

VULNERABILITY ASSESSMENT AND RESILIENCE PLANNING GUIDANCE VERSION 1.2

This guidance outlines a climate change vulnerability assessment and resilience planning process to help the Department of Energy assess and manage climate change related risks to Departmental assets and operations.

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Version	Date	Description of Changes
1.0	09/20/2021	Initial publication.
1.1	02/23/2022	New Risk Assessment Tool embedded in Appendix A, instead of Vulnerability Screening Tool, and updated language related to the Risk Assessment Tool. National Risk Index added as Appendix F, Potential Hazards Tool added as Appendix G, and State Climate Summaries added as Appendix K.
1.2	2/25/2022	Updated a formula within the Risk Assessment Tool and re-embedded in Appendix A.

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Introduction

The U.S. Department of Energy is committed to managing the short and long-term effects of climate change on its mission and operations. To support this priority, DOE sites are expected to conduct vulnerability assessments and develop resilience plans within the next year. The vulnerability assessment and resilience plans (VARPs) will enable sites to identify, prepare for, and meet the challenges posed by climate change, and will build upon other existing DOE risk assessments processes.

To meet the requirements for a VARP and to simplify the process, this guidance consolidates previous climate change vulnerability screening and assessment steps and incorporates planning steps for resilience solutions that will be tracked in the [DOE Sustainability Dashboard](#). It also defines September 30, 2022 as the due date for completion of the VARPs. Sites will prioritize resilience solutions for implementation by considering the following:

- Number and magnitude of key vulnerabilities mitigated
- Mission and operational impacts avoided or mitigated
- Costs and benefits of resilience investments
- Co-benefits of greenhouse gas (GHG) emission reductions
- Enhanced sustainability
- Effects on energy efficiency

The scope of a VARP may vary across the DOE complex. For example, multiple sites that are co-located in the same climate zone with similar operations and/or assets may conduct a single, consolidated VARP. Additionally, it may be more efficient for a multi-location site to conduct one VARP covering all locations across multiple climate zones. Whether multiple VARPs or a single consolidated VARP is conducted, the plan should account for all relevant climate hazards and operational risks. Multiple risk matrices may be necessary. VARPs will be revised at least every four years to incorporate new information and data from the latest National Climate Assessment (NCA).

To conduct the VARP, sites should utilize this implementing guidance and related resources, such as the National Climate Assessment (Appendix B), the U.S. Climate Resilience Toolkit (Appendix C), and Climate Explorer (Appendix D). Sites are also encouraged to use the Federal Energy Management Program's (FEMP) Technical Resilience Navigator (TRN) to complement the VARP. In addition, sites should leverage related risk assessment processes outlined in various DOE Orders that can inform the VARP process (See DOE Orders Crosswalk, Appendix H). For example, sites should utilize their Threat and Hazard Identification and Risk Assessment (THIRA) and other hazard analysis and risk assessments in support of continuity of operations, safety, and emergency response directives.

The Office of Asset Management's Sustainability Performance Division (SPD) is available to provide assistance during the assessment process and will periodically update the guidance documents based on new information and feedback, including the incorporation of lessons learned. Throughout this process, SPD will work closely with the DOE Program Offices to identify common challenges and resilience strategies, as well as share best practices. The Office

of Environment, Health, Safety and Security's Office of Environmental Protection and Environmental, Safety, and Health Reporting and Office of Sustainable Environmental Stewardship will provide back up support to the SPD as needed.

Within the VARP processes, sites will identify a range of climate hazards for which they may be at risk. Plans must consider multiplier effects from compounding threats (e.g., droughts leading to increased wildfires) and the extent that vulnerabilities affect mission critical functions and operations. Throughout this process, sites will evaluate the potential life-cycle costs and consequences of inaction, both to DOE sites and external communities, including the assessment impacts on energy and environmental justice communities. To the extent possible, sites should evaluate the potential costs and benefits of proposed resilience solutions, including the quantification of key metrics that show changes to resilience, energy efficiency, and GHG emissions. Sites should leverage partnerships with various entities such as utility providers, State, local, and Tribal governments, neighboring municipalities, and emergency responders. Each step of the VARP must describe how the step was undertaken at the site level.

