NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

NERC Operating Committee
Compliance Implementation Guidance
Real-time Assessment

1.0 Background

1.1 Preamble

Implementation Guidance provides examples or approaches to illustrate how registered entities could comply with standards that are vetted by industry and endorsed by the Electric Reliability Organization (ERO) Enterprise. The examples provided in this Implementation Guidance are not all inclusive, as there are likely other methods for complying with a particular standard requirement. The ERO Enterprise's endorsement of an example means the ERO Enterprise Compliance Monitoring and Enforcement Program (CMEP) staff will give these examples deference when conducting compliance monitoring activities. Registered entities can rely upon the example and be reasonably assured that compliance requirements will be met with the understanding that final compliance determinations will depend on individual facts, circumstances, and system configurations. [1]

- Guidance documents cannot change the scope or purpose of the requirements of a standard.
- The contents of this guidance document are not the only way to comply with a standard.
- Compliance expectations should be made as clear as possible through the standards development process, which should minimize the need for guidance after final ballot approval of a standard.
- Forms of guidance should not conflict.
- Guidance should be developed collaboratively and posted on the NERC website for transparency.

[1] Source: http://www.nerc.com/pa/comp/Resources/ResourcesDL/Compliance_Guidance_Policy_FINAL_Board_Accepted_Nov_5_2015.pdf

1.2 Purpose

The purpose of this guidance document is to assist NERC registered entities in establishing a common understanding of the practices and processes surrounding the completion of a Real-time Assessment (RTA) as applied in NERC Standards TOP-001-3, Requirement R13 and IRO-008-2, Requirement R4. This guidance also offers examples for managing Real-time Assessments with or without the use of Real-time Contingency Analysis (RTCA) tools or other support applications.

The specific objectives of this guidance document are to provide:

- Guidance on methods to meet compliance requirements surrounding a Real-time Assessment including alternatives to advanced EMS applications.
- Examples of how Real-time Assessments can be completed under abnormal conditions (e.g. loss of support applications such as Real-time Contingency Analysis) and for the complete loss of an Energy Management System (EMS).

1.3 Scope

This guidance document applies to Transmission Operators (TOPs) and Reliability Coordinators (RCs) performing Real-time Assessments in accordance with NERC Standards TOP-001-3, Requirement R13, and IRO-008-2, Requirement R4.

TOP-001-3

R13. *Each Transmission Operator shall ensure that a Real-time Assessment is performed at least once every 30 minutes.*

M13. *Each Transmission Operator shall have, and make available upon request, evidence to show it ensured that a Real-time Assessment was performed at least once every 30 minutes. This evidence could include but is not limited to dated computer logs showing times the assessment was conducted, dated checklists, or other evidence.*

IRO-008-2

R4. *Each Reliability Coordinator shall ensure that a Real-time Assessment is performed at least once every 30 minutes.*

M4. *Each Reliability Coordinator shall have, and make available upon request, evidence to show it ensured that a Real-time Assessment is performed at least once every 30 minutes. This evidence could include but is not limited to dated computer logs showing times the assessment was conducted, dated checklists, or other evidence.*

1.4 Overview

Real-time Assessments are utilized by TOPs and RCs to maintain situational awareness of the Bulk Electric System (BES). There are many methods, information sources, tools and applications available to complete an RTA. Individual entities may elect to perform RTAs in different ways depending on the availability of advanced EMS applications or complexity of their individual TOP or RC areas. For

entities without in-house applications which directly support the completion of an RTA, the use of third-party tools or applications utilized in the Real-time environment may be an option. This document has been created to assist TOPs and RCs in assessing what methods, practices, tools, and information may be utilized to meet compliance with the aforementioned standards.

1.5 NERC Defined Terms

Real-time Assessment (RTA)	An evaluation of system conditions using Real-time data to assess existing (pre-Contingency) and potential (post-Contingency) operating conditions. The assessment shall reflect applicable inputs including, but not limited to: load, generation output levels, known Protection System and Special Protection System status or degradation, Transmission outages, generator outages, Interchange, Facility Ratings, and identified phase angle and equipment limitations. (Real-time Assessment may be provided through internal systems or through third-party services.)

