

SYNTHETIC Customer Walkthrough

ERCOT · Texas Interconnection · SYNTHETIC-100MW

Draft completeness	DRAFT_COMPLETE	Field execution	NOT AUTHORIZED
Site rating	100.0 MW	POI voltage	230.0 kV
PF limit	0.95	Complete / total drafts	14 / 14
Generated draft	GridProof draft procedure SYNTHETIC-100MW · 2026.08.31-r8	Missing planning inputs	0

Execution boundary

Draft completeness means the planning fields are populated, not that their authority, applicability or equipment suitability has been independently verified. Field authorization and existing analysis/evidence gates remain separate. No approval is inferred from a reference or checkbox.

Before field execution

- Release the project procedure:** Verify applicable source revisions, equipment limits and the finished procedure with the responsible project team.
- Obtain test-day operating permission:** Record operator/QSE/TO/ISO coordination, witness arrangements, switching order and abort authority where applicable.
- Check actual equipment and recording readiness:** Confirm installed settings, available power/SOC, limiters, alarms, instrumentation and time synchronization before issuing commands.

How to use this draft pack

Complete missing Planning inputs in GridProof and regenerate. Release the procedure and obtain operating permission before issuing any plant command. Relative cues are planning aids. Record actual UTC times and initials, and return native recorder files with logs, witness notes and deviations. A project-specific screen is not a universal grid rule.

Procedure index

#	Test	Scenarios	Draft completeness	Missing inputs	Primary source
1	ERCOT ESR staged PFR	4	DRAFT COMPLETE	0	ERCOT Nodal Operating Guide Attachment C (December 5, 2025)
2	ERCOT FFR	1	DRAFT COMPLETE	0	ERCOT Nodal Operating Guide (February 1, 2026)
3	ERCOT reactive capability	2	DRAFT COMPLETE	0	ERCOT Nodal Operating Guide Section 3 (December 5, 2025)
4	ERCOT AVR / Q response	2	DRAFT COMPLETE	0	ERCOT Resource Integration
5	ERCOT active-power response	2	DRAFT COMPLETE	0	ERCOT Resource Integration
6	ERCOT capacity / RTE	1	DRAFT COMPLETE	0	ERCOT Resource Integration
7	MOD-026 Volt/VAR model	1	DRAFT COMPLETE	0	NERC MOD-026-2
8	MOD-027 P/f model	1	DRAFT COMPLETE	0	NERC MOD-026-2

01 · ERCOT ESR staged PFR

Published numeric criterion

Attachment C requires online ESR testing in charging and discharging modes, +0.2 Hz and -0.2 Hz frequency offsets, a 100-second event, at least 70% of calculated contribution by t0+16 seconds, and maintenance through t0+46 seconds. The configured droop must match the controlling Section 2.2.7 setting; the 1% preset comes from the current ESR transition material and must be confirmed for the project.

Scenario 1: Charging mode · Underfrequency (-0.2 Hz)

Rule coverage: Published complete sequence · **Draft:** DRAFT COMPLETE · **Field execution:** NOT AUTHORIZED · **Mode:** charging

Raw-file base: SYNTHETIC-RECORDING-09 (preserve native extension)

ERCOT publishes the offset, 100-second event, 16-second delivery checkpoint, 30-second additional sustain, and required positive/negative cases. The displayed 60-second baseline/recovery holds and 50%-rating planning setpoint are explicit GridProof controls, not ERCOT pass/fail criteria.

Step	Phase	Operator action	Exact target / timing	Record	Acceptance checkpoint	Authority / source	Actual / initials
1	Authorization	BEFORE FIELD EXECUTION: Review the controlling test procedure, switching order, one-line, communication plan, and abort limits with the operator and witness. Do not issue a plant command until all required approvals are active.	Cue: PRE-TEST GATE Target: Before field execution, record release of the finished project procedure and required operating permissions. A generated draft is not authorization. Duration: Before test start	Operator, witness, approving entity, approval time, procedure revision, open deviations	All approvals received; zero unresolved safety or operating-limit conflicts	Project-specific basis — approval not established ERCOT Nodal Operating Guide Attachment C (December 5, 2025)	
2	Instrumentation	BEFORE FIELD EXECUTION: Verify POI meter scaling, MW/MVAr sign convention, frequency and voltage units, controller command channels, time synchronization, and recorder health.	Cue: PRE-TEST GATE Target: One synchronized time base; native engineering units; no stale or substituted channels Duration: Complete before baseline	Use the approved recorder rate and preserve native timestamps; the cadence must resolve the configured response deadline and every command transition.	Every required channel changes in the expected direction and timestamps are synchronized	GridProof execution control GridProof data-quality control	
3	Controls	BEFORE FIELD EXECUTION: Confirm the approved plant-control mode, enabled limiters, droop/deadband or AVR settings, SOC window, equipment availability, and abort authority. Record every deviation before proceeding.	Cue: PRE-TEST GATE Target: Installed settings equal the approved procedure settings Duration: Complete before baseline	Controller mode/settings, enabled equipment, SOC, alarms, active limits	No unexplained mismatch between approved and installed settings	Project-specific basis — approval not established ERCOT Nodal Operating Guide Attachment C (December 5, 2025)	
4	Operating point	Place the ESR online in charging mode and set POI active power to -50 MW. Verify that at least 34.305 MW of movement is available in both directions without crossing a plant operating limit.	Cue: NEXT COMMAND-00:01:00 to NEXT COMMAND Target: Baseline -50 MW; bidirectional headroom $\geq$ 34.305 MW; PFR base/MDRR 100 MW Duration: Hold stable for 60 seconds	POI MW, frequency, frequency-offset command, SOC, controller limits and alarms	Baseline remains stable and required bidirectional headroom is demonstrated	GridProof execution control GridProof planning setpoint; ERCOT Attachment C requires a level that permits increase and decrease without operating limits	

Step	Phase	Operator action	Exact target / timing	Record	Acceptance checkpoint	Authority / source	Actual / initials
5	Stimulus	At t0, add an immediate -0.2 Hz offset to measured frequency. Do not ramp the offset. The test frequency is measured frequency -0.2 Hz.	Cue: T+00:00:00 to T+00:01:40 Target: Frequency offset -0.2 Hz, outside the 0.017 Hz deadband Duration: Maintain the offset from t0 through t0+100 seconds	Continuous unit MW level and frequency-offset signal for the complete event	The deadband is exceeded at t0 and the signed offset remains at the commanded value	Official grid requirement ERCOT Nodal Operating Guide Attachment C, ESR Frequency Response Test Procedure ¶¶2–6	
6	Response checkpoint	Observe the autonomous response; do not manually chase the MW value. For this underfrequency case, the correct direction is to increase POI MW.	Cue: T+00:00:00 to T+00:00:16 Target: Calculated contribution +34.305 MW; minimum accepted magnitude 24.014 MW Duration: From t0 through t0+16 seconds	MW at t0 and MW at t0+16 seconds; calculated contribution and droop	At least 70% of calculated contribution (≥ 24.014 MW magnitude) is delivered by t0+16 seconds in the correct direction	Official grid requirement ERCOT Nodal Operating Guide Attachment C ¶7 and ESR test form	
7	Sustain checkpoint	Keep the frequency offset active and verify the delivered response is not lost after the response deadline.	Cue: T+00:00:16 to T+00:00:46 Target: Maintain at least 24.014 MW contribution magnitude Duration: From t0+16 through t0+46 seconds	MW at t0+46 seconds and any limiter/alarm transition	Required response is maintained for the additional 30 seconds through t0+46	Official grid requirement ERCOT Nodal Operating Guide Attachment C ¶7 and ESR test form	
8	Complete event	Continue holding the offset after the acceptance checkpoint. At t0+100 seconds, remove the offset in one step.	Cue: T+00:00:00 to T+00:01:40 Target: Offset active through t0+100 seconds, then 0.000 Hz Duration: 100 seconds total event duration	MW and frequency offset through removal	Offset is not removed early	Official grid requirement ERCOT Nodal Operating Guide Attachment C ¶5	
9	Recovery	Return the ESR to its pretest -50 MW level and verify stable operation before the next case.	Cue: AFTER EVENT HOLD $\geq$ 00:01:00 Target: Return to -50 MW Duration: Hold 60 seconds or until stable, whichever is longer	POI MW, SOC, alarms, operator/witness notes	Pretest MW is restored with no unresolved alarm or operating-limit excursion	GridProof execution control ERCOT Attachment C requires return to pretest MW; 60-second recovery hold is a GridProof execution control	
10	Evidence	Export the native recorder file and complete the ERCOT ESR Frequency Response Test Form. Preserve the original file without smoothing, resampling, or deleted points.	Cue: POST-TEST HANDOFF Target: One immutable raw file plus completed +0.2/-0.2 Hz form entries Duration: Immediately after the case	Raw file name/hash, t0, baseline, t0+16 MW, t0+46 MW, calculated contribution/droop, witness disposition	All required form fields and raw channels are present	Official grid requirement ERCOT Nodal Operating Guide Attachment C ESR test form	

Post-test data handoff	Required signals	Return together	Received / hash / initials
SYNTHETIC-EXAMPLE Preserve the recorder's native extension.	• Timestamp / elapsed time [s or datetime] • Measured active power at the POI [MW] • Frequency or injected frequency offset [Hz]	• Native raw recorder file • Controller command/event log • Operator and witness notes • Deviation/abort log when applicable	UTC: SHA-256: Initials / deviation:

Scenario 2: Charging mode · Overfrequency (+0.2 Hz)

Rule coverage: Published complete sequence · **Draft:** DRAFT COMPLETE · **Field execution:** NOT AUTHORIZED · **Mode:** charging

Raw-file base: SYNTHETIC-RECORDING-08 (preserve native extension)

ERCOT publishes the offset, 100-second event, 16-second delivery checkpoint, 30-second additional sustain, and required positive/negative cases. The displayed 60-second baseline/recovery holds and 50%-rating planning setpoint are explicit GridProof controls, not ERCOT pass/fail criteria.

