Department of the Air Force

Presentation

Before the Senate Appropriations Subcommittee on Military Construction, Veterans Affairs, and Related Agencies

Military Infrastructure and Climate Resilience

Witness Statement of

Mr. Mark A. Correll
Deputy Assistant Secretary of the Air Force for Environment, Safety and Infrastructure

May 19, 2021

BIOGRAPHY

UNITED STATES AIR FORCE

MARK A. CORRELL

Mark A. Correll, a member of the Senior Executive Service, is the Deputy Assistant Secretary of the Air Force for Environment, Safety and Infrastructure, Headquarters U.S. Air Force, Arlington, Virginia. He provides executive leadership on all matters pertaining to formulation, review and execution of plans, policies, programs and budgets for Air Force built and natural infrastructure, environmental, installation energy, safety and occupational health programs. These include facility management, military construction, utilities privatization, energy security, contingency energy, environmental compliance and restoration, occupational safety and workplace health.

Mr. Correll was commissioned in the Air Force in 1981 as a graduate of the U.S. Air Force Academy, earning a degree in civil engineering. He commanded two civil engineer squadrons, a mission support group and an air base wing. He retired in 2010 in the rank of colonel. Prior to his current assignment, Mr. Correll served as the Air Force Deputy Civil Engineer. In that position he provided leadership, direction and technical knowledge to organize, train and equip a 60,000-person engineering force as well as development, construction, operation, maintenance, emergency response, readiness, housing and environmental quality of Air Force bases worldwide. He was appointed to the Senior Executive Service in 2010. Mr. Correll is registered as a licensed professional engineer in the state of Texas.

EDUCATION

1981 Bachelor of Science degree in civil engineering, U.S. Air Force Academy, Colorado Springs, Colo.
1984 Master of Science degree in engineering management, Air Force Institute of Technology, Wright-Patterson Air Force Base, Ohio
1987 Squadron Officer School, Maxwell AFB, Ala.
1993 Air Command and Staff College, Maxwell AFB, Ala.
2001 Air War College, Maxwell AFB, Ala.

CAREER CHRONOLOGY

1. June 1981 – May 1983, Chief, Readiness and Logistics, 375th Civil Engineer Squadron, Scott Air Force Base, Ill.
2. May 1983 – October 1984, Graduate Student, Air Force Institute of Technology, Wright-Patterson AFB, Ohio
3. October 1984 – July 1986, Chief, Resources and Requirements, 1606th Civil Engineering Squadron, Kirtland AFB, N.M.
4. July 1986 – March 1987, Commander, Civic Action team, Truk State, Federated States of Micronesia
5. March 1987 – October 1987, Chief, Operations, 1606th Civil Engineer Squadron, Kirtland AFB, N.M.
6. October 1987 – October 1988, Student, Air Staff Training Program, Headquarters U.S. Air Force, Arlington, Va.
7. October 1988 – August 1992, Action Officer, Civil Engineer Operations Division, Headquarters Military Airlift/Air Mobility Command, Scott AFB, Ill.
8. August 1992 – July 1993, Student, Air Command and Staff College, Maxwell AFB, Ala.
9. July 1993 – September 1996, Chief, Operations Flight, 305th Civil Engineer Squadron, McGuire AFB, N.J.
10. September 1996 – June 1998, Action Officer, Civil Engineer Environmental Division, Headquarters U.S. Air Force, Arlington, Va.

11. June 1998 – July 2000, Commander, 31st Civil Engineer Squadron, Aviano Air Base, Italy
12. July 2000 – June 2001, Student, Air War College, Maxwell AFB, Ala.
13. June 2001 – July 2002, Commander, 60th Civil Engineer Squadron, Travis AFB, Calif.
14. July 2002 – July 2004, Commander, 374th Mission Support Group, Yokota Air Base, Japan
15. July 2004 – July 2006, Vice Commander, 72nd Air Base Wing, Tinker AFB, Okla.
16. July 2006 – July 2008, Commander, 72nd Air Base Wing, Tinker AFB, Okla.
17. July 2008 – August 2010, Civil Engineer, Air Education and Training Command, Randolph AFB, Texas
18. November 2010 – June 2014, Deputy Air Force Civil Engineer, Headquarters U.S. Air Force, Arlington, Va.
19. June 2014 – present, Deputy Assistant Secretary of the Air Force for Environment, Safety and Infrastructure, Headquarters U.S. Air Force, Arlington, Va.

