**ENERGY COMPLIANCE, INC.** | *Field Reference for Reliability Operations*

OPERATIONS SERIES · EC-WP-303

# System Operating Limits & IROLs

*SOLs and IROLs: methodology, monitoring, exceedance, and audit defense.*

An SOL is a limit. An IROL is a limit whose violation could lead to instability, uncontrolled separation, or Cascading, and it carries a clock of no more than thirty minutes. This reference walks through who writes the SOL methodology, who establishes each limit, how limits are monitored in Real-time, what an IROL exceedance demands, and what an auditor will ask for afterward.

*Energy Compliance, Inc. Professional Reference*

**energycomplianceinc.com** **OCTOBER 2026**

# Disclaimer & Legal Notice

This publication is the work product of Energy Compliance, Inc. and is provided for general information and educational purposes only. It does not constitute legal advice, regulatory guidance, engineering advice, or formal interpretation of any NERC Reliability Standard, FERC order, RTO or ISO protocol, or Regional Entity directive.

This publication may not be used or cited as authority in any audit, enforcement, regulatory, or legal proceeding. Compliance with NERC Reliability Standards depends on facts and circumstances unique to each registered entity, and the reader should consult qualified counsel and subject matter experts when making compliance decisions.

NERC, FERC, and the names of Regional Entities are referenced here for descriptive purposes only. Energy Compliance, Inc. is not affiliated with, sponsored by, or endorsed by the North American Electric Reliability Corporation, the Federal Energy Regulatory Commission, or any NERC Regional Entity.

Energy Compliance, Inc. assumes no responsibility or liability for errors, omissions, or outcomes resulting from the use of this publication.

# Foreword

This professional reference is one of a series Energy Compliance, Inc. publishes for registered entities and the people who run their compliance programs.

I have spent more than thirty years on every side of the bulk electric system. I have operated control centers as a Reliability Coordinator, Transmission Operator, and Power System Operator. I have audited grid facilities and signed off on findings as a senior compliance auditor. I have worked enforcement matters from inside the regulator's process. For the last several years I have advised registered entities directly through the firm I founded.

The entities that do reliability well share a habit. They take the standards seriously without confusing them with reliability itself. A NERC Reliability Standard is a floor, not a ceiling. Compliance is something an auditor evaluates; reliability is something a system either delivers or does not. So these entities prepare for audits by building programs that survive real questions, not binders that look thick.

That is the perspective these references try to share. Each one takes a single topic, whether a standard family, an operational function, a regulatory framework, or an emerging industry problem, and walks through how it actually works.

They are written for the compliance manager who wants to understand the system and not just memorize requirements. For the legal counsel who has to brief a board honestly. For the senior operator who has been told that compliance and reliability are

the same thing and suspects they are not. And for the new compliance hire who was handed a binder and told good luck.

These references are not marketing material dressed up as content. They come from three decades of doing this work and watching it succeed and fail. I write them in the same voice I use in a control room or in front of a Regional Entity audit team: direct, grounded in evidence, and honest about what the standards do and do not require.

Energy Compliance exists because much of the consulting offered to registered entities today is structured for billable hours rather than for outcomes. Every engagement is overseen by a senior practitioner. We do not bring five people to a meeting that needs one. We automate the work that should be automated and apply senior judgment to the work that requires it. If that is what you want in a compliance partner, the back of this reference has our contact information.

If not, the reference still belongs to you. Take what is useful and apply it well. And remember the only test that ultimately matters: when the system needs to perform, does it?

*Rob Smith*

*Founder and Principal, Energy Compliance, Inc.*

# Executive Summary

A System Operating Limit is a limit. An Interconnection Reliability Operating Limit is a line in the sand. Cross an SOL and you have a problem. Cross an IROL and you have a cascading event waiting to happen. In my view, the methodology behind each, the Real-time monitoring of both, and the response to exceedances are among the most consequential operational disciplines in the framework.

The rules changed on April 1, 2024. FAC-011-4 and FAC-014-3 took effect, FAC-010-3 and the older versions of FAC-011 and FAC-014 were retired, and the NERC Glossary definition of System Operating Limit was rewritten. There is now one SOL methodology per Reliability Coordinator Area, written by the Reliability Coordinator. The RC establishes the IROLs. Each Transmission Operator establishes its SOLs under that methodology. Planners use the RC's criteria or document why they do not. Any program that still describes a Planning Coordinator "SOL methodology for the planning horizon" is describing a standard that no longer exists.

- Every TOP knows what an SOL is. Fewer can articulate what an IROL is. Fewer still understand the analytical work behind establishing each.
- An IROL exceedance starts a clock. The Glossary caps every IROL Tv at 30 minutes, and the RC's methodology can set it shorter. The clock is not symbolic. It is regulatory.
- Methodologies are documented, distributed, and auditable. Improvising the methodology is not an option.
- An SOL is only as accurate as the Facility Rating it is built on. Stale ratings produce stale limits. FAC-008 was one of the three most frequently reported Operations and Planning noncompliance areas in NERC's 2025 annual report.
- Programs that have not drilled IROL response do not execute it at speed. The drill is the difference between a contained exceedance and an event.

# 1 Definitions, Thresholds, and the Institutional Meaning of SOL and IROL

## 1.1 Why the Definitions Carry Regulatory Weight

SOL and IROL read like engineering terms, and they are. They are also regulatory terms. Section 215 of the Federal Power Act gives FERC jurisdiction over the Electric Reliability Organization, the Regional Entities, and all users, owners, and operators of the bulk-power system for purposes of approving and enforcing reliability standards. The definitions of SOL and IROL sit in the NERC Glossary of Terms Used in Reliability Standards, and the FAC, TOP, and IRO standards build enforceable obligations on top of them. That makes them enforceable boundaries with consequences attached.

The architecture is technical and institutional at the same time. To understand it you have to look at four things together: the definitions, who holds which responsibility, how much operational detail the procedures carry, and how enforcement reads the record afterward. This reference takes them in that order.

## 1.2 What a System Operating Limit Is

Since April 1, 2024, the Glossary defines a System Operating Limit as "all Facility Ratings, System Voltage Limits, and stability limits, applicable to specified System configurations, used in Bulk Electric System operations for monitoring and assessing pre- and post-Contingency operating states."

That definition took effect with the Project 2015-09 standards. Read it as a set. The SOLs are every Facility Rating, System Voltage Limit, and stability limit that applies to the System configuration in front of the operator, used to monitor and assess operating states before and after a Contingency.

The three components each have their own source. Facility Ratings come from the equipment owners under FAC-008-5. System Voltage Limits, a Glossary term added with the same project, are "the maximum and minimum steady-state voltage limits (both normal and emergency) that provide for acceptable System performance." Stability limits come from the analysis the RC's methodology prescribes under FAC-011-4 Requirement R4.

