

# **The NERC Functional Model**

## **Functions and Relationships for Interconnected Systems Operation and Planning**

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A compilation of the documents that explains the background of the Functional Model and the definitions that the NERC Board of Trustees approved on June 12, 2001.

Revisions from the original documents include:

1. Changed name of “Reliability Model” to “Functional Model” to more accurately depict its scope
2. Replaced “Security Authority” with “Reliability Authority” (terminology change only)
3. Added placeholder for Planning Authority

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### **Introduction**

Control Areas were established by vertically integrated utilities to operate their individual power systems in a secure and reliable manner and provide for their customers' electricity needs. The traditional Control Area operator balanced its load with its generation and implemented interchange schedules with other Control Areas.

As utilities began to provide transmission service to other entities, the Control Area also began to perform the function of Transmission Service Provider through tariffs or other arrangements. NERC's Operating Policies and Standards historically have reflected this traditional electric utility industry structure, and ascribed virtually every reliability function to the Control Area.

Beginning in the early 1990s with the advent of open access and restructuring of the electric utility industry to facilitate the operation of wholesale power markets, the functions performed by Control Areas began to change to reflect the newly emerging industry structure. These changes in the functions of Control Areas were necessary because:

1. Some utilities were separating their transmission from their Merchant Functions (functional unbundling), and even selling off their generation,
2. Some states and provinces were instituting "customer choice" options for selecting energy providers, and
3. The developing power markets were requiring wide-area transmission reliability assessment and dispatch solutions, which were beyond the capability of many of today's Control Areas to perform.

As a result, the current NERC Operating Policies, which are centered on Control Area operations, have lost their focus, and are becoming more difficult to apply and enforce. The Task Force's first step in achieving its Long-Term Objectives was to identify all functions required for maintaining electric system reliability. This resulted in almost 100 identified reliability functions that the Task Force then organized into basic groups. The next step was to assign these functional groups to the basic "reliability organizations" such as Control Areas or to Regional Transmission Organizations. But that didn't work because the Control Areas no longer served as a common "reliability organization structure," and the emerging RTOs and ISOs, while following structures as defined in Order 2000, do not all perform the same functions.

Therefore, the Task Force concluded that it needed to build a "Functional Model" consisting of the functions that ensure reliability and meet the needs of the marketplace. In their purest or root-level state, these functions are provided by **Generators, Transmission Service Providers, Transmission Owners, Transmission Operators, Distribution Providers, Load Serving Entities, Purchasing-Selling Entities, Reliability Authorities, Planning Authorities, Balancing Authorities, Interchange Authorities**, and the **Compliance Monitor**. The Task Force has not yet seen a need to further divide any of these functions. In the Functional Model's parlance, the Control Area encompasses the roles of Reliability Authority, Balancing and Interchange Authorities, Generator, Purchasing-Selling Entity, Transmission Owner, Transmission Operator, and Load-Serving Entity.

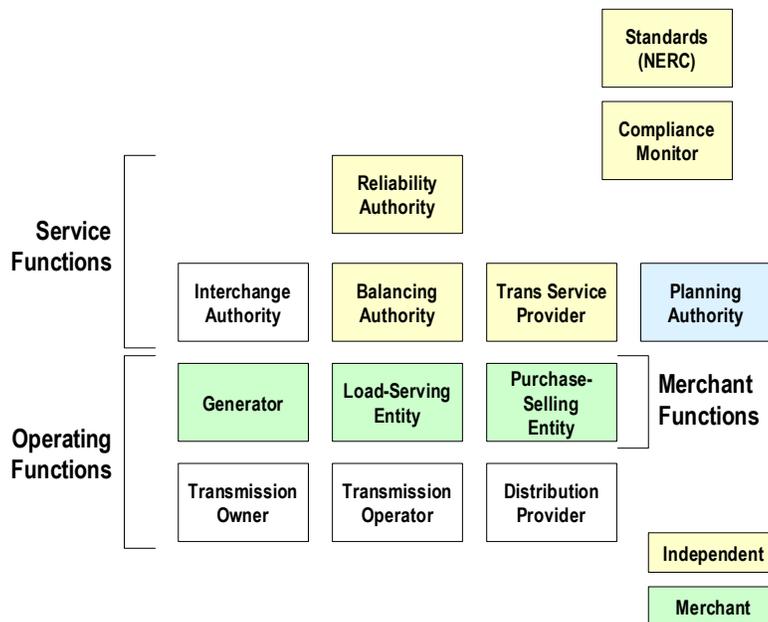
The Functional Model identifies and defines the functions that Control Areas perform when this report was written and does not depend on how organizations are, or will be, structured or how functions are implemented in the future. Regardless of whether the organizations performing the reliability Service Functions are affiliated with, or independent from, the Merchant Function, the Functional Model functional definitions are needed because the "traditional" Control Area has already unbundled its functions.

**How the Functional Model Addresses Commercial Advantages**

The Task Force also addressed the issue of commercial advantages as it was developing the Functional Model. The Model handles this through its definitions of three Service Functions: the Reliability Authority, Balancing Authority, and Transmission Service Provider. These are the critical reliability functions that are pivotal between reliability and merchant needs, and should be independent from the Merchant Function. However, Task Force emphasizes that the function definitions in the Functional Model are not predicated on the definition of “independence.” (The definitions that the Board of Trustees approved do not include independence requirements.)

**Service Functions and Operating Functions**

**Functions.** As Figure 1 on the right shows, the Functional Model groups the functions into “Service Functions” and “Operating Functions” that are necessary to ensure real-time operating reliability. The Model describes the Reliability, Interchange, Planning<sup>1</sup>, and Balancing Authorities, and the Transmission Service Provider as reliability Service Functions the “traditional” Control Area has performed for decades, but are now being defined per se for the first time. The Functional Model also defines the Operating Functions performed by the Purchasing-Selling Entity, Generator, and Load-Serving Entity (these three are further classified as “Merchant Functions”), and the Transmission Owner and Operator, and Distribution Provider and explains the interrelationships between the reliability Service Functions and these Operating Functions. Finally, the Model includes the Regional Councils and NERC Service Functions and the roles they play in developing the Policies and Standards and monitoring compliance. Most importantly, the Functional Model defines *functions*, not organizations or their structures.



**Figure 1 - Functional Model**

**Hierarchy.** The reliability functions are also placed into an organizational hierarchy to establish responsibilities and reliability oversight relationships. The Service Functions provide oversight to the Operating Entities. Within the Service Functions are three “Authorities” (Balancing, Interchange, and Reliability), which are the ultimate decision-makers for their particular function. In other words, there is nothing “higher” than the Interchange Authority for authorizing Transactions. The Balancing Authority is the highest authority for maintaining resource-load balance. The Reliability Authority is the highest authority for approving or curtailing Transactions, and even has authority over the Balancing and Interchange Authorities under emergency conditions or when they are in violation of NERC Policies and Standards.

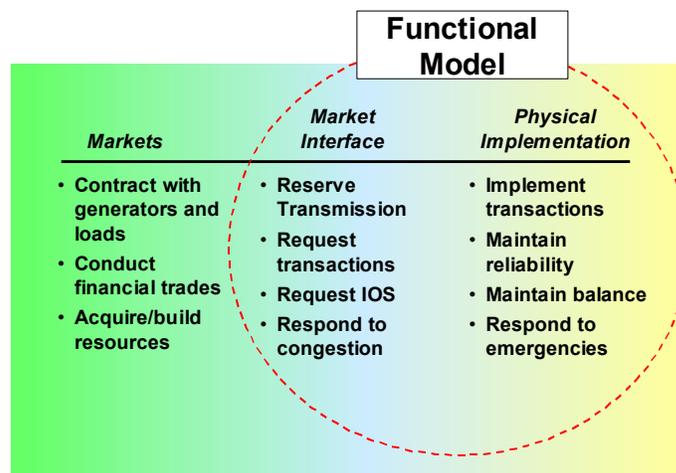
<sup>1</sup> The NERC Planning Committee is currently working on the Planning Authority function definitions.

## The NERC Functional Model

### Function Definitions

**Timeframes.** While the proposed Functional Model is designed to “accommodate the marketplace,” it is *not* a market model. The marketing activity takes place ahead of time, as merchants contract for generation, buy and sell energy “on paper” with each other, and reserve transmission service. Transactions do not enter the Model’s time domain until they are “tagged” and submitted to the Interchange Authority.

The Functional Model defines the reliability functions that are necessary to ensure resource-demand balance and transmission reliability in real time, as well as provides the mechanism for the marketplace to deliver its goods to its customers.



Several readers of the draft White Papers noted that the Functional Model did not appear to accommodate “Scheduling Coordinators,” “Qualified Scheduling Entities,” or “Power Exchanges” that are found within certain RTO and ISO organizations. The Task Force discussed this issue, and concluded that these entities perform a financial arrangement service among the merchant functions. While they may be required to set up balanced (resource-to-load) portfolios, and may even be required to submit those arrangements to the system operator, the Task Force considers that they play a role in the Market timeframe.

**Operating Policy Restructuring.** Using this new Functional Model as a guide, NERC will be able to restructure its Operating Policies and Standards to more accurately focus on the basic reliability Service and Operating Functions. Then, the organizations that are now forming—RTOs, ISOs, Transcos, and so on—can simply “roll up” these functions as necessary into their corporate structure. Control Areas can continue to exist, but the Operating Policies will no longer address Control Areas per se, but rather the reliability functions that Control Areas may perform.

### Recommendations

The Task Force recommends that:

1. NERC revise its Operating Policies along the lines of the Service and Operating Functions defined in the Functional Model, and
2. The operating reliability organizations that exist today, those that are now being formed, and those that will be formed, identify the Service and Operating Functions they perform as identified in this Functional Model.

The Function Definitions are found in the following section.

## **Function Definitions**

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Definitions approved by  
the NERC Board of  
Trustees, June 12, 2001.

