

2017

Black Start Training Summary

**Version 1.0**

Document Revisions

|  |  |  |  |
| --- | --- | --- | --- |
| Date | Version | Description | Author(s) |
| 04/14/2017 | 0.1 | First draft | Evan A. Pierce – author  Erik Johnson – author |

Manager, Operations Training Date

Director, Grid Coordination Date

Table of Contents

[1. Executive Summary 1](#_Toc483896647)

[2. Detailed Description 2](#_Toc483896648)

[3. Black Start Wednesday/Thursday Session Observations 3](#_Toc483896649)

[4. Participant Feedback 8](#_Toc483896650)

[5. Analysis of 2017 Black Start Training Results 10](#_Toc483896651)

[6. Lessons Learned 12](#_Toc483896652)

[7. Recommendation 12](#_Toc483896653)

[8. 2018 Black Start Training 15](#_Toc483896654)

# Executive Summary

ERCOT’s Black Start Training event is required annually and complies with North American Electric Reliability Corporation (NERC) standards EOP-005-2: System Restoration from Blackstart Resources, R10 and EOP-006-2: System Restoration Coordination, R9. All NERC certified Real-Time Operations personnel within the ERCOT ISO participate, including Reliability Coordinators (RCs), Transmission Operators (TOPs), Generator Operators (GOPs), and Qualified Scheduling Entity (QSEs) operators representing generation and load resources. The three-day exercise, hosted at ERCOT’s Taylor campus, is facilitated by ERCOT’s System Operations Training Department with the assistance of ERCOT’s Energy and Market Management System (EMMS) Production team. The seven-week event includes one management-level pilot session and six standard sessions, each delivering 19 Continuing Education Hours (CEHs), including five hours of classroom training and 14 hours of simulation via ERCOT’s Dispatch Training Simulator (DTS). During the 2017 Black Start exercise, ERCOT provided 13,946 NERC CEHs to 734 participants, at an average stakeholder cost of $13.15 per CEH compared to the industry average of $100-$125 per CEH. This accounts for approximately $1.4 to $1.6 million in total ERCOT stakeholder savings in 2017.

ERCOT’s annual Black Start Training is executed with two objectives:

1. Train all ERCOT NERC Certified Real-Time operating personnel on effective execution of their respective Black Start Plans in response to a simulated total or partial system collapse, and
2. Validate ERCOT Black Start Plans for effectiveness and test them against changes in the previous year’s topography.

This process serves two purposes. First, the event allows ERCOT the ability to identify performance deltas while broadly applying the Systematic Approach to Training (SAT) to all ERCOT Operators, allowing collaboration with their respective training departments to “close the loop” on the ADDIE process year-after-year. Second, the event allows ERCOT to validate that restoration plans will work as designed, while determining areas for improvement to be implemented in the annual Black Start Plan review process.

During the 2016 Black Start Training, it was observed that system operators lacked a uniform methodology for judging appropriate load restoration rate and magnitude. This performance delta led to a consistent inability to manage voltage and powerflow following island synchronization. It was determined that unclear training performance objectives incentivized system operators to restore load with little regard for island stability. Consequently, the Black Start Training was redesigned in 2017 to focus on island stability and to disincentivize gross load restoration.

Participant feedback and training results of the 2017 training exercise indicate a dramatic level of success for this new approach. However, while the primary objective for achieving similar week-to-week results was accomplished, the simulator’s inconsistent performance had a direct, negative effect on the engagement of participants.

Performance improvement by system operators enabled large, stable island formation, which had never previously been observed. However, this new system configuration was initially determined to be susceptible to rapid, unpredictable collapse due to generator over-speed or under-frequency trips. The ERCOT Operations Training Department discovered a previously unseen structure to the progression of system restoration revealed by this change in system configuration. This structure provided insight into why discrete stages of restoration were persistently challenging and conclusions that may be relevant industry-wide.

# Detailed Description

The 2017 Black Start Training marked a departure from a completely performance-based exercise to a combination of training and performance, aligning with a traditional “On-the-job Training/Training Performance Evaluation” (OJT/TPE) format. The event was conducted with three overarching objectives.

First, Operations Training shifted the event’s focus from gross load restoration to maintaining island stability. This required Transmission Operators to slow down their restoration efforts and concentrate on balancing load with available generation.