## 1.3 What Makes an SOL an IROL

An Interconnection Reliability Operating Limit is "a System Operating Limit that, if violated, could lead to instability, uncontrolled separation, or Cascading outages that adversely impact the

reliability of the Bulk Electric System." Every IROL is an SOL. Not every SOL is an IROL. The IROL label marks the subset where the exposure reaches beyond the local system.

Cascading is the concept that does the work in that definition. The Glossary defines it as "the uncontrolled successive loss of System Elements triggered by an incident at any location," resulting in "widespread electric service interruption that cannot be restrained from sequentially spreading beyond an area predetermined by studies." To know whether a limit is an IROL, you have to understand how stress propagates after a Contingency. That depends on dispatch, topology, flow patterns, and outages. Identifying an IROL is analytical work, and the answer moves when those inputs move.

Every IROL carries an IROL Tv: "the maximum time that an Interconnection Reliability Operating Limit can be violated before the risk to the interconnection or other Reliability Coordinator Area(s) becomes greater than acceptable." The definition adds that each IROL's Tv "shall be less than or equal to 30 minutes." That sentence is where the 30-minute ceiling comes from.

## 1.4 Who Draws the Line

The boundary between an ordinary SOL and an IROL is drawn by the Reliability Coordinator's SOL methodology, not by operator judgment in the moment. FAC-011-4 Requirement R8 requires the RC to describe how to identify the subset of SOLs that qualify as IROLs, the criteria for when exceeding an SOL qualifies as exceeding an IROL, and the criteria for developing any associated IROL Tv. FAC-014-3 Requirement R1 then requires the RC to establish IROLs for its area in accordance with that methodology.

That allocation follows the Glossary's own description of the RC as the entity whose purview "is broad enough to enable the calculation of Interconnection Reliability Operating Limits, which may be based on the operating parameters of transmission systems beyond any Transmission Operator's vision." The TOP sees its system. The RC sees the Wide Area. The IROL decision belongs to the one with the wider view.

> **From the Field**
>
> An IROL classification changes the entire enforcement profile of a Real-time decision. The threshold language reads simple. The application is not.

### End-of-Chapter Summary

SOLs are the Facility Ratings, System Voltage Limits, and stability limits used in operations. IROLs are the subset whose violation could lead to instability, uncontrolled separation, or Cascading, each with a Tv of no more than 30 minutes. The RC's methodology decides which SOLs are IROLs.

# 2 Methodology Development and Approval for SOLs and IROLs

## 2.1 The 2024 Shift: One Methodology, Owned by the RC

Before April 2024, SOL methodology was split across two standards. FAC-010-3 covered the planning horizon and FAC-011-3 covered the operations horizon. Project 2015-09 retired FAC-010-3, FAC-011-3, and FAC-014-2 immediately prior to the effective date of FAC-011-4 and FAC-014-3, which NERC lists as April 1, 2024. FERC approved the revised standards in Docket No. RD22-2-000 on March 4, 2022.

The result is a single operations-horizon methodology. FAC-011-4 Requirement R1 is one sentence: each Reliability Coordinator "shall have a documented methodology for establishing SOLs (i.e., SOL methodology) within its Reliability Coordinator Area." Planning Coordinators and Transmission Planners no longer write an SOL methodology. Their obligations moved to FAC-014-3, where they consume the RC's criteria and feed planning results back to operations.

Limits are not arbitrary numbers assigned to a line or an interface. They come out of analysis against documented criteria, and the standard requires those criteria to be written down, specific, and shared. That is what makes a limit defensible in an audit and what makes enforcement review objective rather than a debate about engineering opinion.

## 2.2 What the Methodology Must Contain

FAC-011-4 is specific about content. An auditor will read the RC's methodology against each of these requirements.

| Req. | What the SOL methodology must address | VRF |
|---|---|---|
| R2 | How TOPs determine which owner-provided Facility Ratings are used in operations, so the TOP and RC use common ratings | Medium |
| R3 | How TOPs determine System Voltage Limits, including the minimum allowable limit and common limits between neighbors | Medium |
| R4 | How stability limits are determined: criteria for steady-state voltage stability, transient voltage response, angular stability, and damping; model detail; allowed use of RAS; no UFLS or UVLS in establishing stability limits | Medium |
| R5 | The Contingency sets used for stability limits, Operational Planning Analyses, and Real-time Assessments | Medium |
| R6 | The performance framework used to determine SOL exceedances in Real-time monitoring, RTAs, and OPAs | High |

| Req. | What the SOL methodology must address | VRF |
|---|---|---|
| R7 | A risk-based approach for which SOL exceedances must be communicated, and how fast | High |
| R8 | How to identify IROLs and develop each IROL Tv | High |
| R9 | Who receives the methodology, and when | Lower |

Requirement R6 deserves attention because it defines what an exceedance is. With no Contingency, flows must be within Normal Ratings, though Emergency Ratings may be used when adjustments can bring the flow back within the Normal Rating inside the Emergency Rating's time duration. For the single Contingencies in Part 5.1, post-Contingency flow must stay within applicable Emergency Ratings and never above the Facility's highest Emergency Rating. Part 6.4 allows planned manual load shedding in determining the System's response only after all other available System adjustments have been made.

## 2.3 Distribution and Coordination with Planning

A methodology nobody receives is a methodology nobody follows. FAC-011-4 Requirement R9 requires the RC to provide its methodology, before its effective date, to each adjacent RC in the same Interconnection, each Planning Coordinator and Transmission Planner responsible for planning any part of the RC Area, each TOP in the area, and each RC that has asked for updates. A requesting RC with a reliability-related need gets it within 30 days.

FAC-014-3 closes the loop between operations and planning:

- The RC provides each PC and TP in its area the SOLs for the area, including the IROLs, at least once every twelve calendar months (R5.1), with the value, critical Facilities, IROL Tv, critical Contingencies, system conditions, and type of limitation for each stability limit and IROL (R5.2).
- The RC provides each impacted Generator Owner and Transmission Owner a list of their Facilities identified as critical to the derivation of an IROL, and the associated critical Contingencies, at least once every twelve calendar months (R5.6).
- Each PC and TP uses Facility Ratings, steady-state voltage limits, and stability criteria in its Near-Term Planning Assessment that are equally or more limiting than the RC's methodology, unless it provides a technical rationale to the affected entities (R6).
- Each PC and TP annually communicates Corrective Action Plans for identified instability to impacted TOPs and RCs (R7), and annually tells impacted TOs and GOs which of their Facilities make up planning event Contingencies that would cause instability, Cascading, or uncontrolled separation (R8).

Generator Owners should expect these letters. A GO can receive an R5.6 list from its RC or an R8 list from its planner without ever having operated near an IROL. Those letters belong in the compliance file, and the facilities they name deserve a second look in the GO's own rating and maintenance programs.