### ***Reliability Authority***

Service Function

#### *Definition*

Ensures the reliability of the bulk power transmission system within its Reliability Authority Area.

#### *Criteria and Compliance for the organization performing this function*

- NERC-certified
- Must have NERC-certified operators
- Subject to Code of Conduct
- Monitored for compliance by NERC using independent (non-interested, third party)

#### *Responsibilities*

- Monitors all reliability-related data within its Reliability Authority Area
- Develops Operating Reliability Limits
- Performs reliability analysis (actual and contingency) for its Reliability Authority Area
- Specifies Interconnected Operations Services requirements for transmission reliability (e.g., reactive requirements, location of operating reserves)
- Provides oversight of transmission and generation operational plans and directs revisions as required and as permitted by agreements
  - Authority over transmission maintenance schedules
- Coordinates reliability processes and actions with and among other Reliability Authorities
- Identifies, communicates, and directs to the appropriate entities those options necessary to relieve reliability threats and violations in its Reliability Authority Area
- Enforces operational reliability requirements
- Directs implementation of emergency procedures
- Directs and coordinates System Restoration
- Approves Interchange Transactions from reliability perspective

#### *Functional Relationships*

- Receives facility data from Generator; Load-Serving Entity; Transmission Owner and Operator; Distribution Provider
- Evaluates generation and transmission maintenance plans
- Provides reliability analyses to Transmission Operators, Transmission Service Providers, and Balancing Authorities in its Area

## **The NERC Functional Model**

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### **Function Definitions**

- Issues reliability alerts to Generators, Load-Serving Entities, Transmission Operators and Transmission Service Providers, Balancing Authorities, Interchange Authorities, and NERC
- Provides Interchange Transaction approvals to Interchange Authority based on reliability analysis
- Issues corrective actions (e.g., curtailments or load shedding) to Transmission Operators, Transmission Service Providers, Balancing Authorities, and Interchange Authorities
- Coordinates with other Reliability Authorities
- Reports to Regional Compliance Monitor and to NERC
- Receives real-time operational information from Balancing Authority for monitoring

### *Relationships – Boundaries*

- The Reliability Authority covers a defined area called the Reliability Area
- Can not overlap with other Reliability Areas
- Reliability Area may cover one or more Regions

***Planning Authority***  
Service Function

(The Planning Committee is developing the definitions for this function.)

***Balancing Authority***

Service Function

*Definition*

Integrates resource plans ahead of time, and maintains load-interchange-generation balance within its metered boundary and supports system frequency in real time.

*Criteria and Compliance for the organization performing this function*

- NERC-certified
- Must have control of any of the following combinations within its metered boundary:
  1. Load and Generation (an isolated system)
  2. Load and Scheduled Interchange
  3. Generation and Scheduled Interchange
  4. Generation, Load, and Scheduled Interchange
- Must have NERC-certified operators
- Subject to Code of Conduct
- Monitored for compliance by NERC or Region Compliance Monitor

*Responsibilities*

- Reviews generation commitments and load forecasts
- Formulates an operational plan for reliability assessment
  - Approves Interchange Transactions from ramping ability perspective
- Implements interchange schedules
- Directs generators and loads to take action to ensure balance in real time
- Determines amount required and arranges for Interconnected Operations Services to ensure balance (e.g., amount of operating reserve, load-following, frequency response) in coordination with the Reliability Authority
- Provides frequency control
- Monitors control performance and disturbance recovery
- Provides balancing, energy accounting (including hourly checkout of Interchange Schedules and Actual Interchange), and administers Inadvertent paybacks
- Implements Emergency Procedures as directed by the Reliability Authority

*Functional Relationships*

- Receives approved, valid, and balanced Interchange Schedules from the Interchange Authority ahead of time
- Confirms Interchange Schedules with the Interchange Authority after the hour for “checkout.”

## **The NERC Functional Model**

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### **Function Definitions**

- Confirms Actual Interchange with adjacent Balancing Authorities after the hour for “checkout.”
- Receives loss allocation from Transmission Service Provider
- Receives operational plans and commitments from Generators within the metered boundary of the Balancing Authority.
- Develops load forecasts from Load-Serving Entities
- Submits integrated operational plans (including maintenance plans from Generators) to the Reliability Authority for reliability assessment and provide balancing information to the Reliability Authority for monitoring
- Provides real-time operational information for Reliability Authority monitoring
- Complies with reliability requirements specified by Reliability Authority
- Informs Reliability Authority and Interchange Authority of Interchange Schedule interruptions (e.g., due to generation or load interruptions) within its boundaries.
- Confirms ramping capability with Interchange Authority
- Requests Generators to provide Interconnected Operations Services
- Requests Generators to implement redispatch for congestion management as directed by the Reliability Authority.
- Requests operating information from Generators
- Verifies implementation of Emergency Procedures to Reliability Authority
- Coordinates use of interruptible loads with Load Serving Entities (i.e., interruptible load that has been bid in as Interconnected Operations Services)

### *Boundary Relationships*

- May include one or more Transmission Owners
- May include one or more Transmission Service Providers
- May include one or more Generators
- May include one or more Load-Serving Entities
- May receive Interchange Schedules from one or more Interchange Authorities
- Must be within a single Reliability Area

***Interchange Authority***

Service Function

*Definition*

Authorizes valid and balanced Interchange Schedules.

*Criteria and Compliance for Organization performing this function*

- NERC-certified
- Must have NERC-certified operators
- Subject to Code of Conduct
- Monitored for compliance by NERC

*Responsibilities*

- Determines valid, balanced, Interchange Schedules (validation of sources and sinks, Transmission Reservation, Interconnected Operations Services, etc. as provided on the Interchange Transaction tag).
- Verifies Ramping Capability for requested Interchange Schedules with the Balancing Authority
- Collects and disseminates Interchange Transaction approvals, changes, and denials
- Authorizes implementation of Interchange Transactions
- Enters Interchange Transaction information into Reliability Assessment Systems (e.g., Interchange Distribution Calculator)

*Functional Relationships*

- Transmission Service Provider confirms reservation with Interchange Authority.
- Reliability Authority informs Interchange Authority of TLR cuts and redispatch implementation
- Purchasing-Selling Entity requests implementation of Interchange Transactions from the Interchange Authority
- Balancing Authority informs Interchange Authority of Interchange Schedule interruptions due to generation loss or load interruption.
- Balancing Authority informs Interchange Authority of expected Interconnected Operations Services deployments that result in an Interchange Transaction (for example, an Interchange Schedule that is enabled by reducing load in a Balancing Area, which frees up resources.)
- The Interchange Authority informs Transmission Service Provider, Purchasing-Selling Entity, Reliability Authority, and Balancing Authority of Interchange Schedule Implementations and Curtailments.
- Provides Transmission Service Provider with the requested Interchange Transactions received from Purchasing Selling Entities using that Transmission Service Provider's reserved capability. This "schedules" the Transmission Service.

## **The NERC Functional Model**

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### **Function Definitions**

- Provides approved, valid, and balanced Interchange Schedules to the Balancing Authority for implementation
- Confirms with Balancing Authority the ability to meet ramping requirements for submitted portfolio
- Informs Purchasing-Selling Entity on implementation of Load-Provided Interconnected Operations Services that were bid into the market that result in an Interchange Transaction
- Submits all Interchange Schedule Requests to the Reliability Authority for approval

### *Relationships – Boundaries*

- Not included in a particular Reliability Area or Balancing Area
- Can provide Interchange Schedules to any Balancing Authority
- Separate portfolios will be required for each Balancing Authority
- May provide Interchange Scheduling services to one or more Purchasing-Selling Entities.

***Transmission Service Provider***

Service Function

*Definition*

Provides transmission services to qualified market participants under applicable transmission service agreements.

*Criteria and Compliance for the organization performing this function*

- NERC-certified. (The Transmission Service Provider determines Available Transfer Capability).
- Must provide access to the transmission system in accordance with its applicable transmission service agreements
- Subject to Code of Conduct (e.g., maintaining information confidential)
- Monitored for compliance by NERC or Region Compliance Monitor

*Responsibilities*

- Accepts reservation requests via the OASIS and processes each request for service
- Approves/denies transmission reservation requests
- Designs, operates and maintains the OASIS and related e-commerce interfaces directly or via contract with an entity not affiliated with the merchant function
- Approves Interchange Transactions from transmission service arrangement perspective
- Implement dc tie changes
- Develops and maintains business practices and operating agreements
- Determines Transmission Adequacy by calculating ATC
- Allocates transmission losses among its Balancing Authority(s)

*Functional Relationships*

- Approves/denies Transmission Reservation Requests from Purchasing-Selling Entity
- Coordinates ATC with Reliability Authority and other Transmission Service Providers
- Communicates ATC levels with Interchange Authority and Purchasing-Selling Entity
- Provides Transmission Service reservation confirmation to the Interchange Authority
- Receives Interchange Transaction implementation and revisions from the Interchange Authority
- Arranges for transmission loss compensation with Balancing Authority
- Implement DC Tie Operations with Transmission Operator

*Boundary Relationships*

Every transmission facility must be within a Balancing Authority. However, the Transmission Service Provider may manage transmission reservations over transmission facilities that reside within one or more Balancing Areas and/or Reliability Areas.

**Function Definitions**

***Transmission Owner***

Operating Function

*Definition*

Owns transmission facilities.

*Criteria and Compliance for the organization performing this function*

- Subject to code of conduct (will have market-sensitive information)

*Responsibilities*

- Establish ratings of its transmission facilities

*Functional Relationships*

- Develop agreements with the Transmission Service Provider.
- Develop operating agreements with the Transmission Operator.
- Provides transmission facility ratings to Transmission Operator and Reliability Authority

***Transmission Operator***

Operating Function

*Definition*

Operates and maintains the transmission facilities, and executes switching orders.

