Changes Made Based on Industry Comments:

After careful review and consideration of all comments received, the drafting team modified the standard to improve its clarity. The SDT's most significant changes included the following:

- Modified the definition of Cascading.

  > The V0 definition of Cascading is: "The uncontrolled successive failure of system elements triggered by an incident at any location within the Interconnection. Cascading results in widespread electric service interruption that cannot be restrained from sequentially spreading beyond an area predetermined by studies."

  Although this definition provided a general description of a cascading event suitable for a 'best efforts' industry environment, the phrase, "widespread electric service interruption", renders the application of this existing definition as unquantifiable and therefore unacceptable in the development of measurable performance standards subject to mandatory compliance measures.

  In attempting to apply the definition of 'cascading', many in the industry have asked for explicit understanding of the term "widespread".

  - Can a cascading event be called "widespread" if the interruption is contained to within a metropolitan area, a single Control Area a single Reliability Authority Area, or a single Balancing Authority Area?
  - Does an event need to impact adjacent Reliability Authority Areas or Balancing Authority Areas to be classified as widespread?
  - Is a cascading event a "widespread" event if the service interruption goes beyond the "an area predetermined by appropriate studies"? What if the area predetermined by studies is just one bus beyond the previously studied area?

  The industry's comments indicate that the existing definition is not explicit enough.

  To remedy the shortcomings of the current definition of "Cascading" the Standard Drafting Team, with significant input from the industry, has proposed the following definition:

  > Cascading Outages: The uncontrolled and unplanned successive loss of system elements triggered by an incident at any location.

  The proposed definition of "Cascading Outages" simplifies the definition and removes the ambiguous phrases. Any incident (e.g., a fault, misoperation, or switchmen's error) that results in an uncontrolled and successive loss of system elements is a Cascading Outage. However, if an incident results in a planned (e.g., by design or predetermined and predicable) successive loss of system elements, that incident would not be a Cascading Outage under the proposed definition because the extent of the outage caused by the incident was planned as such.

- Clarified the links between the Measures and the Compliance Monitoring Sections of the standard to ensure that the information to be available to the Compliance Monitor is clearly specified.
- Added language to specify which of the requirements and measures are applicable to methodologies developed for use for planning as opposed to operating purposes. The

Functional Model assigns the Planning Authority the responsibility of ensuring there are long-term plans and indicates that these plans are generally 1 year and beyond — this concept is supported in the revised standard.

- Modified Requirement 603 (now Reliability Standard FAC-010-1) to more clearly indicate that the RA is responsible for having and sharing its methodology for developing SOLs used in the operating horizon and the PA is responsible for having and sharing its methodology for developing SOLs used in the planning horizon.
  - Version 2 of the Functional Model is silent on the use of SOLs except for real-time operations and operations planning. The SDT recognized that SOLs are used for developing and analyzing transmission system expansion plans. The SDT asked the Functional Model Review Task Group (FMRTG) to provide a formal interpretation of this omission, and has received a response indicating that the Planning Authority does have responsibility for developing SOLs used in the planning horizon.
- Modified Requirement 603 (Reliability Standard FAC-010-1) to clarify which entity is responsible for the methodology for developing System Operating Limits used for planning purposes and which entity is responsible for the methodology for developing System Operating Limits used for operations. The revised requirement does not require the Transmission Operator (TOP) or the Transmission Planner (TP) to develop a SOL methodology. Under the revised standard, the RA will share its methodology with its TOPs – and the TOPs will be required to use this methodology in developing SOLs in Reliability Standard FAC-011-1. The PA will share its methodology with its TPs, and the TPs will be required to use this methodology in developing SOLs (Reliability Standard FAC-011-1).
  - Version 2 of the Functional Model is unclear as to which function is responsible for developing SOLs. The following conflict exists on page 25 of the Functional Model, under the TOP's list of tasks:

    > 2. Defines operating limits, develops contingency plans, and monitors operations of the transmission facilities under the Transmission Operator's control and as directed by the Reliability Authority.
    >
    > 8. Operates or directs the operations of the transmission system within equipment and facility ratings established by the Transmission Owners and Generator Owners, and system ratings established by the Reliability Authority.