1.6 Commonly Used Terms Within This Document

Note: These definitions are not within or intended to be included in the NERC Glossary of Terms. These particular definitions are identified to ensure a common industry understanding of how they are applied solely within this paper.

Energy Management System (EMS)	A system of computer-aided tools used by System Operators to monitor, control, and optimize the performance of the generation and/or transmission system. The computer technology is also referred to as SCADA/EMS or EMS/SCADA. Besides SCADA (Supervisory Control and Data Acquisition), other EMS applications can include alarm processing, network applications (which includes State Estimation), Power Flow, Contingency analysis (CA), security analysis (SA), and data historians. Data acquisition typically includes data that is received from RTUs or data links.
Real-time Contingency Analysis (RTCA)	An application used to predict electrical system conditions after simulating specific contingencies. It relies on a base case from a state estimator or power flow case.
State Estimator (SE)	An application that calculates the current state of the electrical system (the voltage magnitudes and angles at every bus) using a network model and telemetered measurements. The purpose is to provide a consistent base case of Real-time system conditions

	for use by other network applications programs, such as power flow and Contingency analysis.
Power Flow (PF)	An application that allows the user to study various configurations of the electrical system model to calculate the voltages and flows in the system.

2.0 RTA Expectations

Purpose of an RTA

Current NERC standards TOP-001-3 and IRO-008-2 require RCs and TOPs to perform a Real-time Assessment (RTA) every thirty minutes. The standards' requirements specify the minimum compliance measures for an RTA to reduce reliability risks. System Operators assess risks to the reliability of the BES by monitoring System Operating Limits (SOL) and Interconnection Reliability Operating Limits (IROL), system operating conditions such as loads, generation, system topology, automatic protection schemes, and equipment limitations such as safe operating limits, phase angles, etc. In order to make an accurate assessment of the reliability risks to the system, adequate situational awareness of current and potential system conditions is necessary. For the System Operator to have an appropriate level of situational awareness, the maximum interval between two consecutive RTAs must not exceed 30 minutes.

The main purpose of an RTA is to provide situational awareness to System Operators regarding Real-time and expected conditions (awareness of SOL/IROL exceedances and system conditions). Requirements TOP-001-3 R13 and IRO-008-2 R4 do not require further follow-up action beyond the completion of an RTA. However, TOP-001-3 R14 and IRO-008-2 R5 require actions that a TOP and RC should take when an RTA indicates an SOL or IROL exceedance. This RTA guidance implementation document does not define examples or actions a registered entity should take to mitigate SOL exceedances identified through an RTA.

RTA Definition and Implementation

The first part of the RTA definition mentions "*An evaluation of the system conditions using Real-time data….*" This requires an "*evaluation*" of system conditions using a tool or method capable of performing an assessment utilizing Real-time data. The requirement does not mandate 'how to' perform this "*evaluation.*" Each individual RC and TOP will need to deploy processes and procedures necessary to perform an RTA.

The next part of the sentence says "*to assess existing (pre-Contingency) and potential (post-Contingency) operating conditions*". The assessment of pre-Contingency conditions is an assessment of Real-time system conditions using available Real-time data. Similarly, the assessment of post-Contingency conditions also requires utilizing Real-time data (such as system topology, line flows etc.) to complete a situational awareness picture for System Operators. When System Operators are aware of

system conditions in both pre-Contingency and post-Contingency operating situations, appropriate steps can be taken (or planned to be taken) to manage the BES related reliability risks within acceptable levels.

The second part of the RTA definition lists an applicable set of inputs (load, generation, etc.) that should be considered for a complete RTA. The intent of specifying applicable inputs is to ensure that an RTA contains sufficient details to result in an appropriate level of situational awareness for the System Operators. Most of the applicable inputs listed in the RTA definition are self-explanatory. However, a discussion about Remedial Action Schemes and Protection Systems specifically warrant the following overview.