AWARDS AND HONORS
Air Force Meritorious Civilian Service Award
Meritorious Executive Presidential Rank Award
Air Force Meritorious Civilian Service Award
Legion of Merit with two oak leaf clusters
Bronze Star Medal
Meritorious Service Medal with silver oak leaf cluster
Air Force Commendation Medal with oak leaf cluster
Air Force Achievement Medal with two oak leaf clusters

Professional Memberships and Associations
Society of American Military Engineers

(Current as of January 2019)

Introduction

Every Department of the Air Force (DAF) mission starts and ends on an installation. Installations are weapon systems. We project power, generate readiness, test new platforms, train to support joint operations, and provide safe and healthy communities for our families at our bases. Air Force and Space Force installations serve as key nodes in enabling Joint Force mission success around the world. More than 300,000 Total Force personnel organize, train, and equip at DAF installations, and for thousands of Airmen, Guardians, and their families, installations also serve as their homes and centers of life. The readiness and resiliency of installations is a matter of strategic importance to ensure the Air Force and Space Force can always provide combat capability.

Secretary of Defense Austin recently released his top three priorities for the Department of Defense: Defend the Nation, Take Care of our People, and Succeed through Teamwork. He identified tackling the climate crisis as one of the lines effort under the priority to defend the nation, elevating climate as a national security priority. Changing climate and severe weather events are a continual threat to our installations. Over the past several years, the Department of the Air Force has seen first-hand the impacts climate and severe weather can have on our installations. The Department of the Air Force is smartly moving forward with rebuild efforts at Tyndall Air Force Base (AFB), Florida, following the devastation caused by Hurricane Michael in 2018 and Offutt AFB, Nebraska, following historic flooding in 2019. We are also recovering from and continuing to assess damage from the recent Winter Storm Uri that brought extreme cold to much of the United States, impacting dozens of DAF installations throughout the Midwest and the southern part of the country. We must continually learn from these events and adapt to meet current and future threats to our installations posed by severe weather and climate, as well as physical or cyber-attacks.

The Department of the Air Force Approach to Installation Resilience

Installation resilience is a multi-faceted issue that is addressed through a variety of efforts and funding streams. The DAF views installation resilience as the capability of a base to sustain the projection of combat power by protecting against, responding to, and recovering from intentional or accidental physical, cyber or naturally occurring events that impede air, space, or

cyberspace operations. We take a holistic and deliberate approach to addressing installation resilience on four primary fronts: energy, cyber, infrastructure, and emergency response.

Energy Resilience

The DAF requires reliable power and water to accomplish both operational and training missions. The overarching vision for the DAF's installation energy and water program is "Mission Assurance through Energy Assurance." This vision is focused on securing the ability to perform our warfighting mission, in the face of disruptions to traditional sources, while simultaneously optimizing energy and water availability and productivity through better planning and technology and process improvements. The recently released Department of the Air Force Installation Energy Strategic Plan highlights the DAF approach to integrate resilience concepts and considerations at each step in the mission, from the strategic to tactical levels, to ensure enabling systems enhance mission assurance.

Our approach to energy resilience starts with identifying system vulnerabilities through various methods such as mission thread analysis and black start or Energy Resilience Readiness Exercises (ERRE), developing mitigation actions and incorporating them into Installation Energy Plans (IEPs), and ultimately executing energy projects designed to improve mission resiliency. As one component of the overarching Installation Development Plan (IDP), IEPs identify water and energy requirements for each installation's critical missions, analyze potential vulnerabilities, and develop strategies to make enabling systems more resilient. By aggregating disparate elements of energy and water information and management, the DAF will have the means to assess the status of energy and water systems, and communicate the potential impacts on mission readiness. The IEP does this by establishing a baseline that outlines energy and water requirements for each missions on the installation (both DAF and tenant missions), and enables the installation to target resilient solutions.

