

Exercise Roadmap for Resilience: Requirements, Results, and Resourcing

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THE UNITED STATES EXPERIENCED 1.33 BILLION power outage hours in 2020, a 73 percent increase from about 770 million hours in 2019.¹ This increasing number of power outages impacts other infrastructure sectors and threatens the health of US citizens, and the nation's economy and security. The US Department of Defense (DoD) relies heavily on the nation's commercial electrical infrastructure to conduct critical missions, such as piloting remote aircraft, reviewing reconnaissance, and planning supply logistics from DoD facilities within the continental United States rather than from overseas bases. If a DoD installation doesn't have reliable electrical infrastructure, many of those missions could not be successfully executed. As natural disasters and determined adversaries threaten to destabilize the US electrical infrastructure, DoD must begin to think of *energy resilience* as a critical mission in and of itself.

This article explores how executing functional exercises can strengthen DoD's ability to prepare for, withstand, adapt to, and recover from installation or regional electrical disruptions. Using a hypothetical exercise scenario that illustrates the real-world challenges military installation energy managers face, the article describes how DoD has used Energy Resilience Tabletop Exercises (ERTTXs) and Black Start Exercises (BSXs) to test military installations' dependence on electrical infrastructure to execute critical missions, and highlights some of the ways in which the exercises enable DoD to support its infrastructure and mission success.

Not If, But When, We Lose Power

Imagine you are the energy manager at a military installation located on the West Coast of the United States. Your days have been filled with worry about recurring weather-related flooding that has taken place on and around the installation. In addition to the flooding, the installation is experiencing frequent blackouts due to high winds and



aging infrastructure. These blackouts have caused high-profile tenants to move from their buildings at the remote edges of the installation to contingency locations in the main cantonment. To add to the pressure, the installation is preparing for a satellite launch that has experienced multiple postponements. Leadership is anxious to get the launch accomplished.

Now imagine that, over the next 48 hours, you will learn that intentional tampering has caused a substation to catch on fire, regional power and wastewater treatment outages continue to impact the area due to the persistent flooding, and your utility provider has discovered that an adversary nation has executed a cyber attack on its distribution network.

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No, this isn't a nightmare. This situation is an example of an energy resilience readiness tabletop exercise that was led by DASD(E&ER), the Deputy Assistant Secretary of Defense for Environment and Energy Resilience, at three DoD installations in 2019. Figure 1 provides an overview of the cascading sets of failures that could be used as the prompts for discussion during this ERTTX. The objective of testing high-stress scenarios like this is to prepare installation personnel for regional, prolonged electric power disruptions that would impact critical infrastructure, mission requirements, and personnel availability. DoD has prioritized the use of exercises that identify vulnerabilities in the energy capabilities of installation infrastructure that is directly related to critical mission requirements.

The exercise results have been used to support project development and prioritization across the US military. These exercises have primarily been either tabletop exercises or on-site energy resilience readiness exercises, also known as “pull-the-plugs” or “black starts”—live scenarios that begin with an installation losing its primary power source.

Figure 1. 48-Hour Timeline of Cascading Events²

The objective of an ERTTX is to scheme out how the installation would respond to events that test its ability to execute its missions. A subsequent BSX then builds on this scenario-driven plan by actually cutting off an installation's power for several hours to identify assumed and actual gaps between mission requirements, infrastructure, and personnel procedures. The following sections will discuss how, when, and why ERTTXs and BSXs should be executed, once the facility's requirements for energy resilience have been established.

DoD Energy Resilience

Energy resilience is defined for DoD as “the ability to avoid, prepare for, minimize, adapt to, and recover from anticipated and unanticipated energy disruptions in order to ensure energy availability and reliability sufficient to provide for mission assurance and readiness, including mission essential operations related to readiness, and to execute or rapidly establish mission essential requirements.”³ Vulnerabilities in the existing US electrical infrastructure are driving DoD's efforts to improve its facilities' energy resilience. US critical infrastructure is not only increasingly vulnerable to natural disasters, but is also facing a growing risk of cyber attacks by determined adversaries.⁴ As a result, energy resilience has been incorporated into several DoD policies over the last decade as a central tenet of mission readiness.⁵

In 2020, the US Government Accountability Office reported that more than 98 percent of DoD installations rely on commercial electrical infrastructure that exists “outside the fence line,” i.e., is separate from the installation. DoD's reliance on the commercial power grid requires a restoration and response plan that is shared across multiple



stakeholders, including the installation, utility providers, emergency responders, and community representatives. The Army, Air Force, and Navy have tracked the increasing severity and frequency of prolonged power outages and, in response, have mandated that their installations be able to sustain critical missions independent of the commercial electrical grid for a minimum number of days, ranging from seven days at Air Force bases to more than two weeks at Navy bases.⁶ There is, however, no general DoD requirement for the minimum number of days an installation will need to sustain mission operations if commercial power is not restored within those service-mandated timeframes.