Once complete, the VARP should be submitted to SPD via the Dashboard. Any site with a VARP that contains sensitive national security information, if feasible, should submit a version with the sensitive information removed. Otherwise, submit a password protected version or encrypted email directly to SPD. Resilience solutions will be tracked through the Dashboard and will be reported at least annually. SPD will monitor progress and provide periodic reports to DOE's Chief Sustainability Officer, and Sustainability Steering Committee. VARP assessment and implementation information should also be integrated with other DOE Program Office, site or laboratory planning documents, procedures, and policies.

Key Steps to Climate Change Vulnerability Assessment and Resilience Planning

The following guidance highlights the key steps for completing a VARP which will enhance a site's resilience to climate change impacts.

Step 1: Identify VARP Planning Team

Sites should begin the VARP process by forming a planning team. Possible members include staff from Federal field offices, site sustainability programs, energy programs, research and development, business continuity, emergency management, site planning, procurement, and the environmental management system team. If the site has already created a THIRA team, the site should consider leveraging this established team. The VARP team will guide the process by identifying critical assets and infrastructure, identifying projected climate change and extreme weather hazards and vulnerabilities, and proposing and assessing climate resilience solutions.

Step 2: Identify Critical Assets and Infrastructure

Sites should identify critical assets and infrastructure. The VARP should describe the process for determining the importance of assets and infrastructure systems to maintain core mission activities and capabilities. To complete this step, sites should leverage critical assets and infrastructure systems previously identified to comply with

emergency planning, continuity of operations, and safeguard and security requirements (Appendix H). In addition, relevant sources of information may include non-DOE generated resources, such as state energy assurance plans or state and community hazard mitigation plans.

Examples of critical site assets and infrastructure systems include the following:

- Site workforce (e.g., outdoor workers, researchers, office staff)
- Site buildings (e.g., may be broken down by type, those with critical functions, office buildings)
- Specialized or mission-critical equipment (e.g., lasers, high performance computing, particle accelerators, HVAC systems)
- On-site waste disposal facility
- Energy generation and distribution systems
- IT and telecommunication systems
- Transportation and fleet infrastructure
- Water and wastewater systems
- Supply chains for critical materials
- Site ecology and land preservation

The project team should ensure that critical assets and infrastructure are denoted in the Dashboard's *Facility Goal Category*.

Step 3: Characterize Climate Trends and Events

The VARP planning team should look at historical weather data, climate projections, and the latest climate science to understand future climate scenarios. The team should assess the potential impact of extreme weather events and climate change on the site-specific operational viability of critical assets, infrastructure, and programs. This assessment should consider both near-term climate impacts, as well as long-term impacts over the expected lifespan of critical assets and infrastructure systems. To ensure consistency in approach and comparability of results across the DOE complex, sites should use the climate scenarios represented by [Representative Concentration Pathway](#) (RCP) 4.5 and RCP 8.5, in addition to any other scenarios deemed appropriate. RCP 4.5 represents the Intergovernmental Panel on Climate Change's (IPCC) scenario for lower concentrations of GHG emissions, while RCP 8.5 represents a scenario of higher GHG emissions resulting in greater projected impacts (e.g., temperature extremes, sea level rise and storm surge, droughts and extreme precipitation events) that lead to severe consequences and higher costs.

The Federal Emergency Management Agency's (FEMA) [National Risk Index](#) (NRI) or the [Potential Hazards](#) tool within FEMP's Technical Resilience Navigator can provide a baseline for understanding historical hazards that could be affected by climate change. However, these tools are not forward-looking regarding future climate hazards.

For projected hazards, the NCA provides regional reports that describe specific climate hazards projected for geographic regions (Appendix B). Besides the NCA reports, other local plans, assessments, and resources may be valuable sources of information. For example, the Climate

Resilience Toolkit (Appendix C) and Climate Explorer (Appendix D) provide tools, information, graphs, maps, downloadable data of observed and projected climate variables, and subject matter expertise to help users identify and manage climate-related risks and increase resilience. The Climate Impact Lab (Appendix E) provides downloadable data on climate impacts at a more granular level, which can help inform asset level decisions. In addition, National Oceanic and Atmospheric Administration’s (NOAA) [2022 State Climate Summaries](#) (Appendix K) are produced to meet the demand for state-level climate information and provide historical climate variations, trends, and future climate model projections of climate conditions during the 21st century for each state. Sites with locations in multiple climate zones should identify climate impacts for critical assets and infrastructure systems at each location. VARPs should reference the sources of information used to identify climate hazards, including the NCA.