Remedial Action Schemes

It is also required to consider the status and/or degradation of Remedial Action Schemes (RASs) so pre or post-Contingency system conditions can be accurately assessed and evaluated.

RASs vary in design and triggering conditions that cause them to operate. Offline or seasonal studies may be performed to assess the impact of RASs to Real-time system conditions. However, it is possible that in certain Real-time operating conditions (e.g. during outage conditions) the impact of RASs may not have been fully captured in those offline studies. Therefore, the evaluation of RASs in RTAs is important from a situational awareness perspective. This evaluation could involve the status of the RASs (in service or out of service), trigger conditions or the protective actions that RASs would initiate if the trigger conditions were to be met.

In some instances it may be acceptable to calculate SOLs offline which consider applicable RAS actions and then in Real-time, operate to those SOLs. However if such an approach is used to perform RTAs, it is important for the TOPs and RCs to have processes and procedures to update applicable SOLs as system conditions or RAS actions change.

Protection Systems

The status of a Protection System must also be considered when performing an RTA. Protection Systems, under normal operating conditions, are designed to clear faults before equipment damage or system cascading occurs. However, there may be instances when a Protection System is degraded or not available (i.e., the system is in an abnormal state). In such instances, fault clearing time may increase to an unacceptable level or the backup Protection System may trip more Facilities than the Protection System was originally designed to trip under normal conditions. Thus, as with RASs, it may be necessary to re-evaluate operating conditions by taking into account degraded Protections System when applicable.

The primary objective of the assessment of system conditions in pre or post-Contingency state by considering applicable inputs (loads, generation, system topology, changes to or degradation of RAS/Protection Systems, etc.) as part of an RTA is to ensure system operation within established SOLs (including IROLs).

2.1 Reliability Coordinator and Transmission Operator RTA Practices

Real-time (or pre-Contingency) system conditions are evaluated by receiving System Control and Data Acquisition (SCADA) data in Real-time on a pre-established interval. Real-time data may also be utilized as an input to the SE to determine the current state of the System.

In order to evaluate post-Contingency system conditions, some entities rely on EMS applications such as an RTCA. Similarly, some entities with stability limitations in their systems may choose to rely on Real-time stability analysis programs.

The benefit of utilizing advanced EMS applications such as SE, RTCA or Real-time stability analysis programs is that the Real-time state of the system (topology, loads, generation etc.) being considered for pre or post-Contingency assessment can be updated periodically and automatically.

However, it is not always necessary to use advanced EMS application(s) that utilize a network model to complete an RTA, as there are other methods to perform an adequate pre- and post-Contingency system assessment. For example, small Transmission Operators may have the ability to determine the pre- and post-contingent state of their system through Real-time data and applications outside of an EMS. Applicable entities could utilize outage distribution or shift factor calculations to monitor SOL exceedances. Similarly, in some instances it may be acceptable to utilize SOLs determined via offline studies (e.g. MW flow limit on an interface etc.) and monitor SOL exceedances by utilizing Real-time data. If such proxy methods are utilized to complete the RTA, RCs and TOPs must have processes and procedures in place so that shift factor calculations or the SOLs determined via offline studies are updated as system conditions change.

Entities shall ensure that system conditions such as topology, loading, and generation dispatch sufficiently match actual Real-time conditions regardless of the tools used to perform an RTA.

3.0 Compliance Implementation and Evidence

3.1 Examples of Operating Scenarios and Compliance Evidence

The following table outlines potential system operating states and potential methods for completing an RTA. More comprehensive descriptions for select states are described later in this document. It is noted that the examples provided are not exclusive for meeting an entity's compliance obligation to complete an RTA and other ways or methods may be utilized depending on an entity's individual circumstances.