Black start exercises, or ERREs, are powerful tools the DAF is using to assess an installation's energy resilience and security. These exercises are designed to assess how well the installation can execute its primary missions should power be compromised. The Department executes these exercises, called Resilience Readiness Exercises (ERRE), out of the Office of the Assistant Secretary for Installations, Environment, and Energy. To date the Air Force has conducted ERREs at Vandenberg AFB, California, Hanscom AFB, Massachusetts, and Joint Base

McGuire-Dix-Lakehurst (JBMDL), New Jersey. These ERREs have been extremely helpful in identifying energy gaps and validating response plans. Specifically, the most recent ERRE at JBMDL revealed hidden interdependencies between the installations electrical and communications architectures, identified issues with backup generation assets, and revealed a training gap with installation personnel. Installation leadership was also able to validate several continuity of operation plans could be executed during a power outage. The Air Force has plans to complete additional ERREs at Wright-Patterson AFB, Ohio, and Eielson AFB, Alaska, in 2021.

Cyber Resilience

From an installation resilience perspective, our cyber resilience efforts focus on preventing, detecting, and responding to unauthorized access to DAF facility-related control systems, such as those associated with airfield lighting, power and water distribution, fire and intrusion detection, back-up generators, and heating, ventilation, and air conditioning (HVAC) systems. Control systems used to be manually operated and maintained. As infrastructure has matured to become automated and network-enabled, we have gained operational efficiencies without enough consideration for cyber vulnerabilities or the ability to operate in a cyber-contested environment.

In March of this year, the Secretary and Chief of Staff of the Air Force and Chief of Space Operations signed the first-ever DAF Control Systems Strategic Plan and associated Implementation Plan. These plans, which were developed over the last year by a cross-functional team from across the DAF, provide an actionable, enduring and unified strategy and high-level road map for the next 10+ years for how the DAF can holistically address the aggregated risk to DAF mission execution from vulnerable control systems and infrastructure. The Strategic Plan prescribes the direction, milestones, organization responsibilities and capability requirements to cyber-secure and defend DAF critical control systems.

Following direction provided in the fiscal year (FY) 2017 National Defense Authorization Act and using funding from the FY17 Defense Appropriations Bill, the Air Force has assessed priority installations for cyber vulnerabilities to critical infrastructure. Additional efforts to improve cyber resilience include segmenting these control systems from the Air Force communications network, embedding cybersecurity subject-matter expertise in our Civil Engineer Squadrons to aid the cybersecurity management of these systems, and developing and fielding cyber-specific education and training for our facility maintenance field technicians. When

prioritized, we are also resourcing the modernization and replacing replacement of obsolete control systems through Military Construction (MILCON) or Facility Sustainment, Restoration, and Modernization (FSRM) projects and addressing identified vulnerabilities. Lastly, we are collaborating with the cyber defense community to establish agile detection, coordinated response, and recovery when a cyber-incident occurs.

Infrastructure

The DAF continually accepts risk in installation investment, which over time leads to atrophied facilities and infrastructure. Degraded, older facilities are more susceptible to the effects of routine or severe weather events. For example, separation of roofing materials from a facility introduces a vulnerability where a strong wind could lead the weakened roof to collapse, undermining the facility's structural integrity and causing catastrophic failure. This was evident at Tyndall AFB during Hurricane Michael where facilities constructed more recently, using updated building codes, weathered the storm better than degraded or older facilities which were both constructed under older building codes and subject to longer term deferred maintenance. We also observed this during recent winter storms such as Winter Storm Uri. In many instances, degraded facility systems and components failed which caused water and fire suppression pipes to freeze and eventually burst.

The DAF Infrastructure Investment Strategy (I2S) is our long-term strategy to cost-effectively modernize and restore infrastructure readiness, improve the resiliency of mission-critical nodes, and drive innovation in installation management practices. It serves as a framework for planning and building resilient installations that are ready to withstand and quickly recover from manmade and natural events which potentially impact our missions. Leveraging I2S, the DAF enhances resiliency by proactively upgrading facilities through targeted facility investments informed by powerful analytics, stabilized funding, application of evolving building codes and Unified Facilities Criteria (UFCs) through MILCON or FSRM projects, and improved processes such as more standardized building components to increase maintenance efficiency. UFCs are the Department of Defense building codes that implement industry standards and serve as our planning, design, and constructions foundation. They are updated by a tri-service panel to address changes in public law, military specific requirements and incorporate lessons learned from natural disasters, new technology, and industry innovation.