Step 4: Characterize the Likelihood of Climate Change Hazards

The VARP planning team should use NCA regional climate reports, as well as current and historical climate change hazards that impact operations to identify relevant climate hazards (e.g., ice storms, heat waves, drought, wildfires), and the associated likelihood. When determining whether a hazard applies to the site, the VARP team should consider potential implications of synergistic and cumulative effects that may, even indirectly, compromise the operational capacity of current assets and infrastructure that support mission critical DOE operations. For each relevant climate hazard identified, sites should identify the likelihood of hazard occurrence (e.g., extremely unlikely, unlikely, anticipated, likely, almost certain), and the information used to form the basis for the determination.

Table 1 provides an illustrative example:

Climate Hazard	Current Annual Frequency at Site (# of events/year)	Projected Effect of Climate Change	Confidence in Projection	Projected Annual Frequency at Site with Climate Change (# of events/year)	Projected Hazard Likelihood with Climate Change	Basis for Determination
Increasing Precipitation	3%	Increase	Somewhat Confident	10%	Likely	2015 site vulnerability assessment, NCA, Climate Explorer, recent events, historical record
Drought	7%	Increased	Confident	25%	Likely	NCA, Climate Impact Lab, recent events, historical record

Table 1: Example of an identified climate hazards table.

Step 5: Characterize Current and Projected Impacts of Climate Change Hazards on Assets and Infrastructure Systems

For each critical asset and infrastructure item identified, explain why/how it is vulnerable to the identified climate hazard (e.g., increased frequency of heat waves) and the expected impact, including the impact of no action. The following is an illustrative example of how a site may categorize the impact of a workforce vulnerability due to increased frequency and intensity of heat waves:

Site Y has 300 employees whose day-to-day work involves operating heavy-duty machinery to meet the clean-up mission. Average temperatures are currently 85 degrees Fahrenheit in the summer with typically 10 days of heat waves. The duration of heat waves is projected to increase by 25 percent by 2035, and the number of lost work hours due to heat-related work stoppages is projected to increase by 30 percent.

Step 6: Characterize Vulnerabilities with a Risk Matrix

Use the work performed in Steps 2 through 5 to develop a risk matrix to characterize site vulnerabilities and help visualize the impacts of climate hazards on critical assets and infrastructure.

The Risk Assessment Tool (Appendix A) offers a standardized method of analysis to help prioritize the need for resilience solutions. The input tabs within the Risk Assessment Tool incorporate VARP Steps 2 through 5. The following provides an overview of the input tabs within the screening tool and their correlation with the VARP steps:

- Identification of DOE Site Assets and Infrastructure Systems – Step 2
- Documentation of Historical Weather Events – Step 3
- Identify Likelihood and Current and Projected Climate Hazards – Step 4
- Characterization of Climate Hazard Impacts on Site Assets and Infrastructure Systems and the Vulnerability of these Systems – Step 5

The output of the Risk Assessment Tool is a Risk Matrix for a DOE site. The Risk Matrix (Figure 3) provides an illustrative example that characterizes the potential risk based on the hazard likelihood, hazard impact, criticality of assets and infrastructure, and vulnerability of assets and infrastructure.

Asset and Infrastructure System Type	Asset or Infrastructure Name/Identifier	Hazards		
		Coastal Flooding	Earthquake	Winter Weather
Onsite Waste Disposal Facility	Waste disposal 1	9.0	6.0	7.0
Onsite Waste Disposal Facility	Waste disposal 2	7.5	5.0	6.0
Transportation and Fleet Infrastructure	Bus depot	5.8	1.5	6.5

Figure 3: Example Risk Matrix.

The Risk Matrix categorizes vulnerabilities and enables DOE sites to identify, compare, and rank vulnerabilities by determining priority climate hazards and critical assets and infrastructure systems. When assigning impacts and vulnerability of an asset or infrastructure system, the impact of multiple threats should be considered. For example, the impact of coastal flooding on a site’s transportation system is likely to have secondary effects on the workforce’s ability to travel to/from the site and may require new policies and procedures to address. Compounding effects should be considered when assigning the impact and vulnerability score within the Risk Assessment Tool.