Second, this was paired with a four-island restoration approach developed in the fall of 2016 during ERCOT’s “Synch and Beyond” event. This management-level workshop invited stakeholders to reevaluate system restoration and determine a “best path forward” during Black Start. From this event, it was hypothesized that a four-island restoration may be the most stable system configuration following a Blackout. The Black Start training was subsequently used to test this hypothesis, and to provide data for further analysis in determining a “best path forward.”

Finally, the Operations Training Department designed training to specifically close performance deltas that were identified in 2016, including Three-Part Communication, System Assessment, and Critical Load Restoration awareness.

Each training session began with a two-hour, instructor-led “Basic/Advanced Restoration Principles” focusing on 2016 Lessons Learned, Black Start Roles and Responsibilities, and the Three Phases of Recovery. Introduction of a “Three Phase Recovery” methodology established a systematic restoration pattern of Analysis, Preparation, and Restoration, which distinguishes between operational concerns during stages of recovery.

Following Basic/Advanced Restoration Principles, TOPs and QSEs separated and staffed their respective workstations. Operators spent two hours refamiliarizing themselves with the Macomber Map tool while performing a guided tutorial and worksheet to ensure operator proficiency. In this session, Operators were introduced to a new “Stability Assessment” tool, designed to prime operatorsfor the training focus change from “gross load restoration” to “island stability.”

Day two consisted of a ten-hour training simulation beginning with a partial blackout of the ERCOT system. System analysis and proper three-part communication were heavily stressed by instructors and presented as a priority. To re-enforce these priorities, Operations Training initially paused the simulation and instructed Operators to perform and document a system assessment. After the event was initiated, students were instructed to capture their first two “three-part communications” via a checklist. Prior to lunch, students were asked to now re-perform a stability assessment. Following lunch, students were asked to re-acquire their “three-part communication” target by capturing their first two communications via checklist. Finally, at the conclusion of the day’s event, students were asked to complete a “turnover” worksheet with the pertinent information they would pass on to their shift reliefs.

Day three departed from all previous Black Start Training events. During this continuous performance exercise, Week One continued building their system out on Thursday morning. On Thursday morning of Week Two, Operators continued restoration efforts where the operators from week one left off. Unfortunately, Week Two’s Thursday session was plagued with simulation issues and Operations Training decided to terminate the case and start a new case on the following week. Week Three repeated the efforts from Week One and continued building out the island they started on Wednesday. Weeks Four, Five, and Six did not encounter significant simulation issues and were able to build the system throughout the remainder of Black Start Training.

# Black Start Wednesday/Thursday Session Observations

2017 Black Start Training was centrally focused on creating and maintaining Island Stability. For the purposes of training, a load to generation ratio of 30% was used as a baseline target for minimum island stability. This ratio was consistently observed during the 2016 training and was believed to be a useful basis for comparison.

As the training cycle progressed, Operations Training became more proficient at training operators on island stability criteria. This caused a rapid decline in the amount of time required to reach minimum island stability and a consistent rise in operating time spent above this threshold. On average, reaching this minimum threshold took less than half the time in 2017 as in 2016 (4 hours vs 8.8 hours).

Unique to this year’s training was a previously unseen pattern of large island collapses. Operations Training initially believed this to be due to an erroneous simulator parameter, but was later discovered to be a potential “Upper Island Stability Limit” while controlling frequency on isochronous control. This was observed on Wednesday of Week Three and operators were immediately coached on this potential threshold. Islands unable to maintain stability on isochronous control were observed having approximately 1500 MW of total generation, 500 MW of load, and up to 14 generators under the frequency control of said isochronous unit. Upon discovering this pattern, Operations Training began recommending transferring frequency control to Constant Frequency Control (CFC). Islands that successfully made this transition failed to suffer island stability for the duration of the training exercise. Once these stability limits were recognized and operators were given clear, attainable objectives, island collapses and simulator pause/rollback time was reduced week-to-week.

Thursday of Week Two training was plagued with island instability, causing frequent system collapse and simulator failure. For this reason, the case used in Week Two was discontinued and Week 3 carried over the Wednesday case to Thursday. After this restart, operators were prompted to transition from isochronous island control to CFC. Those islands that successfully made this transition failed to collapse for the remainder of the Black Start training. No significant simulation changes occurred at this point which leads Operations Training to believe that at least some of the problems attributed to the simulator were due to the poor frequency control characteristics of a large island on isochronous control.