  - For this standard, the SDT assumed that the RA is responsible for establishing all SOLs for its RA Area — but may delegate part of this activity to its TOPs. Without formal delegation, the TOP is not responsible for developing any SOLs — and the FMRTG endorsed this assumption in its response to the SDT's request for a formal interpretation of the Functional Model.
- Modified Requirement 603 (Reliability Standard FAC-010-1) to add a requirement that the System Operating Limits methodology address credible multiple element outages if required by the associated Region.
- Modified Requirement 603 (Reliability Standard FAC-010-1) to add WECC's Interconnection-wide Regional Difference. Note that the justification for the WECC Interconnection-wide Regional Difference is posted for your review on the following web page, under the third draft of the Determine Facility Ratings Standard:

  http://www.nerc.com/~filez/standards/Determine-Facility-Ratings.html
- Minimized the cross references within the standard to make the standard easier to understand.

Changes Made Based on the Standards Authorization Committee's Request

Following the second posting of the draft standard, the Standards Authorization Committee (SAC) asked the Determine Facility Ratings Standard Drafting Team (DFR SDT) to bring the following concerns from the August 14, 2003 Blackout to the industry's attention, to collect the industry's feedback, and to make changes to the standard to align with the industry's comments. These concerns were highlighted by FERC as a result of the August 14, 2003 blackout and centered around:

1. A single line rating methodology.
2. Identification of criteria for a single line rating methodology.
3. Technical review of ratings methodologies and associated limits.

The SAC's request was made in response to the following two documents:

From the FERC Order related to the August 14, 2003 Blackout:

> The Final Blackout Report identifies topics that are not currently addressed by NERC standards or are addressed so vaguely as to be ineffective, but are important in maintaining system reliability. Such "gaps" include vegetation management for transmission rights-of-way, **line ratings**, operator training, adequacy of operator tools, and minimum functional requirements and capabilities for reliability authorities and balancing authorities. The Commission advises NERC and the industry to include these

From the Blackout Report Recommendation 27. Develop enforceable standards for transmission line ratings:

> NERC should develop clear, unambiguous requirements for the calculation of transmission line ratings (including dynamic ratings), and require that all lines of 115 kV or higher be re-rated according to these requirements by June 30, 2005.
>
> As seen on August 14, inadequate vegetation management can lead to the loss of transmission lines that are not overloaded, at least not according to their rated limits. The investigation of the blackout, however, also found that even after allowing for regional or geographic differences, there is still significant variation in how the ratings of existing lines have been calculated. This variation — in terms of assumed ambient temperatures, wind speeds, conductor strength, and the purposes and duration of normal, seasonal, and emergency ratings — makes the ratings themselves unclear, inconsistent, and unreliable across a region or between regions. This situation creates unnecessary and unacceptable uncertainties about the safe carrying capacity of individual lines on the transmission networks. Further, the appropriate use of dynamic line ratings needs to be included in this review because adjusting a line's rating according to changes in ambient conditions may enable the line to carry a larger load while still meeting safety requirements.

Before proposing revisions to the DRF Standard for this posting, the SDT first developed the following position in consideration of the SAC's request. Draft revisions to the DFR Standard were then developed based on this perspective.

The SDT intended "methodology," as used in this standard, to include studies procedures, parameters, design criteria and assumptions used to develop the Facility Ratings, System Operating Limits and Transfer Capabilities.

Feasibility of a Single Line Rating Methodology and Its Associated Criteria:

The equipment comprising the North American power system has been provided by various manufacturers over a period of more than 75 years. There is no general rating consistency with respect to manufacturer, initial design criteria, manufacturing quality, age, maintenance condition, climatic conditions, operational history, or local operating or safety standards and requirements.