*Criteria and Compliance for the organization performing this function*

- Must have NERC-certified operators for those performing the reliability function.
- Subject to code of conduct (will have market-sensitive information)

*Responsibilities*

- Operates and maintains transmission facilities according to prudent utility practice
- Adjusts dc ties for those Interchange Transactions that include the dc tie in the Transmission path
- Maintains appropriate voltage profiles
- Provides local network integrity by defining operating limits, developing contingency plans, and monitoring operations
- Provides Telemetry of transmission system

*Functional Relationships*

- Operates transmission system facilities under direction of the Reliability Authority
- Requests Reliability Authority to mitigate Operating Reliability Limit violations. (e.g., redispatch, transmission loading relief)
- Implement reliability measures as directed by Reliability Authority
- Directs Distribution Provider to shed load
- Provides real-time operations information to the Reliability Authority
- Arranges for reactive power with Generator for voltage support
- Implements dc tie operations as directed by the Transmission Service Provider
- Coordinates load shedding, with or as directed, by the Reliability Authority
- Provides maintenance and construction plans to Reliability Authority

**Function Definitions**

***Distribution Provider***

Operating Function

*Definition*

Provides and operates the “wires” between the transmission system and the customer.

*Criteria and Compliance*

- May be Subject to Code of Conduct (depending on state or provincial rules)

*Responsibilities*

- Ability to shed load

*Functional Relationships*

- Sheds load as directed by the Transmission Operator

## **The NERC Functional Model**

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### **Function Definitions**

#### **Generator**

Operating Function/Merchant Function

##### *Definition*

Owns and operates generation unit(s) such as an Independent Power Producer, Exempt Wholesale Generator or Electric Utility (IOU, Cooperative, Municipality) or that runs a market for generation products (such as a power exchange or power pool) that performs the functions of supplying energy and Interconnected Operations Services

##### *Criteria and Compliance*

- Monitored for compliance by NERC Regional Compliance Monitor

##### *Responsibilities*

Generation Operator and Power Exchanges<sup>2</sup>

- Produces generation products (energy or Interconnected Operations Services or both) per contracts or arrangements
- Formulates daily generation plan

Generation Operator only

- Reports operating and availability status of units
- Develops annual maintenance plan for generating units

##### *Relationships – Functions*

Generation Owners only

- Deals directly with either Load Serving or Purchase-Selling Entities via bilateral contracts for energy, capacity and/or Interconnected Operations Services products
- Provides voltage support to Transmission Operator

Power Exchanges Only

- Deals directly with Load Serving Entities or Purchasing-Selling Entities who, through an agreement, allow the Power Exchange to obtain needed generation products

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<sup>2</sup> A power exchange may be an independent entity and not a market participant.

## **The NERC Functional Model**

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### **Function Definitions**

#### Generation Owners and Power Exchanges

- Negotiates agreement whereby Generation Owners supply bids for generation products to the Power Exchange and the Power Exchange can buy emergency power from generation owners

#### Generation Operators and Power Exchanges

- Provides Generation Commitment Plans to Balancing Authorities after notification by Purchase-Selling or Load Serving Entity of transactions approval
- Provides Balancing Authority with Balancing Authority-determined amount of Interconnected Operations Services
- Implements upon direction by Balancing Authorities redispatch and interchange schedules
- Reports operating and availability status of units to Reliability Authority and Balancing Authority
- Reports annual maintenance plan for generating units to Balancing Authority

#### *Relationships – Boundaries*

- Must be within metered boundary of a single Balancing Authority
- Must be within a single Reliability Authority area
- May use services of one or more Purchasing-Selling Entities

***Purchasing-Selling Entity***

Operating Function/Merchant Function

*Definition*

The function of purchasing or selling energy, capacity and all necessary Interconnected Operations Services as required. Purchasing-Selling Entities may be Marketers, Customer Aggregators, and Merchant Affiliates.

*Criteria and Compliance*

- May have an affiliated Interchange Authority
- Not monitored for compliance, but may be denied services if non-compliant

*Responsibilities*

- Purchases and sells generation or capacity
- Purchases and sells Interconnected Operations Services .
- Reserves transmission service
- Requests approval of Interchange Transactions

*Relationships – Functions*

- Works with Load Serving Entities and other Purchasing-Selling Entities to define the type of Interchange Transactions and Interconnected Operations Services needed to supply the needs of the Load-Serving Entities
- Purchases the generation and Interconnected Operations Services needed to serve the Interchange Transactions from Generators, Power Exchanges or other Purchasing-Selling Entities
- Purchases the appropriate transmission service from the Transmission Service Provider and makes appropriate arrangements for Interconnected Operations Services with the Transmission Service Provider for Interchange Transactions
- Submits to the Interchange Authority a request to implement an Interchange Transaction
- Notifies the Generator and Load Serving Entity if the Interchange Transaction request is approved or denied
- Notifies the Interchange Authority of Transaction Cancellations or Terminations

*Relationships – Boundaries*

- May use services of one or more Interchange Authorities
- May use services of one or more Transmission Service Providers
- May service one or more Load-Serving Entities

***Load-Serving Entity***

Operating Function/Merchant Function

*Definition*

Secures energy and transmission (and related generation services) to serve the end user.

*Criteria and Compliance*

- Compliance monitored by Regional Compliance Monitor (e.g., if selling Interconnected Operations Services)

*Responsibilities*

- Collects individual and develops overall load profiles/plans as required. (Daily, Weekly, Monthly etc...)
- Identifies and provides facilities for load curtailment
- Negotiates agreements for needed energy and Interconnected Operations Services

*Relationships – Functions*

- Works with end-use customers and Customer Aggregators to develop and submit load profiles and plans as needed to the Balancing Authority, Generators, and Purchasing-Selling Entities
- Works with Purchasing-Selling Entities and Customer Aggregators to arrange for the delivery of energy to a specific metering point for loads via bilateral contracts
- Works with Generators and Power Exchanges on behalf of end-use customers to secure energy and Interconnected Operations Services needed via bilateral contracts. (In this role the Load Serving Entity is acting like the Purchasing-Selling Entity.)
- Works with the Balancing Authority and Transmission Operator to implement load shedding during emergency conditions and to provide load interruption capability as an Interconnected Operations Service

*Relationships – Boundaries*

- All end-use customers must be within the metered boundary of a Balancing Authority
- May use services of one or more Purchasing-Selling Entities

## ***Compliance Monitor***

Service Function

### *Definition*

An entity of the NERC Region Organization that performs the functions of reviewing and ensuring compliance with NERC Reliability Policies and Standards, and of administering sanctions or penalties for non-compliance to standards.

### *Criteria and Compliance*

- Criteria to be developed by NERC Organization
- Compliance monitoring coordinated by NERC Organization

### *Responsibilities*

- Audits and documents performance of all functional entities to NERC Policies, Requirements, and Standards
- Provides compliance data

### *Relationships – Functions*

- Receives oversight direction from the NERC Organization for consistency
- Monitors Balancing Authorities, Generators, Transmission Operators, Transmission Service Providers, and Load Serving Entities within the NERC Region
- Provides compliance information to the NERC Organization and others as appropriate
- Assists the NERC Organization's monitoring of Reliability Authorities and Interchange Authorities as appropriate

### *Relationships – Boundaries*

- Includes those functional entities within the Regional Council
- Compliance Monitor covers at least one or more Regions

***North American Electric Reliability Council***

Service Function

*Definition*

The entity that performs the function of ensuring the reliable operation of the Interconnections in the United States, Canada, and Baja California Norte, Mexico. The NERC Organization includes the Board of Trustees, all committees and subgroups, Regional Councils, and staff.

*Criteria and Compliance*

- NERC Bylaws (future: NAERO Bylaws and regulatory authorities)

*Responsibilities*

- Develops Standards for the operation of the three electrical Interconnections that serve the United States, Canada, and Baja California Norte, Mexico.
  - Includes Standards for Transmission Operators, Transmission Service Providers, Generators, Load-Serving Entities, Purchasing-Selling Entities, plus Balancing, Interchange, and Reliability Authorities
- Develops Criteria and Certification Procedures for Balancing, Interchange, and Reliability Authorities, and Transmission Service Providers
- Provides data (via NERCnet) for monitoring and reliability assessment
  - Includes Interchange Transactions via IDC in Eastern Interconnection
- Monitors and reports on the adequacy of electricity supply.
- Coordinates the compliance programs of the ten Regional Councils.
- Provides for dispute resolution

*Relationships – Functions*

- Receives operating data via the Balancing, Interchange, and Reliability Authorities
- Disseminates operating data via NERCnet and related communications applications (e.g. ISN)

*Relationships – Boundaries*

- Includes all reliability entities

## The Authorities – Balancing, Interchange, and Reliability

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### **Balancing Authority**

As with today's Control Area, the Balancing Authority is electrically defined with metered boundaries that we refer to as the Balancing Area. Every generator, transmission facility, and end-use customer must be in a Balancing Area. The Balancing Authority's mission is to balance load with generation and Interchange Schedules within its Balancing Area. It does not serve a transmission reliability function.

**Role in approving Transactions.** The Balancing Authority approves Transactions with respect to the ramping requirements of the Generation that must increase or decrease. The Balancing Authority provides its approval or denial to the Interchange Authority.

**Real-time control.** The Balancing Authority will calculate an Area Control Error for its Balancing Area. Operating Policies and Standards will set the limits for acceptable ACE, and the Balancing Authority will send control signals to those Generators that are providing regulation (to cover minute-to-minute variations in load) and load-following (to cover longer-term diurnal variations). The Balancing Authority is also responsible for taking action, either under its own initiative or direction by the Reliability Authority, if the Balancing Authority cannot comply with NERC's Control Performance standards (i.e., can not maintain ACE within acceptable levels).