Updated design criteria also come from changes to public law. In the FY 2019 NDAA, Congress directed OSD to update Department of Defense forms 1391 (DD 1391), *Military Construction Project Data,* submitted for each MILCON project to include a certification whether the project is located in a 100-year floodplain. The provision also required mitigation of flood risk for facilities that must be constructed in a 100-year floodplain due to mission requirements by following minimum flood mitigation requirements of the facility being cited two or three feet above floodplain level, depending on mission criticality of the facility. Following implementation guidance provided by OSD, all DAF DD 1391s submitted with the FY21 President's Budget request complied with the 100-year floodplain disclosure mandate. Additionally, the DAF is implementing floodplain mitigation plans for several notable MILCON projects. Three mission-critical campuses at Offutt AFB, which were destroyed by historic flooding in spring 2019, must be rebuilt in 100-year floodplains due to mission requirements. The elevation of the entire site is being raised above the 100-year flood plain in accordance with the NDAA.

The DAF is embracing an approach to natural infrastructure to enhance installation resiliency that relies on partnerships with other DoD organizations as well as Federal entities outside of DoD. As witnessed by the devastation at Tyndall and Offutt Air Force Bases, damage to DAF built infrastructure can be severe, but in the case of climactic events, they may be attenuated by environmentally-conscious improvements to natural infrastructure. We are embarking on such a partnered approach at Tyndall AFB this year, where approximately $26 million in cost shared efforts are underway. These efforts bring together federal, state, non-government and academic partners to field test environmentally conscious improvements to natural infrastructure. These improvements attenuate storm energy, whether from waves or wind, lessening the intensity of what passes through to build infrastructure. Combined with built infrastructure, which applies resilience features such as raised floor elevations and higher wind standards, the natural infrastructure improvements provide a cost-effective force multiplier to resilience, survivability, and mission assurance. Another example is underway at Offutt AFB where civil works built infrastructure provides additional flood protection for DAF real property. In this case, the Missouri River Natural Resources District is repairing and improving levees that protect Offutt AFB. This is a $35 million project that will raise the levees two to three feet and widen their bases. The work began in September 2019 and is scheduled to be completed in May

2021. This is a case where a non-federal partner is providing a front line of defense through natural infrastructure improvements.

Emergency Response

Improving resilience is not just about the tangible aspects of an installation, it also includes prepared Airmen, Guardians, and civilians. Even with the most state-of-the art building systems, installations will always be at risk due to deliberate, accidental, or naturally occurring events. Emergency management, disaster response, and continuity of operations planning are essential to ensure an installation can respond and recover from an incident quickly while continuing to execute the mission or, in more extreme situations, minimizing downtime. The Air Force Incident Management System uses the National Incident Management System as its foundation to integrate prevention, protection, mitigation, response, and recovery efforts across the installation while also synchronizing with local, state, and other federal agencies. Routine exercises of Installation Emergency Management Plans ensure personnel are ready to face any disaster. Two days before Hurricane Michael hit Tyndall AFB it went from a Category 2 on a path to bypass the installation to a Category 5 with direct line of sight on the installation. Due to emergency management preparedness, emergency management exercises, and installation emergency management plans, Tyndall AFB evacuated all mission-capable aircraft, military members, and families in less than 48 hours. The result: *no loss of life or aircraft*.

Installation Planning Efforts

Our installation planning efforts impact each of the four primary DAF focus areas. Effective installation planning, to include assessment of natural and manmade threats, is critical to ensure our energy and infrastructure investments are effective and efficient and lead to ready and resilient installations. Planning efforts also help inform contingency and emergency response plan development and execution. In recent years, Congress has included numerous provisions in legislation specific to installation master planning efforts to enhance installation resilience efforts across the Department of Defense.

The FY18, FY19, and FY20 NDAAs strengthened installation planning by requiring resilience be considered in each installation master plan, which the DAF calls Installation Development Plans, or IDPs, specifically including energy and climate resiliency efforts. In April

2020, the Air Force published a Severe Weather and Climate Screening and Risk Assessment Playbook. This playbook gives installation-level planners a consistent and systematic framework to screen for severe weather and climate hazards, assess relative current and future risks, and integrate the outputs into existing planning and project development processes. The playbook also offers planners suggestions for how to adapt to hazards. As of early 2021, all major installations have used the playbook to complete initial assessments of installation exposure and risk due to severe weather and climate hazards. The results of these assessments will be used to develop the new FY20 NDAA-required Installation Resilience Component plan for DAF IDPs over the next several years.