## 2.4 What an Auditor Expects to See

Methodology evidence is document evidence. FAC-011-4's measures point to dated electronic or hard copy documentation of the methodology, and for distribution, emails with receipts, registered mail receipts, or postings to a secure website with notifications. In practice an auditor will want:

- The current methodology, with its effective date and a version history.
- Proof it reached every recipient R9 names before that effective date.
- Evidence that the SOLs and IROLs in use trace back to the methodology, and that the operating models reflect it.
- For the TOP, evidence under FAC-014-3 R2 and R3 that it established its SOLs under the RC's methodology and provided them to the RC.

A methodology also has to stay current. Changes in generation mix, topology, and load patterns can make a method's assumptions obsolete. FAC-011-4 does not set a fixed review cycle, which in my view makes an internal review trigger more important. An outdated methodology is a reliability risk and a latent compliance exposure at the same time.

> **From the Field**
>
> Pull the methodology version your EMS limits were built from and the version in the compliance file. If they are not the same document, fix that before an auditor asks for both.

### End-of-Chapter Summary

Since April 1, 2024, the Reliability Coordinator owns the only SOL methodology, under FAC-011-4. FAC-014-3 assigns IROLs to the RC, SOLs to the TOP, and coordination duties to planners, including annual notices to the GOs and TOs whose Facilities are critical to IROLs. The methodology, its distribution, and its traceability to the limits in use are what an auditor will test.

# 3 Real-Time Monitoring and Operational Responsibility

## 3.1 The Transmission Operator's Monitoring Obligation

Limits that live in a methodology do nothing until they live in the control room. TOP-001-6, effective April 1, 2024, carries the Transmission Operator's Real-time obligations.

Requirement R10 tells the TOP what it must monitor to determine SOL exceedances: Facilities in its area, the status of Remedial Action Schemes, non-BES facilities it has identified as necessary, and status, voltage, and flow data from outside its area where it needs them. Requirement R13 requires the TOP to ensure a Real-time Assessment is performed at least once every 30 minutes. Both carry a High VRF.

A Real-time Assessment is "an evaluation of system conditions using Real-time data to assess existing (pre-Contingency) and potential (post-Contingency) operating conditions." State estimation and Real-time Contingency Analysis are the usual tools. They tell the operator what is loaded, where voltage sits, and what the next Contingency would do. The operator has to know which limits apply to the present configuration and how each Contingency moves the system toward them.

## 3.2 The Reliability Coordinator's Wide-Area View

The RC carries a parallel set of obligations in IRO-008-3, also effective April 1, 2024. Requirement R4 requires a Real-time Assessment at least once every 30 minutes. Requirement R5 requires the RC to notify impacted TOPs and BAs, and other impacted RCs as its Operating Plan indicates, when an RTA shows an actual or expected condition that results in, or could result in, an SOL or IROL exceedance within its Wide Area. Requirement R6 requires a second notice when the exceedance has been prevented or mitigated.

The RC's view crosses TOP boundaries. Some limit problems are shared by more than one TOP, and a fix in one area can push the stress into the next. The RC's Wide Area view exists so that mitigation solves the problem for the Interconnection, not just for the system that noticed it first.

## 3.3 Data and Analysis Quality

An RTA built on bad data gives a confident wrong answer. The standards treat data quality as its own obligation.

TOP-010-1(i) requires each TOP to implement an Operating Process or Procedure for the quality of the Real-time data behind its monitoring and RTAs, with criteria for evaluating quality, a way to show quality to the System Operator, and actions to resolve problems with the entity

providing the data (R1). It requires the same for the quality of the analysis used in RTAs (R3), and an alarm process monitor that tells System Operators when the Real-time alarm processor has failed (R4). IRO-018-1(i) imposes the RC's counterpart obligations.

The data itself flows under specifications. IRO-010-5, effective July 1, 2025, requires the RC to maintain a documented specification of the data it needs for OPAs, Real-time monitoring, and RTAs. TOP-003-7, effective October 1, 2026, does the same for TOPs and BAs. Generator Operators and Generator Owners who receive those specifications are part of the limit-management chain whether they think of themselves that way or not.

Limits also have to match across the planning and operations groups. If a rating change reaches the planning model but not the EMS, the operator monitors against a number that is no longer true. Getting updated limit values into the tools on time is part of limit management, and it needs a named owner.

## 3.4 Coordination Across Functions

Balancing Authorities move generation to manage frequency and Interchange. That movement changes transmission loading. The standards divide responsibility by function, but they expect the functions to act together. TOP-001-6 Requirement R18 requires the TOP to operate to the most limiting parameter when SOLs differ. IRO-009-2 Requirement R4 requires the RC to operate to the most limiting IROL and Tv when RCs responsible for the same Facility disagree. IRO-014-3 requires each RC to have and implement Operating Procedures, Processes, or Plans for activities that require notification or coordination with adjacent RC Areas.

> **From the Field**
>
> Limits are static numbers. Conditions are dynamic. The operator's job is to recognize when the gap between limit and condition is closing faster than the operating procedure anticipated.

### End-of-Chapter Summary

TOPs and RCs monitor SOLs and IROLs in Real-time and each must run a Real-time Assessment at least every 30 minutes. Data and analysis quality are separate obligations under TOP-010-1(i) and IRO-018-1(i). Where limits differ between entities, the most limiting value governs. Effective limit management depends on current data, current limits in the tools, and prompt action.

# 4 IROL Exceedances, Mitigation Timelines, and Escalation Protocols

## 4.1 The Clock

The institutional difference between an SOL and an IROL is clearest during an exceedance. An SOL exceedance requires the TOP to initiate its Operating Plan and to communicate as the RC's methodology requires. An IROL exceedance runs against the IROL Tv, the maximum time the IROL can be violated before the risk becomes unacceptable, and the Glossary caps it at 30 minutes.

The Tv is not a number the operator chooses on shift. FAC-011-4 Requirement R8 requires the RC's methodology to state the criteria for developing it, and FAC-014-3 Requirement R5 requires the RC to give the associated Tv for each IROL to impacted planners and TOPs. A Tv that is too long exposes the Interconnection. One that is too conservative forces aggressive action the system did not need. The methodology has to show its reasoning either way.

| Clock | Source | Applies to |
|---|---|---|
| IROL Tv of no more than 30 minutes | NERC Glossary; IRO-009-2 R3; TOP-001-6 R12 | RC must mitigate within Tv; TOP must not operate outside an IROL longer than Tv |
| Real-time Assessment at least every 30 minutes | TOP-001-6 R13; IRO-008-3 R4 | TOP and RC |
| Certain SOL exceedances communicated if not resolved within 30 minutes | FAC-011-4 R7.2 | Post-Contingency exceedances of Facility Ratings and emergency System Voltage Limits; pre-Contingency exceedances of normal maximum voltage limits |
| Notice to other BAs, TOPs, and neighboring RCs within 30 minutes of an Emergency notification | EOP-011-4 R5 | RC |
| Unplanned outages of 30 minutes or more of telemetry, control, monitoring, and assessment capability reported | TOP-001-6 R9 | TOP and BA |

## 4.2 What the Reliability Coordinator Must Have and Do

IRO-009-2 is the RC's IROL standard. For each IROL identified one or more days ahead, Requirement R1 requires Operating Processes, Procedures, or Plans that identify the actions the RC will take or direct others to take, up to and including load shedding, both to prevent the

exceedance and to mitigate its magnitude and duration so that it is relieved within the Tv. Requirement R2 requires the RC to initiate processes intended to prevent an IROL exceedance identified in Real-time monitoring or an RTA. Requirement R3 requires the RC to act or direct others to act so that the magnitude and duration of an IROL exceedance is mitigated within the Tv. Requirement R4 requires the RC to operate to the most limiting IROL and Tv when RCs differ.