Step 7: Identify and Assess Resilience Solutions

Determine possible resilience solutions for the climate hazards and the associated critical assets and infrastructure systems, including the known barriers to implementation. In determining the appropriateness of resilience solutions, sites should assess effectiveness, feasibility, cost, community benefit, and timeline for implementation. The following should be identified:

- *Solution*: Identify the solution being considered.
- *Brief Description*: Provide an overview of the solution and why it is needed.
- *Critical Asset(s)*: Identify the assets/infrastructure identified in Step 2 that will be made more resilient by the solution.
- *Hazards*: Identify the anticipated climate-related impact(s) being addressed by the solution.
- *Expected Effectiveness*: Identify the resilience solution’s capacity to reduce the overall risk. Risk is defined as the combined magnitude of consequences and likelihood that a vulnerability will affect the site.
- *Feasibility*: Provide an assessment of whether the solution can be implemented, financially, legally, technically, and organizationally.
- *Cost and Funding Type*: Estimate the expected monetary cost and likely funding source(s) (e.g., appropriated funds, performance contract).

- *Benefit*: Provide the benefits that the DOE site will receive from the resilience solution.
- *Community Impact*: Provide the impacts (positive or negative) that the surrounding community will receive from the resilience solution. If the impacts will affect an energy or environmental justice community, please specify.
- *Environmental Impact*: List benefit or detriment to the site ecology and GHG emissions, if any.
- *Recommended Approach*: Provide the site's recommended path forward.

The comprehensive table below is an illustrative example of what could be utilized:

Solution	Description	Critical Asset(s)	Hazard(s)	Expected Effectiveness	Feasibility (Easy, Moderate, Difficult)	Cost & Funding Type	Community Impact	Environmental Impact	Recommended Approach
On-site renewable energy production	Develop 20MW PV array on-site to ensure electricity availability	Electricity	Heat, drought & wildfires causing excessive peak demand & brownouts	Effective – currently no adaptive capacity exists, so adding protection will reduce risk by reducing vulnerability	Moderate	\$500k, Energy Savings Performance Contract (ESPC)	Reduce burden on utility, allowing more electricity availability for community	Impact on-site ecology	Proceed to Step 8

Figure 4: Example of a comprehensive Resilience Solutions Table.

Step 8: Develop and Implement a Portfolio of Resilience Solutions

Following the assessment of identified resilience solutions, the VARP team will identify the most appropriate solutions for inclusion in the solution portfolio (Figure 5). The development process will require an evaluation of the candidate solution, including a comparison of refined cost/benefit estimates to specified criteria and an assessment of each solution’s feasibility, efficacy, co-benefits, and ability to withstand a range of climate impacts. The resulting benefits will vary with asset and system conditions, the probability of climate impacts, the timing of those impacts, and the collective mix of selected solutions.

For implementation, the timing and funding mechanisms (i.e., appropriated funds, performance contract) should be identified. Implementation status will be tracked in the Dashboard and should be updated by sites annually, at a minimum. Tracking implementation solutions in the Dashboard will help provide a standard way of reporting progress on implemented resilience solutions and will be used by SPD to update DOE’s progress.

Solution	Priority Rank (High, Medium, Low)	Timing (Planned Start/End Dates)	Funding Mechanism	Implementation Status
PV array	High	7/1/2022 – 6/30/2023	Utility Energy Services Contract (UESC)	Planning stage
Reconfigure outdoor worker shift structure to avoid excessive summer heat.	Medium	6/1/2021 – 6/14/2021	Appropriated funds	Complete

Figure 5: Example portfolio of Resilience Solutions.

Step 9: Monitor, Evaluate, and Reassess the Resilience Plan

Planning for climate change and extreme weather hazards includes uncertainty not only about how the climate will differ in the future, but also how technologies and climate policies may

change in parallel. A robust plan should be adaptable to changing expectations and evidence as well as facilitate monitoring of progress and evaluation of implemented solutions. The VARP should describe how the following are addressed:

- *Monitoring progress:* Measuring implementation milestones against the resilience plan and gathering feedback from various site organizations implementing the plan.
- *Evaluation of implementation:* Assessing the effectiveness of completed adaptation/resilience solutions and incorporating and comparing feedback with new information about climate change, energy policies, installation costs, resilience technologies, and implementation experience.
- *Reassess:* Reassessing the VARP by completing a periodic review or by repeating steps at least every four years to incorporate new information such as updated climate science information from the latest NCA.