**Day-ahead analyses.** The Balancing Authority is responsible for ensuring that Load-Serving Entities within the Balancing Area have balanced generation resources on a day-ahead basis. These resources could be provided by a pool or affiliated generation within that Balancing Area or bilaterally from another Balancing Area. The Balancing Authority must also provide its day-ahead dispatch pattern to the Reliability Authority for analysis. If the Reliability Authority determines that the proposed dispatch would jeopardize transmission reliability, the Reliability Authority will work with the Balancing Authority to develop an alternate dispatch plan. The Balancing Authority would then confer with the Generator or the Load-Serving Entity for a market solution.

**Energy Emergencies.** In the event of an Energy Emergency, the Balancing Authority can implement Public Appeals, DSM programs, and, ultimately load shedding<sup>3</sup>. Obviously, it must do this in concert with the Reliability Authority.

The Balancing Authority is also responsible for coordinating generation (re)dispatch for congestion management as directed by the Reliability Authority. However, the Balancing Authority is not responsible for transmission reliability.

**Interconnected Operations Services.** The Balancing Authority is responsible for determining the type and amount of Interconnected Operations Services, and for deploying those Services. It is also the "provider of last resort" for Interconnected Operations Services. This is the extent to which the Balancing Authority is involved in the marketplace. The Balancing Authority would not take ownership of Interconnected Operations Services, but rather act as an agent for the Load-Serving Entities that are in the Balancing Area. The Task Force does not consider the Balancing Authority to be performing a Merchant Function with respect to deploying Interconnected Operations Services for reliability purposes.

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<sup>3</sup> The Balancing Authority can not implement voltage reductions because it does not control the distribution system. Voltage reductions are accomplished by the Transmission Operator under the direction of the Reliability Authority

## **The NERC Functional Model**

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### **The Authorities – Balancing, Interchange, and Reliability**

The Balancing Authority must be able to accommodate pool arrangements, where generation is “bid in,” as well as bilateral arrangements between generators and customers. It must implement all authorized Transactions from any certified Interchange Authority.

***Interchange Authority***

**The Authorization Function.** The Interchange Authority serves a function very similar to the Tag Authority that is now assigned to the Sink Control Area. That is, it collects approvals or denials from the other reliability functions — Reliability and Balancing Authorities, and Transmission Service Provider — and verifies the validity of the source and sink. The **Transmission Service Provider** has the responsibility (as it does today under the *pro forma* tariff) of approving the Transaction by confirming to the Interchange Authority that there is a valid Transmission Reservation. During the authorization process, the Interchange Authority sends the “tag”<sup>4</sup> to each Transmission Service Provider on the scheduling path. Thus, even if the Interchange Authority had determined that the source and sink are “valid” generator and load busses, if the Transmission Service Provider, upon reviewing the “tag,” does not believe the source and sink information is equivalent to the source-sink information as reserved, then it can inform the Interchange Authority that it (the TSP) does not approve the Transaction.

The Interchange Authority provides the **Balancing Authority** with the individual Transactions as well as the “net” of those Transactions. The Balancing Authority needs to track the individual Transactions in case one or more of them are curtailed by the Reliability Authority. The net Interchange Schedule is used by the Balancing Authority for checkout with the Interchange Authority (see “Technical Discussion 1 – Interchange Scheduling Practices”).

The Balancing Authority also approves the capability to ramp the Transactions in or out and the **Reliability Authority** performs a reliability assessment to make sure the Transaction will not jeopardize the integrity of the Transmission System.

Only when it receives approvals from the Transmission Service Provider, Balancing Authority, and Reliability Authority, does the Interchange Authority direct the source and sink Balancing Authorities to implement the Transaction. If any of these three — TSP, BA, or RA — do not approve the Transaction, then the Interchange Authority cannot authorize the transaction.

It is important to note that *all physical bilateral* Transactions between Generators and Load-Serving Entities set up by a Purchasing-Selling Entity must be authorized by the Interchange Authority—even those Transactions that are within the same Balancing Authority. In other words, “Interchange” refers to a bilateral generator-to-load arrangement. It does not refer only to Transactions between two Balancing Authorities the way Interchange Transaction or Interchange Schedule refers to two Control Areas today.

A Load-Serving Entity does not need to arrange for Interchange Authority services for serving its own load with its own generation. Likewise, where a pool is operated for its generators and loads, bilateral arrangements do not need to be made through the Interchange Authority. However, in these situations, the Load-Serving Entity and Generators must provide the Balancing Authority with their load and generation commitments.

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<sup>4</sup> We use the term “tag” because of its familiarity. It refers in the general sense to the collection of data that defines a Transaction, not specifically to the “E-tag” or ERCOT tagging system.

## **The NERC Functional Model**

### **The Authorities – Balancing, Interchange, and Reliability**

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**Ensuring balanced, valid Interchange Transactions.** The Interchange Authority also ensures that the resulting Interchange Transactions are balanced and valid prior to physical delivery. This means:

1. The source MW must be equal to the sink MW (plus losses if they are “self-provided”), and
2. The Transactions are between valid sources and sinks, and
3. There is a (continuous) transmission arrangement from the Source to the Sink.

The NERC Operating Manual defines a **Transaction** as “An agreement arranged by a Purchasing-Selling Entity to transfer energy from a seller to a buyer.” For the purposes of the Functional Model, it is important that adequate information be provided to enable the Reliability Authority to properly assess the impact of a Transaction ready to “go physical” on the Interconnection. This does not mean that the Functional Model prohibits partial path transmission reservations. It does mean that when the Purchasing-Selling Entity is ready for the Transaction to be handed off to the Interchange Authority for physical implementation, the PSE must “link” those partial paths.

The Interchange Authority function is not being performed today on a formal basis, rather the source-sink mismatches are discovered and corrected through the “daisy chain” Interchange Schedule confirmations between adjacent Control Areas. When this isn’t successful, generators produce power that no one pays for, or customers think they are purchasing power when they’re not, and Interconnection frequency suffers. These disagreements also play havoc with Inadvertent accounting balance reconciliation between Control Areas. The Task Force believes that the Interchange Authority’s management of all bilateral Transactions, including hourly Interchange Schedule checkout with the Balancing Authorities, will greatly enhance Inadvertent account balancing.

**Curtailments.** The Interchange Authority coordinates curtailments ordered by the Reliability Authority by notifying the Balancing Authorities, Transmission Service Providers, and Purchasing-Selling Entities. The Interchange Authority also communicates and coordinates the resulting modified Interchange Schedules that resulted from the curtailments. This should also help remedy the myriad problems with inadvertent balancing that the Eastern and Western Interconnections are experiencing today.

**Transmission Parking.** As we explained in the “Control Area Issues” section of this report, these are financial arrangements with which the Functional Model is not concerned. Purchasing-Selling Entities can make deals ahead of time with any number of Generators and customers without informing the Interchange Authority. The Interchange Authority does not come into play until the Purchasing-Selling Entities are ready for their “deals” to go to physical delivery.

***Reliability Authority***

The Reliability Authority is the highest-level authority and can direct all reliability functions<sup>5</sup>. The Reliability Authority determines Operating Reliability Limits according to Transmission Owners’ specified equipment ratings. The Reliability Authority monitors and ensures transmission system reliability at all times. It also specifies the requirements for Interconnected Operations Services to ensure transmission reliability.

**Role in approving Transactions.** The Reliability Authority approves Transactions with respect to transmission reliability and provides its approval or denial to the Interchange Authority.

**Day-ahead analysis.** The Reliability Authority will receive the dispatch plans from the Balancing Authority on a day-ahead basis. The Reliability Authority will then analyze the dispatch from a transmission reliability perspective. If the Reliability Authority determines that the Balancing Authority’s dispatch plans will jeopardize transmission reliability, the Reliability Authority will work with the Balancing Authority to determine where the dispatch plans need to be adjusted. The Reliability Authority has the “final say” in the generation dispatch.

The Reliability Authority obtains generation and transmission maintenance schedules from Generators and Transmission Operators. The Reliability Authority can deny a transmission outage request if transmission system reliability would be adversely affected.

**Emergency actions.** The Reliability Authority is responsible for real-time system reliability, which includes calling for the following emergency actions:

- Curtailing Transactions
- Directing redispatch to alleviate congestion
- Mitigating energy and transmission emergencies, and
- Ensuring energy balance and Interconnection frequency.

The Reliability Authority, in collaboration with the Balancing Authority and Load-Serving Entity, can invoke public appeals, demand-side management, and even load shedding if the Balancing Authority cannot achieve generation-load balance.

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<sup>5</sup> There is a “reliability function” performed at all levels of the transmission system. For example, the Transmission Operator provides an operating reliability function that covers a more “local” level. This is briefly mentioned in the Transmission Operator section on Page 31

## **The NERC Functional Model**

### **The Authorities – Balancing, Interchange, and Reliability**

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**One versus several.** The Task Force has not specified an optimal number of Reliability Authorities, not because of controversy, but because of practicality. The Task Force believes that the “roll-up” of functions into organizations will be a more important determining factor in the “right” number of Reliability Authorities rather than the pre-conclusion that a single Reliability Authority is the only appropriate solution. One Reliability Authority does not need to be the singular source for curtailment directives. Some believe that de-centralization allows for more simultaneous directions to be given and monitored for response. On the other hand, the Task Force is also aware of arguments for a Reliability Authority-type of entity that covers an entire Interconnection.<sup>6</sup> What is necessary is an effective communication system between the Reliability Authorities within an Interconnection to coordinate activities and their independence from the Merchant Function<sup>7</sup> to ensure objective control actions.

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<sup>6</sup> See “Options To Ensure Compliance With NERC And Regional Reliability Council Policies, Standards And Criteria,” October 12, 1996, NERC.

<sup>7</sup> The Functional Model does not define the degree of “independence.”

## Other Service Functions – Transmission Service Provider, Distribution Provider, and NERC

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### ***Transmission Service Provider***

The Transmission Service Provider as defined in the Functional Model is not the same as the “Transmission Provider” in the RTO Order. The Transmission Service Provider authorizes use of the Transmission System and maintains the OASIS site. However, the Functional Model recognizes that the Transmission Service Provider may not necessarily be the Transmission Owner or Operator, and so the Task Force has defined these functions separately.