R2, R3, and R4 carry a High VRF. Late recognition and failure to direct timely mitigation are each separate exposures. A wrong Tv is a different problem, and it traces back to the RC's methodology under FAC-011-4 R8 and the IROL it established under FAC-014-3 R1. None requires an actual instability or Cascading event to become a violation.

## 4.3 What the Transmission Operator Must Not Do

TOP-001-6 Requirement R12 is short: the TOP "shall not operate outside any identified Interconnection Reliability Operating Limit (IROL) for a continuous duration exceeding its associated IROL Tv." The measure asks for dated logs or reports showing the date, time, duration, and details of any excursion, or an attestation that none occurred.

For SOLs generally, Requirement R14 requires the TOP to initiate its Operating Plan to mitigate an SOL exceedance identified in Real-time monitoring or an RTA, and Requirement R15 requires it to tell the RC what it did to return the System within limits, in accordance with the RC's methodology. TOPs need procedures that tell an IROL event apart from routine limit management, because the two run on different clocks.

## 4.4 Escalation into Emergency Operations

When normal mitigation is not working, the situation is no longer congestion management. It is a reliability event. TOP-001-6 Requirement R8 requires the TOP to inform its RC, known impacted BAs, and known impacted TOPs of actual or expected operations that result in, or could result in, an Emergency. EOP-011-4 Requirement R1 requires each TOP to develop, maintain, and implement RC-reviewed Operating Plans to mitigate operating Emergencies. Under Requirement R5, an RC that receives an Emergency notification must notify the other BAs and TOPs in its area and neighboring RCs within 30 minutes. IRO-014-3 requires an RC to notify other impacted RCs of an expected or actual Emergency (R3) and requires each impacted RC to operate as though the Emergency exists when RCs disagree about whether it does (R4).

Documentation has to keep pace with the event. Auditors reconstruct exceedances from operating logs, timestamps, voice recordings, and RTA outputs. Late documentation does not cure a missing record. The purpose of the escalation structure is to stop exceedance conditions from becoming normal.

## 4.5 Drills Are a Requirement, Not a Nicety

PER-005-2 Requirement R4 requires each RC, BA, TOP, and TO that has operational authority or control over Facilities with established IROLs, or has established protection systems or operating guides to mitigate IROL violations, to provide emergency operations training using simulation technology that replicates the operational behavior of the BES. If you are an RC, BA,

TOP, or TO that meets either test, simulation technology is part of compliance. R4 does not reach Generator Operators.

> **From the Field**
>
> SOL exceedances tolerate broader response windows. IROL exceedances do not. Every minute an operator spends finding the procedure comes out of the Tv.

## End-of-Chapter Summary

IROL exceedances run on the Tv, which the RC's methodology defines and the Glossary caps at 30 minutes. The RC must plan for, prevent, and mitigate IROL exceedances under IRO-009-2, and the TOP must not exceed the Tv under TOP-001-6 R12. Escalation into Emergency operations follows TOP-001-6, EOP-011-4, and IRO-014-3. PER-005-2 R4 requires simulation-based emergency operations training for the RCs, BAs, TOPs, and TOs it covers.

# 5 Facility Ratings, Contingency Analysis, and the Foundation of Limit Accuracy

## 5.1 Ratings Come from the Owners

SOLs and IROLs are only as accurate as the Facility Ratings and assumptions underneath them. A Facility Rating is "the maximum or minimum voltage, current, frequency, or real or reactive power flow through a facility that does not violate the applicable equipment rating of any equipment comprising the facility." The most limiting piece of equipment sets the rating.

FAC-008-5 puts the ratings with the owners. Requirement R6 requires each Transmission Owner and Generator Owner to have Facility Ratings for its solely and jointly owned Facilities that are consistent with its rating methodology or documentation. Requirement R8 requires owners to provide rating information on request to their RCs, PCs, TPs, TOs, and TOPs. On the operations side, FAC-011-4 Requirement R2 requires the RC's methodology to tell TOPs how to determine which owner-provided ratings are used in operations, so the TOP and RC use common Facility Ratings.

## 5.2 How Ratings Drive the Limit Hierarchy

The relationship is direct. Under normal conditions a line may be thermally limited. After a Contingency the same path may be limited by voltage or stability. The RC's performance framework in FAC-011-4 Requirement R6 measures pre-Contingency flow against Normal Ratings and post-Contingency flow against Emergency Ratings, so an error in either number moves the limit. A rating that is too high produces a limit that does not protect the equipment. One that is too low gives away transfer capability and can trigger mitigation the system did not need.

Ratings drift when the field changes and the database does not. A replaced breaker, a new jumper, or a relay setting change after a modification can all make the rating on file wrong. The SOL built on it is then wrong too, and nobody notices until an exceedance or an audit.

## 5.3 Contingency Analysis and Models

Contingency analysis is the dynamic part of limit determination. FAC-011-4 Requirement R5 requires the methodology to identify the Contingency sets used for stability limits, OPAs, and RTAs, including at minimum the loss of a generator, transmission circuit, transformer, shunt device, or single pole of an HVDC system. RTCA tools evaluate those Contingencies against current topology, dispatch, and parameters. Missing or mismatched data degrades the result and can understate the risk.

Planning studies feed the same picture. TPL-001-5.1 sets planning performance requirements. FAC-014-3 R7 sends planning-horizon instability findings to impacted TOPs and RCs, and R8 tells impacted TOs and GOs which of their Facilities make up those Contingencies. Models connect the two. MOD-033-3 requires each Planning Coordinator to compare planning model performance to actual System behavior at least once every 24 calendar months, for steady-state and dynamic simulations. If dynamic parameters are wrong, stability-limited conditions may be missed and the Tv may rest on a flawed study.