Appendix A: Risk Assessment Tool

The Risk Assessment Tool offers a standardized method to help sites identify regional climate hazards, critical assets and infrastructure, the likelihood of each climate hazard, and score the impacts on assets and infrastructure. The Risk Assessment Tool can be accessed through the icon below if the guidance is in Word Document format. Note, the tool was updated in February 2022, based on feedback. As a result, this tool uses standard risk assessment methodology.



DOE Risk
Assessment Tool.xls

Appendix B: National Climate Assessment

The National Climate Assessment (NCA) is a quadrennial Congressionally mandated report that analyzes the effects of global climate change on the natural environment, agriculture, energy production and use, land and water resources, transportation, human health and welfare, human social systems, and biological diversity. The NCA also analyzes current trends in climate change, both natural and human-induced, and projects major trends for the subsequent 25 to 100 years. The report is designed to help decision-makers, utility and natural resource managers, public health officials, and other stakeholders examine the impacts of climate change across the U.S. The [2018 NCA](#) analyzes U.S. climate change impacts by region:

Geographic Location of DOE Site	NCA Region	Full Chapter
CT, DE, MA, ME, MD, NJ, NY, NH, PA, RI, VT, WV	Northeast	https://nca2018.globalchange.gov/downloads/NCA4_Ch18_Northeast_Full.pdf
AL, AR, FL, GA, KY, LA, MS, NC, SC, TN, VA	Southeast	https://nca2018.globalchange.gov/downloads/NCA4_Ch19_Southeast_Full.pdf
IN, IL, IA, MO, MI, MN, OH, WI	Midwest	https://nca2018.globalchange.gov/downloads/NCA4_Ch21_Midwest_Full.pdf
MT, NE, ND, SD, WY	Northern Great Plains	https://nca2018.globalchange.gov/downloads/NCA4_Ch22_Northern-Great-Plains_Full.pdf
KS, OK, TX	Southern Great Plains	https://nca2018.globalchange.gov/downloads/NCA4_Ch23_Southern-Great-Plains_Full.pdf
AZ, CA, CO, NM, NV, UT	Southwest	https://nca2018.globalchange.gov/downloads/NCA4_Ch25_Southwest_Full.pdf
ID, OR, WA	Northwest	https://nca2018.globalchange.gov/downloads/NCA4_Ch24_Northwest_Full.pdf
AK	Alaska	https://nca2018.globalchange.gov/downloads/NCA4_Ch26_Alaska_Full.pdf
HI and Pacific Islands	Hawai'i and Pacific Islands	https://nca2018.globalchange.gov/downloads/NCA4_Ch27_Hawaii-Pacific-Islands_Full.pdf

Appendix C: U.S. Climate Resilience Toolkit

The [U.S. Climate Resilience Toolkit](#) provides tools, information, and subject matter expertise to help users identify and manage climate-related risks and build resilience. The U.S. Climate Resilience Toolkit compiles climate resilience information from U.S. Federal agencies into one easy-to-use location. For example, sites can access various tools and publications on the toolkit by looking under the “Topics” tab and selecting the “Energy” topic.

Appendix D: Climate Explorer

The [Climate Explorer](#) offers graphs, maps, and downloadable data of observed and projected climate variables for every county in the contiguous United States. The tool offers graphs and maps of climate projections for temperature, precipitation, and related climate variables for two possible futures—one in which humans make a significant attempt to reduce global emissions of heat-trapping gases, and one in which the rate of global emissions continues to rise through 2100.

Appendix E: Climate Impact Lab

The [Climate Impact Lab](#) offers maps and downloadable data of observed and projected climate variables to quantify the impacts and costs of climate change by sector in communities around the world. The Climate Impact Lab leverages climate and economic data to estimate the relationship between a changing climate and human well-being across eight categories: human health, labor productivity, energy demand, agriculture, manufacturing, damage to coastal infrastructure, increased social conflict and crime, and altered migration patterns.