**Role in approving Transactions.** The Transmission Service Provider approves Transactions with respect to the Transactions’ transmission reservation. The Transmission Service Provider does this by comparing the Transmission Service reservation it provided to the Purchasing-Selling Entity with the Transmission information supplied by the Interchange Authority. The Transmission Service Provider provides its approval or denial to the Interchange Authority.

**Providing Transmission Service.** As its name implies, the Transmission Service Provider is responsible for providing transmission service to the Purchasing-Selling Entity. The Transmission Service Provider determines Available Transfer Capability and coordinates ATC with other Transmission Service Providers. The Transmission Service Provider manages the reservation of transmission service via the OASIS using the Transmission Owners’ facilities and within the operating reliability limits determined by the Reliability Authority. The Transmission Service Provider does not itself have a role in maintaining system reliability in real time—that is the Reliability Authority’s responsibility.

The Transmission Service Provider arranges for transmission loss compensation with the Balancing Authority. (See discussion of Losses in the Balancing Authority section, page 40).

### ***NERC***

NERC establishes reliability policies and standards through its technical standing committees. NERC is shown at the top of the functional hierarchy because its policies and standards drive all of the other reliability functions.

The Task Force’s definition of NERC includes:

1. Regional Councils
2. All technical standing committees and their subgroups
3. Board of Trustees
4. NERC staff

The Regional Councils also develop policies and standards that are, in many cases, more detailed or rigorous than NERC’s. The Functional Model recognizes that these Regional policies and standards will continue to exist.

## **Operating Functions – Generator, Purchasing-Selling Entity, Load-Serving Entity, Transmission Owner, and Transmission Operator**

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### **Generator**

The Task Force separates the Generator function into “Merchant” and “Pool/Affiliated.” The Task Force defines the “Merchant” as any and all generation arranged through bilateral agreements. It does not mean IPP or merchant plant *per se*—it could be any generator entering into a bilateral agreement. The “Pool/Affiliated” generation is thought of as a “generation plan” or arrangement between loads and affiliated generation (ownership or contract) or between pool members—generators and loads.

The Generator will provide the Balancing Authority and Pool Operator with the operating and availability status of generating units.

### **Load-Serving Entity**

The Load-Serving Entity provides energy but does not include distribution services (“wires”). The Task Force has defined a Distribution Provider function separately.

Let’s examine how the Functional Model sets up the generation dispatch: Load-Serving Entities will either own generation or contract with generators for capacity and energy to serve their load, or use a combination of both. They will also purchase capacity and energy from non-affiliated generators through Purchasing-Selling Entity or a “Pool” Operator. These Load-Serving Entities will have the “initial say” for scheduling their generation to meet their load.

The Load-Serving Entity will report pool or affiliated generation arrangements to serve load to the Balancing Authority sometime before the generation is actually dispatched, perhaps noon the day before. The Balancing Authority will combine these arrangements with other bilateral arrangements provided through the Interchange Authority and evaluate them to ensure that there is enough load-resource balance. The Balancing Authority then submits these day-ahead plans to the Reliability Authority, who analyzes the dispatch plan to ensure that operational reliability is maintained. The Reliability Authority has the “final say” over this generation dispatch.

### **Transmission Operator and Transmission Owner**

The **Transmission Owner** determines ratings of its transmission facilities (wires, breakers, switches, etc)

The **Transmission Operator** operates and maintains the transmission facilities, and is responsible for local reliability functions. The Transmission Operator under the Reliability Authority’s direction can take action, such as implementing voltage reductions, to help mitigate an Energy Emergency.

### **Distribution Provider**

The Distribution Provider is defined as the function—not the voltage level— that provides the physical connection between the Customer and the electric system. For those Customers who are served at transmission voltages, the Transmission Owner also serves as the Distribution Provider function.

The Distribution Provider was added to the Functional Model because the Task Force realized that Transmission Owner was often not the final “wires” provider. Most retail customers are physically connected to the Distribution System, not the Transmission System. The Distribution Provider is responsible for “local” safety and reliability. The Distribution Provider knows which customers are “critical” loads that should be shed only as a last resort, and it is the Distribution Provider who provides the switches and reclosers for this emergency action.

### ***Relationships for Ensuring Operating Reliability***

Retail customers will interact with the Distribution Provider to obtain “wires” service, identify the load’s expected maximum demand on the system and if the load is a “critical load” (e.g., hospitals, police). This is necessary for the Distribution Provider to install facilities of sufficient capability and flexibility to meet the expected maximum load of that customer and all the other customers on the Distribution Provider’s system. “Critical load” identification is necessary so maximum service is maintained for those customers.

The Load-Serving Entity knows which customers it is serving and has communicated that to the Distribution Provider. In addition, the Load-Serving Entity has communicated to the Balancing Authority its load expectations, generation capacity to meet its load projections, and any interruptible load capability with applicable terms and conditions.

The Load-Serving Entity must, however, identify to the Distribution Provider the kinds of loads it is serving:

1. Firm load
2. Interruptible load
3. Critical loads (such as hospitals, police stations).

Only the Load-Serving Entity has this information.

The Distribution Provider and Transmission Operator will use the above data to project load to be served by each substation on the transmission system.

The Task Force believes that load could be curtailed by the Transmission Operator or the Distribution Provider for a variety of reasons. These include:

1. **Safety or local reliability problems.** The Transmission Operator or Distribution Provider will interrupt load on its own initiative to maintain local reliability and public safety. The Distribution Provider will know which customers are “critical” and will take steps to minimize interruption of those “critical” customers.
2. **Wide-area reliability problems.** The Reliability Authority may direct the Transmission Operator to reduce load to mitigate a reliability problem. The Transmission Operator may, in turn, direct the Distribution Provider to interrupt customers. The Distribution Provider will know which customers are “critical” and will take steps to minimize interruption of those “critical” customers.
3. **Energy emergency.** Under an Energy Emergency, the Reliability Authority, in collaboration with the Balancing Authority, may direct the Transmission Operator to curtail load. The Transmission Operator may, in turn, direct the Distribution Provider to interrupt customers.

Regarding who is responsible for load curtailment, the Task Force expects the Reliability Authority will monitor, analyze and order the need for load reduction based on inputs from the Transmission Operators, Generators, Purchasing-Selling Entities, and Load-Serving Entities.

## Examples

This section of the White Paper will explain using three examples how the Functional Model accommodates a financial Transaction into the physical delivery of energy from the Generator to the Load-Serving Entity. (We have ignored losses in these examples to keep them simple. Please see Technical Discussion 1 – Interchange Scheduling Practices for a complete discussion of how losses are handled.)

### Example 1 – Bilateral Transaction within Single RA, BA, and TSP

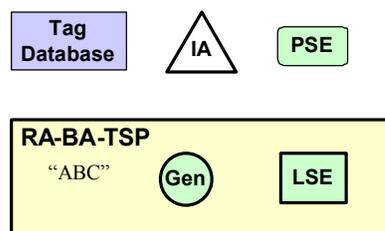
**Setup.** In this example, we have “rolled up” the Reliability Authority, Balancing Authority, and Transmission Service Provider into a single, reliability organization that we’ll refer to as the “ABC Organization.”

Within the area served by ABC are a Generator and a Load-Serving Entity, neither of which are affiliated with ABC. An Interchange Authority exists someplace else (it could also be rolled up into ABC, but in this case, we assume it is separate). A “tag” database<sup>8</sup> houses the information about each Transaction.

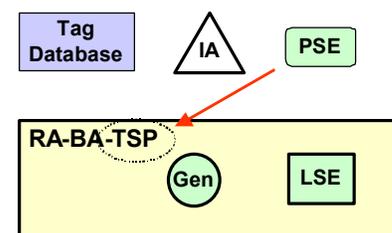
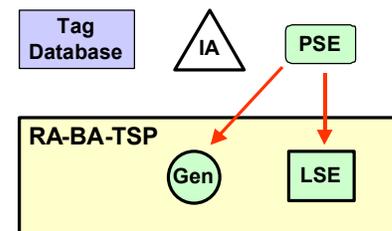
A Load-Serving Entity seeking an energy supply contacts a merchant (Purchasing-Selling Entity).

The following steps explain how the Functional Model implements the resulting Transaction from the Generator to the Load-Serving Entity.

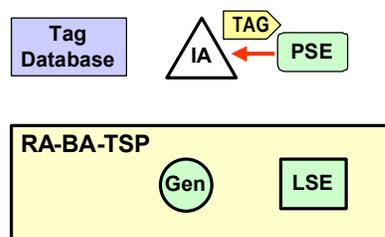
**Step 1 – Purchasing-Selling Entity contacts Generator and Load-Serving Entity.** The Purchasing-Selling Entity contacts the Generator and arranges for an energy purchase and contacts the Load-Serving Entity for the sale. (Or, the PSE may have purchased this energy from another PSE. But for simplicity’s sake, we will assume the same PSE arranges for the Generation that serves the LSE. In either case, these arrangements take place before the Functional Model’s timeframe).



**Step 2 – Purchasing-Selling Entity reserves Transmission.** The Purchasing-Selling Entity arranges for Transmission Service from the TSP via the OASIS.



**Step 3 – Purchasing-Selling Entity submits “Tag” to Interchange Authority.** The Purchasing-Selling Entity submits the Interchange Transaction information to the Interchange Authority. This begins the



<sup>8</sup> We use the term “tag” because of its familiarity. It refers in the general sense to the collection of data that defines a Transaction, not specifically to the “E-tag” or ERCOT tagging system.