## 5.4 What Auditors Test

The ERO Enterprise's CMEP Practice Guide on evaluating Facility Ratings and SOLs, issued June 17, 2020, tells CMEP staff how they approach this work. It was written against earlier versions of FAC-008, FAC-011, and FAC-014, but its approach still describes what auditors look for. It notes that entities with strong controls and asset change management typically have more accurate ratings, and that entities without validated field conditions are most prone to discrepancies. It describes field walk-downs and comparison of the ratings database against one-lines. It states that CMEP staff "shall not accept design drawings as sole evidence of Equipment Ratings." And it directs auditors to evaluate internal controls such as asset change management, periodic review of ratings, and peer review.

The enforcement record backs that focus. NERC's 2025 ORCP and CMEP Annual Report, published February 11, 2026, lists FAC-008 among the three most frequently reported Operations and Planning noncompliance areas in 2025, with ineffective preventive controls as the leading root cause.

Limit integrity is shared work across the control room, engineering, planning, and asset management. Rating changes have to reach every entity that uses them, on time. A gap in that chain is a latent reliability risk even when each organization is doing its own part well.

> **From the Field**
>
> Ask when each rating in the EMS was last checked against the field. If nobody can answer, the limits built on those ratings have not been checked either.

### End-of-Chapter Summary

Accurate SOLs and IROLs depend on accurate Facility Ratings under FAC-008-5, common ratings under FAC-011-4 R2, sound Contingency analysis, and validated models under MOD-033-3. Auditors test field conditions and internal controls, and do not accept design drawings as the sole evidence of equipment ratings. FAC-008 remains one of the most frequently reported O&P noncompliance areas.

# 6 Communication, Authority Gradients, and Directive Compliance

## 6.1 Three Functions, One Hierarchy

SOL and IROL management runs through three linked functions. The Transmission Operator acts to maintain the reliability of its own area, by its own actions or by issuing Operating Instructions (TOP-001-6 R1). The Balancing Authority maintains the Demand and resource balance and supports Interconnection frequency. The Reliability Coordinator is, in the Glossary's words, "the highest level of authority who is responsible for the Reliable Operation of the Bulk Electric System," with the Wide Area view and the authority to prevent or mitigate emergency operating situations. IRO-001-4 Requirement R1 requires it to act to address the reliability of its area through direct actions or Operating Instructions.

These relationships show up most clearly under limit stress. When an SOL or IROL is projected to be reached or exceeded, communication is not optional.

## 6.2 Operating Instructions Are Not Suggestions

An Operating Instruction is "a command by operating personnel responsible for the Real-time operation of the interconnected Bulk Electric System to change or preserve the state, status, output, or input of an Element of the Bulk Electric System or Facility of the Bulk Electric System." The definition adds that a discussion of general information or options is not a command.

IRO-001-4 Requirement R2 requires each TOP, BA, Generator Operator, and Distribution Provider to comply with its RC's Operating Instructions unless the instruction cannot be physically implemented or would violate safety, equipment, regulatory, or statutory requirements. Requirement R3 requires the entity to inform the RC when it cannot perform the instruction. TOP-001-6 Requirements R3 and R4 impose the same structure on BAs, GOPs, and DPs receiving a TOP's Operating Instructions. Those are the only exceptions. There is no exception for cost, inconvenience, or disagreement.

The 2025 enforcement record shows what happens when that line blurs. Of the three serious-risk filings NERC reported for 2025, one involved IRO-001-4 R2: an entity failed to comply with the RC's Operating Instructions after the RC said a lengthier stability study was needed before requested generator testing could occur.

## 6.3 Communication When Limits Are Approached

The RC's methodology decides what must be communicated and how fast. FAC-011-4 Requirement R7 requires a risk-based approach that always communicates IROL exceedances, stability-limit exceedances, post-Contingency exceedances with a validated risk of instability,

Cascading, or uncontrolled separation, and pre-Contingency exceedances of Facility Ratings and normal minimum voltage limits, within a timeframe the RC sets. Two more categories must be communicated if not resolved within 30 minutes: post-Contingency exceedances of Facility Ratings and emergency System Voltage Limits, and pre-Contingency exceedances of normal maximum System Voltage Limits (R7.2). IRO-008-3 Requirements R5 and R6 cover the RC's notices outward, and TOP-001-6 Requirement R15 covers the TOP's report of the actions it took.

Ambiguity is the enemy here. A TOP that treats an instruction as a suggestion, or assumes a mitigation step does not apply to the event in front of it, creates both reliability and enforcement exposure. COM-002-4 (effective July 1, 2016) requires BAs, RCs, and TOPs to document communications protocols for Operating Instructions (R1), and requires three-part communication for oral two-party Operating Instructions during an Emergency (R5 and R6). Those protocols, and clear identification of a command as an Operating Instruction, remove that ambiguity.

## 6.4 Reliability and Market Dispatch

Reliability actions affect economic dispatch. Redispatch for a constraint costs money, and organized markets have their own rules for settling out-of-market actions. Those settlement rules sit in tariffs and market protocols. The reliability obligations do not wait for them. IRO-009-2 requires mitigation within the Tv, and IRO-001-4 lists the only grounds for not following an RC's Operating Instruction. Economics is not one of them. In my view, any control room procedure that pauses for a cost check during an IROL exceedance has the order of operations backward.

## 6.5 Evidence of Communication

Every one of these requirements is measured by the record. The measures in TOP-001-6, IRO-001-4, and IRO-009-2 point to dated operator logs, dated and time-stamped voice recordings or transcripts, electronic communications, and equivalent documentation. Auditors review those recordings and logs after events and during audits. If the instruction was clear but the log is not, the log is what the auditor sees.

> **From the Field**
>
> Documentation discipline is what survives audit. The methodology, the limit, the exceedance, and the response all have to be evidenced at the time they happen.

### End-of-Chapter Summary

SOL and IROL management depends on communication within a defined hierarchy of TOP, BA, and RC. Operating Instructions must be followed unless they cannot be physically implemented or would violate safety, equipment, regulatory, or statutory requirements, and inability must be reported. The RC's methodology sets what is communicated and how fast. The record of those communications is the compliance evidence.

# 7 Enforcement Risk, Event Review, and Compliance Exposure

## 7.1 Where the Exposure Comes From

SOL and IROL management is operationally critical and enforcement-sensitive. Operating decisions about limits are reviewed after the fact, against evidence, with an eye to risk. The common exposure paths map to specific requirements:

- An SOL exceedance where the TOP did not initiate its Operating Plan (TOP-001-6 R14) or did not report its actions to the RC (R15).
- Operation outside an IROL beyond its Tv (TOP-001-6 R12), or RC failure to act or direct action within the Tv (IRO-009-2 R3).
- An SOL methodology missing required content (FAC-011-4 R2 through R8) or not distributed as required (R9).
- SOLs not established under the RC's methodology, or not provided to the RC (FAC-014-3 R2 and R3).
- Facility Ratings inconsistent with the owner's methodology (FAC-008-5 R6), which corrupts every limit built on them.
- Failure to comply with, or to report inability to comply with, an Operating Instruction (IRO-001-4 R2 and R3; TOP-001-6 R3 and R4).