Step	Phase	Operator action	Exact target / timing	Record	Acceptance checkpoint	Authority / source	Actual / initials
1	Authorization	BEFORE FIELD EXECUTION: Review the controlling test procedure, switching order, one-line, communication plan, and abort limits with the operator and witness. Do not issue a plant command until all required approvals are active.	Cue: PRE-TEST GATE Target: Before field execution, record release of the finished project procedure and required operating permissions. A generated draft is not authorization. Duration: Before test start	Operator, witness, approving entity, approval time, procedure revision, open deviations	All approvals received; zero unresolved safety or operating-limit conflicts	Project-specific basis — approval not established ERCOT Nodal Operating Guide Attachment C (December 5, 2025)	
2	Instrumentation	BEFORE FIELD EXECUTION: Verify POI meter scaling, MW/MVAr sign convention, frequency and voltage units, controller command channels, time synchronization, and recorder health.	Cue: PRE-TEST GATE Target: One synchronized time base; native engineering units; no stale or substituted channels Duration: Complete before baseline	Use the approved recorder rate and preserve native timestamps; the cadence must resolve the configured response deadline and every command transition.	Every required channel changes in the expected direction and timestamps are synchronized	GridProof execution control GridProof data-quality control	
3	Controls	BEFORE FIELD EXECUTION: Confirm the approved plant-control mode, enabled limiters, droop/deadband or AVR settings, SOC window, equipment availability, and abort authority. Record every deviation before proceeding.	Cue: PRE-TEST GATE Target: Installed settings equal the approved procedure settings Duration: Complete before baseline	Controller mode/settings, enabled equipment, SOC, alarms, active limits	No unexplained mismatch between approved and installed settings	Project-specific basis — approval not established ERCOT Nodal Operating Guide Attachment C (December 5, 2025)	
4	Operating point	Place the ESR online in charging mode and set POI active power to -50 MW. Verify that at least 34.305 MW of movement is available in both directions without crossing a plant operating limit.	Cue: NEXT COMMAND-00:01:00 to NEXT COMMAND Target: Baseline -50 MW; bidirectional headroom $\geq$ 34.305 MW; PFR base/MDRR 100 MW Duration: Hold stable for 60 seconds	POI MW, frequency, frequency-offset command, SOC, controller limits and alarms	Baseline remains stable and required bidirectional headroom is demonstrated	GridProof execution control GridProof planning setpoint; ERCOT Attachment C requires a level that permits increase and decrease without operating limits	
5	Stimulus	At t_0 , add an immediate +0.2 Hz offset to measured frequency. Do not ramp the offset. The test frequency is measured frequency +0.2 Hz.	Cue: T+00:00:00 to T+00:01:40 Target: Frequency offset +0.2 Hz, outside the 0.017 Hz deadband Duration: Maintain the offset from t_0 through t_0+100 seconds	Continuous unit MW level and frequency-offset signal for the complete event	The deadband is exceeded at t_0 and the signed offset remains at the commanded value	Official grid requirement ERCOT Nodal Operating Guide Attachment C, ESR Frequency Response Test Procedure ¶¶2–6	
6	Response checkpoint	Observe the autonomous response; do not manually chase the MW value. For this overfrequency case, the correct direction is to decrease POI MW.	Cue: T+00:00:00 to T+00:00:16 Target: Calculated contribution -34.305 MW; minimum accepted magnitude 24.014 MW Duration: From t_0 through t_0+16 seconds	MW at t_0 and MW at t_0+16 seconds; calculated contribution and droop	At least 70% of calculated contribution ($\geq$ 24.014 MW magnitude) is delivered by t_0+16 seconds in the correct direction	Official grid requirement ERCOT Nodal Operating Guide Attachment C ¶7 and ESR test form	

Step	Phase	Operator action	Exact target / timing	Record	Acceptance checkpoint	Authority / source	Actual / initials
7	Sustain checkpoint	Keep the frequency offset active and verify the delivered response is not lost after the response deadline.	Cue: T+00:00:16 to T+00:00:46 Target: Maintain at least 24.014 MW contribution magnitude Duration: From t0+16 through t0+46 seconds	MW at t0+46 seconds and any limiter/alarm transition	Required response is maintained for the additional 30 seconds through t0+46	Official grid requirement ERCOT Nodal Operating Guide Attachment C ¶17 and ESR test form	
8	Complete event	Continue holding the offset after the acceptance checkpoint. At t0+100 seconds, remove the offset in one step.	Cue: T+00:00:00 to T+00:01:40 Target: Offset active through t0+100 seconds, then 0.000 Hz Duration: 100 seconds total event duration	MW and frequency offset through removal	Offset is not removed early	Official grid requirement ERCOT Nodal Operating Guide Attachment C ¶15	
9	Recovery	Return the ESR to its pretest -50 MW level and verify stable operation before the next case.	Cue: AFTER EVENT HOLD >= 00:01:00 Target: Return to -50 MW Duration: Hold 60 seconds or until stable, whichever is longer	POI MW, SOC, alarms, operator/witness notes	Pretest MW is restored with no unresolved alarm or operating-limit excursion	GridProof execution control ERCOT Attachment C requires return to pretest MW; 60-second recovery hold is a GridProof execution control	
10	Evidence	Export the native recorder file and complete the ERCOT ESR Frequency Response Test Form. Preserve the original file without smoothing, resampling, or deleted points.	Cue: POST-TEST HANDOFF Target: One immutable raw file plus completed +0.2/-0.2 Hz form entries Duration: Immediately after the case	Raw file name/hash, t0, baseline, t0+16 MW, t0+46 MW, calculated contribution/droop, witness disposition	All required form fields and raw channels are present	Official grid requirement ERCOT Nodal Operating Guide Attachment C ESR test form	

Post-test data handoff	Required signals	Return together	Received / hash / initials
SYNTHETIC-EXAMPLE Preserve the recorder's native extension.	• Timestamp / elapsed time [s or datetime] • Measured active power at the POI [MW] • Frequency or injected frequency offset [Hz]	• Native raw recorder file • Controller command/event log • Operator and witness notes • Deviation/abort log when applicable	UTC: SHA-256: Initials / deviation:

Scenario 3: Discharging mode · Underfrequency (-0.2 Hz)

Rule coverage: Published complete sequence · **Draft:** DRAFT COMPLETE · **Field execution:** NOT AUTHORIZED · **Mode:** discharging

Raw-file base: SYNTHETIC-RECORDING-11 (preserve native extension)

ERCOT publishes the offset, 100-second event, 16-second delivery checkpoint, 30-second additional sustain, and required positive/negative cases. The displayed 60-second baseline/recovery holds and 50%-rating planning setpoint are explicit GridProof controls, not ERCOT pass/fail criteria.

Step	Phase	Operator action	Exact target / timing	Record	Acceptance checkpoint	Authority / source	Actual / initials
1	Authorization	BEFORE FIELD EXECUTION: Review the controlling test procedure, switching order, one-line, communication plan, and abort limits with the operator and witness. Do not issue a plant command until all required approvals are active.	Cue: PRE-TEST GATE Target: Before field execution, record release of the finished project procedure and required operating permissions. A generated draft is not authorization. Duration: Before test start	Operator, witness, approving entity, approval time, procedure revision, open deviations	All approvals received; zero unresolved safety or operating-limit conflicts	Project-specific basis — approval not established ERCOT Nodal Operating Guide Attachment C (December 5, 2025)	
2	Instrumentation	BEFORE FIELD EXECUTION: Verify POI meter scaling, MW/MVAR sign convention, frequency and voltage units, controller command channels, time synchronization, and recorder health.	Cue: PRE-TEST GATE Target: One synchronized time base; native engineering units; no stale or substituted channels Duration: Complete before baseline	Use the approved recorder rate and preserve native timestamps; the cadence must resolve the configured response deadline and every command transition.	Every required channel changes in the expected direction and timestamps are synchronized	GridProof execution control GridProof data-quality control	
3	Controls	BEFORE FIELD EXECUTION: Confirm the approved plant-control mode, enabled limiters, droop/deadband or AVR settings, SOC window, equipment availability, and abort authority. Record every deviation before proceeding.	Cue: PRE-TEST GATE Target: Installed settings equal the approved procedure settings Duration: Complete before baseline	Controller mode/settings, enabled equipment, SOC, alarms, active limits	No unexplained mismatch between approved and installed settings	Project-specific basis — approval not established ERCOT Nodal Operating Guide Attachment C (December 5, 2025)	
4	Operating point	Place the ESR online in discharging mode and set POI active power to 50 MW. Verify that at least 34.305 MW of movement is available in both directions without crossing a plant operating limit.	Cue: NEXT COMMAND-00:01:00 to NEXT COMMAND Target: Baseline 50 MW; bidirectional headroom $\geq$ 34.305 MW; PFR base/MDRR 100 MW Duration: Hold stable for 60 seconds	POI MW, frequency, frequency-offset command, SOC, controller limits and alarms	Baseline remains stable and required bidirectional headroom is demonstrated	GridProof execution control GridProof planning setpoint; ERCOT Attachment C requires a level that permits increase and decrease without operating limits	
5	Stimulus	At t0, add an immediate -0.2 Hz offset to measured frequency. Do not ramp the offset. The test frequency is measured frequency -0.2 Hz.	Cue: T+00:00:00 to T+00:01:40 Target: Frequency offset -0.2 Hz, outside the 0.017 Hz deadband Duration: Maintain the offset from t0 through t0+100 seconds	Continuous unit MW level and frequency-offset signal for the complete event	The deadband is exceeded at t0 and the signed offset remains at the commanded value	Official grid requirement ERCOT Nodal Operating Guide Attachment C, ESR Frequency Response Test Procedure ¶¶2–6	
6	Response checkpoint	Observe the autonomous response; do not manually chase the MW value. For this underfrequency case, the correct direction is to increase POI MW.	Cue: T+00:00:00 to T+00:00:16 Target: Calculated contribution +34.305 MW; minimum accepted magnitude 24.014 MW Duration: From t0 through t0+16 seconds	MW at t0 and MW at t0+16 seconds; calculated contribution and droop	At least 70% of calculated contribution ($\geq$ 24.014 MW magnitude) is delivered by t0+16 seconds in the correct direction	Official grid requirement ERCOT Nodal Operating Guide Attachment C ¶7 and ESR test form	

Step	Phase	Operator action	Exact target / timing	Record	Acceptance checkpoint	Authority / source	Actual / initials
7	Sustain checkpoint	Keep the frequency offset active and verify the delivered response is not lost after the response deadline.	Cue: T+00:00:16 to T+00:00:46 Target: Maintain at least 24.014 MW contribution magnitude Duration: From t0+16 through t0+46 seconds	MW at t0+46 seconds and any limiter/alarm transition	Required response is maintained for the additional 30 seconds through t0+46	Official grid requirement ERCOT Nodal Operating Guide Attachment C ¶17 and ESR test form	
8	Complete event	Continue holding the offset after the acceptance checkpoint. At t0+100 seconds, remove the offset in one step.	Cue: T+00:00:00 to T+00:01:40 Target: Offset active through t0+100 seconds, then 0.000 Hz Duration: 100 seconds total event duration	MW and frequency offset through removal	Offset is not removed early	Official grid requirement ERCOT Nodal Operating Guide Attachment C ¶15	
9	Recovery	Return the ESR to its pretest 50 MW level and verify stable operation before the next case.	Cue: AFTER EVENT HOLD >= 00:01:00 Target: Return to 50 MW Duration: Hold 60 seconds or until stable, whichever is longer	POI MW, SOC, alarms, operator/witness notes	Pretest MW is restored with no unresolved alarm or operating-limit excursion	GridProof execution control ERCOT Attachment C requires return to pretest MW; 60-second recovery hold is a GridProof execution control	
10	Evidence	Export the native recorder file and complete the ERCOT ESR Frequency Response Test Form. Preserve the original file without smoothing, resampling, or deleted points.	Cue: POST-TEST HANDOFF Target: One immutable raw file plus completed +0.2/-0.2 Hz form entries Duration: Immediately after the case	Raw file name/hash, t0, baseline, t0+16 MW, t0+46 MW, calculated contribution/droop, witness disposition	All required form fields and raw channels are present	Official grid requirement ERCOT Nodal Operating Guide Attachment C ESR test form	

Post-test data handoff	Required signals	Return together	Received / hash / initials
SYNTHETIC-EXAMPLE Preserve the recorder's native extension.	• Timestamp / elapsed time [s or datetime] • Measured active power at the POI [MW] • Frequency or injected frequency offset [Hz]	• Native raw recorder file • Controller command/event log • Operator and witness notes • Deviation/abort log when applicable	UTC: SHA-256: Initials / deviation:

Scenario 4: Discharging mode · Overfrequency (+0.2 Hz)

Rule coverage: Published complete sequence · **Draft:** DRAFT COMPLETE · **Field execution:** NOT AUTHORIZED · **Mode:** discharging

Raw-file base: SYNTHETIC-RECORDING-10 (preserve native extension)

ERCOT publishes the offset, 100-second event, 16-second delivery checkpoint, 30-second additional sustain, and required positive/negative cases. The displayed 60-second baseline/recovery holds and 50%-rating planning setpoint are explicit GridProof controls, not ERCOT pass/fail criteria.

