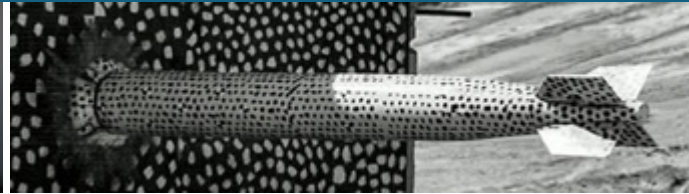
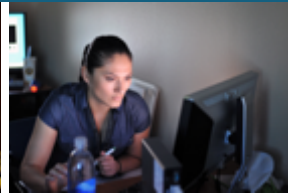




Extreme Environment Events and Physical Protection Systems



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- Nuclear facilities need to maintain effective security at all times
- One potential case where security may be challenged in unexpected ways are Extreme Weather Events (EWEs)
- EWEs can be divided into two categories
 - EWEs without advanced notice
 - Earthquakes, tornadoes, etc.
 - EWEs with advanced notice
 - Hurricanes, wildfires, etc.
- EWEs present several potential problems to security
 - During an EWE, parts of the security system may be uninhabitable
 - An EWE can damage nuclear power plant (NPP) safety systems and elements of the security system
 - After an EWE, effective security needs to be maintained until the security system can be restored to its normal operating condition

Framework and Methodology



- Define the Problem
 - Extreme Weather Events and their impacts on physical protection systems
 - Current implementation of emergency plans, severe weather plans, contingency plans and compensatory measures
- Literature review – Work informing the present issue
 - Impact of previous EWEs on nuclear facilities and other critical infrastructure
 - Pre-event, during event, post event
 - Regulatory Framework – International, Domestic (U.S.), and local requirements
- Virtual SME Interviews
 - Experienced professionals within and external to Sandia in nuclear or other high-consequence facility protection and planning, threat analysis, and law enforcement
- Modeling & Simulation
 - Hypothetical SMR Facility
 - SCRIBE3D©
 - PATHTRACE©
 - Tabletop Scenarios

SME Interviews: Findings



- A site **must** be aware of the weather events it is susceptible to and have emergency and security plans for all of them
- A **risk assessment** based on historical data should be conducted and account for predicted future conditions
- While sites typically do not explicitly consider an adversary attempting to leverage EWE conditions as part of the DBT or vulnerability assessment, all plans should account for these conditions **with input from** the security organization
- Security could participate in tabletop scenarios for emergency planning
- Importance of coordination and training with emergency response organizations and local law enforcement **offsite**
- **Significant disagreement regarding credibility of the threat of adversaries attempting to take advantage of EWEs**

Hypothetical SMR Facility



Modeling & Simulation Design Process



- Tabletop Exercises were conducted based on HAZUS analysis and previous examples of physical security damages that occurred during EWEs
 - All facility, adversary characteristics, and scenarios are hypothetical
- Three Scenarios were developed using the analysis results and case studies
 - **Scenario 1:** Category II hurricane over the site
 - **Scenario 2:** Category III hurricane over the site
 - **Scenario 3:** Category IV-V hurricane over the site
- The Tabletop Exercise and force-on-force simulations were conducted using SCRIBE3D©

Scenario 1 Results and Findings



Parameter Name	Value
Probability of Interruption (%)	99
Probability of Neutralization (%)	93
System Effectiveness	92
Number of Runs	100



All facilities and data are hypothetical/notional

Scenario 2 Results and Findings



Parameter Name	Value
Probability of Interruption (%)	99
<i>Probability of Neutralization (%)</i>	34
<i>System Effectiveness (%)</i>	34
Number of Runs	100



All facilities and data are hypothetical/notional

Scenario 3: Results and Findings



Parameter Name	Value
Probability of Interruption (%)	99
Probability of Neutralization (%)	99
System Effectiveness (%)	99
Number of Runs	100



All facilities and data are hypothetical/notional

Conclusions & Recommendations



- Sites should have contingency plans, emergency plans, and severe weather plans
 - Contingency plans should consider extreme weather events
 - Severe weather plans should consider the weather events that may impact their site based on long-term historical data
- Sites should consider the impact that extreme weather events in design basis events (DBEs) which may have compensatory measures to the physical protection system
 - Consideration should be given to the effectiveness of the physical protection system before, during and after a weather event
- Sites should consider evaluating contingency, emergency, and severe weather plans through force-on-force exercises/simulations and tabletops
 - **Preliminary analysis shows that two of the compensatory measures considered may lack the desired system effectiveness and/or high-level of Blue Force KIAs (>40% of Response Force)**
- Sites should conduct regular training on contingency, emergency, and severe weather plans
- If sites rely on offsite response forces, proper coordination and exercises should be considered if an FWF occurs at the site



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