Different requirements, same underlying issue: the system was exposed to risk the framework was built to prevent.

## 7.2 How Risk and Penalties Are Assessed

Most of the Real-time requirements in this reference carry a High VRF, including IRO-009-2 R2 through R4, TOP-001-6 R12 through R14, and FAC-011-4 R6 through R8. Under the NERC Sanction Guidelines, the initial monetary penalty value comes from the intersection of the VRF and the Violation Severity Level, and the assessed risk is the potential impact to the Bulk Power System multiplied by the likelihood of that impact, or the actual harm. The Guidelines also direct NERC or the Regional Entity to consider duration: longer violations generally draw a larger increase. Potential impact counts. A violation does not need an actual cascade to be treated as serious.

## 7.3 What the 2025 Record Shows

NERC's 2025 ORCP and CMEP Annual Report puts numbers on this. Registered entities self-identified approximately 85 percent of reported noncompliance in 2025. FAC-008 was among the three most frequently reported O&P areas. All three serious-risk filings involved O&P standards, two of them squarely in this reference's territory: the IRO-001-4 R2 Operating Instruction case described in Chapter 6, and a TOP-001-5 R1 case in which a TOP failed to act

to maintain the reliability of its area because of a known programmatic weakness in its alarm notification system, which resulted in a loss of load in the second of two instances.

That second case is a monitoring failure, not a limit calculation failure. It belongs next to TOP-010-1(i) R4 and the alarm process monitor requirement in Chapter 3.

## 7.4 Latent Methodology Errors and IROL Misidentification

An error in the SOL methodology may not show up until an exceedance exposes an inconsistency in the results. Then the review covers both the event and the method behind it. That is the practical case for periodic revalidation.

Classification errors cut both ways. Failing to identify a limit as an IROL when the methodology's criteria are met removes the Tv discipline exactly where it matters. Designating too many limits as IROLs dilutes operator attention across a list that no longer means anything. Getting the classification right depends on good analysis and good documentation of it.

## 7.5 Self-Reports, Mitigation, and the Public Record

Event review starts with the record: operator logs, RTA and contingency analysis outputs, messages, and acknowledged instructions. Many issues surface in post-event review, and the CMEP provides for Self-Reports under Section 4.5 of Appendix 4C to the NERC Rules of Procedure. Mitigation typically addresses process, training, tools, and methods. Mitigation matters to the outcome, but it does not undo the violation.

The outcome becomes public. Under Section 5.9 of Appendix 4C, NERC files the Notice of Penalty with FERC, and the Compliance Enforcement Authority tells the entity at least five business days before the public filing and posting. Those filings are the industry's best study material. In my view, the patterns worth watching in them are the ones in this reference: incomplete Real-time monitoring, weak communication protocols, and procedures that do not match how the work is actually done.

> **From the Field**
>
> "An SOL is just a recommendation." No. Operating beyond an SOL has compliance and reliability consequences.
>
> "An IROL is the same thing as an SOL." No. The IROL classification triggers a different clock, different procedures, and a different audit posture.
>
> "We have a methodology, so we're compliant." The methodology is necessary. Its content, its distribution, and its continued validity are what the auditor tests.

### End-of-Chapter Summary

Exposure under the IRO, TOP, and FAC standards comes from exceedances, delayed mitigation, deficient methodology, bad ratings, and noncompliance with Operating Instructions. Penalties are assessed on risk and duration, and potential impact counts. The 2025 record shows serious-risk cases in Operating Instruction compliance and Real-time monitoring, and FAC-008 near the top of O&P noncompliance.

# 8 Evolving System Conditions and the Future of Limit Management

## 8.1 Inverter-Based Resources and Stability Limits

The methods for analyzing SOL and IROL conditions grew up on systems dominated by synchronous generation, predictable load growth, and stable topologies. The resource mix is changing. Inverter-based resources respond to faults and voltage differently than synchronous machines, and retirements of synchronous units change system inertia, fault current, and voltage support. Those changes move transient and steady-state stability margins.

FAC-011-4 already requires the methodology to specify criteria for steady-state voltage stability, transient voltage response, angular stability, and damping (R4.1), and to describe model detail (R4.5). The models have to keep up with the fleet. MOD-026-2, effective April 1, 2026, governs verification and validation of dynamic models and data. If the models do not represent the resources accurately, the stability limits and Tv values built on them will not either.

## 8.2 Large Loads and Shifting Flows

Large loads such as data centers and electrification-driven industrial processes can change transmission loading quickly and in places planners did not expect. Interfaces that never bound before may start binding. In my view, those shifts need to reach planning studies quickly and flow back into operating limits through FAC-014-3, because the operator inherits whatever the study missed.

Transmission expansion cuts both ways. New lines relieve some constraints and create new interfaces to monitor. Delayed lines push more of the burden onto redispatch. Interregional transfers stress interfaces that were historically lightly loaded. The authority gradients in the standards still hold. They are simply exercised under more complicated conditions.

## 8.3 Ratings That Move with the Weather

Extreme heat and cold test equipment that was rated for milder assumptions. FERC Order No. 881, published January 13, 2022, requires public utility transmission providers to implement ambient-adjusted ratings on the lines over which they provide transmission service and to use uniquely determined emergency ratings. The CMEP Practice Guide addresses dynamic line ratings directly: auditors should ask the entity to show that the ratings observed are consistent with the calculation method in its Facility Ratings methodology. Ratings that move are fine. Ratings that move without a documented, traceable method are a finding waiting to happen.

## 8.4 Better Tools, Same Discipline

Better state estimation and wide-area measurement have improved what operators can see, and better visibility improves contingency analysis and early detection of emerging exceedances. None of it removes the need for accurate input data, validated models, and documented methods. TOP-010-1(i) and IRO-018-1(i) still require operators to know when the data or the analysis is bad.

## 8.5 What Is Still Moving

The SOL family is not finished. As of October 2026, NERC lists FAC-011-5 as pending regulatory filing. IRO-010-6 and TOP-003-8, the next versions of the RC and TOP data specification standards, are subject to future enforcement on April 1, 2029. Programs should track those dates and plan for methodology and data specification updates rather than discover them at audit.

The SOL and IROL framework is only as durable as the planning insight, engineering models, and operating procedures that make it up. The standards allow the analytical criteria to change without changing the authority structure. Limit management is harder than it used to be. It is not less important.

### End-of-Chapter Summary

The resource mix, load patterns, transmission configuration, and weather are all changing the conditions under which SOLs and IROLs are determined. The current standards already require the methodology to address stability criteria and model detail, and Order 881 and dynamic ratings bring new traceability demands. FAC-011-5, IRO-010-6, and TOP-003-8 are the next changes to watch.