The tables provided for Wednesday training results highlight the 30% minimum island stability threshold. They are provided for a week-to-week comparison of time necessary to reach and duration operating above target island stability.

The following tables provided for Thursday compare Weeks One and Two progress and Weeks Three and Four progress. The final Thursday table represents the sustained efforts of Week Two through Week Six.

Note that times and dates reflect simulator date and time, not event date and time.

## Wednesday Weekly Results

**Week 1:**

**Week 2:**

**Week 3:**

**Week 4:**

**Week 5:**

**Week 6:**

## Thursday Session Results

**Week 2**

**Week 1**

**Week 4**

**Week 3**

**Week 3**

**Week 6**

**Week 5**

**Week 4**

# Participant Feedback

The following tables include 2017 Black Start Training Survey data collected from operators at the time of this report. Table 1 represents the percentage of operators answering “Yes” to the question, “Did this add value to the restoration exercise?” Results in Table 1 are divided in to training days: Tuesday (blue), Wednesday (red), and Thursday (orange) respectively. Table 2 and 3 separate Wednesday and Thursday training approval results for ease of view.

A substantial amount of participant feedback was dedicated to voicing dissatisfaction regarding simulator performance. It was noted by Operations Training that, following Week 3, there was a sharp upswing in approval of simulator performance without substantial changes made to the training simulator. On Thursday of Week Three, operations training began recommending that larger islands swap frequency control from isochronous to Constant Frequency Control prior to reaching an observed upper island stability limit. This operational change led to a drastic improvement in island stability and reduced the amount of simulator roll-backs. This appears to be reflected by a sharp spike in stakeholder satisfaction.

**ERCOT Operator-Specific Feedback**

Following the 2017 Black Start Training, ERCOT System Operators were introduced to a potential restoration methodology change and polled on operational concerns with this methodology as well as Black Start Restoration in general. Thirty-seven operators replied with 129 total comments. The following topics represent System Operator’s reported top three areas of concern. It is noted that almost one-third of all operator concerns are related to generation.

1. Generation: (Generators, CFC, AGC/LFC, Isoch, Reserves, Frequency Control)
2. Command and Control: (Visibility, Communications, Tie-Line Monitoring and Control)
3. Market Restoration: (How will this be coordinated?)

# Analysis of 2017 Black Start Training Results

**Methodology Change**

ERCOT’s 2017 Black Start Training was designed to address performance gaps identified in previous training events. Historically, Black Start Training simulations were launched from a total blackout condition; a methodology that prevented some system operators from fully participating for portions of the training. The 2017 departure created two discrete scenarios. First, operators would begin with a partial system blackout, enabling them to take advantage of available resources while ensuring all operators, regardless of access to Black Start resources, could begin operating immediately. Second, the final day of training would continue where the restoration effort from the previous week left off. This would allow the system to build out in an organic and realistic fashion and help determine the feasibility of ERCOT’s current restoration plan.

**All-Hazards System Restoration**

From Week-to-week it was observed that some large islands maintained stability while adjacent islands were subject to frequent, unexplained collapse. Unstable islands initially appeared to collapse with no consistency regarding magnitude of cold-load pickup or total generating capacity, irrespective of island load to generation ratio. The seemingly random nature of island collapses led both students and instructors to believe the simulator cases were corrupted and prompted Operations Training to frequently restore scenarios to earlier save-states and then continue with restoration. It was also noted that TOP island stability varied on a week-to-week basis without regard for the previous week’s level of success. This led Operations Training to suspect there was another underlying, yet unidentified stability problem.

Upon further questioning of participants, it was noted that in large islands that were unable to maintain stability, there was an excessive amount of generation and generators under control of a single, small isochronous unit. Island characteristics for failing stability were consistently observed to have upwards of 1500 MW of total generation, 500 MW of load, and 14 generators under the frequency control of a single isochronous unit. The consistent island failure that was observed led Operations Training to believe there is an unidentified “Upper Stability Limit” for island frequency control while in isochronous governor control. This theory is further bolstered by the fact that, once an island had transferred to Constant Frequency Control (CFC), they suffered no more island collapses while restoring load.