Appendix F: National Risk Index

The Federal Emergency Management Agency (FEMA) [National Risk Index \(NRI\)](#) is a dataset and online tool that uses available source data for natural hazard and community risk factors to develop a baseline relative risk measurement for each United States county and Census tract. Users can visualize risk using a mapping tool and create reports to capture risk details or conduct community-based risk comparisons, as well as export data for analysis outside of the site.

Appendix G: Potential Hazards Tool

The [Potential Hazards](#) tool within FEMP’s TRN uses estimates from FEMA’s NRI to help users understand the range of possible hazards and how frequently they may impact a site. The data has been modified within the TRN to display the likely annual frequency of a hazard at a site.

Appendix H: DOE Orders Crosswalk

The following table provides a high-level summary of the overlap between the VARP steps and existing DOE resilience requirements. The table is not an exhaustive analysis, but provides an indication of where common themes exist between the various DOE orders and the VARP. Note, VARP Steps 1 and 9 are not included in the table as they do not overlap with existing DOE resilience requirements. A blank cell indicates that there are no common themes.

DOE Orders	VARP Step 2: Identify Critical Assets and Critical Infrastructure	VARP Steps 3: Characterize Climate Trends and Events; 4: Characterize the Likelihood of Climate Change Hazards; and 5: Characterize Current and Projected Impacts of Climate Change Hazards on Assets and Infrastructure Systems	VARP Step 7: Identify and Assess Resilience Solutions	VARP Step 8: Develop and Implement a Portfolio of Resilience Solutions
DOE Order (O) 150.1A, <i>Continuity Programs</i>	Identify Mission Essential Assets (MEAs) and Mission Essential Functions (MEFs) Conduct Business Impact Analysis	Identify Hazards and Threats, Identify Vulnerabilities, Analyze Risks, Prioritize Liabilities	Determine Solutions	Financing Resilience Driven Projects
DOE O 470.4B, <i>Safeguards and Security Program</i>	Identify Mission Essential Assets (MEAs) and Mission Essential Functions (MEFs) Conduct Business Impact Analysis	Identify Hazards and Threats, Identify Vulnerabilities, Analyze Risks, Prioritize Liabilities	Determine Solutions	Financing Resilience Driven Projects
DOE O 420.1C, <i>Facility Safety</i>		Identify Hazards and Threats, Prioritize Liabilities Assign Mission Criticality Level to Mission Essential Assets (MEAs) and Mission Essential Functions (MEFs)	MEA Current Condition Assessment Input Other Infrastructure Assessment Determine Solutions	Implementing Resilience

DOE Orders	VARP Step 2: Identify Critical Assets and Critical Infrastructure	VARP Steps 3: Characterize Climate Trends and Events; 4: Characterize the Likelihood of Climate Change Hazards; and 5: Characterize Current and Projected Impacts of Climate Change Hazards on Assets and Infrastructure Systems	VARP Step 7: Identify and Assess Resilience Solutions	VARP Step 8: Develop and Implement a Portfolio of Resilience Solutions
DOE O 470.3 Chg. 1, <i>Design Basis Threat</i>	Identify Mission Essential Assets (MEAs) and Mission Essential Functions (MEFs)	Identify Hazards and Threats, Analyze Risks Assign Mission Criticality Level to Mission Essential Assets (MEAs) and Mission Essential Functions (MEFs)		Implementing Resilience
DOE Standard (STD)-1066-2016, <i>Fire Protection</i>	Identify Mission Essential Assets (MEAs) and Mission Essential Functions (MEFs)	Assess Liabilities, Identify Hazards and Threats, Analyze Risks	Identify Resilience Gaps and Determine Resilience Readiness Solutions	
DOE STD-1020-2016, <i>Natural Phenomena Hazards Analysis and Design Criteria for DOE Facilities</i>	Identify Mission Essential Assets (MEAs) and Mission Essential Functions (MEFs)	Identify Hazards and Threats, Analyze Risks	Determine Solutions	
DOE STD-1189-2016, <i>Integration of Safety into the Design Process</i>		Identify Hazards and Threats, Analyze Risks	Identify Resilience Gaps and Determine Resilience Readiness Solutions Input Other Infrastructure Assessment	
DOE O 205.1C, <i>Department of Energy Cyber Security Program</i>		Assess Liabilities, Identify Hazards and Threats, Analyze Risks	Identify Resilience Gaps and Determine Resilience Readiness Solutions	
DOE O 151.1D, <i>Comprehensive Emergency Management System</i>		Identify Hazards and Threats	Identify Resilience Gaps and Determine Resilience Readiness Solutions	