Achieving Energy Resilience Through Exercises

Energy resilience exercises are an effective method that defense leadership can use to verify that installations are meeting their resilience goals.⁷ Recognizing the importance of integrating energy disruption scenarios into the military's exercise program to strengthen the energy resilience posture of DoD installations, DASD(E&ER) developed the ERTTX and BSX frameworks in 2018. It then executed three ERTTXs in which DoD installations faced hypothetical risk scenarios similar to those faced by the energy manager earlier in this article. Examinations of installation-specific infrastructure vulnerabilities, the region's history of natural disasters, and risks to the security posture of the installation helped inform the development of installation-specific scenarios that incorporated realistic threats to mission capabilities.

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As of fiscal year 2021 (FY21), DoD had conducted more than 10 exercises using the ERTTX and BSX frameworks, and has dozens more exercises scheduled in the next five years. These exercises focus on creating a controlled, realistic environment that either replicates an adversary-caused power outage based on prior events, or builds on assessments of likely scenarios unique to the installation being tested. The exercises demonstrate the real-world gaps between critical mission requirements and infrastructure energy resilience, and give the installation personnel a unique opportunity to both practice their response to a grid power outage and validate the performance of the installation's systems, processes, and assets. The exercise results provide the installation with the proper justification

to request funding support for infrastructure improvements or to address critical gaps identified in the results.

The DASD(E&ER) exercises demonstrated their effectiveness in those initial programs; since then, the US Army, Navy, and Air Force have begun to develop exercise programs for their installation portfolios. In the FY21 National Defense Authorization Act, Congress required each US military service to conduct at least five "black start" exercises per year through FY27, "to evaluate the ability of the installation to perform critical missions without access to off-installation energy resources."⁸

Energy Resilience Tabletop Exercise

ERTTXs present participants with the scenario of a large-scale, multi-day event that would affect the commercial energy distribution system servicing a DoD installation. The participants then spend one or more days in a facilitated discussion of how they and their personnel would respond to the primary scenario and to each new input. The objective of the exercises is to test the ability of the installation's personnel to continue their mission during such an event, to demonstrate how the installation can support its mission through personnel response and infrastructure resilience, and to reveal critical gaps that need to be addressed. These gaps become the basis for planning resilience improvement projects that will enhance DoD's mission-readiness posture.

An ERTTX convenes DoD leaders and decision-makers, together with critical installation stakeholders, to work through a scenario that exploits the specific vulnerabilities and challenges facing that particular installation and the surrounding community. The scenarios are realistic and immersive, and are designed to provide specific new inputs throughout an exercise, according to a set formula:

- First, an apparent natural or accidental event causes a severe power outage on the installation, requiring immediate action.
- Later, it becomes clear that a determined adversary has caused the outage and is disrupting recovery efforts.
- Finally, it is revealed that the power grid will take multiple weeks to recover, requiring the installation and critical mission operators to plan for and activate long-term contingency plans.



Civil Engineering Squadron personnel prepare to shut down electrical power during an ERTTX, 19 November 2020.

ERTTX Outcomes

An ERTTX provides an installation with the opportunity to prepare for energy and mission disruptions. This kind of preparation can have a wide range of beneficial outcomes for the installation and larger DoD enterprise, including the following:

Develop a shared understanding of mission requirements

During an ERTTX, mission operators and installation support personnel work together to develop a common understanding of mission requirements, current energy resilience capabilities, and any gaps between requirements and capabilities. Due to the way that military installations are typically organized, installation support personnel do not often have an opportunity to understand the mission requirements of the building or infrastructure that they maintain. During an ERTTX, knowledge sharing happens organically, and when each stakeholder possesses the same knowledge, the installation as a whole will be more prepared to deal with prolonged regional electric power disruptions.