Potential System Operating States	Description of RTA	Examples of Compliance Evidence
Normal Operations - Required SCADA and Inter-Control Center Communications Protocol (ICCP) data is available and RTA tools are solving.	- Monitor pre-Contingency state via EMS alarming and/or other situational awareness tools - Examine post-Contingency state via RTCA or other simulation tool	- See section 3.2 Normal Operations for example evidence
Required SCADA and ICCP data is available and RTA tools are not solving.	- TOP: Rely on RC RTA tools if RC tools are available and are representative of actual system conditions for the TOP footprint, request RC and neighboring TOPs to continue monitoring system. Ensure processes are established with the RC to perform an RTA on the behalf of the TOP. - RC: Rely on neighboring RC's or its TOP's RTA tools if those tools are available and are representative of actual conditions for the RC footprint. Ensure processes are established with neighboring RCs and/or TOPs to perform an RTA on behalf of the RC. - Monitor pre-Contingency state via SCADA, EMS alarming and/or other situational awareness tools - Conduct offline studies which are based off available Real-time data (telemetry or other derived data from previous forecasts, manual updates, etc.) and representative of Real-time system conditions	- Logs/voice recordings for notification from impacted entity (RC/TOP) to the entity (TOP/RC) monitoring their system -Logs from other entity establishing that an RTA was performed on behalf of impacted entity at least every thirty minutes - Provide a log of Real-time EMS alarms or other logs as evidence of pre-Contingency state monitoring - Provide log of RTA tools failure - If offline cases/studies or distribution factors are used to perform an RTA, provide samples of saved power flow cases, analysis results, or manual logs as evidence that the offline processes were representative of Real-time system conditions and were executed at least every thirty minutes

Potential System Operating States	Description of RTA	Examples of Compliance Evidence
		- Third-Party RTCA results used in lieu of entity results and the capturing or logging of those results - Provide Operational Planning Analysis results and the comparison (e.g. Operator Log) of Real-time conditions versus studied system conditions
Partial SCADA and ICCP data is available. (Loss of some data sources)[2] and RTA tools are solving.	- Utilize other tools such as SE to compensate for lost telemetry - Monitor pre-Contingency state via EMS alarming and/or other situational awareness tools where data is available - Examine post-Contingency state via RTCA or other simulation tool - If necessary, receive manual statuses/flow information updates from applicable internal personnel and/or external entities	- Provide a log of Real-time EMS alarms - Provide SE availability logs if applicable - Provide a sample of RTCA run logs or output files, Operator logs or voice recordings for receiving data from internal personnel and/or external entities (if applicable)

[2] Partial SCADA data availability means the complete loss of flow and/or status information for a particular data point. For example, if a status point for a circuit breaker has redundant data sources, loss of both primary and secondary sources would be considered to be loss of SCADA visibility. If primary data source is lost, but a secondary data source is still available, it is not considered a loss of situational awareness.

Potential System Operating States	Description of RTA	Examples of Compliance Evidence
Partial SCADA and ICCP data is available (Loss of some data sources) and RTA tools are not solving.	- TOP: Rely on RC RTA tools if RC tools are available and are representative of actual system conditions for the TOP footprint, notify RC and neighboring TOPs to continue monitoring system if RC tools are working. Ensure processes are established with the RC to perform an RTA on behalf of the TOP - RC: Rely on neighboring RC's or its TOP's RTA tools if those tools are available and are representative of actual conditions for the RC footprint. Ensure processes are established with neighboring RCs and/or TOPs to perform an RTA on behalf of the RC. - Notify TOPs and neighboring RCs to continue monitoring the system if tools are working - Monitor pre-Contingency state via EMS alarming and/or other situational awareness tools - Conduct offline studies which are based off available Real-time data (telemetry or other derived data from previous forecasts, manual updates, etc.) and representative of Real-time system conditions - If necessary, receive manual statuses/flow information updates from applicable internal personnel and/or external entities[3]	- Logs/voice recordings for RC notification. - Provide a log of Real-time EMS alarms. - Provide log of RTA Tools failure. - If able to create a valid off-line model, provide an example of a saved model case representative of actual system conditions and analysis results in the form of a report to operators - Operator logs or voice recordings for receiving data from internal personnel and external entities (if applicable) - Provide Operating Planning Analysis results and the comparison (e.g. Operator Log) of Real-time conditions versus studied system conditions

[3] Utilization of manual status and flow information may be required for entities that do not utilize applications such as a state estimator. Entities that utilize a state estimator may be able to perform RTA with partial loss of SCADA by utilizing the available set of Real-time data.

