# Technical Justification of Generator Thresholds

## 3.1 Background

On August 8, 2005, the Energy Policy Act of 2005 (EPAct 2005) was enacted into law. Title XII of EPAct 2005 added a new section 215 to the FPA, which requires a Commission-certified ERO to develop mandatory and enforceable Reliability Standards, subject to Commission review and approval. Once approved, the Reliability Standards may be enforced by the ERO, subject to Commission oversight, or by the Commission independently.

On March 16, 2007, in Order No. 693, pursuant to section 215(d) of the FPA, the Commission approved 83 of 107 proposed Reliability Standards, six of the eight proposed regional differences, and the Glossary of Terms Used in Reliability Standards developed by NERC, the Commission-certified ERO. In addition, Order No. 693 addressed the applicability of mandatory Reliability Standards to the statutorily defined Bulk-Power System.

In Order No. 693, the Commission explained that section 215(a) of the FPA broadly defines the Bulk-Power System as:

> Facilities and control systems necessary for operating an interconnected electric energy transmission network (or any portion thereof) [and] electric energy from generating facilities needed to maintain transmission system reliability.

The Commission also approved NERC's definition of "bulk electric system," which is an integral part of the NERC Reliability Standards and is included in the NERC Glossary of Terms Used in Reliability Standards:

> As defined by the Regional Reliability Organization, the electrical generation resources, transmission lines, interconnections with neighboring systems, and associated equipment, generally operated at voltages of 100 kV or higher. Radial transmission facilities serving only load with one transmission source are generally not included in this definition.

NERC submitted its petition in response to the Commission's directive in Order No. 743 that NERC develop a revised definition of "bulk electric system" using NERC's Reliability Standards development process. NERC proposed the following "core" definition of bulk electric system:

> Unless modified by the [inclusion and exclusion] lists shown below, all Transmission Elements operated at 100 kV or higher and Real Power and Reactive Power resources connected at 100 kV or higher. This does not include facilities used in the local distribution of electric energy.

The revised definition of bulk electric system:

> removes the basis for regional discretion in the current bulk electric system definition;
> establishes a bright-line threshold so that the "bulk electric system" will be facilities operated at 100 kV or higher, if they are Transmission Elements, or connected at 100 kV or higher, if they are Real Power or Reactive Power resources; and
> contains specific inclusions (I1-I5) and exclusions (E1-E4) to provide clarity in the definition that the facilities described in these configurations are included in or excluded from the "bulk electric system."

NERC's proposed revision to the definition of "bulk electric system" removes regional discretion and establishes a 100 kV bright-line threshold.

## 3.2 Problem Statement

In the Phase 1 Bulk Electric System filing, Inclusion I2 of the BES definition provides the following statement:

> Generating resource(s) with gross individual nameplate rating greater than 20 MVA or gross plant/facility aggregate nameplate rating greater than 75 MVA including the generator terminals through the high-side of the step-up transformer(s) connected at a voltage of 100 kV or above.

Inclusion I2 addresses generating resources with a gross individual nameplate rating greater than 20 MVA or a gross plant/facility aggregate nameplate rating greater than 75 MVA. According to the Phase 1 BES filing made by NERC, inclusion I2 includes in the bulk electric system the generator terminals through the high-side of the step-up transformers connected at a voltage of 100 kV or above. This filing also states that this inclusion mirrors the text of the NERC Registry Criteria (Appendix 5B of the NERC Rules of Procedure) for generating resources. The Phase 1 filing also states that a "basic tenet that was followed in developing the [revised definition] was to avoid changes to Registrations…if such changes are not technically required for the [revised definition] to be complete."

It should be noted that while inclusion I2 specifies "generator terminals through the high-side of the step-up transformer(s) connected at a voltage of 100 kV or above," the NERC Registry Criteria specifies a "direct connection" to the Bulk-Power System.

Also in the Phase 1 Bulk Electric System filing, Inclusion I4 of the BES definition provides the following statement:

> Inclusion I4 identifies as part of the bulk electric system dispersed power producing resources with aggregate capacity greater than 75 MVA (gross aggregate nameplate rating) utilizing a system designed primarily for aggregating capacity, connected at a common point at a voltage of 100 kV or above.

NERC stated in its Phase 1 filing that the goals of Inclusion I4 were to accommodate the effects of variable generation on the bulk electric system. It further states that even though inclusion I4 could be considered subsumed in Inclusion I2 (generating resources), NERC believes it is appropriate "to expressly cover dispersed power producing resources utilizing a system designed primarily for aggregating capacity.

## 3.3 Capacity Background

NERC collects two different types of capacity[1] to classify generators on the bulk power system.

The nameplate capacity of a resource is defined as the maximum output (usually in MW) the resource can achieve under specific conditions designated by the manufacturer. Nameplate capacity usually does not include resource uprates (upgrades made to generator to increase output) and/or derates and capacity reductions for station/auxiliary services.