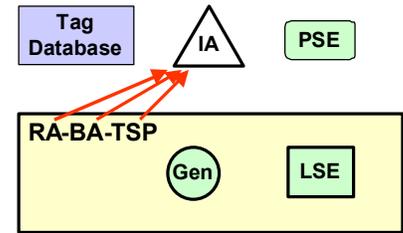
## The NERC Functional Model

### Examples

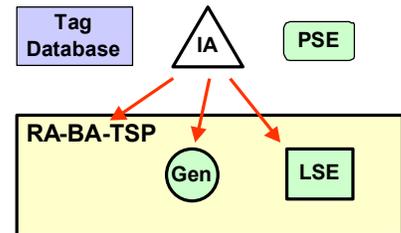
Authorization process for the IA. (Today this is done with a “Tag” in the Eastern and Western Interconnections).

**Step 4 – Interchange Authority collects Approvals and Denials.** The Interchange Authority checks with the following entities:

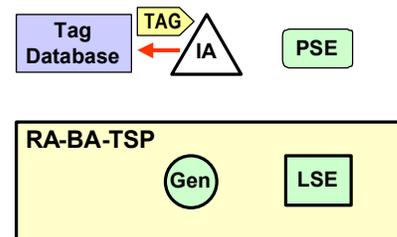
- Generator and Load-Serving Entity to validate Source and Sink information.
- Balancing Authority must approve Interchange Transaction for ramping capability. (That is, whether the Balancing Authority can accommodate the generation changes that need to occur.)
- Reliability Authority must approve Interchange Transaction for transmission reliability.
- Transmission Service Provider must confirm that there was a transmission reservation that corresponds to the transmission information supplied and approve the use of the transmission system.



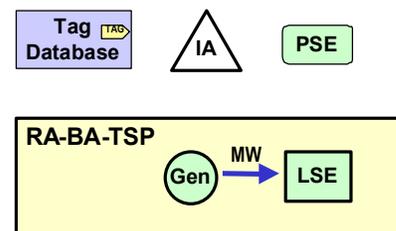
**Step 5 – Interchange Authority Authorizes Transaction.** The Interchange Authority notifies the Balancing Authority as well as the Purchasing-Selling Entity (in this case the Generator and Load-Serving Entity) that the Transaction can proceed.



**Step 6 – Interchange Authority enters Transaction into Tag Database.** In the Eastern Interconnection, this database supplies information for Reliability Authority analysis and congestion management, such as the TLR Procedure. In the Western Interconnection, it would supply information for the Unscheduled Flow Reduction Program.



**Step 7 – Transaction is implemented.** The Transaction “goes physical” at the time and with the energy profile stated on the Tag.

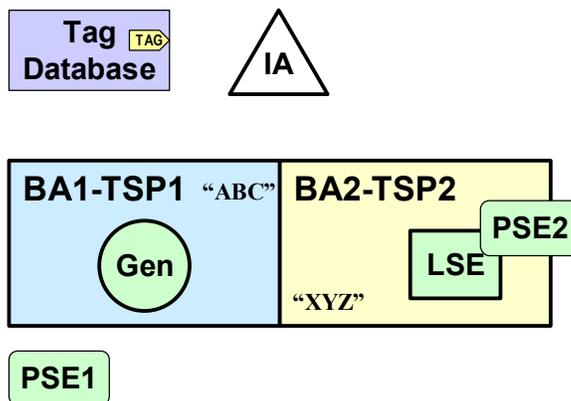


Examples

**Example 2 – Bilateral Transaction between two BAs, two TSPs, arranged by two PSEs (merchants).**

**Setup.** In Example 2, we have two reliability organizations, ABC and XYZ, each of which result from “rolling up” the Balancing Authority and Transmission Service Provider. Both ABC and XYZ are within a single Reliability Area that is in the purview of a separate Reliability Authority organization.

Also present is an unaffiliated merchant (PSE1) and a merchant affiliated with the Load-Serving Entity (PSE2). In many cases, merchants have already set up financial “deals” between themselves. We don’t show those arrangements in these examples because the Functional Model does not have a role in those arrangements. It only comes into play when the Interchange Transaction is tagged and handed off to the Interchange Authority in preparation for the Transaction “going physical.”



The steps are quite similar as in Example 1:

**Step 1 – PSE 1 contacts Generator and sells title for energy to PSE 2**, who is the agent for the Load-Serving Entity. This is arranged before the “deal” is ready to go physical.

**Step 2 – PSE 2 reserves Transmission.** PSE 2 arranges for Transmission Service from TSP1 and TSP2 via their respective OASIS sites.

OR

**Alternate Step 1 – PSE 1 contacts Generator and TSP 1 and arranges for a “partial path” transmission reservation** to the interconnection between TSP1 and TSP2. In this case, PSE1 may not yet have an arrangement to sell the generation, but anticipates finding a customer. If TSP1 permits a PSE to reserve a “partial” transmission path from the Generator to the TSP1-2 boundary, this would allow PSE 1 to find a customer at a later time and purchase the remaining transmission links.

**Alternate Step 2 – PSE 1 reserves remaining transmission links.** PSE1 finds the merchant for the Load-Serving Entity (PSE 2) and reserves the final transmission link from the border of TSP 1-2 to the Load-Serving Entity.

**Step 3 – PSE 2 submits Tag to Interchange Authority.** PSE 2 submits the Interchange Transaction information to the Interchange Authority. This begins the Authorization process for the IA and brings the Functional Model into play.

**Step 4 – Interchange Authority collects Approvals and Denials.** The Interchange Authority checks with the following entities:

- Generator and Load-Serving Entity to validate Source and Sink information.
- BA1 and BA2 must approve Interchange Transaction for ramping capability. (That is, whether the Balancing Authorities can accommodate the generation changes that need to occur.)
- Reliability Authority must approve Interchange Transaction for transmission reliability.

### Examples

- TSP1 and TSP2 must confirm that there was a transmission reservation that corresponds to the transmission information supplied and approve the use of the transmission system.

**Step 5 – Interchange Authority Authorizes Transaction.** The Interchange Authority notifies the BA1 and BA2 as well as PSE2 (the merchant for the Load-Serving Entity) that the Transaction can proceed. BA1 and BA2 enter the Interchange Transaction into their EMS systems.

There are two ways to look at the relationship between BA1 and BA2. In the traditional sense, we have an Interchange Schedule between BA1 and BA2. But we can also look at this as two separate schedules: From BA1 to the IA, and from the IA to BA2. Therefore, BA1 and BA2 do not really need to know each other's role in this Transaction. Of course, the Reliability Authority will. (See also Technical Discussion 1 – Interchange Scheduling Practices).

**Step 6 – Interchange Authority enters Transaction into Tag Database.**

**Step 7 – Transaction is implemented.** The Transaction “goes physical” at the time and with the energy profile stated on the Tag.

Examples

**Example 3 – Bilateral Transaction between two non-adjacent BAs, three TSPs, arranged by one PSE (merchant).**

**Setup.** This example shows how an Interchange Transaction is handled between two non-adjacent Balancing Authorities.

**Step 1 – PSE contacts Generator and arranges an Interchange Transaction for the Load-Serving Entity**

**Step 2 – PSE reserves Transmission.** The PSE must reserve a continuous transmission path from the Generator to the Load-Serving Entity. Depending on Transmission Service tariffs, the PSE may purchase a “contract” path or flow-based paths. The Functional Model will accommodate both arrangements.

In this example, we will assume that the PSE reserves a contract path from TSP 1, TSP 3, and TSP 4. Note that each of these Transmission Services encompasses two or more Balancing Authorities.

**Step 3 – PSE submits Tag to Interchange Authority.** The PSE submits the Interchange Transaction information to the Interchange Authority. This begins the Authorization process for the IA and brings the Functional Model into play.

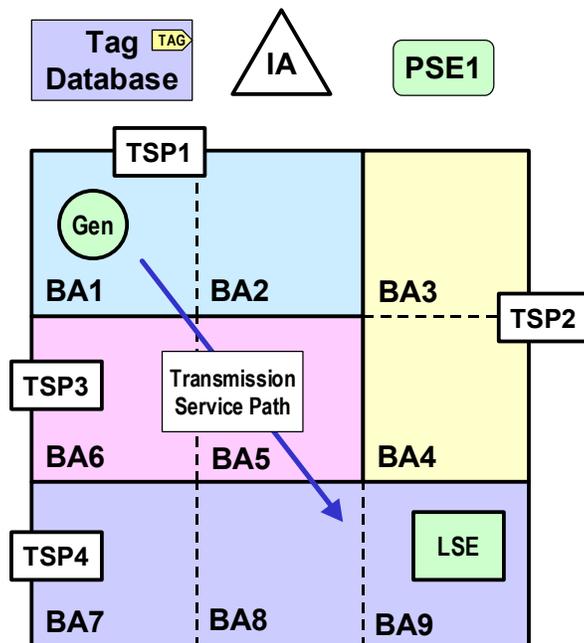
**Step 4 – Interchange Authority collects Approvals and Denials.** The Interchange Authority checks with the following entities:

- Generator and Load-Serving Entity to validate Source and Sink information.
- BA1 and BA9 must approve the Interchange Transaction for ramping capability. (That is, whether the Balancing Authorities can accommodate the generation changes that need to occur.) Note that BAs 2 through 8 were not notified by the Interchange Authority because they play no role in implementing the Interchange Transaction. Their Transmission Service Providers (TSPs 1, 3, and 4) will compensate Balancing Authorities 1, 2, 5, 6, 7, 8, and 9 for providing transmission losses.
- The Reliability Authority must approve the Interchange Transaction for transmission reliability.
- TSP1, TSP 3, and TSP4 must confirm that there was a transmission reservation that corresponds to the transmission information supplied and approve the use of the transmission system.

**Step 5 – Interchange Authority Authorizes Transaction.** The Interchange Authority notifies BA1 and BA9 as well as the PSE (the merchant for the Load-Serving Entity) that the Transaction can proceed. BA1 and BA9 enter the Interchange Transaction into their EMS systems. None of the other Balancing Authorities enter this Transaction in their EMS. (Note: This is *not* “skip scheduling,” because a contiguous transmission path is required. See Technical Discussion 1 – Interchange Scheduling Practices for further details.)