Another component plan of the IDP is the IEP. The DAF is actively developing IEPs for 85 major Active Duty installations. These IEPs provide a standardized framework for Air Force installations to identify risks and track and adjust requirements to advance energy and water resilience goals. IEPs use a 5R framework (robustness, redundancy, resourcefulness, response and recovery) to assess resilience gaps and identify how an installation plans for and performs in a crisis. When complete, IEPs will be a component plan to the installation's IDP. To date, the DAF has completed IEPs at 24 installations and is currently developing 20 more with estimated completion by November 2021. The DAF is planning to initiate 15 IEPs in summer 2021, and complete the 26 remaining installations in two additional phases.

In the 24 completed IEPs, the DAF has identified over 300 installation-level resilience gaps, and an even larger number of mission-level gaps at individual buildings. These gaps range in priority, size, and complexity, but the DAF is evaluating all of them for potential mitigation through additional analysis and a follow-up requirement development report which focuses on actionable tasks to close the gap. Common gaps the DAF identified throughout the enterprise include lack of redundancy in electric transmission and distribution infrastructure, aging infrastructure past its useful life, lack of redundant HVAC systems for server equipment, fuel delivery and capacity concerns, water storage and quality concerns, lack of sufficient backup power, and energy and water conservation and efficiency improvement opportunities.

Following completion of IEPs, the DAF develops one or more installation requirement development reports which recommend executable projects to mitigate energy and water resilience requirements and close the gaps identified in the IEP. The Air Force Office of Energy Assurance

(OEA) has accomplished nine of these reports so far, identifying three Energy Assurance Leases (EALs), one Energy Resilience and Conservation Investment Program (ERCIP) concept, one Energy Savings Performance Contract (ESPC) and four Utility Energy Service Contracts (UESCs). Overall, through IEPs and other processes, the DAF has planned and is currently executing 15 projects representing $904 million in investments to directly address climate and extreme weather resilience as a primary driving factor. For example, ERCIP projects will help defend Beale AFB and Vandenberg AFB in California against the impacts of the devastating wildfires the region has experienced in recent years and two additional projects are supporting a microgrid for Offutt AFB, to maintain mission essential power in case of future flooding. Out of these 15 projects, $750 million are budget neutral ESPC and UESC projects that are funded through energy conservation measures, helping to reduce DoD climate impacts while utilizing the latest in clean energy and efficient technologies from industry partners. Furthermore, the DAF has 20 ERCIP projects for $238M in planning or execution that provide climate/extreme weather resilience as an additional benefit, with 20+ more projects currently in early development stages with OEA. In total, these projects represent nearly $1.3B in planned DAF energy resilience investment.

Moving Forward After Natural Disasters and Severe Weather Events

The DAF has seen the impacts natural disasters and severe weather can have on installations. Recent examples include the devastation of Tyndall AFB from Hurricane Michael in 2018, severe flooding of Offutt AFB in 2019, and historic winter storms such as Winter Storm Uri which impacted 28 DAF installations this year. We continually learn from these events and adapt to meet current and future threats to our installations.

Tyndall AFB is being reconstructed as an Installation of the Future and includes cutting-edge approaches to ensure the installation can withstand future climactic threats. The built infrastructure is being designed and constructed using the latest UFCs. In addition, given the extensive level of damage, the DAF made a policy decision to design beyond the minimum UFC criteria for civil and structural engineering. The minimum design wind speed being used for all new facilities at Tyndall AFB is 165 miles per hour, exceeding the highest wind speed captured during Hurricane Michael, and incorporates best practices from the Florida Building Code's High Velocity Hurricane Zone for Miami-Dade, Broward, and coastal Palm Beach Counties. Facilities

are also being designed 14 to 19 feet above today's mean sea level, which incorporates a 7 foot predicted sea level rise scenario through the year 2100. The DAF used the DoD Regional Sea Level (DRSL) database sea level rise scenarios to inform development of a Design Flood Elevation for reconstruction at Tyndall AFB. Using DRSL data, DAF personnel generated spreadsheets and visualizations for several planning scenarios for future sea-level change, in combination with the 100-year floodplain elevation for Tyndall AFB. The site-specific Design Flood Elevation of 14 and 19 feet will ensure new facilities are built at an elevation above mean sea level that balances long-term risk aversion with minimal cost implications.