Step	Phase	Operator action	Exact target / timing	Record	Acceptance checkpoint	Authority / source	Actual / initials
1	Authorization	BEFORE FIELD EXECUTION: Review the controlling test procedure, switching order, one-line, communication plan, and abort limits with the operator and witness. Do not issue a plant command until all required approvals are active.	Cue: PRE-TEST GATE Target: Before field execution, record release of the finished project procedure and required operating permissions. A generated draft is not authorization. Duration: Before test start	Operator, witness, approving entity, approval time, procedure revision, open deviations	All approvals received; zero unresolved safety or operating-limit conflicts	Project-specific basis — approval not established ERCOT Nodal Operating Guide Attachment C (December 5, 2025)	
2	Instrumentation	BEFORE FIELD EXECUTION: Verify POI meter scaling, MW/MVAR sign convention, frequency and voltage units, controller command channels, time synchronization, and recorder health.	Cue: PRE-TEST GATE Target: One synchronized time base; native engineering units; no stale or substituted channels Duration: Complete before baseline	Use the approved recorder rate and preserve native timestamps; the cadence must resolve the configured response deadline and every command transition.	Every required channel changes in the expected direction and timestamps are synchronized	GridProof execution control GridProof data-quality control	
3	Controls	BEFORE FIELD EXECUTION: Confirm the approved plant-control mode, enabled limiters, droop/deadband or AVR settings, SOC window, equipment availability, and abort authority. Record every deviation before proceeding.	Cue: PRE-TEST GATE Target: Installed settings equal the approved procedure settings Duration: Complete before baseline	Controller mode/settings, enabled equipment, SOC, alarms, active limits	No unexplained mismatch between approved and installed settings	Project-specific basis — approval not established ERCOT Nodal Operating Guide Attachment C (December 5, 2025)	
4	Operating point	Place the ESR online in discharging mode and set POI active power to 50 MW. Verify that at least 34.305 MW of movement is available in both directions without crossing a plant operating limit.	Cue: NEXT COMMAND-00:01:00 to NEXT COMMAND Target: Baseline 50 MW; bidirectional headroom $\geq$ 34.305 MW; PFR base/MDRR 100 MW Duration: Hold stable for 60 seconds	POI MW, frequency, frequency-offset command, SOC, controller limits and alarms	Baseline remains stable and required bidirectional headroom is demonstrated	GridProof execution control GridProof planning setpoint; ERCOT Attachment C requires a level that permits increase and decrease without operating limits	
5	Stimulus	At t0, add an immediate +0.2 Hz offset to measured frequency. Do not ramp the offset. The test frequency is measured frequency +0.2 Hz.	Cue: T+00:00:00 to T+00:01:40 Target: Frequency offset +0.2 Hz, outside the 0.017 Hz deadband Duration: Maintain the offset from t0 through t0+100 seconds	Continuous unit MW level and frequency-offset signal for the complete event	The deadband is exceeded at t0 and the signed offset remains at the commanded value	Official grid requirement ERCOT Nodal Operating Guide Attachment C, ESR Frequency Response Test Procedure ¶¶2–6	
6	Response checkpoint	Observe the autonomous response; do not manually chase the MW value. For this overfrequency case, the correct direction is to decrease POI MW.	Cue: T+00:00:00 to T+00:00:16 Target: Calculated contribution –34.305 MW; minimum accepted magnitude 24.014 MW Duration: From t0 through t0+16 seconds	MW at t0 and MW at t0+16 seconds; calculated contribution and droop	At least 70% of calculated contribution ($\geq$ 24.014 MW magnitude) is delivered by t0+16 seconds in the correct direction	Official grid requirement ERCOT Nodal Operating Guide Attachment C ¶7 and ESR test form	

Step	Phase	Operator action	Exact target / timing	Record	Acceptance checkpoint	Authority / source	Actual / initials
7	Sustain checkpoint	Keep the frequency offset active and verify the delivered response is not lost after the response deadline.	Cue: T+00:00:16 to T+00:00:46 Target: Maintain at least 24.014 MW contribution magnitude Duration: From t0+16 through t0+46 seconds	MW at t0+46 seconds and any limiter/alarm transition	Required response is maintained for the additional 30 seconds through t0+46	Official grid requirement ERCOT Nodal Operating Guide Attachment C ¶17 and ESR test form	
8	Complete event	Continue holding the offset after the acceptance checkpoint. At t0+100 seconds, remove the offset in one step.	Cue: T+00:00:00 to T+00:01:40 Target: Offset active through t0+100 seconds, then 0.000 Hz Duration: 100 seconds total event duration	MW and frequency offset through removal	Offset is not removed early	Official grid requirement ERCOT Nodal Operating Guide Attachment C ¶15	
9	Recovery	Return the ESR to its pretest 50 MW level and verify stable operation before the next case.	Cue: AFTER EVENT HOLD >= 00:01:00 Target: Return to 50 MW Duration: Hold 60 seconds or until stable, whichever is longer	POI MW, SOC, alarms, operator/witness notes	Pretest MW is restored with no unresolved alarm or operating-limit excursion	GridProof execution control ERCOT Attachment C requires return to pretest MW; 60-second recovery hold is a GridProof execution control	
10	Evidence	Export the native recorder file and complete the ERCOT ESR Frequency Response Test Form. Preserve the original file without smoothing, resampling, or deleted points.	Cue: POST-TEST HANDOFF Target: One immutable raw file plus completed +0.2/-0.2 Hz form entries Duration: Immediately after the case	Raw file name/hash, t0, baseline, t0+16 MW, t0+46 MW, calculated contribution/droop, witness disposition	All required form fields and raw channels are present	Official grid requirement ERCOT Nodal Operating Guide Attachment C ESR test form	

Post-test data handoff	Required signals	Return together	Received / hash / initials
SYNTHETIC-EXAMPLE Preserve the recorder's native extension.	- Timestamp / elapsed time [s or datetime] - Measured active power at the POI [MW] - Frequency or injected frequency offset [Hz]	- Native raw recorder file - Controller command/event log - Operator and witness notes - Deviation/abort log when applicable	UTC: SHA-256: Initials / deviation:

Acceptance calculation

Check	Formula	Current substitution	Pass threshold
Expected PFR response	Expected $\Delta P = P_{base} \times \Delta f \div (f_{nom} \times droop - deadband)$	$P_{base}=100 \text{ MW}$; $ \Delta f =0.2 \text{ Hz}$; $f_{nom}=60 \text{ Hz}$; $droop=1\%$; $deadband=0.017 \text{ Hz}$	Expected 34.305 MW; deliver $\geq 24.014 \text{ MW}$
Response timing	Evaluate delivery from selected frequency trigger	Response window=16 s	Required delivery by $\leq 16 \text{ s}$
Sustained response	Maintain required delivery after the response deadline	Sustain duration=30 s	Required delivery maintained for $\geq 30 \text{ s}$

Sources

ERCOT Nodal Operating Guide Attachment C (December 5, 2025)
<https://www.ercot.com/files/docs/2021/09/01/08C-120525.docx>

ERCOT Nodal Operating Guides
<https://www.ercot.com/mktrules/guides/noperating/current>

ERCOT ESR Single-Model AS Qualification Transition

https://www.ercot.com/files/docs/2025/10/27/AS-Qualification-Transistion-to-ESR-Single-model_TWG_102325.pptx

ERCOT Energy Storage Resources

https://www.ercot.com/files/docs/2026/06/30/2026_07-Energy-Storage-Resources.pdf

02 · ERCOT FFR

Published numeric criterion

Trigger at 59.85 Hz; deliver 95%-110% of qualified capacity within 15 cycles; sustain within the same band for at least 15 minutes; record frequency and MW at no less than 32 samples/second. Recall is at 59.95 Hz in current ESR training.

Qualification procedure and revision: SYNTHETIC walkthrough fixture Rev 1 — not a field procedure

Frequency injection/ramp profile, units and timing: SYNTHETIC walkthrough fixture Rev 1 — not a field procedure

Recall condition, pretest MW and recovery sequence: SYNTHETIC walkthrough fixture Rev 1 — not a field procedure

Planned recovery interval (seconds): 60.0

Scenario 1: Underfrequency FFR qualification

Rule coverage: Published qualification timing · **Draft:** DRAFT COMPLETE · **Field execution:** NOT AUTHORIZED · **Mode:** online/armed

Raw-file base: SYNTHETIC-RECORDING-05 (preserve native extension)

ERCOT publishes the trigger floor, 15-cycle delivery deadline, 95%–110% band, 15-minute sustain, and 32 samples/second recorder minimum. The exact injected frequency ramp and recall choreography must match the ERCOT-approved qualification procedure.

Step	Phase	Operator action	Exact target / timing	Record	Acceptance checkpoint	Authority / source	Actual / initials
1	Authorization	BEFORE FIELD EXECUTION: Review the controlling test procedure, switching order, one-line, communication plan, and abort limits with the operator and witness. Do not issue a plant command until all required approvals are active.	Cue: PRE-TEST GATE Target: Before field execution, record release of the finished project procedure and required operating permissions. A generated draft is not authorization. Duration: Before test start	Operator, witness, approving entity, approval time, procedure revision, open deviations	All approvals received; zero unresolved safety or operating-limit conflicts	Project-specific basis — approval not established ERCOT Nodal Operating Guide (February 1, 2026)	
2	Instrumentation	BEFORE FIELD EXECUTION: Verify POI meter scaling, MW/MVAR sign convention, frequency and voltage units, controller command channels, time synchronization, and recorder health.	Cue: PRE-TEST GATE Target: One synchronized time base; native engineering units; no stale or substituted channels Duration: Complete before baseline	Record synchronized frequency and POI MW at ≥ 32 samples/s for the entire baseline, trigger, delivery, sustain, and recall interval.	Every required channel changes in the expected direction and timestamps are synchronized	GridProof execution control GridProof data-quality control	
3	Controls	BEFORE FIELD EXECUTION: Confirm the approved plant-control mode, enabled limiters, droop/deadband or AVR settings, SOC window, equipment availability, and abort authority. Record every deviation before proceeding.	Cue: PRE-TEST GATE Target: Installed settings equal the approved procedure settings Duration: Complete before baseline	Controller mode/settings, enabled equipment, SOC, alarms, active limits	No unexplained mismatch between approved and installed settings	Project-specific basis — approval not established ERCOT Nodal Operating Guide (February 1, 2026)	
4	Operating point	Place the resource online with the qualified FFR capacity armed and enough POI headroom/SOC to deliver the full obligation.	Cue: NEXT COMMAND-00:01:00 to NEXT COMMAND Target: Qualified FFR capacity 100 MW; available headroom ≥ 100 MW Duration: Hold stable for 60 seconds	POI MW, frequency, SOC, armed status, breaker/relay/controller status	Full qualified capacity is available with no blocking limiter	GridProof execution control GridProof execution control; ERCOT requires the resource to be online	