Potential System Operating States	Description of RTA	Examples of Compliance Evidence
Complete loss of SCADA and ICCP data and RTA tools are unavailable.	- TOP: Rely on RC RTA tools if RC tools are available and are representative of actual system conditions for the TOP footprint, notify RC and neighboring TOPs to continue monitoring system if RC tools are working - Advise local staff of the current state and potential need to man critical stations - RC: Rely on neighboring RC's or its TOP's RTA tools if those tools are available and are representative of actual conditions for the RC footprint. Ensure processes are established with neighboring RCs and/or TOPs to perform an RTA on behalf of the RC. - Notify TOPs and neighboring RCs to continue monitoring the system if tools are working - Conduct offline studies which are based off available Real-time data (telemetry or other derived data from previous forecasts, manual updates, etc.) and representative of Real-time system conditions	- Operator and Phone Logs - Applicable Loss of EMS procedures - Alternative monitoring capabilities e.g. synchrophasor data, field resources deployed at certain pre-determined sites as human RTUs and/or the execution of off-line studies that have been updated to reflect actual system conditions to the fullest extent possible - Logs from other entity that an RTA was performed for impacted entity at least every thirty minutes

3.2 Normal Operations

Under normal operations, a combination of one or more of the following may be used by the entity to meet compliance with TOP-001-3, Requirement R13, or IRO-008-2, Requirement R4.

- Real-time data: SCADA or other application logs indicating Real-time data were being received. RC and TOPs can utilize the data identified in the data specification developed per TOP-003-3 and IRO-010-2. The required evidence for receipt of Real-time data does not need to include the evidence that every single SCADA point was being received correctly. The evidence that

SCADA was available to perform the required functions is sufficient, which could include the receipt of Real-time data necessary to perform Real-time Assessments. Entities may use data from other applications such as SE output as compliance evidence for a Real-time Assessment.

- Alarming: Entities rely on alarming functionality to alert System Operators to changes in system conditions. When Registered Entities identify EMS alarming functionality as part of their RTA, compliance evidence may include an EMS log of applicable alarms or a heartbeat monitor that monitors the functionality of the Real-time alarming application.

Evidence for SE runs may include:

- An availability log of the SE indicating periodicity of execution.
- If an entity is using a manual process, such as power flow studies, to perform Real-time assessments, a manual log indicating when said studies were completed and reviewed may suffice as supplemental compliance evidence.
- An absence of alarms or indications that are generated when an SE is unavailable may be an acceptable form of evidence for SE availability. An automated log from a tool or application that monitors SE unavailability and logs each occurrence may also suffice as compliance evidence.

Evidence for RTCA may include:

- Logs or saved studies indicating valid RTCA solutions at least every thirty minutes.
- If an entity is using a manual process for an RTCA, such as power flow studies, to perform Real-time assessments, a manual log indicating when said studies were completed and reviewed may suffice as supplemental compliance evidence.
- An absence of alarms or indications that are generated when RTCA is unavailable is an acceptable form of evidence for RTCA availability. An automated log from a tool or application that monitors RTCA unavailability and logs each occurrence may also suffice as compliance evidence.

Other forms of RTA supporting evidence:

- Manually updating a log or other documentation to confirm receipt of Real-time data, monitoring of distribution or shift factor equations, alarm monitoring, load or generation changes, RTCA Completion, Protection System degradation, etc.

Transient or Voltage Stability: Some entities that have stability issues on their system may have the need to calculate Real-time transient or voltage stability limits to complete an RTA. The compliance evidence for such an approach may include application logs indicating valid stability analysis.