In the development of this standard, commenters highlighted many concerns with respect to implementing a single ratings methodology. In the following discussion, the SDT tried to assemble those comments, along with the SDT's experience, in highlighting issues associated with requiring the use of a single methodology, with a single set of criteria for establishing line ratings.

A single absolute set of criteria for a single line rating methodology is not practical because of the huge variations in the critical considerations used to develop individual line ratings. The various elements that must be considered in developing any facility rating fall into the following categories:

- Ratings and guidance provided by equipment suppliers and equipment specialists
- Original design criteria/specifications (e.g., including applicable references to industry rating practices or other standards including safety standards)
- Ambient conditions
- Allowance for use of operating procedures
- Other assumptions

Owners Must Consider Ratings Provided by Equipment Suppliers in Developing their Line Ratings

A key element in the development of a facility's rating is the equipment rating provided by the manufacturer. Manufacturers, who establish and use their own rating methodologies based on a variety of assumptions, link their warranties to requirements that owners respect the equipment rating provided by the manufacturer. Establishing facility ratings outside those established by the manufacturer may void any warranty. With numerous manufacturers producing the same type of equipment, equipment ratings for similar equipment can vary simply on the basis of which manufacturer's equipment was installed.

Owners Must Consider Design Criteria in Developing their Line Ratings

A transmission line is a collection of series and shunt elements that, in total, comprise the connection between two power system stations. Typically, a transmission line includes a number of elements such as:

- Breakers
- Disconnect switches
- Current transformers
- Potential transformers
- Power Transformers
- Jumpers (bus riser conductors)

- Communication wavetraps
- Series and shunt compensation devices
- The transmission conductor (including supporting structures, insulators and hardware, etc.)
- Protective relays

The individual ratings and settings of all of the individual elements must be considered when the rating of a line is established. While the conductor (or cable) rating may typically define the thermal rating, sometimes another series device such as a current transformer may limit the rating of its associated line. Rating this equipment involves more factors, including the age of equipment, the manufacturer of equipment, the technology used for insulation and construction, the acceptance of loss of equipment life, the maintenance history, the protection system available and used, the operation history (such a previous exposure to faults and overloads).

Owners Must Consider Ambient Conditions in Developing a Line's Ratings

The rating of a line is a function of parameters such as:

- Conductor type and configuration
- Conductor bundling configuration
- The line routing (considerations of direction, terrain, expected activities under the line)
- Distance between towers, tower/conductor height and tower configuration
- The emissivity of the conductor (related to the surface condition) — the ability of the conductor to radiate heat
- The insolation (peak sunshine) on the conductor
- Expected wind speed and direction, humidity and ambient temperature
- Icing

These parameters are functions of the environment of the line's physical location.

Owners Must Consider Other Assumptions

Safety and Reliability Considerations in Establishing Conductor Ratings

The current (amperage) rating of an overhead conductor is limited by physical constraints. Conductor heating due to current flow, as altered by weather conditions such as sun, wind, temperature, etc., must be kept low enough so that unacceptable conductor damage does not occur and minimum safety clearances are maintained. These factors are very important for the line owners, because of reliability and safety issues as well as the cost of replacement (outage costs, materials and labor). Clearances for safety purposes are documented in other industry (or owner's) regulations, codes and standards and must also be respected in the development of line ratings.

Local Operating or Safety Standards and Laws

Any local operating or safety standards, regulations or laws must be respected in the development of line ratings.

Resultant Changes to Standard:

- Reliability Standard FAC-008-1 was revised to require that the methodology for Facility Ratings address a minimum set of criteria and enables peer review of that methodology.