**Step 6 – Interchange Authority enters Transaction into Tag Database.**

**Step 7 – Transaction is implemented**



## Technical Discussion 1 – Interchange Scheduling Practices

The Interchange process under the Functional Model is different than today’s usual practices, and will require a change in Operating Policies. Today, NERC requires that Interchange be scheduled between *adjacent* Control Areas<sup>9</sup>. This means that if a Purchasing-Selling Entity is selling generation across several Control Areas, the resulting Interchange Schedule is passed from Control Area to Control Area in a “daisy chain” fashion until it arrives at the Sink Control Area, as in the example depicted in Figure 2.

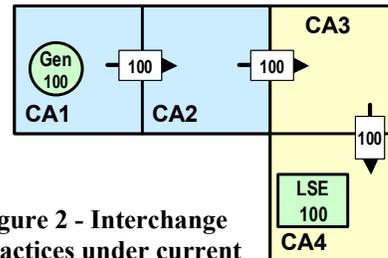


Figure 2 - Interchange practices under current NERC Policies

This discussion explains the concepts of how interchange scheduling would function under the Functional Model.

The Functional Model introduces a new function — the Interchange Authority — that is responsible for administering the implementation of Interchange Transactions. (See “Interchange Authority” section for a detailed explanation) Because the Interchange Authority knows the source and sink Balancing Authorities, and Transmission Service Providers providing the transmission path, there is no need for the “intermediary” Balancing Authorities to pass Interchange Schedules from one to the next. Instead, the source and sink Balancing Authorities schedule Interchange with the Interchange Authority as shown in Figure 3. While we can identify the source and sink Balancing Authorities, they do not need to confirm Interchange Schedules with each other — only with the Interchange Authority. Furthermore, Balancing Authorities 2 and 3 play no part in this Interchange Transaction, and there is no point in having them schedule the energy in and out. (BA2 and 3 will have a role to play in loss compensation, and that will be covered in the subsection on Losses that follows.)

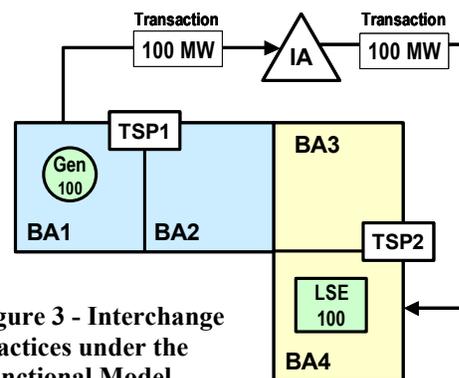


Figure 3 - Interchange practices under the Functional Model. Balancing Authorities schedule with the Interchange Authority.

The process we have described is *not* “skip scheduling.” There must always be a contiguous transmission path (in this example, through TSP1 and TSP2). Indeed, the Interchange Authority will always check for this path between the source and sink Balancing Authorities before authorizing the Interchange Transaction.

<sup>9</sup> See Policy 3, “Interchange” and “Interchange Reference Document” in the NERC Operating Manual for details.

**The NERC Functional Model**

**Technical Discussion 1 – Interchange Scheduling Practices**

**Interchange “Checkout.”** The table below shows how Control Areas check out their interchange under existing NERC Policies, and how Balancing Authorities will check out their Interchange under the Functional Model.

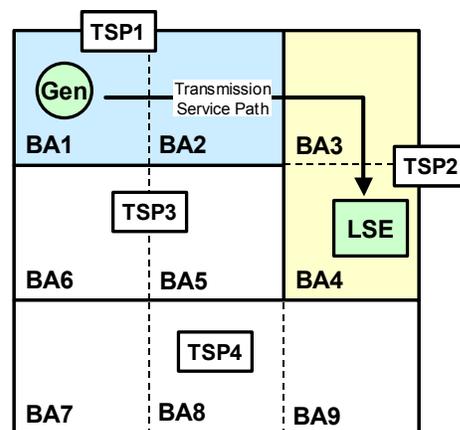
<b>Checkout under Existing NERC Policies</b>			
<b>Control Area</b>	<b>Actual from Tie Meters</b>	<b>Schedule with CA</b>	<b>Inadvertent</b>
CA1	+100 to CA2	+100 to CA2	0
CA2	-100 from CA1 +100 to CA3	-100 from CA1 +100 to CA3	0
CA3	-100 from CA2 +100 to CA4	-100 from CA2 +100 to CA4	0
CA4	-100 from CA3	-100 from CA3	0
<b>Checkout under the Functional Model</b>			
<b>Balancing Authority</b>	<b>Actual from Tie Meters</b>	<b>Schedule with IA</b>	<b>Inadvertent</b>
BA1	+100 to BA2	+100 to IA	0
BA2	-100 from BA1 +100 to BA3	0	0
BA3	-100 from BA2 +100 to BA4	0	0
BA4	-100 from BA3	-100 from IA	0

Actual Interchange checkout remains the same under the Functional Model. This is actual power flow between adjacent Control Areas or Balancing Authorities as recorded on their tie line meters.

Schedule Interchange works differently under the Functional Model. According to existing NERC Policies (Policy 3, “Interchange”), Interchange may only be scheduled between adjacent Control Areas; therefore we would see three individual schedules from CA1→CA2; CA2→CA3; and CA3→CA4. Under the Functional Model, Interchange is scheduled from the source Balancing Authority to the Interchange Authority and from the Interchange Authority to the sink Balancing Authority. Thus, we would have two schedules in this example: BA1→IA and IA→BA4.

**Compensation for Losses.** Before delving into how the Functional Model handles compensation for losses, we need to review two physical properties of losses (see Figure 4):

1. **Losses occur when power flows over the transmission system, and these losses are simply part of the load within the Balancing Authority’s area.** The Balancing Authority can not tell what part of its load is due to losses and what part is due to customers’ toasters and air-conditioners because load isn’t metered. Only generation and tie-lines are metered.
2. **Losses due to Transactions are not confined to the Balancing Authorities along the transmission service path.** In Figure 4, the incremental losses caused by the Transaction from the Generator in BA1 to the Load-Serving Entity in BA4 appears as a load change in all the Balancing Authorities 1-9.



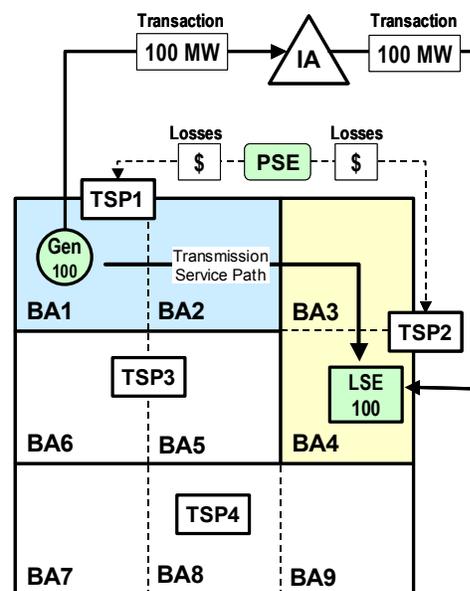
**Figure 4 - The portion of the losses caused by the Transaction from the Generator in BA1 to the Load-Serving Entity in BA4 appear as a load change in all the Balancing Authorities 1-9.**

Because losses are part of the Balancing Authority’s load, there must be compensation for serving that part of the load. We now need to review two fundamental assumptions regarding how losses are compensated:

1. **Loss compensation is only provided to the Balancing Authorities via their Transmission Service Providers who are providing the transmission service path.** In Figure 4, only BA1, 2, 3, and 4 are compensated through TSP1 and TSP2<sup>10</sup>.
2. **Loss compensation may be in dollars (financial payment) or energy (“self-provision”).** This depends on the requirements in the Transmission Service Providers’ tariffs.

We now turn our discussion to the details of loss compensation.

**Financial Compensation.** The Purchasing-Selling Entity may compensate the Transmission Service Providers by monetary payment according to the transmission tariffs. The Transmission Service Providers, in turn, pass these payments to their Balancing Authorities who reimburse those Generators providing load-following service.



**Figure 5 - The PSE may compensate the TSPs with monetary payment.**

The financial loss compensation is shown in Figure 5. In this case, the total energy contracted for (100 MW) is delivered from the Generator in BA1 to the Load-Serving Entity in BA4, and the Purchasing-Selling Entity reimburses TSP1 and TSP2 according to their tariffs.

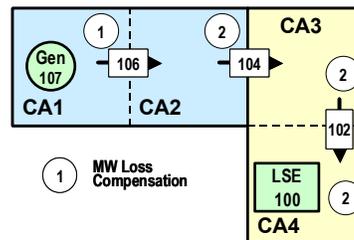
<sup>10</sup> This example assumes a “contract path.” A regional transmission arrangement might compensate Balancing Authorities who are parties to the arrangement on a flow basis.

## The NERC Functional Model

### Technical Discussion 1 – Interchange Scheduling Practices

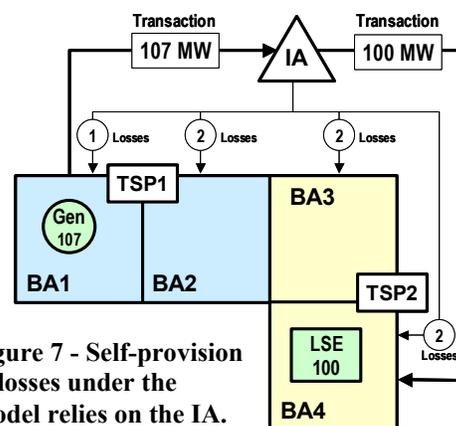
**“Self-provision” Compensation.** If the Transmission Service Provider’s tariff allows, the Purchasing-Selling Entity may supply the energy losses himself as MW. This can be done two different ways:

Today, the most common way of self-provision involves the Purchasing-Selling Entity purchasing the Transaction energy plus losses energy from the Generator, and “dropping off” the losses along the transmission scheduling path as shown in Figure 6. Traditionally, this has been done between adjacent Control Areas, with each Control Area’s net interchange equal to its loss compensation. This compensation is determined by the Transmission Provider’s tariff. In the figure on the right, the Purchasing-Selling Entity has purchased 107 MW from the Generator in CA1, and has “dropped off” a total of 7 MW of losses within each Control Area along the scheduling path so that 100 MW arrives at the point of delivery to the Load-Serving Entity. The numbers in the white circle indicates the MW loss compensation.