**Generator Dynamics**

Operations Training believes that there is a wide-spread lack of System Operator understanding regarding generator dynamics which was a contributing cause of dynamic instability. It was noted, through training relevant discussion, that Real-Time Operators in RC, TOP, QSE, and GOP positions were unable to distinguish between the following terms: Load Frequency Control (LFC), Constant Frequency Control (CFC), Automatic Generation Control (AGC), Isochronous Control, and Governor Droop. This unfamiliarity with terminology manifested in an inability to adequately monitor and dispatch generation.

This is, tentatively assumed, to be a level of knowledge gap which has manifested over time since market deregulation. Prior to deregulation, transmission operators would give Verbal Dispatch Instructions (VDIs) to Resource Entities. This is now accomplished automatically via Security Constrained Economic Dispatch (SCED). ERCOT’s aging work force and subsequent movement toward a “retirement cliff” has left a level of knowledge gap with regards to generator dynamics and how to issue a VDI.

Consequently, failure to properly dispatch generation was the event’s leading cause of island collapse.

**Command and Control**

Two general weaknesses regarding Command and Control were observed by Operations Training during Black Start Training. Operating Instructions were observed to be both ambiguous and lacking a common vocabulary across all Real-Time Operating functions. Operating Instructions consistently lacked units (MW/MVAR), clarity (“load this unit up”), and common terminology (LFC/AGC/CFC/Isoch). Lack of a questioning attitude from real-time operators receiving Operating Instructions led to communication break-down and misoperation.

**Data Collection and Analysis**

The 2017 Black Start restoration drill was Operations Training’s first attempt at robust data collection that could be used to meaningfully analyze operator performance. However, the Macomber Map was immediately found to have shortfalls, which hampered data collection. Island Summaries contained conflicting information and miscalculations. This distraction necessitated that Operations Training continuously verify data, detracting from training.

**Effects of Simulator Performance on Training**

Effective training and evaluation, of performance-based activities requires a near instantaneous feedback loop. This process informs trainees of real-time cause and effect and is crucial for performance improvement. During the 2017 Black Start Training, the inability to clearly and immediately identify the cause of island collapses directly and negatively impacted training value. Slow restoration progress caused by poor simulator performance led to an extreme level of stakeholder dissatisfaction.

Of particular note was a decline in simulator performance when compared to the 2016 Black Start Training. The 2017 Black Start Training was the first large scale, multi-user event with ERCOT’s upgraded simulator. Severe simulator performance problems were observed. Extensive simulator testing was performed the weeks prior to the Pilot Session and the weeks prior to the first training week and desired performance was observed. The problems persisted during the training weeks, although dimished weeks 5 and 6 due to simulator adjustments, fixes and a change in training emphasis. One key simulator defect was not able to be resolved during the training.

The DTS currently does not provide visibility as to the specific reason a crash occurs for given system conditions (i.e., a switching error leading to power flow unable to solve vs. incorrect settings leading to power flow unable to solve). Due to a simulator instructor log failure, Operations Training was unable to determine why simulator crashes were occurring. During the training sessions, DTS pauses and crashes occurred with such frequency, participants expressed the assumption that every crash was due to a faulty simulation versus a possible switching error. This led to poor training delivery and a high level of frustration from operators.

# Lessons Learned

* Transmission Operators reached minimum island stability criteria in 2017 more than twice as fast as in 2016.
* Operations training observed a naturally occurring pattern of restoration.
* Operators at all functions displayed a lack of knowledge regarding generator dynamics.
* ERCOT lacks a clear and concise set of terms for issuing and receiving Operating Instructions
* A lack of visibility and explanation for Operations Training and operators as to why island collapses occur must be resolved in order to provide meaningful and immediate feedback to participants.

# Recommendation

**Implement an All-Hazards Restoration Methodology**

During Black Start Training, a pattern of restoration was observed by Operations Training. This pattern may inform the interconnection of an “All-Hazards” Methodology to System Restoration. This methodology targets being effective, regardless of the cause of island collapse, by observing naturally occurring milestones and creating discreet stages of restoration. These stages would have thresholds allowing for specific Real-Time operational targets for ERCOT operators. While stages Zero through Three were actually observed week-to-week during Black Start Training and “Market Restoration” is considered the threshold for returning to normal operations, it is currently assumed that a transition to AGC/LFC control is an intermediary, but yet unobserved, step. Therefore, Operations Training recommends that Market Operations determine the minimum operational criteria necessary to restart Day-Ahead Market Operations. This will allow Operations to create a target threshold to transition to Stage Five of system recovery.