Challenge assumptions about critical infrastructure

ERTTXs highlight infrastructure gaps and potential impacts on military missions in the event of an evolving energy disruption. The exercise scenarios are created using information about an installation's infrastructure in conjunction with interviews with mission operators

and installation engineering staff to realistically test assumptions about how the infrastructure will hold up in a disruption.

Understand the consequences of a long-term disruption

Some longer-term impacts do not become apparent through the voluntary testing of backup power because such tests are executed only for a short duration (typically less than one hour). In contrast, an ERTTX provides the opportunity to think through how a long-term disruption, measured in days or weeks, would inevitably interrupt mission plans.

Justify funding for facility improvements

ERTTXs identify mission disruptions caused by insufficient infrastructure capability. When an installation's personnel confirm that a critical load is not supported by backup power through an energy resilience exercise, they have not only identified but also validated an energy resilience gap. These disruptions provide the justification and validation that is often required to secure funding for energy resilience improvement projects to increase infrastructure capabilities that will meet mission needs.

Prepare for a BSX

After completing an ERTTX, an installation may want to complete a BSX to validate some of the findings from the tabletop exercise. In addition, this real-world exercise will



Personnel prepare to shut down electrical power to a military base during an ERRTX in November 2020.

physically test different assumptions and highlight additional vulnerabilities and opportunities for infrastructure improvement projects.

Black Start Exercise

The key difference between an ERRTX and a BSX is the mechanics of the simulation. Each kind of exercise—one conducted in a conference room, the other involving the actual facility—prompts different questions, reveals different vulnerabilities, and stresses different capabilities. The two distinct processes are highly complementary and, when used together, reveal a more complete picture of an installation's resilience posture. An ERRTX will prompt discussions around how the installation *might* react to the scenarios and their consequences, while a BSX requires the installation's leadership and support staff to make real-time decisions to continue operations when installation power has actually been disconnected.

A Black Start Exercise requires the installation's leadership and support staff to make real-time decisions when installation power has actually been disconnected.

By simulating a scenario in which an installation is without commercial power for 6 to 24 hours, a BSX pushes installation personnel past assumptions into a controlled but realistic situation that can highlight unforeseen vulnerabilities. Most installations use a combination of diesel generators and uninterruptible power systems to provide backup power to their critical loads. However, the process of transferring critical loads to backup power is often not tested during normal operations. Without such testing under realistic conditions, there is no certainty that the backup power systems will in fact be able to start, transfer, and carry mission-critical loads when not connected to commercial utility power for an extended period of time. Executing a scenario in a controlled exercise environment allows installation personnel to address vulnerabilities in a

productive and safe manner before they face a real threat in an uncontrolled environment where mitigation might not be feasible.

BSXs test the ability of an installation's power system to function as designed, verify that the mission can function during a power disruption, and identify mitigation projects that will increase the mission's readiness posture. A successful BSX depends on strong installation and operational leadership support. A "no-notice" BSX provides the most value by testing the immediate response and performance of an installation's systems, people, and infrastructure under duress. BSXs use a four-phased approach to achieve these objectives:

Information collection: The exercise designers use data calls, interviews, and site visits to provide them with a functional understanding of an installation's infrastructure capabilities and mission requirements. This information is used by the designers to identify any gaps between the two.

Exercise development: Based on the information identified in the information collection phase, the exercise is constructed to highlight those gaps between requirements and capabilities. Exercises are scoped to include safeguards to prevent and protect against catastrophic failures to the installation.

Exercise execution: Installation personnel respond to the loss of commercial utility power and work to continue mission operations for multiple hours. Exercise observers document the identified gaps and potential areas that could be improved through project upgrades and process changes.

Outcome analysis and validation: Exercise observers and designers craft recommendations to improve installation resilience based on the exercise findings. Installation and operational leadership review the recommendations, event outcomes, and themes to prioritize the next steps.

The Outcomes of a BSX

The most basic benefit of intentionally disconnecting the commercial utility power for the installation is to test the ability of the backup systems to start, transfer, and carry the required loads. This is important because many installations do not consistently identify the electrical loads powering critical missions. In many instances, only specific organizations or individuals know where critical pieces of equipment such as network switches or alarm systems are located. Even when installations have identified their

critical loads, it is difficult to create a prioritized facility list that all tenant organizations know about and agree with. Broader benefits of BSXs include the following:

Developing a common understanding among stakeholders

Mission operators often work in organizational structures that are entirely separate from the infrastructure owners responsible for providing power to the missions. The exercise forces conversations and helps break down communication silos that previously may have kept mission operators from conveying their requirements to owners. The exercise also enables infrastructure owners to gain buy-in from mission operators to test the capabilities of the infrastructure systems. Thus, a well-planned BSX can increase communication among vital actors and lower barriers to cooperation.