Step	Phase	Operator action	Exact target / timing	Record	Acceptance checkpoint	Authority / source	Actual / initials
5	Recorder	Start high-speed recording before the frequency ramp or injection.	Cue: FULL TEST WINDOW Target: Frequency and POI MW at ≥ 32 samples/second Duration: Entire baseline, trigger, deployment, sustain, and recall	Native high-speed frequency and MW	Effective sample rate ≥ 32 samples/second with synchronized timestamps	Official grid requirement ERCOT Nodal Operating Guide §2 FFR qualification	
6	Trigger	Apply the approved frequency profile until frequency first reaches 59.85 Hz and initiates FFR. Mark that interpolated crossing as t0.	Cue: PROJECT PLANNING WINDOW — see duration Target: SYNTHETIC walkthrough fixture Rev 1 — not a field procedure; preserve the displayed regional thresholds and timing Duration: See recorded profile for injection/ramp timing	Frequency crossing, t0, relay/controller initiation, POI MW	FFR initiates at the approved threshold, not below 59.85 Hz	User-supplied draft basis — not independently verified SYNTHETIC walkthrough fixture Rev 1 — not a field procedure	
7	Delivery	Allow the automatic FFR action to deploy; do not manually change the output during the response interval.	Cue: T+00:00:00 to T+00:00:00.25 Target: 95.000 to 110.000 MW of FFR Duration: Reach full responsibility within 0.25 seconds (15 cycles at 60 Hz) after t0	MW immediately before t0 and at the delivery deadline	Delivered FFR is 95%–110% of 100 MW by t0+0.25 seconds	Official grid requirement ERCOT Nodal Operating Guide §2 FFR qualification	
8	Sustain	Maintain the scheduled deployment continuously after full delivery.	Cue: AT TARGET HOLD $\geq$ 00:15:00 Target: Remain within 95%–110% of 100 MW Duration: At least 15 minutes (900 seconds)	Continuous frequency, MW, SOC, limiters and alarms	Delivery remains in band for at least 15 minutes	Official grid requirement ERCOT Nodal Operating Guide §2 FFR qualification	
9	Recall and recovery	Execute the ERCOT/approved recall instruction or approved qualification-test recovery profile. Return to the pretest operating point only after recall authorization.	Cue: PROJECT PLANNING WINDOW — see duration Target: SYNTHETIC walkthrough fixture Rev 1 — not a field procedure; preserve the displayed regional thresholds and timing Duration: Planned recovery: 60 seconds; only after recall permission	Recall instruction/time, recovered MW, SOC, alarms	No early withdrawal and stable return to the pretest point	User-supplied draft basis — not independently verified SYNTHETIC walkthrough fixture Rev 1 — not a field procedure	
10	Evidence	Export the original high-speed file and qualification worksheet without smoothing or resampling.	Cue: POST-TEST HANDOFF Target: Complete frequency/MW record and signed qualification result Duration: Immediately after test	Raw file hash, qualified MW, trigger t0, delivery time, 15-minute band check, deviations	All official numeric checks can be reproduced from the original record	GridProof execution control GridProof evidence control	

Post-test data handoff	Required signals	Return together	Received / hash / initials
SYNTHETIC-RECORDING-05 Preserve the recorder's native extension.	- Timestamp / elapsed time [s or datetime] - Measured active power at the POI [MW] - Absolute frequency [Hz]	- Native raw recorder file - Controller command/event log - Operator and witness notes - Deviation/abort log when applicable	UTC: SHA-256: Initials / deviation:

Acceptance calculation

Check	Formula	Current substitution	Pass threshold
FFR delivery band	Qualified MW $\times$ delivery percentage	100 MW $\times$ 95% to 110%	95.000 to 110.000 MW

Check	Formula	Current substitution	Pass threshold
Response deadline	Measure from interpolated frequency trigger	Configured deadline=0.25 s	Enter delivery band by ≤ 0.25 s
Qualification evidence	Sustain delivery and meet recorder rate	Sustain=900 s; sample rate=32 Hz	≥ 900 s and ≥ 32 samples/s

Sources

ERCOT Nodal Operating Guide (February 1, 2026)
<https://www.ercot.com/files/docs/2026/01/29/February-1-2026-Nodal-Operating-Guide.pdf>

ERCOT Nodal Operating Guides
<https://www.ercot.com/mktrules/guides/noperating/current>

ERCOT Energy Storage Resources
https://www.ercot.com/files/docs/2026/06/30/2026_07-Energy-Storage-Resources.pdf

03 · ERCOT reactive capability

Published numeric criterion

Demonstrate leading and lagging reactive capability equivalent to ± 0.95 power factor at maximum real-power capability in all four signed P/Q quadrants, subject to the current Reactive Study Scope, resource classification, CURL, approved sign convention, and test plan.

Resource classification, applicable test case and source/revision: SYNTHETIC walkthrough fixture Rev 1 — not a field procedure

Lagging test hold (seconds): 60.0

Leading test hold (seconds): 60.0

Scenario 1: Positive-Q / lagging

Rule coverage: Published partial sequence · **Draft:** DRAFT COMPLETE · **Field execution:** NOT AUTHORIZED · **Mode:** lagging

Raw-file base: SYNTHETIC-RECORDING-12 (preserve native extension)

ERCOT publishes different one-minute, 15-minute, and one-hour CURL cases by resource type and operating point. Confirm the project's ERCOT classification before execution; the app does not silently apply a Generation Resource/IRR hold to an ESR.

Step	Phase	Operator action	Exact target / timing	Record	Acceptance checkpoint	Authority / source	Actual / initials
1	Authorization	BEFORE FIELD EXECUTION: Review the controlling test procedure, switching order, one-line, communication plan, and abort limits with the operator and witness. Do not issue a plant command until all required approvals are active.	Cue: PRE-TEST GATE Target: Before field execution, record release of the finished project procedure and required operating permissions. A generated draft is not authorization. Duration: Before test start	Operator, witness, approving entity, approval time, procedure revision, open deviations	All approvals received; zero unresolved safety or operating-limit conflicts	Project-specific basis — approval not established ERCOT Nodal Operating Guide Section 3 (December 5, 2025)	
2	Scheduling	BEFORE FIELD EXECUTION: Select Coordinated or Non-Coordinated testing and send the required notice through the QSE.	Cue: PRE-TEST GATE Target: Coordinated: request by 15:00 one day before; Non-Coordinated: notify at least 2 hours before Duration: Before test	Request/notification time, ERCOT/TO response, planned MW/MVAr range, CURL	ERCOT and TO have not denied or cancelled the test	Official grid requirement ERCOT Nodal Operating Guide Section 3 §3.3.2.2	
3	Instrumentation	BEFORE FIELD EXECUTION: Verify POI meter scaling, MW/MVAr sign convention, frequency and voltage units, controller command channels, time synchronization, and recorder health.	Cue: PRE-TEST GATE Target: One synchronized time base; native engineering units; no stale or substituted channels Duration: Complete before baseline	Record continuous, synchronized POI P/Q/voltage evidence at the rate required by the controlling procedure.	Every required channel changes in the expected direction and timestamps are synchronized	GridProof execution control GridProof data-quality control	
4	Controls	BEFORE FIELD EXECUTION: Confirm the approved plant-control mode, enabled limiters, droop/deadband or AVR settings, SOC window, equipment availability, and abort authority. Record every deviation before proceeding.	Cue: PRE-TEST GATE Target: Installed settings equal the approved procedure settings Duration: Complete before baseline	Controller mode/settings, enabled equipment, SOC, alarms, active limits	No unexplained mismatch between approved and installed settings	Project-specific basis — approval not established ERCOT Nodal Operating Guide Section 3 (December 5, 2025)	

Step	Phase	Operator action	Exact target / timing	Record	Acceptance checkpoint	Authority / source	Actual / initials
5	Operating point	Set active power to 90.000 MW (90% of the 100 MW basis) and keep AVR/voltage control in service.	Cue: NEXT COMMAND-00:01:00 to NEXT COMMAND Target: POI active power $\geq$ 90.000 MW; POI voltage within the approved schedule/band Duration: Hold stable for 60 seconds before moving MVar	POI and applicable terminal MW, MVar, voltage, controller mode, SOC	Active power and voltage are stable with normal auxiliary equipment in service	GridProof execution control GridProof baseline control; replace the MW point when the controlling curve/procedure specifies another	
6	Reactive movement	Move reactive output toward the lagging limit in controlled increments while maintaining the active-power target and voltage limits.	Cue: HOLD — FOLLOW PREVIOUS STEP Target: Reach +32.868 MVar or the first documented equipment/system limit Duration: Move only as authorized by the grid/TO operator	Each MW/MVar/voltage point, limiter activation, equipment status and operator instruction	No voltage, thermal, current, SOC, or equipment limit is exceeded	Project-specific basis — approval not established ERCOT Nodal Operating Guide Section 3 (December 5, 2025) — confirm these planned values during procedure release	
7	Capability hold	At the achieved lagging point, hold the plant steady and collect the required capability evidence.	Cue: PROJECT PLANNING WINDOW — see duration Target: Configured screen +32.868 MVar at $ P \geq 90.000$ MW Duration: Hold 60 seconds under the recorded project case; not an inferred universal ISO duration	Low-side gross, auxiliary, high-side net/POI MW and MVar; scheduled/actual voltage; active limiter	ERCOT Section 3: use the classification-specific CURL test and hold; this 15-minute value is not automatically assigned to an ESR without confirming applicability	User-supplied draft basis — not independently verified SYNTHETIC walkthrough fixture Rev 1 — not a field procedure	
8	Recovery	Return reactive output to the approved normal voltage/VAR schedule and verify stable operation.	Cue: AFTER EVENT HOLD $\geq$ 00:01:00 Target: Normal voltage/VAR schedule Duration: Hold 60 seconds or until stable	MW, MVar, voltage, alarms and operator release	Normal schedule restored with no unresolved limit or alarm	GridProof execution control GridProof recovery control	
9	Evidence	Export the original recorder file and complete the applicable grid form/ticket with every limiting condition and calculated point identified.	Cue: POST-TEST HANDOFF Target: Traceable raw data plus grid submission form Duration: After each test point	Raw file hash, test point, curve/version, measurements, limits, approvals and witness result	The grid/TO can reproduce the submitted capability point	Official grid requirement ERCOT Nodal Operating Guide Section 3 (December 5, 2025)	

Post-test data handoff	Required signals	Return together	Received / hash / initials
SYNTHETIC-EXAMPLE Preserve the recorder's native extension.	• Timestamp / elapsed time [s or datetime] • Measured active power at the POI [MW] • Measured reactive power at the POI [MVar] • POI voltage [kV or pu]	• Native raw recorder file • Controller command/event log • Operator and witness notes • Deviation/abort log when applicable	UTC: SHA-256: Initials / deviation:

Scenario 2: Negative-Q / leading

Rule coverage: Published partial sequence · **Draft:** DRAFT COMPLETE · **Field execution:** NOT AUTHORIZED · **Mode:** leading

Raw-file base: SYNTHETIC-RECORDING-13 (preserve native extension)

ERCOT publishes different one-minute, 15-minute, and one-hour CURL cases by resource type and operating point. Confirm the project's ERCOT classification before execution; the app does not silently apply a Generation Resource/IRR hold to an ESR.

