency plans for rationing of temporary generators and generator fuel*

The second step a jurisdiction should take would be stepped-up planning for unprecedented power outages and the likely failure of multiple generators triggered by such a scenario. This would involve contingency planning for shortages of generators and generator fuel of varying degrees of severity. The planning would focus on which hospitals to close and

**Table 4: Emergency power fuel consumption by the 271 generators among 80 LAC hospitals at full and reduced operating capacity over an extended power outage. (The federal government has established 96 hours of run time as the goal for hospital emergency power systems during outages.)**

| *Operating capacity* | *24 hours of run time* | *48 hours of run time* | *72 hours of run time* | *96 hours of run time* |
|---|---|---|---|---|
| 100% | 439,920 gallons | 879,840 gallons | 1,319,760 gallons | 1,759,680 gallons |
| 75% | 329,940 gallons | 659,880 gallons | 989,820 gallons | 1,319,760 gallons |
| 50% | 219,960 gallons | 439,920 gallons | 659,880 gallons | 879,840 gallons |
| 25% | 109,980 gallons | 219,960 gallons | 329,940 gallons | 439,920 gallons |

which to keep open. Limited generator and fuel resources would be reserved for the hospitals prioritised to remain open.

If such a scenario unfolded in LAC, the County's fleet of 800kW and 200kW generators could be quickly depleted, forcing reliance on state caches and the federal government's large fleet of temporary emergency power assets (the largest cache in the US).

The California Governor's Office of Emergency Services (CalOES) maintains an updated Southern California Catastrophic Earthquake Plan that calls upon county governments in California, functioning during disasters as operational areas, to prioritise which critical facilities will receive federal emergency power resources. It is unclear how many counties have undertaken this contingency planning. The Earthquake Plan also details the logistics around distribution of generators and fuel, delineating responsibility between state and federal agencies — helpful guidance for other jurisdictions interested in developing advanced contingency plans. (The current version of the Earthquake Plan is not publicly available, but a jurisdiction's emergency management agency may be able to access the document.)

Designing a contingency plan for rationing temporary generators and fuel during a power outage in a local jurisdiction requires careful consideration of several factors. When developing such a plan for rationing among hospitals, an initial step would be to determine which hospitals should be prioritised over others. Likely considerations would include prioritising hospitals that serve unique populations that could not be as easily cared for in other hospitals, eg psychiatric, burn, paediatric patients.

The duration and scope of the outage will also drive contingency planning. In an outage lasting several days to a week, in a localised geographic area, a jurisdiction could reasonably hope to keep all of its hospitals supplied with replacement generators and fuel as needed. Yet in a catastrophic, unprecedented black sky scenario in which power could be out for weeks over a very large geographic area, a jurisdiction would likely need to consider closing hospitals (and other critical facilities that rely on emergency power) to conserve generator fuel. Since such a catastrophic power outage has never occurred in the US, it would be difficult to develop contingency plans for all potential scenarios. As a result, emergency managers will need to remain flexible and adapt response plans as the power outage continues and additional generator failures materialise.

In a scenario in which fuel is being rationed to operate generators in prioritised facilities, it is possible that rationing of fuel for citizens may be required — a development that underscores the importance of creating an effective public communications strategy as part of a jurisdiction's contingency planning. This communications strategy should ensure transparent, frequent and accurate communication with the public.

It is worth noting that following Hurricane Maria's devastation of Puerto Rico in 2017, FEMA and the U.S. Army Corps of Engineers ran out of smaller generators needed to power grocery stores and small clinics.

### *Step 3: Extend emergency power resilience work for hospitals across all critical facilities that rely on emergency power*

Extending some or all of the emergency power resilience work the LAC EMS Agency conducted for hospitals across all critical facilities that rely on emergency power would bring important benefits to a jurisdiction.

Success in undertaking this work would best be achieved by an active leadership

role of the jurisdiction's emergency management agency, working in coordination with lead agencies for individual sectors, ie police and fire, water/wastewater, healthcare, emergency shelters, etc.

Key elements of a multisector emergency power resilience initiative should include:

- Identifying the protocols in place, or lack of protocols, related to emergency power threat reporting and response by government agencies for all critical facilities. The reporting protocols will likely be different depending on the sector. Hospitals, for example, will likely report emergency power threats to a health department or EMS Agency, while police and fire stations would report failures through their chain of command.
- Conducting a census of emergency power systems across all critical infrastructure sectors would provide a jurisdiction with a full picture of emergency power dependencies and vulnerabilities, including the total number of generators by size and age. This census would also identify the number of seriously outdated generators, all single-generator facilities and the run time for all facilities based on onsite fuel storage capacity. This data would help a jurisdiction better anticipate the number and size of temporary generators and the amount of generator fuel that may be needed during an extended outage.
- Encouraging all critical facilities that rely on emergency power to conduct the same type of fuel conservation planning as recommended for hospitals (above) would enable the emergency management agency to develop a more refined rationing plan if generator fuel became scarce during an extended outage.
- Creation of an Emergency Power Industry Working Group.
- Creation of an up-to-date list of the locations and custodial points of contact for any temporary emergency power assets that could be deployed to hospitals or other critical facilities experiencing an emergency power failure during a power outage.
- Enhanced power outage coordination with the jurisdiction's electric utilities.

## CONCLUSION

The LAC EMS Agency initiative described in this paper represents the most advanced work to date by a state or local jurisdiction to identify vulnerabilities in hospital emergency power systems and develop rigorous new protocols to address these weaknesses.

The discovery of so many seriously outdated generators, particularly in single-generator hospitals, serves as a caution to other jurisdictions that have yet to determine whether they are similarly vulnerable. This finding should also prompt scrutiny from the CMS, the agency in charge of federal requirements governing hospital emergency power systems.

In December 2013, the agency published its initial draft of the CMS Emergency Preparedness Rule, which sought to toughen federal standards for hospital emergency power systems. The proposed rule reflected deadly lessons from Hurricane Katrina, when emergency power failures contributed to the deaths of patients at Memorial Medical Center hospital.[11] CMS proposed requiring hospitals to conduct a four-hour generator test each year, instead of once every three years as required at the time. The rationale was that more frequent testing would help identify generators at greater risk of failure and enable repair or replacement of failing generators before the next outage.

The hospital industry strenuously pushed back, arguing that the four-hour test was not a reliable enough indicator of future performance to warrant the millions of dollars in added cost hospitals would face. When the final CMS Emergency Preparedness Rule was published nearly three years later, HHS had dropped its proposed increase in the frequency of the test.[12] It is an open question whether federal officials would have modified their approach had they been aware of how many outdated generators exist in US hospitals, especially in facilities with no redundant source of emergency power.

Regardless of whether federal officials tackle the issue of outdated generators in the nation's hospitals, state and local officials can and should do so now. To make this task easier, they can look to the LAC EMS Agency initiative as a helpful roadmap. Not every jurisdiction will face the same challenges as LAC or have the same emergency power resources, but the new protocols adopted by the EMS Agency, including accelerated emergency power status reporting by hospitals during outages and the confidential risk rating of hospital emergency power systems, are new approaches every jurisdiction could benefit from.

To help calibrate an initiative with available resources, this paper details three levels of effort a jurisdiction could consider, ranging from the least resource-intensive to a project requiring a major investment of personnel time.

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