|  |  |  |  |
| --- | --- | --- | --- |
| Stage | Condition | Voltage Control | Frequency Control |
| 5 | **Market Restoration** | **X** | **X** |
| 4 | **AGC/LFC** | **X** | **X** |
| 3 | **Multi-TO CFC** | **X** | **X** |
| 2 | **Single-TO CFC** | **X** | **X** |
| 1 | **Isochronous Island** | **X** | **X** |
| 0 | **Initial Blackout** | **X** | **X** |

**Additional day of Black Start Training**

Operations Training observed a consistent lack of knowledge by Real-Time Operators at all positions with regard to generator control and dynamics. It is assumed that prior to deregulation in the ERCOT market, transmission operators were familiar with generation redispatch and maintained proficiency regarding Verbal Dispatch Instruction, However, in the years since deregulation, this knowledge has degraded or been lost due to a system operator “retirement cliff.” Operations Training believes it is imperative to get ahead of this deficiency before this knowledge has been eliminated from the interconnect. Therefore, Operations Training recommends an additional day of optional Black Start Training with ten associated Continuting Education Hours (CEHs). The session would be classroom training paired with a simulation. The intent of training would be to allow new operators the ability to gain intuition with regardto modes of governor control, load transfer, and dynamic operations. The additional ten hours of CEHs would account for a stakeholder savings of approximately 0.63 to 0.82. million dollars.

**Reclassification of some “Critical Loads” to “Black Start Loads”**

It was observed by Operations Training that “Critical Loads” identified by TOPs in their respective Black Start Plans varied wildly in quality and priority. Because of this, and due to the nature of participant expertise, it is recommended that “Critical Loads,” which are necessary for self-sustaining efforts following a Black Start, be classified as “Black Start Loads.” ERCOT lacks the sufficient expertise to determine the thresholds for criticality regarding “human needs” following a major system disruption. ERCOT is, however, well equipped to determine exactly what loads must be energized to maintain self-sustaining operation of the electric grid. It is therefore recommended that loads necessary to self-sustain the ERCOT Bulk Electric System be bifurcated from critical loads and to defer determining “critical load” threshold to a qualified authority (DHS, FEMA, and SOC).

Note: Substantive Rules Chapter 25: Applicable to Electric Service Providers; Subchapter R. Customer Protection Rules for Retail Electric Service; 25.497 Critical Load Industrial Customers, Critical Load Public Safety Customers, Critical Care Residential Customers, and Chronic Condition Residential Customers does not include loads necessary to maintain a self-sustaining electric grid as a “Critical Load.” Additionally, Subchapter C. Infrastructure Reliability; 25.52 Reliability of Continuity of Service (c)(1) defines critical loads as those loads “for which electric service is considered crucial for the protection or maintenance of public safety, including but not limited to hospitals, police stations, fire stations, critical water and wastewater facilities, and customers with special in-house life-sustaining equipment. This Substantive Rule does not include loads necessary to maintain a self-sustaining electric grid as a “Critical Load.”

**Improved Stakeholder Tools**

Due to using a common EMS type operations tool, an excessive amount of time has been dedicated to training stakeholders on how to use ERCOT’s training tools. This time would be better used to deliver actual training. Because of this, it is recommended that more user-friendly tools be created, which are engineered to minimize the likelihood of operator human performance error.

**Black Start Benchmarking Program**

During 2017 Black Start Training, in an effort to capture best practices, ERCOT Operations Training began benchmarking stakeholder Black Start training. Operations Training strongly recommends creating an official, sustained benchmarking program to ensure stakeholder needs are consistently met.

**Clarification of Roles during Restoration**

After identifying natural stages of Black Start progression, several operational transitions were noted to be lacking clear lines of communications. At key milestones, different stakeholders may enter or leave communiation chains and without proper guidance, communication failure is highly likely.

**Focus on Common Terminology**

Inaccurate and consistent Operating Instructions from Transmission Operators to QSEs/GOPs played a significant role in operational mistakes up to and including island collapse. It has been noted that operational changes in ERCOT’s recent history have included terminology changes that have not been captured and/or trained on by ERCOT. Clear and concise terminology practiced in non-emergency situations effectively prepares operators for emergency operations.