Step	Phase	Operator action	Exact target / timing	Record	Acceptance checkpoint	Authority / source	Actual / initials
1	Authorization	BEFORE FIELD EXECUTION: Review the controlling test procedure, switching order, one-line, communication plan, and abort limits with the operator and witness. Do not issue a plant command until all required approvals are active.	Cue: PRE-TEST GATE Target: Before field execution, record release of the finished project procedure and required operating permissions. A generated draft is not authorization. Duration: Before test start	Operator, witness, approving entity, approval time, procedure revision, open deviations	All approvals received; zero unresolved safety or operating-limit conflicts	Project-specific basis — approval not established ERCOT Nodal Operating Guide Section 3 (December 5, 2025)	
2	Scheduling	BEFORE FIELD EXECUTION: Select Coordinated or Non-Coordinated testing and send the required notice through the QSE.	Cue: PRE-TEST GATE Target: Coordinated: request by 15:00 one day before; Non-Coordinated: notify at least 2 hours before Duration: Before test	Request/notification time, ERCOT/TO response, planned MW/MVAr range, CURL	ERCOT and TO have not denied or cancelled the test	Official grid requirement ERCOT Nodal Operating Guide Section 3 §3.3.2.2	
3	Instrumentation	BEFORE FIELD EXECUTION: Verify POI meter scaling, MW/MVAr sign convention, frequency and voltage units, controller command channels, time synchronization, and recorder health.	Cue: PRE-TEST GATE Target: One synchronized time base; native engineering units; no stale or substituted channels Duration: Complete before baseline	Record continuous, synchronized POI P/Q/voltage evidence at the rate required by the controlling procedure.	Every required channel changes in the expected direction and timestamps are synchronized	GridProof execution control GridProof data-quality control	
4	Controls	BEFORE FIELD EXECUTION: Confirm the approved plant-control mode, enabled limiters, droop/deadband or AVR settings, SOC window, equipment availability, and abort authority. Record every deviation before proceeding.	Cue: PRE-TEST GATE Target: Installed settings equal the approved procedure settings Duration: Complete before baseline	Controller mode/settings, enabled equipment, SOC, alarms, active limits	No unexplained mismatch between approved and installed settings	Project-specific basis — approval not established ERCOT Nodal Operating Guide Section 3 (December 5, 2025)	
5	Operating point	Set active power to 90.000 MW (90% of the 100 MW basis) and keep AVR/voltage control in service.	Cue: NEXT COMMAND-00:01:00 to NEXT COMMAND Target: POI active power ≥ 90.000 MW; POI voltage within the approved schedule/band Duration: Hold stable for 60 seconds before moving MVAr	POI and applicable terminal MW, MVAr, voltage, controller mode, SOC	Active power and voltage are stable with normal auxiliary equipment in service	GridProof execution control GridProof baseline control; replace the MW point when the controlling curve/procedure specifies another	
6	Reactive movement	Move reactive output toward the leading limit in controlled increments while maintaining the active-power target and voltage limits.	Cue: HOLD — FOLLOW PREVIOUS STEP Target: Reach -32.868 MVAr or the first documented equipment/system limit Duration: Move only as authorized by the grid/TO operator	Each MW/MVAr/voltage point, limiter activation, equipment status and operator instruction	No voltage, thermal, current, SOC, or equipment limit is exceeded	Project-specific basis — approval not established ERCOT Nodal Operating Guide Section 3 (December 5, 2025) — confirm these planned values during procedure release	

Step	Phase	Operator action	Exact target / timing	Record	Acceptance checkpoint	Authority / source	Actual / initials
7	Capability hold	At the achieved leading point, hold the plant steady and collect the required capability evidence.	Cue: PROJECT PLANNING WINDOW — see duration Target: Configured screen -32.868 MVar at $ P \geq 90.000$ MW Duration: Hold 60 seconds under the recorded project case; not an inferred universal ISO duration	Low-side gross, auxiliary, high-side net/POI MW and MVar; scheduled/actual voltage; active limiter	ERCOT Section 3: use the classification-specific CURL test and hold; this 15-minute value is not automatically assigned to an ESR without confirming applicability	User-supplied draft basis — not independently verified SYNTHETIC walkthrough fixture Rev 1 — not a field procedure	
8	Recovery	Return reactive output to the approved normal voltage/VAR schedule and verify stable operation.	Cue: AFTER EVENT HOLD $\geq 00:01:00$ Target: Normal voltage/VAR schedule Duration: Hold 60 seconds or until stable	MW, MVar, voltage, alarms and operator release	Normal schedule restored with no unresolved limit or alarm	GridProof execution control GridProof recovery control	
9	Evidence	Export the original recorder file and complete the applicable grid form/ticket with every limiting condition and calculated point identified.	Cue: POST-TEST HANDOFF Target: Traceable raw data plus grid submission form Duration: After each test point	Raw file hash, test point, curve/version, measurements, limits, approvals and witness result	The grid/TO can reproduce the submitted capability point	Official grid requirement ERCOT Nodal Operating Guide Section 3 (December 5, 2025)	

Post-test data handoff	Required signals	Return together	Received / hash / initials
SYNTHETIC-EXAMPLE Preserve the recorder's native extension.	• Timestamp / elapsed time [s or datetime] • Measured active power at the POI [MW] • Measured reactive power at the POI [MVar] • POI voltage [kV or pu]	• Native raw recorder file • Controller command/event log • Operator and witness notes • Deviation/abort log when applicable	UTC: SHA-256: Initials / deviation:

Acceptance calculation

Check	Formula	Current substitution	Pass threshold
Reactive capability each direction	$Q = P \times \tan(\arccos(PF)) \times \text{required capability \%}$	$100 \text{ MW} \times \tan(\arccos(0.95)) \times 100\%$	$\geq \pm 32.868 \text{ MVar}$
Minimum active-power loading	$P_{\min} = \text{rated MW} \times \text{minimum loading \%}$	$100 \text{ MW} \times 90\%$	$ P \geq 90.000 \text{ MW}$
Four-quadrant evidence	Count only observations meeting P loading and Q capability in each signed P/Q quadrant	Q1–Q4; qualifying $ Q \geq 32.868 \text{ MVar}$	≥ 2 qualifying samples in every quadrant

Sources

ERCOT Nodal Operating Guide Section 3 (December 5, 2025)
<https://www.ercot.com/files/docs/2022/03/01/03-120525.docx>

ERCOT Resource Integration
<https://www.ercot.com/services/rq/integration>

ERCOT Energy Storage Resources
https://www.ercot.com/files/docs/2026/06/30/2026_07-Energy-Storage-Resources.pdf

04 · ERCOT AVR / Q response

TP / project-specific screen

Use the approved ERCOT AVR/BESS procedure and project-specific response limits.

Scenario 1: Positive Q

Rule coverage: Project procedure controls timing · **Draft:** DRAFT COMPLETE · **Field execution:** NOT AUTHORIZED · **Mode:** online

Raw-file base: SYNTHETIC-RECORDING-15 (preserve native extension)

The displayed planning points make the worksheet executable, but the governing grid documents do not publish one universal step magnitude and hold time for this commissioning test. The approved procedure must confirm or replace them.

Step	Phase	Operator action	Exact target / timing	Record	Acceptance checkpoint	Authority / source	Actual / initials
1	Authorization	BEFORE FIELD EXECUTION: Review the controlling test procedure, switching order, one-line, communication plan, and abort limits with the operator and witness. Do not issue a plant command until all required approvals are active.	Cue: PRE-TEST GATE Target: Before field execution, record release of the finished project procedure and required operating permissions. A generated draft is not authorization. Duration: Before test start	Operator, witness, approving entity, approval time, procedure revision, open deviations	All approvals received; zero unresolved safety or operating-limit conflicts	Project-specific basis — approval not established ERCOT Resource Integration	
2	Instrumentation	BEFORE FIELD EXECUTION: Verify POI meter scaling, MW/MVAR sign convention, frequency and voltage units, controller command channels, time synchronization, and recorder health.	Cue: PRE-TEST GATE Target: One synchronized time base; native engineering units; no stale or substituted channels Duration: Complete before baseline	Use the approved recorder rate and preserve native timestamps; the cadence must resolve the configured response deadline and every command transition.	Every required channel changes in the expected direction and timestamps are synchronized	GridProof execution control GridProof data-quality control	
3	Controls	BEFORE FIELD EXECUTION: Confirm the approved plant-control mode, enabled limiters, droop/deadband or AVR settings, SOC window, equipment availability, and abort authority. Record every deviation before proceeding.	Cue: PRE-TEST GATE Target: Installed settings equal the approved procedure settings Duration: Complete before baseline	Controller mode/settings, enabled equipment, SOC, alarms, active limits	No unexplained mismatch between approved and installed settings	Project-specific basis — approval not established ERCOT Resource Integration	
4	Operating point	Set and hold the starting command at +0.000 MVAR.	Cue: NEXT COMMAND-00:01:00 to NEXT COMMAND Target: Use the displayed configured starting command. Confirm plant limits and the planned value during procedure release; the numeric planning point is already populated. Duration: Hold stable for 60 seconds	POI measured value, command, voltage, SOC, limits and alarms	Stable baseline and no active blocking limiter	GridProof execution control GridProof planning point; replace with the approved procedure value	
5	Command	Apply one direct command change to 32.868 MVAR without intermediate manual steps.	Cue: COMMAND+00:00:00 to +00:00:05 Target: Final target 32.868 MVAR Duration: Reach response band within 5 seconds	Command and measured POI response at native cadence	Response time ≤ 5 seconds	Project-specific basis — approval not established ERCOT Resource Integration — confirm these planned values during procedure release	

Step	Phase	Operator action	Exact target / timing	Record	Acceptance checkpoint	Authority / source	Actual / initials
6	Final hold	Hold the final command without operator trimming and observe settling/overshoot.	Cue: COMMAND+00:00:00 to +00:00:07 Target: Final error $\leq 3\%$ of step magnitude Duration: At least 7 seconds after command; including ≥ 2 seconds continuously in band	Measured response, setpoint, overshoot, limiters and alarms	In band for ≥ 2 seconds and all configured response/overshoot checks pass	Project-specific basis — approval not established ERCOT Resource Integration — confirm these planned values during procedure release	
7	Recovery	Return to the starting command and confirm stable normal operation.	Cue: AFTER EVENT HOLD $\geq 00:01:00$ Target: Return to 0.000 MVar Duration: Hold 60 seconds or until stable	Command, measured response and alarms	Starting point restored	GridProof execution control GridProof recovery control	
8	Evidence	Export the native recorder file and controller event log without smoothing, resampling, or deleted points.	Cue: POST-TEST HANDOFF Target: Complete raw record Duration: Immediately after case	Raw file hash, command times, actual values, deviations and witness result	All configured checks can be reproduced	GridProof execution control GridProof evidence control	

Post-test data handoff	Required signals	Return together	Received / hash / initials
SYNTHETIC-EXAMPLE Preserve the recorder's native extension.	• Timestamp / elapsed time [s or datetime] • Measured reactive power at the POI [MVar] • Reactive-power command / setpoint [MVar] • POI voltage [kV or pu]	• Native raw recorder file • Controller command/event log • Operator and witness notes • Deviation/abort log when applicable	UTC: SHA-256: Initials / deviation:

Scenario 2: Negative Q

Rule coverage: Project procedure controls timing · **Draft:** DRAFT COMPLETE · **Field execution:** NOT AUTHORIZED · **Mode:** online

Raw-file base: SYNTHETIC-RECORDING-14 (preserve native extension)

The displayed planning points make the worksheet executable, but the governing grid documents do not publish one universal step magnitude and hold time for this commissioning test. The approved procedure must confirm or replace them.