The net capacity (for both summer and winter seasons) is the maximum output (MW) a generator can supply to system load at the time of summer or winter peak demand. The net capacity includes resource uprates (upgrades) and/or derates and capacity reductions for station/auxiliary services. However, net capacity values can be impacted by market conditions, environmental regulations, and other factors.

Through its Reliability Assessment data request process, NERC collects capacity of generators in MW.

In the United States, using data from the 2010 Long Term Reliability Assessment, there are approximately 13,699 generating resources and can be broken down into different bands based on the capacity (MW) of the resource.

Less than 10 MW: 5,288 resources

Between 10 MW and 99.9 MW: 5,320 resources

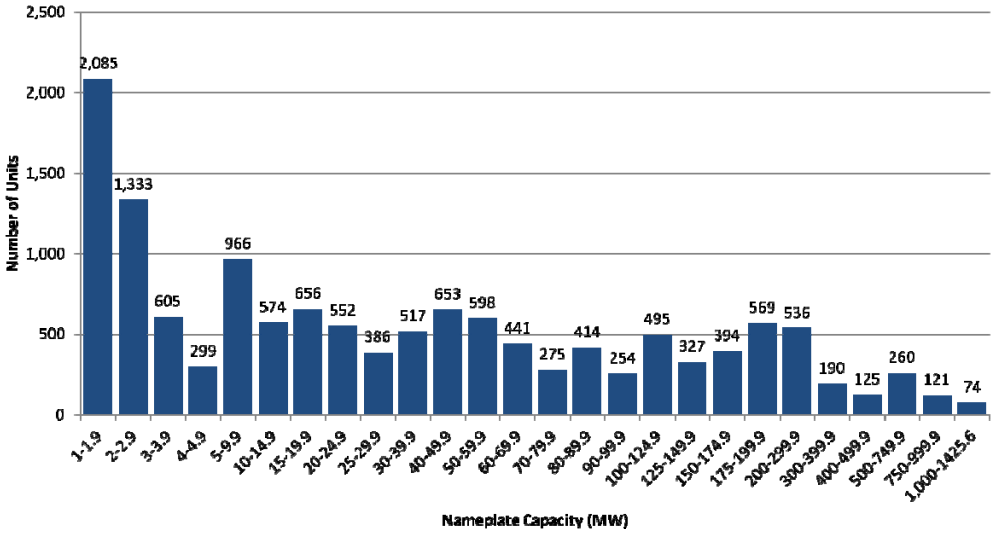
Between 100 MW and 499.9 MW: 2,636 resources

Greater than 500 MW: 455 resources

Figure 1 shows an aggregation of Nameplate Capacity of generating resources (MW) by resource size.

[1] Capacity is a measure of how much electricity a generator can produce under specific conditions.

**Figure 1: Number of Resources by Nameplate Capacity (MW) of Generating Resource[2]**




## 3.4 Technical Alternatives under Consideration

The Reliability Assessment Subcommittee (RAS) explored multiple alternatives regarding the generator thresholds contained in the proposed Bulk Electric System (BES) definition and selected the following five alternatives for further review and consideration by the entire Subcommittee:

### 3.4.1 Technical Alternative A

Technical Alternative A would require all generation resources, regardless of capacity value (MW), generator size (MVA) or voltage at the point of interconnection, to be considered part of the BES.

### 3.4.2 Technical Alternative B

Technical Alternative B would require the development of either a uniform generator performance criterion or the development of a uniform method to assess a generator's potential impact on the reliability of the BES and determine whether a generator should be considered as part of the BES or excluded from the BES.

### 3.4.3 Technical Alternative C

Technical Alternative C would change the proposed Inclusion I2 to include all generating resource(s) whose nameplate ratings are greater than 20 MVA. This would include generating resources where the generator terminals through the high-side of the step-up transformer(s) were connected at a voltage of 100 kV or above.

### 3.4.4 Technical Alternative D

[2] Data source is 2010 Long Term Reliability Assessment

Technical Alternative D would seek to define BES generation resources based on characteristics such as:

Generation resource connection voltage to the BES;

Capacity obligations of the generation resource;

Nameplate capacity of the generation resource (Using Energy Information Administration (EIA) reporting threshold of greater than 1MW);

The inertia constant of the generation resource

Using Adequate Level of Reliability metrics to determine generation resource contributions to reliability

### 3.4.5 Technical Alternative E

Technical Alternative E would not change the currently proposed Inclusion I2 that consists of generating resources (s) with gross individual nameplate rating greater than 20 MVA or gross plant/facility aggregate nameplate rating greater than 75 MVA including the generator terminals through the high side of the step-up transformer (s) are connected at a voltage of 100 kV or above.

Alternative E would also not change the currently proposed Inclusion I4 which identifies as part of the bulk electric system dispersed power producing resources with aggregate capacity greater than 75 MVA (gross aggregate nameplate rating) utilizing a system designed primarily for aggregating capacity, connected at a common point at a voltage of 100 kV or above.