Coastal resiliency is one of the most important aspects to the plan. This partnered approach includes cost-shared investments which combine with DAF FSRM and MILCON investments to attenuate storm energy through natural infrastructure before it reaches built infrastructure. Key partners in these efforts include the Defense Advanced Research Projects Agency, the United States Army Corps of Engineers Engineer Research and Development Center, the Readiness and Environmental Protection Integration Program, the National Oceanic and Atmospheric Administration, Fish and Wildlife Service, Bay County, the Florida Department of Environmental Protection, the University of Florida, the Nature Conservancy, and the National Fish and Wildlife Foundation. Several key low life-cycle cost Engineering with Nature initiatives being explored include sand fencing, submerged shoreline stabilization, living shorelines, oyster reefs, and marsh and seagrass enhancements.

The DAF is incorporating several efforts specifically targeted at increasing resiliency in the rebuild as well. Tyndall AFB is partnering with Gulf Power to install a micro-grid, which includes photovoltaic generation and a battery energy storage system, to provide back-up power to the First Air Force (1 AF) / Air Forces Northern (AFNORTH) compound. The 1 AF / AFNORTH HQ, plans, directs, and assesses air and space operations for the North American Aerospace Defense Command (NORAD), is currently unable to conduct uninterrupted operations should an outage occur. Another planned facility that directly enhances the Tyndall's resiliency is the Installation Resilience Operations Center (IROC). This capability will optimize facility operations for engineers and enhance situational awareness for first responders by improving the cybersecurity for sensors and other systems installed across the installation. Sensors installed on facilities across the installation will feed data into the IROC where it will be collected, analyzed, archived and

distributed to various operations centers and base leaders to enhance the decision making process and integrate into existing DAF business systems. Facility operations personnel will have improved visibility of the status and condition of installed equipment and first responders will have instantaneous awareness of incidents, such as active shooter situations, across the installation.

At Offutt AFB, we are consolidating and relocating facilities to higher ground and incorporating building techniques for facilities that must be rebuilt in lower areas that will minimize cleanup, recovery cost, and timelines should they flood in the future. To mitigate flood risk for the Nuclear Command, Control and Communications, Non-kinetic Operations and Security Forces campuses, approximately six hundred thousand cubic yards of fill material, or about forty thousand dump trucks, will be brought in. The elevation of the entire site will be raised to at least three feet above the 100-year floodplain. Though a significant effort, it will ensure personnel working out of these facilities can continue to execute this national strategic mission should Offutt AFB experience flooding in the future. Other features include elevating critical building systems above the first floor or to the roof to reduce the vulnerability and using building materials on the first floor less susceptible to damage when exposed to water.

Recent extreme winter storms throughout much of the Midwest and southern United States had a considerable impact on DAF installations. Initial assessments indicate some degree of damage directly attributable to the storms at 28 installations. The DAF continues to assess the damage and will restore facilities to full mission capability. Though the intensity of recent winter storms was abnormal, DAF installations proactively prepare for extreme weather. Some preparatory actions are considered just-in-time, such as winterization of facilities and adjustments to work schedules and shop manning levels. Others are routine and continual processes, such as maintenance of facilities and generators, coordination with local utility providers, and implementation of contingency plans. Preparatory actions also include longer-term infrastructure investment efforts to modernize and recapitalize infrastructure and execute projects to improve facility and energy resiliency. The DAF will continue to assess installation preparations and response actions related to these historic storms, but several overarching themes have already emerged.

A majority of the damage was the result of ruptured water or fire suppression lines due to freezing. Not only must the damaged lines be repaired, so must the damage to the facility caused by flooding from broken pipes. When this occurs, water must be shut off to the facility until repairs

are completed. Depending on the severity of water breaks, larger portions of the installation may be impacted as well. Prior to the storms, installations enacted just-in-time winterization measures in an attempt to limit damage. Some of these measures include ensuring facility doors and windows were secured to retain as much heat as possible, slow dripping faucets and running toilets to reduce stagnant water, which is more susceptible to freezing, and installing additional insulation on critical infrastructure such as water system pumps. These just-in-time preparations and winterization actions reduced utility system interruptions and damage, but did not eliminate it.