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Understanding the immediate impact of a power outage

BSXs are executed over a range of 6 to 24 hours, often without notice, to test the immediate response of personnel and their ability to maintain the required level of mission readiness. Validating the speed and quality of a disaster response is particularly vital for missions that support warfighting capabilities.

Identifying gaps

BSXs expose areas where an installation's infrastructure capabilities fail to meet its mission requirements. This frequently happens when systems do not have the proper backup power equipment or there is a communication breakdown between stakeholders during the exercise. Typically, once leaders have had a window into the real-world consequences of infrastructure and process gaps and the potential implications for the mission if those gaps are not addressed, they are motivated to develop solutions that will strengthen mission continuity.

Justifying project funding

BSXs document the gaps in infrastructure requirements and demonstrate where energy resilience upgrades are most needed and where limited resources can be most effectively applied. The findings help decision-makers

determine which projects need immediate funding to support mission-critical operations and which can wait to be funded at some future date.

Resilience Exercise Results and Recommendations

Energy resilience exercises ensure policy compliance, identify mission requirements, map existing infrastructure and potential vulnerabilities, and generate engagement and discussions across organizations at an installation. Since 2015, DoD has completed more than 30 energy resilience site assessments and executed a variety of exercises.⁹ It is clear that there are consistent challenges and opportunities for installations regardless of the installation size, location,

their critical infrastructure and to better understand how they can serve an important customer in addition to the surrounding community.

These exercises are changing assumptions within the US military, most tangibly at the installations where they have been executed. Until recently, DoD took access to a reliable electrical system for granted; these exercises spotlighted the flaws in assuming that electrical power will always be available when needed. After participating in ERTTXs and BSXs, installation leaders have shared reactions such as, “You don’t even know what you need to be worried about until you start poking and prodding,” and “I am buying risk every day and I don’t know it.”¹⁰

Any company, organization, university, community, or nation that relies on power to maintain operations would benefit from executing an energy resilience exercise.

or military service. We know that our infrastructure is increasingly vulnerable because of extreme weather, outdated infrastructure, and heightened cyber attacks. These exercises allow each installation to understand its specific threats within those categories and work to strengthen its energy resilience posture.

Conclusion and Recommendations

Energy resilience exercises such as BSXs and ERTTXs are relatively new to DoD, but have already provided valuable information for both the participating installations and the US military community at large. But any company, organization, university, community, or nation that relies on power to maintain operations would benefit from executing an energy resilience exercise. The basic principles of such exercises remain constant no matter the kind or size of the organization that undertakes one, and they can raise stakeholder awareness of unsupported assumptions, faulty planning, and potential failures in energy systems in a controlled environment. The alternative is that these critical gaps in capabilities might otherwise go unnoticed until an actual disaster strikes.

These exercises also provide an opportunity for the organizations and stakeholders to understand their reliance on one another and the larger infrastructure systems. Mission operators, installation leadership, civil engineering departments, and exercise leaders at a military installation can push for energy resilience exercises to be included as part of their exercise curriculum and requirements. Installation utility providers can recommend a joint exercise to test

DoD must accelerate the process of shifting mindsets from making assumptions to conducting real-world exercises. This should include critical missions that were previously excluded from testing out of concern that even a controlled power loss would cause mission failure. The more important the mission, the greater everyone’s desire should be to test the system and validate that the mission will not fail during an actual outage. It is also likely that such an outage will not be isolated to the installation, but will also impact the surrounding community. Military installations are often seen as the beacon on the hill during a crisis, and the local community often houses much of the installation workforce. This is why community leaders are well positioned to advocate for a joint exercise that will identify ways in which the installation can support “beyond the fenceline” energy needs while ensuring mission continuity.

As “once in a lifetime” disasters occur more frequently and cyber attacks disrupt national critical infrastructure, understanding the military’s reliance on electric infrastructure becomes paramount.¹¹ Through energy resilience exercises, military leaders have an opportunity to understand how dependence on the electric grid affects mission readiness, and plan projects that will enhance mission assurance. These leaders must do what they can to advance the energy resilience training and exercises that will ensure mission readiness and enhance national security.

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