**Isochronous/Constant Frequency Control Modeling**

For simulation purposes, all generation resources within ERCOT’s operating area are modeled with isochronous capability. Operations Training recommends surveying all QSEs and determining which generating units are actually capable of isochronous operation and updating the OTS to reflect this information.

For simulation purposes, not all QSEs are modeled to have CFC mode of operation for their generating fleets. Operations Training recommends updating the OTS to reflect actual QSE CFC capability.

**Market Restart**

ERCOT’s Black Start Training has traditionally been executed as a bottom-up Black Start Plan performance test, targeting a return to normal operations but stopping shy of full market restoration. Operations Training is aware that a return to normal operations includes full market restoration and therefore strongly recommends comprehensive development of minimum criteria for initial market restoration. Operations Training, in coordination with Commercial Operations, is currently establishing a clear path forward to determining minimal market restart criteria, as well as a Market Restoration table-top event tentatively scheduled for fall of 2018.

**Planning Restoration Absent SCADA or EMS (PRASE)**

In June of 2017, a Report on the FERC-NERC-Regional Entity Joint Review of Restoration and Recovery Plans Further Joint Study Report: PRASE was released. Among the report’s recommendations is a focus on restoration training without the use of SCADA or EMS. ERCOT cyclic training addressing this issue is already underway. ERCOT recommends a continued focus on training with a loss of SCADA or EMS both internally and at the stakeholder level.

# 2018 Black Start Training

## Future Training for ERCOT Operators

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Day One | | Day Two | | Day Three | | Day Four | |
|  | | 0700-0800 | Prior Day Review | 0700-1200 | Blackout, System Assessment, and Initial Restoration Module | 0700-1100 | Cumulative System Restoration Module |
| 0800-1200 | Voltage Control/  Power Flow |
| 1200-1300 | Lunch | 1100-1200 | Feedback and Review |
| 1200-1300 | Black Start Fundamentals | 1300-1330 | Introduction/ Lessons Learned | 1200-1300 | Lunch |  | |
| 1300-1500 | All Hazards Method of System Restoration | 1330-1600 | Advanced Restoration Principles | 1300-1700 | Continuing Restoration Module |
| 1500-1600 | Basic Restoration Principles |
| 1500-1700 | Generator Frequency Dynamics with Simulation | 1600-1700 | Simulator Review |

## Black Start Working Group (BSWG) and Operations Training Working Group (OTWG)

ERCOT Operations Training recommends that the OTWG develop a collaborative strategy between ERCOT and its stakeholders. The 2016’s Synch and Beyond event leveraged stakeholder knowledge and understanding of the ERCOT system to create a four-island solution to Black Start. For 2017 Synch and Beyond, it is recommended that stakeholders identify initial conditions and outages that would provide realism and quality training value to their personnel.

This creates ownership in annual Black Start Training as well as a forum for ERCOT to facilitate the SAT process on behalf of its stakeholders. Results from Black Start can be fed back to participants to develop training and rapidly close the loop on performance deltas. This would provide proof of compliance for ERCOT stakeholders satisfying NERC PER-005-2 Operations Personnel Training R1.2, R1.3, R1.4, R2.2, R2.3, R 2.4, R3, R4, and R6.

Recognition

Credit for the success of this training activity goes to the diverse team of actively involved trainers, engineers, technical experts and support personnel. These include Mark Spinner (Manager of System Operations Training), Stacy Wozny (ERCOT System Operations Training Coordinator), ERCOT System Operations Trainers (John Jarmon, Erik Johnson, Brian Legg, Anh Tran, Chris Forral, and Evan A. Pierce), James Stone (former ERCOT System Operations Trainer), Jithender Polusani, Karthik Gopinath, Paul Li, Venkata Kanduri, Steve White, Richard Howard, Sreenivas Badri, Dave Dickenson, Bill Chastain, Holly Smith, Mark Tucker, Jennifer Hibbard, Ray Landry, Jeff Simien, Brittany Wilkerson, Eric Dahl, Yancy Harlow, Nate Gamble, Mike Dougherty, Paul Huehlefeld, Matt Tschetter, Tony ElHabr, Wen Zhang, Ben Picone, Angel Clark, Ricky Clark, Ricky Gonzalez Megan Miller, Wallace Dunkin, Melissa Marek, Mallory Vrana, Jeremiah Smith, Jimmy Mizell, and other physical security personnel. It is also important to recognize the efforts and cooperation of the ERCOT Black Start Working Group (BSWG).