In many cases winterization actions, especially at installations in more southern locations where sub-freezing temperatures are uncommon, were simply not enough. Many facilities in these locations are not designed or constructed to handle sustained sub-freezing temperatures. Numerous facilities were constructed in accordance with building codes requiring less insulation than that required for facilities located in areas were cold is more common. Installations in Texas experienced the most significant water break issues, but this type of damage was not limited to the south. Installations in locations where harsh winter conditions are common start general facility winterization in late fall, minimizing just-in-time preparations before anticipated abnormally cold weather. Many installations that are used to sustained sub-freezing temperatures, such as FE Warren AFB in Wyoming, Minot AFB in North Dakota, Malmstrom AFB in Montana, and Peterson AFB in Colorado, still experienced frozen water or fire suppression lines that caused damage, just to a lesser degree.

Facility condition is another factor that led to damage. Degraded roofs, walls, windows, and doors can provide a pathway for moisture to enter the facility, which can freeze and further damage the facility. Degradation of these building components also can prevent the facility from retaining heat well, requiring heating systems to work harder to keep the facility warm. In many instances, degraded heating systems could not keep up and failed, leading to sub-freezing temperature within a facility and frozen water lines. The DAF has continually accepted risk in installation investment leaving facilities and infrastructure in a degraded condition. Leveraging our long-term Infrastructure Investment Strategy (I2S), the DAF is seeking to restore the condition of facilities and infrastructure and enhance resiliency by proactive upgrades through targeted facility investments informed by analytics, stabilized funding, application of evolving building

codes, and improved processes such as more standardized building components through category management.

Coordination with utility providers, installation back-up power and water plans, and past infrastructure investments minimized the scope and impact of outages. DAF installations rely on local utility providers as the primary source of power and water. As a result, if the community experiences interruptions during a storm, the base is also at risk of losing service. As installations are very much part of the surrounding communities, partnerships and working relationships with local utility companies are critical. Installations are constantly engaging with utility partners to ensure common understanding of needs, identify risks, find solutions which mutually benefit the installation and surrounding community, and synchronize response procedures should to interruptions or outages occur.

During the recent winter storms, several installations experienced limited power or water interruptions consistent with interruptions experienced by the local communities. Effective prior coordination helped minimize downtime. Several installations were able to effectively partner with local electrical power providers to minimize outages and mitigate impacts the installations. 72nd Air Base Wing Civil Engineer personnel at Tinker AFB communicated routinely with the local electrical power provider prior to and during the storm to ensure continuity of operations. The team took extraordinary measures to reduce heat set points in facilities across the installation and monitor them throughout the storm. These efforts significantly reduced the installation's energy consumption helping the utility provider stabilize the power grid and minimize rolling blackouts. Additionally, Offutt AFB and Altus AFB in Oklahoma were each able to coordinate with the local electrical power provider to conduct electrical load curtailment by operating on-base back-up power plants. The efforts lowered the installations' demand on the local power grid, enabling the utility provider to better support surging demand in the community.

In addition to power and water provided by local utility companies, installations must have secondary sources to support mission critical operations should local supplies be interrupted. Secondary power is primarily provided by a combination of back-up generators installed on critical facilities and mobile generators which can be relocated as required to respond to changing conditions. Electrical power back-up plans were generally effective during the recent storms to minimize the impact of power interruptions to installations or localized outages on an installation.

Several installations, including Minot AFB, North Dakota, Laughlin AFB, Texas, and Barksdale AFB, Louisiana, temporarily lost commercial power, but generators operated as designed to support mission requirements. One of the more critical instances where back-up generators ensured mission success was at Minot AFB. A portion of the missile field lost commercial power but back-up generators effectively kept the facilities operational until commercial power was restored.

Installations also maintain reserve water supplies, generally in buried or above ground tanks, in case of outages or emergencies and in some cases operate water wells as a secondary source. During recent storms, there were few instances where water supply to an installation was interrupted. There were numerous instances of localized outages which were caused by water distribution line breaks on installations or the need to shut off water to select facilitates to address broken pipes due to freezing. With few exceptions, reserve water supplies were able to support mission critical operations. The most notable issue was at Dyess AFB, Texas. Due to an off-base power outage, which did not directly impact the installation, the city of Abilene was unable to provide water for 24 hours. The installation's emergency reserve water tanks were drained faster than expected due to numerous water line breaks in facilities around the installations. The installation was forced to turn off water when the emergency tanks reached 10% in order to preserve the remaining water for firefighting capabilities.