Step	Phase	Operator action	Exact target / timing	Record	Acceptance checkpoint	Authority / source	Actual / initials
1	Authorization	BEFORE FIELD EXECUTION: Review the controlling test procedure, switching order, one-line, communication plan, and abort limits with the operator and witness. Do not issue a plant command until all required approvals are active.	Cue: PRE-TEST GATE Target: Before field execution, record release of the finished project procedure and required operating permissions. A generated draft is not authorization. Duration: Before test start	Operator, witness, approving entity, approval time, procedure revision, open deviations	All approvals received; zero unresolved safety or operating-limit conflicts	Project-specific basis — approval not established ERCOT Resource Integration	
2	Instrumentation	BEFORE FIELD EXECUTION: Verify POI meter scaling, MW/MVAr sign convention, frequency and voltage units, controller command channels, time synchronization, and recorder health.	Cue: PRE-TEST GATE Target: One synchronized time base; native engineering units; no stale or substituted channels Duration: Complete before baseline	Use the approved recorder rate and preserve native timestamps; the cadence must resolve the configured response deadline and every command transition.	Every required channel changes in the expected direction and timestamps are synchronized	GridProof execution control GridProof data-quality control	
3	Controls	BEFORE FIELD EXECUTION: Confirm the approved plant-control mode, enabled limiters, droop/deadband or AVR settings, SOC window, equipment availability, and abort authority. Record every deviation before proceeding.	Cue: PRE-TEST GATE Target: Installed settings equal the approved procedure settings Duration: Complete before baseline	Controller mode/settings, enabled equipment, SOC, alarms, active limits	No unexplained mismatch between approved and installed settings	Project-specific basis — approval not established ERCOT Resource Integration	
4	Operating point	Set and hold the starting command at +0.000 MVAr.	Cue: NEXT COMMAND-00:01:00 to NEXT COMMAND Target: Use the displayed configured starting command. Confirm plant limits and the planned value during procedure release; the numeric planning point is already populated. Duration: Hold stable for 60 seconds	POI measured value, command, voltage, SOC, limits and alarms	Stable baseline and no active blocking limiter	GridProof execution control GridProof planning point; replace with the approved procedure value	
5	Command	Apply one direct command change to -32.868 MVAr without intermediate manual steps.	Cue: COMMAND+00:00:00 to +00:00:05 Target: Final target -32.868 MVAr Duration: Reach response band within 5 seconds	Command and measured POI response at native cadence	Response time ≤ 5 seconds	Project-specific basis — approval not established ERCOT Resource Integration — confirm these planned values during procedure release	
6	Final hold	Hold the final command without operator trimming and observe settling/overshoot.	Cue: COMMAND+00:00:00 to +00:00:07 Target: Final error ≤ 3% of step magnitude Duration: At least 7 seconds after command; including ≥ 2 seconds continuously in band	Measured response, setpoint, overshoot, limiters and alarms	In band for ≥ 2 seconds and all configured response/overshoot checks pass	Project-specific basis — approval not established ERCOT Resource Integration — confirm these planned values during procedure release	

Step	Phase	Operator action	Exact target / timing	Record	Acceptance checkpoint	Authority / source	Actual / initials
7	Recovery	Return to the starting command and confirm stable normal operation.	Cue: AFTER EVENT HOLD >= 00:01:00 Target: Return to 0.000 MVar Duration: Hold 60 seconds or until stable	Command, measured response and alarms	Starting point restored	GridProof execution control GridProof recovery control	
8	Evidence	Export the native recorder file and controller event log without smoothing, resampling, or deleted points.	Cue: POST-TEST HANDOFF Target: Complete raw record Duration: Immediately after case	Raw file hash, command times, actual values, deviations and witness result	All configured checks can be reproduced	GridProof execution control GridProof evidence control	

Post-test data handoff	Required signals	Return together	Received / hash / initials
SYNTHETIC-EXAMPLE Preserve the recorder's native extension.	• Timestamp / elapsed time [s or datetime] • Measured reactive power at the POI [MVar] • Reactive-power command / setpoint [MVar] • POI voltage [kV or pu]	• Native raw recorder file • Controller command/event log • Operator and witness notes • Deviation/abort log when applicable	UTC: SHA-256: Initials / deviation:

Acceptance calculation

Check	Formula	Current substitution	Pass threshold
Qualified command step	command after – command before	Detection threshold=0.5 MVar	Step magnitude ≥ 0.5 MVar
Response time	First sustained entry into configured tolerance band	Maximum response=5 s	≤ 5 s
Final tracking error	actual – target ÷ step × 100	Tolerance=3%	≤ 3%
Overshoot	Peak excursion beyond target ÷ step × 100	Maximum overshoot=15%	≤ 15%

Sources

ERCOT Resource Integration
<https://www.ercot.com/services/rq/integration>

05 · ERCOT active-power response

TP / project-specific screen

Configure the approved commissioning checklist and resource-specific ramp/settling requirements.

Scenario 1: Step Up

Rule coverage: Project procedure controls timing · **Draft:** DRAFT COMPLETE · **Field execution:** NOT AUTHORIZED · **Mode:** online

Raw-file base: SYNTHETIC-RECORDING-03 (preserve native extension)

The displayed planning points make the worksheet executable, but the governing grid documents do not publish one universal step magnitude and hold time for this commissioning test. The approved procedure must confirm or replace them. Active-power evidence is eligible for this scenario only when the selected command event matches both configured command points within the configured ± 0 MW plan/event tolerance.

Step	Phase	Operator action	Exact target / timing	Record	Acceptance checkpoint	Authority / source	Actual / initials
1	Authorization	BEFORE FIELD EXECUTION: Review the controlling test procedure, switching order, one-line, communication plan, and abort limits with the operator and witness. Do not issue a plant command until all required approvals are active.	Cue: PRE-TEST GATE Target: Before field execution, record release of the finished project procedure and required operating permissions. A generated draft is not authorization. Duration: Before test start	Operator, witness, approving entity, approval time, procedure revision, open deviations	All approvals received; zero unresolved safety or operating-limit conflicts	Project-specific basis — approval not established ERCOT Resource Integration	
2	Instrumentation	BEFORE FIELD EXECUTION: Verify POI meter scaling, MW/MVAr sign convention, frequency and voltage units, controller command channels, time synchronization, and recorder health.	Cue: PRE-TEST GATE Target: One synchronized time base; native engineering units; no stale or substituted channels Duration: Complete before baseline	Use the approved recorder rate and preserve native timestamps; the cadence must resolve the configured response deadline and every command transition.	Every required channel changes in the expected direction and timestamps are synchronized	GridProof execution control GridProof data-quality control	
3	Controls	BEFORE FIELD EXECUTION: Confirm the approved plant-control mode, enabled limiters, droop/deadband or AVR settings, SOC window, equipment availability, and abort authority. Record every deviation before proceeding.	Cue: PRE-TEST GATE Target: Installed settings equal the approved procedure settings Duration: Complete before baseline	Controller mode/settings, enabled equipment, SOC, alarms, active limits	No unexplained mismatch between approved and installed settings	Project-specific basis — approval not established ERCOT Resource Integration	
4	Operating point	Set and hold the starting command at 20 MW.	Cue: NEXT COMMAND-00:01:00 to NEXT COMMAND Target: Use the displayed configured starting command. Confirm plant limits and the planned value during procedure release; the numeric planning point is already populated. Duration: Hold stable for 60 seconds	POI measured value, command, voltage, SOC, limits and alarms	Stable baseline and no active blocking limiter	GridProof execution control GridProof planning point; replace with the approved procedure value	

Step	Phase	Operator action	Exact target / timing	Record	Acceptance checkpoint	Authority / source	Actual / initials
5	Command	Apply one direct command change to 80.000 MW without intermediate manual steps.	Cue: COMMAND+00:00:00 to +00:00:10 Target: Final target 80.000 MW Duration: Reach response band within 10 seconds	Command and measured POI response at native cadence	Response time ≤ 10 seconds	Project-specific basis — approval not established ERCOT Resource Integration — confirm these planned values during procedure release	
6	Final hold	Hold the final command without operator trimming and observe settling/overshoot.	Cue: COMMAND+00:00:00 to +00:00:12 Target: Final error ≤ 2% of step magnitude Duration: At least 12 seconds after command; including ≥ 2 seconds continuously in band	Measured response, setpoint, overshoot, limiters and alarms	In band for ≥ 2 seconds and all configured response/overshoot checks pass	Project-specific basis — approval not established ERCOT Resource Integration — confirm these planned values during procedure release	
7	Recovery	Return to the starting command and confirm stable normal operation.	Cue: AFTER EVENT HOLD >= 00:01:00 Target: Return to 20.000 MW Duration: Hold 60 seconds or until stable	Command, measured response and alarms	Starting point restored	GridProof execution control GridProof recovery control	
8	Evidence	Export the native recorder file and controller event log without smoothing, resampling, or deleted points.	Cue: POST-TEST HANDOFF Target: Complete raw record Duration: Immediately after case result	Raw file hash, command times, actual values, deviations and witness result	All configured checks can be reproduced	GridProof execution control GridProof evidence control	

Post-test data handoff	Required signals	Return together	Received / hash / initials
SYNTHETIC-EXAMPLE Preserve the recorder's native extension.	• Timestamp / elapsed time [s or datetime] • Measured active power at the POI [MW] • Active-power command / setpoint [MW]	• Native raw recorder file • Controller command/event log • Operator and witness notes • Deviation/abort log when applicable	UTC: SHA-256: Initials / deviation:

Scenario 2: Step Down

Rule coverage: Project procedure controls timing · **Draft:** DRAFT COMPLETE · **Field execution:** NOT AUTHORIZED · **Mode:** online

Raw-file base: SYNTHETIC-RECORDING-02 (preserve native extension)

The displayed planning points make the worksheet executable, but the governing grid documents do not publish one universal step magnitude and hold time for this commissioning test. The approved procedure must confirm or replace them. Active-power evidence is eligible for this scenario only when the selected command event matches both configured command points within the configured ± 0 MW plan/event tolerance.