**Figure 6 - Present practice for self-provision of losses .**

The Task Force proposes a change in this method under the Functional Model. As we explained above in the “Interchange” subsection, “intermediary” Balancing Authorities are not parties to Interchange Transactions between the source and sink Balancing Authorities. Therefore, self-provided losses can not be simply “dropped” along the way by decrementing the Interchange Schedules from BA to BA. Instead, the Interchange Authority will serve as the loss distributor by setting up individual Transactions with the “intermediary” Balancing Authorities on behalf of the Purchasing-Selling Entity as shown in Figure 7. The Purchasing-Selling Entity notifies the Transmission Service Provider(s) of this loss compensation arrangement. The TSP, in turn, confirms the loss compensation arrangement with the IA when the IA approaches the TSP to confirm the transmission arrangements.



**Figure 7 - Self-provision of losses under the Model relies on the IA.**

Balancing Authority	Actual from Tie Meters	Schedule(s) with IA
BA1	+106 to BA2 <b>NET = +106</b>	+107 to IA -1 from IA for losses <b>NET = +106</b>
BA2	-106 from BA1 +104 to BA3 <b>NET = -2</b>	-2 from IA for losses <b>NET = -2</b>
BA3	-104 from BA2 +102 to BA4 <b>NET = -2</b>	-2 from IA for losses <b>NET = -2</b>
BA4	-102 from BA3 <b>NET = -102</b>	-100 from IA -2 from IA for losses <b>NET = -102</b>

The table above explains the resulting actual and scheduled interchange between the Balancing Authorities and the Interchange Authority.

The Purchasing-Selling Entity could also supply these losses from another Generator via separate Transactions.

## Technical Discussion 2 – Transmission Constraints and Generation Deficiencies

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This section provides an overview of how the reliability functions deal with Operating Reliability Limit violations, Generation failures, and Energy Emergencies. The details for handling these situations will be covered in NERC Policies and Standards.

### ***Transmission Loading Relief***

The Reliability Authority will first seek a market solution to mitigate the congestions. If a market solution is not available, then the Reliability Authority begins Interchange Transaction curtailments:

- The Reliability Authority obtains the “cut” list using the Interconnection’s line loading relief procedure.
- The Reliability Authority then provides the cutlist to the Interchange Authority
- The Interchange Authority confirms value (MW) of the curtailment with the Purchasing-Selling Entity (the Purchasing-Selling Entity could decide to cut certain Interchange Transaction more than ordered or cut to zero)
- The Interchange Authority submits the adjustment to the Source and Sink Balancing Authorities and directs implementation. (The IA would issue an adjust tag, which would be entered into the Tag Database).
- The Interchange Authority then notifies all other parties to the transaction of the curtailment or adjustment

Note that the Interchange Authority plays a key role in the Transaction curtailment process, just as it plays a key role in setting up the initial Interchange Schedules from those Transactions.

### ***Generator Failure***

A generator failure may or may not require an Interchange Schedule adjustment depending on 1.) the location of generation with respect to the Load-Serving Entity, and 2.) the agreements between the Load-Serving Entity and its resource (for example, operating reserves to provide for backup service).

The Reliability Authority would need to know about the generator failure and new dispatch scheme, but would not need to take any action unless his reliability analysis showed a transmission reliability problem.

If an Interchange Schedule adjustment is needed because the Load-Serving Entity has elected to purchase its generation from a Generator within another Balancing Area, the Balancing Authority would notify the Interchange Authority of the adjustment. The Interchange Authority would then notify the other parties to the Transaction (the Transmission Service Provider and Purchasing-Selling Entity(s)) and obtain the necessary approvals to authorize the new Interchange Schedule.

If the Load-Serving Entity did not have arrangements to obtain an alternate generation resource, the Reliability Authority, in coordination with the Balancing Authority, orders the Transmission Operator to shed firm load. The Transmission Operator, in turn, will direct the Distribution Provider to interrupt customers.

***Energy Emergencies***

Energy emergencies are defined as the inability of the Load-Serving Entity to provide for the energy requirements of its customers. One option is for the Load-Serving Entity to declare an Energy Emergency Alert in accordance with Appendix 9B, “Energy Emergency Alerts,” in the NERC Operating Manual.

When an EEA is declared by the Load-Serving Entity, it notifies its Balancing Authority who will notify its Reliability Authority who will issue Energy Emergency alerts.

If it is apparent that the Balancing Authority cannot obtain resources to maintain its load-generation balance, the Balancing Authority will then take emergency actions, which may include curtailing all nonfirm wholesale and retail sales and implementing Demand-side Management (including load-curtailment Interconnected Operations Services), and issuing Public Appeals.

Meanwhile, the Reliability Authority notifies Purchasing-Selling Entities and other Reliability Authorities to see if energy is available. The Reliability Authority also notifies the Transmission Service Providers to see if operating limits can be increased (the Transmission Service Provider will consult with the Transmission Owner).

If these actions do not mitigate the Energy Emergency, the Reliability Authority, in coordination with the Balancing Authority, orders the Transmission Operator to shed firm load. The Transmission Operator, in turn, will direct the Distribution Provider to interrupt customers.

## Technical Discussion 3 – Compliance Monitoring and Certification

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### **Compliance Monitoring**

NERC’s Compliance Program hinges around the formation of Regional Reliability Organizations (RROs) with their own compliance programs and with NERC oversight. As it developed the definitions for the Service and Operating Functions in the Functional Model, the Task Force also deliberated on how to monitor the organizations providing these functions for compliance with NERC Policies and Standards.

The Functional Model, as this report frequently points out, defines *functions*, not organizations. Nevertheless, the Task Force often imagined how these functions might roll up into organizations, and it realized that some of the reliability organizations being formed — especially RTOs — may overlap more than one RRO. Or the RTO may also be the RRO. The Interchange Authority function, on the other hand, may be provided by an organization that doesn’t physically exist within or belong to any RRO — or may belong to one or more.

### **Recommendations**

The NERC Compliance Program needs to review how organizations will be monitored for compliance under the new Functional Model. The Task Force offers the following options:

1. The Reliability Authority’s decisions affect the entire Interconnection. If the RRO is performing the Reliability Authority function, or if the Reliability Authority function is performed by an organization that covers more than one RRO, compliance should be monitored by an independent third party under NERC oversight.
2. Organizations performing the Interchange Authority function should be monitored for compliance by an independent third party under NERC oversight.

### **Certification of Personnel and Organizations**

An important step in ensuring compliance with organization standards and policies is the certification of organizations and their staffs. Today, NERC requires that the “Operating Authority” be certified as follows:

NERC Operating Policy 8C, “Operating Personnel and Training – Certification,” explains the requirements for the certification of system operators. The Policy uses the expression “operating authority” defined as:

**Operating Authority.** An entity that:

1. Has ultimate accountability for a defined portion of the BULK ELECTRIC SYSTEM to meet one or more of three reliability objectives – generation/demand balance, transmission reliability, and/or emergency preparedness; and
2. Is accountable to NERC and its Regional Reliability Councils for complying with NERC and Regional Policies; and
3. Has the authority to control or direct the operation of generating resources, transmission facilities, or loads, to meet these Policies.

Policy 8 then requires:

**Positions requiring NERC-Certified SYSTEM OPERATORS.** An OPERATING AUTHORITY that maintains a control center(s) for the real-time operation of the

interconnected BULK ELECTRIC SYSTEM, shall staff operating positions that meet both of the following criteria with NERC-Certified SYSTEM OPERATORS in accordance with the schedule in Standard 1B:

- Positions that have the primary responsibility, either directly or through communications with others, for the real-time operation of the interconnected BULK ELECTRIC SYSTEM, **and**
- Positions that are directly responsible for complying with *NERC Operating Policies*.

**Recommendations**

1. The Task Force believes that *system operators* who perform the Reliability Authority, Balancing Authority, Interchange Authority, and Transmission Operator functions are responsible for the real-time operation of the Bulk Electric System and comprise the set of “Operating Authorities” that should be certified by NERC.
2. The Task Force also recommends that those *organizations* that provide the Reliability Authority, Balancing Authority, and Interchange Authority functions be certified by the Regional Reliability Organization (or NERC) just as Control Areas are today. Furthermore, because the Transmission Service Provider’s role in accurately calculating Available Transfer Capability is critical to ensuring operating reliability and minimizing congestion, the Task Force also believes that the organization serving as the TSP function should be certified.

The Task Force does not believe that personnel and organizations who perform the Purchasing-Selling Entity, Generator, or Load-Serving Entity need to be certified. These functions are primarily commercial functions and their performance will be bound by contractual agreements with the organizations providing the Service Functions. Furthermore, they do not provide a reliability “oversight” function as do the Authorities.

## “Roll-up” Table

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This table shows how the Service Functions defined in the Functional Model “roll up” into the higher-level organizations. Note that these organizations do not perform a Merchant Function.

<i>Organizations</i>	<i>Service Functions</i>				<i>Merchant Functions</i>			
	<i>BA</i>	<i>TSP</i>	<i>RA</i>	<i>IA</i>	<i>GEN</i>	<i>PSE</i>	<i>LSE</i>	<i>COMP</i>
PJM	✓	✓	✓	✓				
IMO	✓	✓	✓	✓				
Cal ISO	✓	✓	✓	✓				
ERCOT (ISO)	✓	✓	✓	✓				✓
MISO (RTO)		✓	✓	✓				