# Glossary

Definitions marked as NERC terms are quoted or abridged from the NERC Glossary of Terms Used in Reliability Standards as published on nerc.com in October 2026. Abridged entries are marked. Consult the current Glossary for the official text.

| Term | Meaning in this paper |
|---|---|
| Bulk Electric System (BES) | NERC term, abridged. Unless modified by the inclusions and exclusions in the Glossary, all Transmission Elements operated at 100 kV or higher and Real Power and Reactive Power resources connected at 100 kV or higher. This does not include facilities used in the local distribution of electric energy. |
| Cascading | NERC term. The uncontrolled successive loss of System Elements triggered by an incident at any location. Cascading results in widespread electric service interruption that cannot be restrained from sequentially spreading beyond an area predetermined by studies. |
| Facility Rating | NERC term. The maximum or minimum voltage, current, frequency, or real or reactive power flow through a facility that does not violate the applicable equipment rating of any equipment comprising the facility. |
| Interconnection | NERC term. A geographic area in which the operation of Bulk Power System components is synchronized such that the failure of one or more of such components may adversely affect the ability of the operators of other components within the system to maintain Reliable Operation of the Facilities within their control. When capitalized, any one of the four major electric system networks in North America: Eastern, Western, ERCOT and Quebec. |
| Interconnection Reliability Operating Limit (IROL) | NERC term. A System Operating Limit that, if violated, could lead to instability, uncontrolled separation, or Cascading outages that adversely impact the reliability of the Bulk Electric System. |
| IROL Tv | NERC term (Interconnection Reliability Operating Limit Tv). The maximum time that an Interconnection Reliability Operating Limit can be violated before the risk to the interconnection or other Reliability Coordinator Area(s) becomes greater than acceptable. Each Interconnection Reliability Operating Limit's Tv shall be less than or equal to 30 minutes. |
| Operating Instruction | NERC term. A command by operating personnel responsible for the Real-time operation of the interconnected Bulk Electric System to change or preserve the state, status, output, or input of an Element of the Bulk Electric System or Facility of the Bulk Electric System. A discussion of general information and of potential options or alternatives to resolve Bulk Electric System operating concerns is not a command and is not considered an Operating Instruction. |

| Term | Meaning in this paper |
|---|---|
| Planning Coordinator (PC) | NERC term; the Glossary points to Planning Authority: the responsible entity that coordinates and integrates transmission Facilities and service plans, resource plans, and Protection Systems. |
| Real-time Assessment (RTA) | NERC term, abridged. An evaluation of system conditions using Real-time data to assess existing (pre-Contingency) and potential (post-Contingency) operating conditions. |
| Reliability Coordinator (RC) | NERC term. The entity that is the highest level of authority who is responsible for the Reliable Operation of the Bulk Electric System, has the Wide Area view of the Bulk Electric System, and has the operating tools, processes and procedures, including the authority to prevent or mitigate emergency operating situations in both next-day analysis and real-time operations. |
| SOL methodology | The Reliability Coordinator's documented methodology for establishing SOLs within its Reliability Coordinator Area, required by FAC-011-4 Requirement R1. |
| System Operating Limit (SOL) | NERC term, effective April 1, 2024. All Facility Ratings, System Voltage Limits, and stability limits, applicable to specified System configurations, used in Bulk Electric System operations for monitoring and assessing pre- and post-Contingency operating states. |
| System Voltage Limit | NERC term. The maximum and minimum steady-state voltage limits (both normal and emergency) that provide for acceptable System performance. |
| Transmission Operator (TOP) | NERC term. The entity responsible for the reliability of its "local" transmission system, and that operates or directs the operations of the transmission Facilities. |
| Transmission Planner (TP) | NERC term. The entity that develops a long-term (generally one year and beyond) plan for the reliability (adequacy) of the interconnected bulk electric transmission systems within its portion of the Planning Authority area. |

# How Energy Compliance Can Help

SOL and IROL compliance lives or dies on records made at the moment something happened.

## Audit defense and audit preparation

EC provides audit and enforcement support (non-advocacy), audit defense with Notice of Penalty response and settlement posture, and NERC compliance program support, interpretation, and audit preparation. RSAW production and data request strategy come from the senior practitioner who will answer the follow-up questions.

## Methodology, ratings, and program reviews

A regulator-perspective program review tests whether your SOL methodology, distribution record, Facility Ratings, and exceedance logs would survive real audit questions. Reliability governance and program assessments, compliance program design and improvement, operational and engineering reliability alignment, and mitigation planning and Self-Report development follow from the findings.

## Senior advisory and training

EC offers NERC reliability and compliance advisory support, senior advisory on specific and complex reliability questions, registration and applicability analysis, training and executive briefings on reliability frameworks, and industry engagement in standards development and working-group participation.

## WattOps Compliance

Methodology versions, distribution receipts, and RTA logs should be organized before the audit notice arrives. WattOps Compliance is EC's NERC compliance evidence platform (wattopscompliance.com). EC will run one standard at one facility through WattOps at no cost (CIP standards excluded).

## RenewOps

For renewable and storage operators, the Real-time data behind TOP and RC assessments starts at the plant. RenewOps is EC's renewable operations monitoring and analytics platform, with a Data Center module.

Did an FAC-014-3 letter name your Facility as IROL-critical? Call us before the audit does.

Website: energycomplianceinc.com · Email: rsmith@complianceforenergy.com

Phone: 763.438.4427

# About the Author

Rob Smith is the Founder and Principal of Energy Compliance, Inc., with more than thirty years in the industry on every side of the system. He began in control-room operations as a Reliability Coordinator, Transmission Operator, and Power System Operator across RTO/ISO and utility control centers. On the regulator side, he was a senior compliance auditor and subject matter expert for NERC Reliability Standards. He audited grid facilities, evaluated mitigation adequacy, participated in risk-based oversight of utility mitigation activities, and supported the development of violation notifications and settlements in FERC-directed enforcement actions. He conducted a regulatory audit in the Sultanate of Oman against the Sultanate's Sector Law and Grid Code.

He founded Energy Compliance, Inc. to deliver senior regulator-side compliance authority without the layered staffing and billable-hour overhead of larger firms.

Education:

- MBA, Energy Management, University of Mary
- MSL, Compliance Law, Fordham Law University
- BAS, Energy Management, Bismarck State College
- BAS, Mechanical Engineering, Metallurgy minor, University of Florida
- BAS, Criminology, St. Petersburg College (State Law Enforcement Certification)
- AAS, Power Plant Technology, Bismarck State College
- AAS, Electrical Transmission System Technology, Bismarck State College

Certifications: NERC Lead Auditor training; previously NERC-certified at the Reliability Coordinator level; 1st Class A Boiler Engineer License, Minnesota.