Step	Phase	Operator action	Exact target / timing	Record	Acceptance checkpoint	Authority / source	Actual / initials
1	Authorization	BEFORE FIELD EXECUTION: Review the controlling test procedure, switching order, one-line, communication plan, and abort limits with the operator and witness. Do not issue a plant command until all required approvals are active.	Cue: PRE-TEST GATE Target: Before field execution, record release of the finished project procedure and required operating permissions. A generated draft is not authorization. Duration: Before test start	Operator, witness, approving entity, approval time, procedure revision, open deviations	All approvals received; zero unresolved safety or operating-limit conflicts	Project-specific basis — approval not established ERCOT Resource Integration	
2	Instrumentation	BEFORE FIELD EXECUTION: Verify POI meter scaling, MW/MVAr sign convention, frequency and voltage units, controller command channels, time synchronization, and recorder health.	Cue: PRE-TEST GATE Target: One synchronized time base; native engineering units; no stale or substituted channels Duration: Complete before baseline	Use the approved recorder rate and preserve native timestamps; the cadence must resolve the configured response deadline and every command transition.	Every required channel changes in the expected direction and timestamps are synchronized	GridProof execution control GridProof data-quality control	
3	Controls	BEFORE FIELD EXECUTION: Confirm the approved plant-control mode, enabled limiters, droop/deadband or AVR settings, SOC window, equipment availability, and abort authority. Record every deviation before proceeding.	Cue: PRE-TEST GATE Target: Installed settings equal the approved procedure settings Duration: Complete before baseline	Controller mode/settings, enabled equipment, SOC, alarms, active limits	No unexplained mismatch between approved and installed settings	Project-specific basis — approval not established ERCOT Resource Integration	
4	Operating point	Set and hold the starting command at 80 MW.	Cue: NEXT COMMAND-00:01:00 to NEXT COMMAND Target: Use the displayed configured starting command. Confirm plant limits and the planned value during procedure release; the numeric planning point is already populated. Duration: Hold stable for 60 seconds	POI measured value, command, voltage, SOC, limits and alarms	Stable baseline and no active blocking limiter	GridProof execution control GridProof planning point; replace with the approved procedure value	
5	Command	Apply one direct command change to 20.000 MW without intermediate manual steps.	Cue: COMMAND+00:00:00 to +00:00:10 Target: Final target 20.000 MW Duration: Reach response band within 10 seconds	Command and measured POI response at native cadence	Response time ≤ 10 seconds	Project-specific basis — approval not established ERCOT Resource Integration — confirm these planned values during procedure release	

Step	Phase	Operator action	Exact target / timing	Record	Acceptance checkpoint	Authority / source	Actual / initials
6	Final hold	Hold the final command without operator trimming and observe settling/overshoot.	Cue: COMMAND+00:00:00 to +00:00:12 Target: Final error $\leq 2\%$ of step magnitude Duration: At least 12 seconds after command; including ≥ 2 seconds continuously in band	Measured response, setpoint, overshoot, limiters and alarms	In band for ≥ 2 seconds and all configured response/overshoot checks pass	Project-specific basis — approval not established ERCOT Resource Integration — confirm these planned values during procedure release	
7	Recovery	Return to the starting command and confirm stable normal operation.	Cue: AFTER EVENT HOLD $\geq 00:01:00$ Target: Return to 80,000 MW Duration: Hold 60 seconds or until stable	Command, measured response and alarms	Starting point restored	GridProof execution control GridProof recovery control	
8	Evidence	Export the native recorder file and controller event log without smoothing, resampling, or deleted points.	Cue: POST-TEST HANDOFF Target: Complete raw record Duration: Immediately after case point	Raw file hash, command times, actual values, deviations and witness result	All configured checks can be reproduced	GridProof execution control GridProof evidence control	

Post-test data handoff	Required signals	Return together	Received / hash / initials
SYNTHETIC-EXAMPLE Preserve the recorder's native extension.	• Timestamp / elapsed time [s or datetime] • Measured active power at the POI [MW] • Active-power command / setpoint [MW]	• Native raw recorder file • Controller command/event log • Operator and witness notes • Deviation/abort log when applicable	UTC: SHA-256: Initials / deviation:

Acceptance calculation

Check	Formula	Current substitution	Pass threshold
Qualified command step	command after – command before	Detection threshold=1 MW	Step magnitude ≥ 1 MW
Response time	First sustained entry into configured tolerance band	Maximum response=10 s	≤ 10 s
Final tracking error	actual – target $\div$ step $\times 100$	Tolerance=2%	$\leq 2\%$
Overshoot	Peak excursion beyond target $\div$ step $\times 100$	Maximum overshoot=10%	$\leq 10\%$

Sources

ERCOT Resource Integration
<https://www.ercot.com/services/rq/integration>

06 · ERCOT capacity / RTE

TP / project-specific screen

Capacity and efficiency thresholds are commercial/project criteria, not universal ERCOT acceptance limits.

Capacity procedure / equipment basis and revision: SYNTHETIC walkthrough fixture Rev 1 — not a field procedure

Upper SOC endpoint (%): 90.0

Lower SOC endpoint (%): 10.0

Discharge power magnitude (MW): 60.0

Charge power magnitude (MW): 60.0

Rest between discharge and charge (seconds): 0.0

Auxiliary-load and energy-meter boundary: SYNTHETIC walkthrough fixture Rev 1 — not a field procedure

Scenario 1: Full discharge/charge capacity cycle

Rule coverage: Commercial/project procedure controls sequence · **Draft:** DRAFT COMPLETE · **Field execution:** NOT AUTHORIZED · **Mode:** charge and discharge

Raw-file base: SYNTHETIC-RECORDING-04 (preserve native extension)

No universal grid hold time governs this commercial capacity/RTE test. Exact SOC endpoints, power, rest time, and auxiliary boundary must come from the controlling project or market procedure.

Step	Phase	Operator action	Exact target / timing	Record	Acceptance checkpoint	Authority / source	Actual / initials
1	Authorization	BEFORE FIELD EXECUTION: Review the controlling test procedure, switching order, one-line, communication plan, and abort limits with the operator and witness. Do not issue a plant command until all required approvals are active.	Cue: PRE-TEST GATE Target: Before field execution, record release of the finished project procedure and required operating permissions. A generated draft is not authorization. Duration: Before test start	Operator, witness, approving entity, approval time, procedure revision, open deviations	All approvals received; zero unresolved safety or operating-limit conflicts	Project-specific basis — approval not established ERCOT Resource Integration	
2	Instrumentation	BEFORE FIELD EXECUTION: Verify POI meter scaling, MW/MVAr sign convention, frequency and voltage units, controller command channels, time synchronization, and recorder health.	Cue: PRE-TEST GATE Target: One synchronized time base; native engineering units; no stale or substituted channels Duration: Complete before baseline	Record continuously through the complete charge/discharge cycle with a common POI power time base and mapped plant SOC; explicitly select whether native SOC is percent (0-100) or per-unit (0-1). Timestamp gaps, an unselected SOC source unit, and unequal cycle endpoints block a final disposition.	Every required channel changes in the expected direction and timestamps are synchronized	GridProof execution control GridProof data-quality control	

Step	Phase	Operator action	Exact target / timing	Record	Acceptance checkpoint	Authority / source	Actual / initials
3	Controls	BEFORE FIELD EXECUTION: Confirm the approved plant-control mode, enabled limiters, droop/deadband or AVR settings, SOC window, equipment availability, and abort authority. Record every deviation before proceeding.	Cue: PRE-TEST GATE Target: Installed settings equal the approved procedure settings Duration: Complete before baseline	Controller mode/settings, enabled equipment, SOC, alarms, active limits	No unexplained mismatch between approved and installed settings	Project-specific basis — approval not established ERCOT Resource Integration	
4	Starting condition	Set the battery to the approved upper SOC endpoint, stabilize auxiliaries, and start the revenue/POI energy recorder.	Cue: CYCLE START-00:15:00 to CYCLE START Target: Upper SOC 90%; meter/auxiliary boundary: SYNTHETIC walkthrough fixture Rev 1 — not a field procedure Duration: Hold stable for 15 minutes	SOC, POI MW, auxiliary MW, temperature and alarms	Starting endpoint matches the approved capacity procedure	User-supplied draft basis — not independently verified SYNTHETIC walkthrough fixture Rev 1 — not a field procedure	
5	Discharge	Discharge at the approved constant POI power until the approved lower SOC/end condition is reached.	Cue: HOLD — PROCEDURE-DEFINED Target: Discharge magnitude 60 MW to SOC 10% Duration: Until approved lower endpoint	Continuous POI MW, SOC, alarms, curtailments and end time	Integrated discharge energy ≥ 340.000 MWh	User-supplied draft basis — not independently verified SYNTHETIC walkthrough fixture Rev 1 — not a field procedure	
6	Turnaround	Hold idle, record auxiliary consumption, then obtain approval to begin charging.	Cue: PROJECT PLANNING WINDOW — see duration Target: Rest 0 seconds; preserve auxiliary consumption in SYNTHETIC walkthrough fixture Rev 1 — not a field procedure Duration: 0 seconds; obtain operating permission before charging	Idle MW, SOC, temperatures and approval time	Rest period and thermal conditions meet the approved procedure	User-supplied draft basis — not independently verified SYNTHETIC walkthrough fixture Rev 1 — not a field procedure	
7	Charge	Charge at the approved constant POI power back to the upper SOC/end condition.	Cue: HOLD — PROCEDURE-DEFINED Target: Charge magnitude 60 MW to SOC 90% Duration: Until approved upper endpoint	Continuous POI MW, SOC, alarms and end time	Calculated AC round-trip efficiency is 85% to 100%	User-supplied draft basis — not independently verified SYNTHETIC walkthrough fixture Rev 1 — not a field procedure	
8	Evidence	Export the complete cycle as one synchronized raw record with no removed idle periods.	Cue: POST-TEST HANDOFF Target: Full discharge, rest and charge cycle Duration: After cycle	Raw file hash, signed MWh each direction, declared SOC basis, SOC endpoints, auxiliaries and deviations	Initial/final SOC differs by ≤ 2 percentage points after explicit basis normalization and the phase ledger is reproducible	GridProof execution control GridProof evidence control	

Post-test data handoff	Required signals	Return together	Received / hash / initials
SYNTHETIC-RECORDING-04 Preserve the recorder's native extension.	- Timestamp / elapsed time [s or datetime] - Measured active power at the POI [MW] - Plant state of charge [explicitly declared percent (0-100) or per-unit (0-1); required for final disposition]	- Native raw recorder file - Controller command/event log - Operator and witness notes - Deviation/abort log when applicable	UTC: SHA-256: Initials / deviation:

Acceptance calculation

Check	Formula	Current substitution	Pass threshold
Available discharge energy	$\int \text{discharge MW dt}$	Rated energy=400 MWh × 85%	$\geq 340.000 \text{ MWh}$
AC round-trip efficiency	$\text{Discharge MWh} \div \text{charge MWh} \times 100$	Configured RTE range=85% to 100%	$\geq 85\%$ and $\leq 100\%$
Cycle coverage	Integrated energy in each direction	Minimum each direction=1 MWh	Charge and discharge each $\geq 1 \text{ MWh}$
Equivalent SOC endpoints	$ \text{final SOC} - \text{initial SOC} $	Maximum difference=2 percentage points	$\leq 2 \text{ percentage points}$

Sources

ERCOT Resource Integration
<https://www.ercot.com/services/rq/integration>

07 · MOD-026 Volt/VAR model

TP / project-specific screen

NERC requires verified usable model response; numerical fit limits remain the configured TP/project engineering screen.

Model-validation procedure / planner basis and revision: SYNTHETIC walkthrough fixture Rev 1 — not a field procedure

Validation case and initial conditions: SYNTHETIC walkthrough fixture Rev 1 — not a field procedure

Model identifier and revision: SYNTHETIC walkthrough fixture Rev 1 — not a field procedure

Disturbance definition, magnitude and units: SYNTHETIC walkthrough fixture Rev 1 — not a field procedure

Complete measured/model comparison window (seconds): 60.0

Scenario 1: Voltage/Reactive model validation

Rule coverage: Reliability standard objective; TP procedure controls stimulus · **Draft:** DRAFT COMPLETE · **Field execution:** NOT AUTHORIZED · **Mode:** offline/record-based

Raw-file base: SYNTHETIC-RECORDING-06 (preserve native extension)

NERC requires a verified usable model but does not prescribe one universal disturbance magnitude or hold time for every plant. The Transmission Planner/approved procedure controls the exact case.