Documented Methodologies for Facility Ratings
The DFR standard requires the facility owner to document its Facility Ratings Methodology and then to follow that methodology in establishing its Facility Ratings. Rather than establish a single methodology with a single set of criteria for developing line ratings, this standard requires that the owner's Facility Rating Methodology **consider all of the following**:

- Ratings and guidance provided by equipment suppliers and specialists
- Design criteria (e.g., including applicable references to industry rating practices or other standards)
- Ambient conditions
- Any other assumptions

Technical Review of Line Ratings Methodologies and Limits
The DFR standard requires the developer of a ratings methodology to distribute the methodology to entities that use its ratings and requires the developer to respond to comments it receives on its ratings methodology. The entity that develops the methodology is required to retain both the comments it receives on its methodology, and the responses it provides to commenters. Because this is 'discoverable' evidence in any investigation that would take place following a significant operating event, this should adequately motivate methodology developers to give serious consideration to each comment received.

Technical Review of System Operating Limits and Transfer Capabilities
The DFR standard requires the developers of limits to provide those limits to the entities that have a reliability-related need for those limits. Additional language was not added to address any formal challenges to the technical accuracy of those limits. Other standards have requirements that address processes for RAs to take when there is a disagreement on which system operating limit is appropriate.

Changes Made to Bring a Common Understanding to the Identification of IROLs *:*

The DFR SDT met jointly with members of the OLD-TF and the IROL SDT at the request of the NERC Operating Committee to reach common agreement on the definition of IROLs and a generalized methodology for identifying which SOLs are further classified as IROLs. During this meeting, participants determined that the identification of IROLs is more appropriately done when the SOLs are developed. The IROL-related information the industry wants to be provided to real time operations personnel is typically identified during the various activities designed to identify SOLs. Based on these observations, the participants in the joint meeting recommended moving the IROL identification and communication requirements from the Operate Within IROLs Standard to the DFR Standard and recommended soliciting industry feedback on the appropriateness of this move. In addition, the OLD-TF agreed to align its activities associated with SOLs and IROLs to that proposed in this revised DFR Standard.

The participants in the joint meeting agreed that the criteria used to determine whether an SOL is also an IROL is the same for both the planning and the operating horizon:

If exceeding the SOL results (or could result) in one of the following, then that SOL is also an IROL.

- Instability
- Uncontrolled separation
- Initiation of cascading outages

When an IROL has been identified, the following supporting information should also be supplied to the Reliability Authority(ies) and Transmission Operator(s):

- Definition of the IROL, including the transmission **facility(ies) that are to be monitored**, and the critical **contingency(ies)** that could lead to instability, uncontrolled separation, or Cascading Outages. As part of this definition, the **status of other facilities and system conditions** (e.g. critical generation status, transmission facility outages, load level etc.) that is necessary for the SOL under consideration to be stratified as an IROL.
- The value of the Interconnected Reliability Operating Limit (typically in terms of MW or MVA) and its associated $T_{v.}$ Where $T_{v.}$ the **maximum amount of time** delays that the bulk transmission system can be in this state without unduly jeopardizing the reliability of the transmission system (Note T_v can be as little as zero seconds, but in no case greater than 30 minutes).
- The **type of limitation** of electrical phenomena represented by the Interconnection Reliability Operating Limit. (e.g., voltage collapse, angular stability, Cascading Outage)

Resultant Changes to Standard:

- The following definitions were moved from the IROL Standard to this standard:
  - Interconnection Reliability Operating Limits
  - Interconnection Reliability Operating Limit T_v
- The definition of IROL was updated to read as follows:

  Interconnection Reliability Operating Limit: A System Operating Limit, the violation of which could result in instability, uncontrolled separation, or Cascading Outages affecting the Bulk Electric System, if the defining contingency occurs or if other defining system parameters are exceeded.
- The requirement to identify IROLs was added to Standard 603 (Reliability Standard FAC-010-1)
- The requirement to distribute IROLs was added to Standard 604 (Reliability Standard FAC-011-1)

The DFR SDT wishes to thank all those who have helped in the development of this standard by providing written comments. We think the revised standard is much clearer, and will result in improving the consistency with which limits are established.