An alternative approach to utilizing a Real-time transient or voltage stability application could be to calculate offline transient or voltage stability limits where applicable and then utilize these limits in an RTA. The compliance evidence for such an approach may be the historical data associated with Real-time limits and Real-time flows. However, if such an approach is used to perform RTAs, it is important

for TOPs and RCs to have processes and procedures to update applicable SOLs as system conditions change.

The RTA definition provides entities with the option of performing an RTA by themselves or they can utilize services of a third-party to assist them in completing an RTA. If an entity is relying on a third-party to perform an RTA, they should ensure that their System Operators have visibility to or awareness of RTA results so the System Operators can be alerted to adverse system conditions detected by an RTA and can initiate Operating Plans. This will be discussed more in Section 4 below.

Additionally and as stated in the rationale for TOP-001-3, Requirement R13:

> "*…The Operating Plan should contain instructions as to how to perform Operational Planning Analysis and Real-time Assessment with detailed instructions and timing requirements as to how to adapt to conditions where processes, procedures, and automated software systems are not available (if used). This could include instructions such as an indication that no actions may be required if system conditions have not changed significantly and that previous Contingency analysis or Real-time Assessments may be used in such a situation.*"

Discussion of entities utilizing previous RTCA or RTA results is further discussed in Section 4.0 below.

3.3 Complete Loss of EMS (SE, SCADA, EMS Network Down) and Continued RTA Completion

An entity experiencing a complete loss of Primary or Backup EMS capability would be obligated to meet the requirements of EOP-008-1, in particular Requirement R1 which requires an Operating Plan for backup functionality to meet its functional obligation with regard to the reliable operations of the BES, to fully implement the Plan in 2-hours (R1.5), and also to include in the Plan "*actions to take during this period to manage the risk to the BES during the transition from Primary to backup functionality as well as during outages of the primary or backup functionality*" (R1.6.2).

During the 2-hour transition period described above and to ensure compliance, the applicable entity must show that an RTA was completed once every 30 minutes.

4.0 Entities with no EMS Network Applications

As discussed above, a Real-time Assessment may be provided through internal systems or supported by third-party services. It is not necessary for every TOP to own SE/RTCA applications to complete an RTA, as there may be other methods to perform post-Contingency system analysis.

Possible evidence of compliance for entities not owning EMS network applications, for example, SEs and RTCA, may include:

- Third-party agreement where one entity completes a defined RTA for another. When an entity is relying on a third party to complete an RTA at least once every 30 minutes, they should ensure that their System Operators have visibility to RTA results or applicable communication protocols are established to ensure System Operators can be alerted to

adverse system conditions detected and initiate Operating Plans. This can be completed by System Operator logging or the capturing of RTA results completed by the third-party.

- Third-party agreement where one entity provides the results of an RTCA. For example, an RC is able provide RTCA results to an applicable TOP and its specific TOP Area. The TOP is then responsible to complete an RTA through internal processes, which could include actions listed above in Section 3.2. To meet compliance, an RTA must be completed once every 30 minutes.
- Procedures to complete an RTA if communication is lost with the third-party provider of RTA or RTCA related information. To ensure compliance during the loss of third party communication, evidence must be provided by the applicable entity that shows an RTA was completed within 30 minutes.
- As stated in the rationale section of TOP-001-3, Requirement R13, an entity's Operating Plan should contain instructions on how to perform Operational Planning Analysis and a Real-time Assessment with detailed instructions and timing requirements as to how to adapt to conditions where processes, procedures, and automated software systems are not available or owned. This could include instructions such as an indication that no actions may be required if system conditions have not changed significantly and that previous RTCA results or Real-time Assessments may be used in such a situation. An entity shall define the time frame where this type of analysis can be used along with the definition of "no significant system changes". During the scenarios described above and to ensure compliance, the applicable entity must show that an RTA was completed once every 30 minutes.