The DAF has made effective past infrastructure investments, some in collaboration with utility providers, which have enhanced installation resiliency. Projects have been executed to specifically enhance power and water distribution infrastructure, install secondary or back-up power sources, and add redundancy to distribution systems through looped and cross-connected designs or connections to additional utility provider systems. Efforts to relocate overhead power lines underground in order to decrease the vulnerabilities of environmental conditions on the electrical distribution network have dramatically decreased power outages during wind or ice storms. Installation of back-fed circuits have allowed power to be re-routed in case of a localized outage or the need for maintenance or repair. Installations impacted by recent storms, such as Vance AFB, Oklahoma, Altus AFB, Little Rock AFB, Arkansas, Scott AFB, Illinois, Cannon AFB, New Mexico, and Grand Forks AFB, North Dakota, have invested significant funds over the last several years to enhance their electrical distribution systems by burying power lines and

installing back-fed capabilities. Barksdale AFB is an example of an installation where connection to a secondary water provider paid off. When Barksdale's primary water source from Shreveport was compromised, the installation was able to switch to the city of Bossier, its back-up provider, for water. The redundancy provided by an alternate water supply minimized the length of a required boil water notice on Barksdale AFB.

MILCON Investments

Each MILCON project incorporates aspects of installation resilience through the application of updated UFCs during design and construction. Facilities designed and built in accordance with the latest standards are more resilient to the threats posed by climate change and severe weather. Most of our current mission MILCON projects replace facilities which no longer support mission requirements or are outdated and susceptible to climate and severe weather threats due to their age, condition, or the fact they were build using now outdated design criteria. Energy resilience is most directly addressed through ERCIP projects or efforts leveraging third-party financing such as EALs, ESPCs, and UESCs.

In FY20, the DAF undertook several resiliency related projects including designs for seven projects in Florida, Hawaii, South Carolina, Nebraska, North Dakota, Germany, and Japan. In FY21, the DAF funded designs for projects at Joint Base Anacostia-Bolling in Washington D.C. and another on Wake Island. All of these projects will address a resilience risk associated with a natural or manmade threat to the installation. In addition to funding project designs, FY21 funds were also used to enable technical analysis in support of tri-service UFC updates specific to installation resilience.

Conclusion

Ready and resilient installations are at the core of Air Force and Space Force mission success. Not only do we launch missions from our installations, they are the platform on which more than 300,000 Total Force personnel organize, train, and equip and are home for thousands of Airmen, Guardians, and their families. Natural disasters and severe weather have impacted DAF installations across the world over the years and that threat is not going away. Tackling the current climate crisis is a matter of national security and the DAF is committed to ensuring our installations are protected against the threats posed by deliberate, accidental, or naturally occurring events and

that our personnel are able to respond and recover our installations should an event occur. We have learned and adapted after each impacting event and we are taking proactive action to enhance installation resilience across the enterprise.

We incorporate installation resilience in all aspects of operations, approaching it from four fronts: energy, cyber, infrastructure, and response. Energy, to include electricity, natural gas and water, is essential to mission accomplishment. Our focus is on secure the ability to perform our warfighting mission in the face of disruptions to traditional energy sources while simultaneously optimizing availability and productivity through better planning and technology and process improvements. Our cyber resilience efforts, from an installations perspective, focus on preventing, detecting, and responding to unauthorized access to DAF facility-related control systems, such as those associated with power and water distribution, back-up generators, and HVAC systems. Infrastructure efforts ensure the installations themselves are ready now and in the future. Our focus is on limiting damage and recovery time following an event. We construct new facilities with MILCON and modernize existing facilities with FSRM using the latest design codes, which are routinely updated to address climate and weather risks. The DAF I2S guides investment decisions and business processes to restore the condition of our facilities and infrastructure so that that they are better able to weather a storm. We are also embracing innovating approaches to natural infrastructure, capitalizing on partnerships with other government and non-government agencies to enhance installation resiliency.

The effectiveness of all of the planning and execution that goes into enhancing the resiliency of our installations is minimized if our more valuable resource, our people, are not ready to respond. Emergency management, disaster response, and continuity of operations planning is essential to ensure an installation and its people can respond and recover from an incident quickly while continuing to execute the mission or, in more extreme situations, minimizing downtime. Our holistic approach to installation resilience is what ensures the Air Force and Space Forces can provide timely and effective combat capability.