# About Energy Compliance, Inc.

Energy Compliance, Inc. is an independent consulting and advisory firm based in Bloomington, Minnesota, focused exclusively on electric reliability, cybersecurity reliability, and regulatory compliance for organizations connected to the North American Bulk Electric System. We support Generator Owners and Operators, Transmission Owners and Operators, Reliability Coordinators, Balancing Authorities, and Distribution Providers across NERC Reliability Standards, FERC orders, RTO/ISO market participation rules, Regional Entity oversight, and state regulatory frameworks.

We do this work differently than larger consulting firms. A senior practitioner with regulator-side experience oversees every engagement. We staff for outcomes, not billable hours. Our deliverables are written to be operationally executable and audit-defensible, structured for the auditor's question rather than the consultant's binder. Where automation can replace manual work, we build the automation. Where senior judgment is required, the senior is in the room.

Rigorous compliance. Defensible programs. We partner with registered entities on the institutional and technical questions that define strong reliability and cybersecurity programs, from classification through audit through enforcement response. Each engagement is scoped to the entity's role, function, and bulk system impact.

Energy Compliance is not affiliated with, sponsored by, or endorsed by the North American Electric Reliability Corporation, the Federal Energy Regulatory Commission, or any Regional Entity. Learn more at energycomplianceinc.com.

# Sources and Authorities


- Federal Power Act Section 215, Electric Reliability, 16 U.S.C. § 824o. https://www.law.cornell.edu/uscode/text/16/824o
- North American Electric Reliability Corporation, Glossary of Terms Used in NERC Reliability Standards (definitions of System Operating Limit, System Voltage Limit, IROL, IROL Tv, and related terms), accessed October 2026. https://www.nerc.com/glossary-of-terms
- NERC Reliability Standard FAC-011-4, System Operating Limits Methodology for the Operations Horizon (effective April 1, 2024). https://www.nerc.com/globalassets/standards/reliability-standards/fac/fac-011-4.pdf
- NERC Reliability Standard FAC-014-3, Establish and Communicate System Operating Limits (effective April 1, 2024). https://www.nerc.com/globalassets/standards/reliability-standards/fac/fac-014-3.pdf
- NERC, Project 2015-09 Establish and Communicate System Operating Limits, Implementation Plan (April 2021), retiring FAC-010-3, FAC-011-3, and FAC-014-2. https://www.nerc.com/pa/Stand/Project%20201509%20Establish%20and%20Communicate%20System%20Op/2015-09_Implementation%20Plan_clean.pdf
- NERC, FAC Reliability Standards listing (status and effective dates), accessed October 2026. https://www.nerc.com/standards/reliability-standards/fac
- NERC Reliability Standard FAC-008-5, Facility Ratings (effective October 1, 2021). https://www.nerc.com/globalassets/standards/reliability-standards/fac/fac-008-5.pdf
- NERC Reliability Standard TOP-001-6, Transmission Operations (effective April 1, 2024). https://www.nerc.com/globalassets/standards/reliability-standards/top/top-001-6.pdf
- NERC Reliability Standard TOP-010-1(i), Real-time Reliability Monitoring and Analysis Capabilities (effective April 1, 2018). https://www.nerc.com/standards/reliability-standards/top/top-010-1i
- NERC, TOP Reliability Standards listing (status and effective dates), accessed October 2026. https://www.nerc.com/standards/reliability-standards/top
- NERC Reliability Standard IRO-001-4, Reliability Coordination, Responsibilities (effective April 1, 2017). https://www.nerc.com/globalassets/standards/reliability-standards/iro/iro-001-4.pdf
- NERC Reliability Standard IRO-008-3, Reliability Coordinator Operational Analyses and Real-time Assessments (effective April 1, 2024). https://www.nerc.com/globalassets/standards/reliability-standards/iro/iro-008-3.pdf
- NERC Reliability Standard IRO-009-2, Reliability Coordinator Actions to Operate Within IROLs (effective January 1, 2016). https://www.nerc.com/standards/reliability-standards/iro/iro-009-2

- NERC Reliability Standard IRO-014-3, Coordination Among Reliability Coordinators (effective April 1, 2017). https://www.nerc.com/globalassets/standards/reliability-standards/iro/iro-014-3.pdf
- NERC, IRO Reliability Standards listing (status and effective dates), accessed October 2026. https://www.nerc.com/standards/reliability-standards/iro
- NERC Reliability Standard COM-002-4, Operating Personnel Communications Protocols (effective July 1, 2016). https://www.nerc.com/globalassets/standards/reliability-standards/com/com-002-4.pdf
- NERC Reliability Standard EOP-011-4, Emergency Operations (effective October 1, 2024). https://www.nerc.com/globalassets/standards/reliability-standards/eop/eop-011-4.pdf
- NERC Reliability Standard PER-005-2, Operations Personnel Training (effective July 1, 2016). https://www.nerc.com/globalassets/standards/reliability-standards/per/per-005-2.pdf
- NERC Reliability Standard MOD-033-3, Steady-State and Dynamic System Model Validation (effective April 1, 2026). https://www.nerc.com/globalassets/standards/reliability-standards/mod/mod-033-3.pdf
- NERC Reliability Standard TPL-001-5.1, Transmission System Planning Performance Requirements (effective July 1, 2023). https://www.nerc.com/globalassets/standards/reliability-standards/tpl/tpl-001-5.1.pdf
- NERC, MOD Reliability Standards listing (MOD-026-2 and MOD-033-3 effective April 1, 2026), accessed October 2026. https://www.nerc.com/standards/reliability-standards/mod
- ERO Enterprise CMEP Practice Guide: Evaluation of Facility Ratings and System Operating Limits (June 17, 2020). https://www.nerc.com/pa/comp/guidance/CMEPPracticeGuidesDL/ERO%20Enterprise%20CMEP%20Practice%20Guide_%20Evaluation%20of%20Facility%20Ratings%20and%20System%20Operating%20Limits.pdf
- NERC, ORCP and CMEP Annual Report (February 11, 2026), Chapter 5, Year in Review. https://www.nerc.com/globalassets/programs/enforcement/cmep-and-vegetation-reports/2025-orcp-and-cmep-annual-report.pdf
- NERC Rules of Procedure, Appendix 4B, Sanction Guidelines of the North American Electric Reliability Corporation (effective January 19, 2021). https://www.nerc.com/globalassets/who-we-are/rules-of-procedure/appendix-4b.pdf
- NERC Rules of Procedure, Appendix 4C, Compliance Monitoring and Enforcement Program (effective May 19, 2022), Section 4.5, Self-Reports, and Section 5.9, Notice of Penalty. https://www.nerc.com/globalassets/who-we-are/rules-of-procedure/appendix-4c.pdf
- Federal Energy Regulatory Commission, Managing Transmission Line Ratings, Order No. 881, Docket No. RM20-16-000, 87 Fed. Reg. 2244 (January 13, 2022). https://www.federalregister.gov/documents/2022/01/13/2021-27735/managing-transmission-line-ratings


© Energy Compliance, Inc. · EC-WP-303 · October 2026