DOE Orders	VARP Step 2: Identify Critical Assets and Critical Infrastructure	VARP Steps 3: Characterize Climate Trends and Events; 4: Characterize the Likelihood of Climate Change Hazards; and 5: Characterize Current and Projected Impacts of Climate Change Hazards on Assets and Infrastructure Systems	VARP Step 7: Identify and Assess Resilience Solutions	VARP Step 8: Develop and Implement a Portfolio of Resilience Solutions
DOE O 436.1, <i>Departmental Sustainability</i>				Financing Resilience Driven Projects Implementing Resilience
10 Code of Federal Regulation (CFR) Part 830, <i>Nuclear Safety Management</i>		Identify Hazards and Threats	Determine Solutions	
DOE O 461.1C, <i>Packaging and Transportation for Offsite Shipment of Materials of National Security Interest</i>		Identify Hazards and Threats, Analyze Risks		
DOE O 461.2, <i>On-site Packaging and Transfer of Materials of National Security Interest</i>		Identify Hazards and Threats, Analyze Risks		
DOE O 413.3B, <i>Program and Project Management for the Acquisition of Capital Assets</i>		Identify Hazards and Threats Conduct Criticality Assessment		
DOE Guidance (G) 151.1-1A, <i>Emergency Management Fundamentals and the Operational Emergency Base Program</i>		Identify Hazards and Threats		
DOE O 430.1C, <i>Real Property Asset Management</i>	Identify Mission Essential Assets (MEAs) and Mission Essential Functions (MEFs)			

Appendix I: 2015 Vulnerability Assessment Guidance

SPD's 2015 Vulnerability Assessment Guidance, *Practical Strategies for Climate Change Vulnerability Assessments*, can be accessed [here](#). Note, this document serves as a reference only. Sites should refer to the VARP Guidance for the most recent requirements.

Appendix J: Pilot Climate Vulnerability Assessments

To help DOE sites develop climate vulnerability assessments, SPD launched a pilot program in 2014, which provided funding for four national laboratories to jump-start their vulnerability assessment and planning efforts. The pilot assessments conducted at Idaho National Laboratory (INL), Thomas Jefferson National Accelerator Facility (TJNAF), National Renewable Energy Laboratory (NREL), and Pacific Northwest National Laboratory (PNNL) are summarized in this guidance. Links, where available, are provided to the case studies in their entirety. Note, these examples follow the prior Vulnerability Screening and Assessment Guidance (Appendix I). These assessments are only provided as a resource, and are not consistent with the VARP Guidance.

Idaho National Laboratory (INL)

[Climate Change Vulnerability Assessment for Idaho National Laboratory: October 2014](#)

[INL's Climate Change Vulnerability Assessment Stakeholder Presentation: July 2014.](#)

Thomas Jefferson National Accelerator Facility (TJNAF)

Climate Vulnerability Screening at Thomas Jefferson National Accelerator Facility: October 2014. Contact SPD directly to obtain a copy of the TJNAF pilot assessment.

National Renewable Energy Laboratory (NREL)

[A Climate Change Vulnerability Assessment Report for the National Renewable Energy Laboratory: May 23, 2014 -- June 5, 2015](#)

[A Resiliency Action Plan for the National Renewable Energy Laboratory: May 23, 2014 -- June 5, 2015](#)

Pacific Northwest National Laboratory (PNNL)

[Climate Resiliency Action Planning at Pacific Northwest National Laboratory: September 2015](#)

Appendix K: State Climate Summaries

National Oceanic and Atmospheric Administration's (NOAA) [State Climate Summaries](#) provide historical climate variations, trends, and future climate projections of climate conditions during the 21st century for each state. These state summaries were updated in 2022 and use information from the third edition of the NCA.