Step	Phase	Operator action	Exact target / timing	Record	Acceptance checkpoint	Authority / source	Actual / initials
1	Authorization	BEFORE FIELD EXECUTION: Review the controlling test procedure, switching order, one-line, communication plan, and abort limits with the operator and witness. Do not issue a plant command until all required approvals are active.	Cue: PRE-TEST GATE Target: Before field execution, record release of the finished project procedure and required operating permissions. A generated draft is not authorization. Duration: Before test start	Operator, witness, approving entity, approval time, procedure revision, open deviations	All approvals received; zero unresolved safety or operating-limit conflicts	Project-specific basis — approval not established NERC MOD-026-2	
2	Instrumentation	BEFORE FIELD EXECUTION: Verify POI meter scaling, MW/MVAR sign convention, frequency and voltage units, controller command channels, time synchronization, and recorder health.	Cue: PRE-TEST GATE Target: One synchronized time base; native engineering units; no stale or substituted channels Duration: Complete before baseline	Export measured and model channels on one synchronized time base with identical units and no manual resampling before GridProof ingestion.	Every required channel changes in the expected direction and timestamps are synchronized	GridProof execution control GridProof data-quality control	
3	Controls	BEFORE FIELD EXECUTION: Confirm the approved plant-control mode, enabled limiters, droop/deadband or AVR settings, SOC window, equipment availability, and abort authority. Record every deviation before proceeding.	Cue: PRE-TEST GATE Target: Installed settings equal the approved procedure settings Duration: Complete before baseline	Controller mode/settings, enabled equipment, SOC, alarms, active limits	No unexplained mismatch between approved and installed settings	Project-specific basis — approval not established NERC MOD-026-2	

Step	Phase	Operator action	Exact target / timing	Record	Acceptance checkpoint	Authority / source	Actual / initials
4	Case freeze	Freeze the approved voltage/reactive validation case, model version, parameters, bases, initial conditions, and disturbance definition.	Cue: PRE-TEST GATE Target: Case: SYNTHETIC walkthrough fixture Rev 1 — not a field procedure; model: SYNTHETIC walkthrough fixture Rev 1 — not a field procedure; disturbance: SYNTHETIC walkthrough fixture Rev 1 — not a field procedure Duration: Before model run	Model hash/version, settings, bases, event file and approver	Measured and model cases use identical initial conditions and event timing	User-supplied draft basis — not independently verified SYNTHETIC walkthrough fixture Rev 1 — not a field procedure	
5	Measured record	Collect the approved measured voltage/reactive disturbance with a stable pre-event and complete recovery window.	Cue: PROJECT PLANNING WINDOW — see duration Target: Case: SYNTHETIC walkthrough fixture Rev 1 — not a field procedure; model: SYNTHETIC walkthrough fixture Rev 1 — not a field procedure; disturbance: SYNTHETIC walkthrough fixture Rev 1 — not a field procedure Duration: Complete synchronized window: 60 seconds	Export measured and model channels on one synchronized time base with identical units and no manual resampling before GridProof ingestion.	Measured record covers every comparison window without an unapproved gap	User-supplied draft basis — not independently verified SYNTHETIC walkthrough fixture Rev 1 — not a field procedure	
6	Model run	Run the frozen model without manual curve fitting between comparison channels, then export measured and simulated signals on one time base.	Cue: FOLLOW PREVIOUS STEP Target: Identical units, bases, event timing and initial conditions Duration: Complete simulation window	Native measured/model channels and run log	Inputs are traceable and no post-hoc alteration is hidden	GridProof execution control GridProof evidence control	
7	Acceptance	EVIDENCE REVIEW: Calculate the configured NRMSE, correlation and final-window errors and compare every result with the approved TP/project screen.	Cue: POST-TEST HANDOFF Target: All configured acceptance thresholds Duration: After export	Calculated metrics, formulas, thresholds and deviations	Every required metric passes or is dispositioned as REVIEW/NOT READY	Project-specific basis — approval not established NERC MOD-026-2	
8	Evidence	Archive the immutable measured file, model input/output, settings, software version, and comparison report.	Cue: POST-TEST HANDOFF Target: Reproducible validation package Duration: After review	Hashes and approval record for every file	Independent rerun can reproduce the result	GridProof execution control GridProof evidence control	

Post-test data handoff	Required signals	Return together	Received / hash / initials
SYNTHETIC-RECORDING-06 Preserve the recorder's native extension.	• Timestamp / elapsed time [s or datetime] • Measured POI voltage [kV or pu] • Model voltage [same as measured] • Measured reactive power [MVAR] • Model reactive power [MVAR]	• Native raw recorder file • Controller command/event log • Operator and witness notes • Deviation/abort log when applicable	UTC: SHA-256: Initials / deviation:

Acceptance calculation

Check	Formula	Current substitution	Pass threshold
Voltage model fit	NRMSE(measured V, model V)	Configured limit=10%	≤ 10%
Reactive-power model fit	NRMSE(measured Q, model Q)	Configured limit=10%	≤ 10%

Check	Formula	Current substitution	Pass threshold
Model correlation	Pearson correlation	Configured minimum=0.95	≥ 0.95
Final-window error	$ \text{mean}(\text{model tail}) - \text{mean}(\text{measured tail}) \div \text{normalization} \times 100$	Configured maximum=5%	$\leq 5\%$

Sources

NERC MOD-026-2
<https://www.nerc.com/standards/reliability-standards/mod/mod-026-2>

ERCOT Resource Integration
<https://www.ercot.com/services/rq/integration>

08 · MOD-027 P/f model

TP / project-specific screen

Legacy MOD-027 active-power/frequency verification is carried forward under current MOD-026-2; numerical fit limits are configurable.

Model-validation procedure / planner basis and revision: SYNTHETIC walkthrough fixture Rev 1 — not a field procedure

Validation case and initial conditions: SYNTHETIC walkthrough fixture Rev 1 — not a field procedure

Model identifier and revision: SYNTHETIC walkthrough fixture Rev 1 — not a field procedure

Disturbance definition, magnitude and units: SYNTHETIC walkthrough fixture Rev 1 — not a field procedure

Complete measured/model comparison window (seconds): 60.0

Scenario 1: Frequency/Active-Power model validation

Rule coverage: Reliability standard objective; TP procedure controls stimulus · **Draft:** DRAFT COMPLETE · **Field execution:** NOT AUTHORIZED · **Mode:** offline/record-based

Raw-file base: SYNTHETIC-RECORDING-07 (preserve native extension)

NERC requires a verified usable model but does not prescribe one universal disturbance magnitude or hold time for every plant. The Transmission Planner/approved procedure controls the exact case.

Step	Phase	Operator action	Exact target / timing	Record	Acceptance checkpoint	Authority / source	Actual / initials
1	Authorization	BEFORE FIELD EXECUTION: Review the controlling test procedure, switching order, one-line, communication plan, and abort limits with the operator and witness. Do not issue a plant command until all required approvals are active.	Cue: PRE-TEST GATE Target: Before field execution, record release of the finished project procedure and required operating permissions. A generated draft is not authorization. Duration: Before test start	Operator, witness, approving entity, approval time, procedure revision, open deviations	All approvals received; zero unresolved safety or operating-limit conflicts	Project-specific basis — approval not established NERC MOD-026-2	
2	Instrumentation	BEFORE FIELD EXECUTION: Verify POI meter scaling, MW/MVAR sign convention, frequency and voltage units, controller command channels, time synchronization, and recorder health.	Cue: PRE-TEST GATE Target: One synchronized time base; native engineering units; no stale or substituted channels Duration: Complete before baseline	Export measured and model channels on one synchronized time base with identical units and no manual resampling before GridProof ingestion.	Every required channel changes in the expected direction and timestamps are synchronized	GridProof execution control GridProof data-quality control	
3	Controls	BEFORE FIELD EXECUTION: Confirm the approved plant-control mode, enabled limiters, droop/deadband or AVR settings, SOC window, equipment availability, and abort authority. Record every deviation before proceeding.	Cue: PRE-TEST GATE Target: Installed settings equal the approved procedure settings Duration: Complete before baseline	Controller mode/settings, enabled equipment, SOC, alarms, active limits	No unexplained mismatch between approved and installed settings	Project-specific basis — approval not established NERC MOD-026-2	

Step	Phase	Operator action	Exact target / timing	Record	Acceptance checkpoint	Authority / source	Actual / initials
4	Case freeze	Freeze the approved frequency/active-power validation case, model version, parameters, bases, initial conditions, and disturbance definition.	Cue: PRE-TEST GATE Target: Case: SYNTHETIC walkthrough fixture Rev 1 — not a field procedure; model: SYNTHETIC walkthrough fixture Rev 1 — not a field procedure; disturbance: SYNTHETIC walkthrough fixture Rev 1 — not a field procedure Duration: Before model run	Model hash/version, settings, bases, event file and approver	Measured and model cases use identical initial conditions and event timing	User-supplied draft basis — not independently verified SYNTHETIC walkthrough fixture Rev 1 — not a field procedure	
5	Measured record	Collect the approved measured frequency/active-power disturbance with a stable pre-event and complete recovery window.	Cue: PROJECT PLANNING WINDOW — see duration Target: Case: SYNTHETIC walkthrough fixture Rev 1 — not a field procedure; model: SYNTHETIC walkthrough fixture Rev 1 — not a field procedure; disturbance: SYNTHETIC walkthrough fixture Rev 1 — not a field procedure Duration: Complete synchronized window: 60 seconds	Export measured and model channels on one synchronized time base with identical units and no manual resampling before GridProof ingestion.	Measured record covers every comparison window without an unapproved gap	User-supplied draft basis — not independently verified SYNTHETIC walkthrough fixture Rev 1 — not a field procedure	
6	Model run	Run the frozen model without manual curve fitting between comparison channels, then export measured and simulated signals on one time base.	Cue: FOLLOW PREVIOUS STEP Target: Identical units, bases, event timing and initial conditions Duration: Complete simulation window	Native measured/model channels and run log	Inputs are traceable and no post-hoc alteration is hidden	GridProof execution control GridProof evidence control	
7	Acceptance	EVIDENCE REVIEW: Calculate the configured NRMSE, correlation and final-window errors and compare every result with the approved TP/project screen.	Cue: POST-TEST HANDOFF Target: All configured acceptance thresholds Duration: After export	Calculated metrics, formulas, thresholds and deviations	Every required metric passes or is dispositioned as REVIEW/NOT READY	Project-specific basis — approval not established NERC MOD-026-2	
8	Evidence	Archive the immutable measured file, model input/output, settings, software version, and comparison report.	Cue: POST-TEST HANDOFF Target: Reproducible validation package Duration: After review	Hashes and approval record for every file	Independent rerun can reproduce the result	GridProof execution control GridProof evidence control	

Post-test data handoff	Required signals	Return together	Received / hash / initials
SYNTHETIC-RECORDING-07 del_ercot_mod027_frequency_model_validation_R AW Preserve the recorder's native extension.	• Timestamp / elapsed time [s or datetime] • Frequency or injected frequency offset [Hz] • Measured active power [MW] • Model active power [MW]	• Native raw recorder file • Controller command/event log • Operator and witness notes • Deviation/abort log when applicable	UTC: SHA-256: Initials / deviation:

Acceptance calculation

Check	Formula	Current substitution	Pass threshold
Active-power model fit	NRMSE(measured P, model P)	Configured limit=10%	≤ 10%
Model correlation	Pearson correlation	Configured minimum=0.95	≥ 0.95

Check	Formula	Current substitution	Pass threshold
Final-window error	$ \text{mean}(\text{model tail}) - \text{mean}(\text{measured tail}) \div \text{normalization} \times 100$	Configured maximum=5%	$\leq 5\%$

Sources

NERC MOD-026-2
<https://www.nerc.com/standards/reliability-standards/mod/mod-026-2>

ERCOT Resource Integration
<https://www.ercot.com/services/rq/integration>