## 3.5 Technical Rationale

### 3.5.1 Technical Alternative A Discussion

Setting a small capacity value of generator resources for modeling with well defined points of interconnection at BES voltage levels would not require significant changes in the way generation is recognized in simulation models. The difficulties associated with representing small generation resources at defined points of interconnection are those of developing and maintaining reliable datasets of resource performance in an operational environment.

Future system studies will most likely be concerned about the cumulative behavior of new "classes" of generation, where a class is made up of a large number of very small generating resources (which could include different types of resources from rooftop solar systems). These generating resources will most likely have:

No readily identifiable point of interconnection with the BES,

The capacity of these generating resources is commingled with demand from nearby loads;

The generating resources making up the class are so small, their locations and ownership so diverse, and their technical details so varied, that explicit representation within system models in the traditional equipment-based sense is impossible.

There may be assessment areas within the BES where the cumulative output and the operating performance of small generating resources might be essential to maintaining the reliability of the BES.

If the operating performance of small generating resources could be counted on to be benign or at least 'neutral' with regard to the behavior of the BES, it might be reasonable to allow present practice to continue.

The industry already faces this situation with regard to load. In 1997, WECC found that it was necessary to recognize that a large amount of its load is electric motors and to recognize motor behavior. Recent work on the FIDVR phenomenon is developing modeling of new classes of load whose cumulative behavior is of great importance to the grid. The approach recognizes that it is necessary to represent the basic physical characteristics of a class of device but that it is impractical to get this representation by modeling individual modules.

It will be a natural extension of composite load modeling to recognize that a class, or classes, of distributed small generating resources can have a cumulative impact on the reliability of the BES. The RAS does not consider setting a small (e.g., 1 MW) generator threshold to be practical from engineering and administrative perspectives. Therefore, this alternative is not being pursued by the RAS.

### 3.5.2 Technical Alternative B Discussion

RAS has explored the possibility of developing a uniform generator performance criteria or a uniform assessment method to assess a generator's potential impact on the reliability of the BES and determine whether a generator should be considered as part of the BES or excluded from the BES.

RAS has reviewed the draft White Paper "Generation Exclusion Below 75 MVA in BES Definition – Position Paper" developed by the BES Standard Drafting Team.[3] It was noted by RAS that the various case studies identified in this paper only considered stead-state conditions in effect testing the deliverability of the resources dispatched in place of the generation being removed. It would be expected to find minimal issues using this method. However, if this method or a similar method is applied to select large generating resources, the results are expected be similar.

RAS consulted several experts, including John Undrill, PhD[4], in the field of dynamic simulation studies and requested their opinion on potential methods to determine a generation threshold based on a study of dynamic simulations. These potential methods would require the development of specific criteria based on engineering judgment that could vary between

[3] Link to BES Problem Statement Whitepaper (TBD)

[4] John Undrill, PhD is an IEEE Fellow, a member of the National Academy of Engineering: http://www.nae.edu/42087.aspx and is a Research Professor at the Arizona State University School of Electrical, Computer, and Energy Engineering: http://engineering.asu.edu/ecee/eceeresearchfaculty

interconnections. Based on the feedback received by the RAS, no clear technical rationale was identified to establish a minimum generator threshold criterion. Therefore, this alternative is not being pursued by the RAS.

### 3.5.3 Technical Alternative C Discussion

The RAS considered enhancing Inclusion I2 of the proposed BES definition and by eliminating the distinction between individual and aggregate generating facilities and selecting a single bright-line registration criteria such as 20 MVA . This would modify the proposed Inclusion I2 as shown below and remove Inclusion I4:

> Inclusion I2 consisting of generating resources (s) with individual or aggregate nameplate rating greater than 20 MVA including the generator terminals through the high side of the step-up transformer (s) are connected at a voltage of 100 kV or above

The RAS has concluded that there is no technical rationale for having a generator threshold value for a single resource and a different threshold value for a group of resources at a plant/facility. The RAS members concur that the potential impact to the BES for the loss of a single generating resource or a plant/facility at the same generation level would be similar. Therefore, the same generation threshold should apply to single generating resource as well as to a plant/facility. However, no technical rationale has been identified at this time in order to establish a single generator threshold value. Therefore, this alternative is not being pursued by the RAS.

The RAS also notes that the selection of a single criteria of 20 MVA is less restrictive that the data requirements currently imposed by the U.S. Energy Information Administration Form EIA-860[5], which collects generator-level specific information about existing and planned generators at electric power plants with 1 MW or greater of combined nameplate capacity. In addition, a 20 MW generator threshold value is supported by the FERC in Order 2006[6] as well as the NERC GADS.[7]

### 3.5.4 Technical Alternative D Discussion

RAS considered Technical Alternative D in an effort to define BES generation resources based on the characteristics of the generating resource. These alternatives included:

> Generation resource connection voltage to the BES;
> Capacity obligations of the generation resource;
> Nameplate capacity of the generation resource (Using U.S. Energy Information Administration (EIA) reporting threshold of greater than 1MW);
> The inertia constant of the generation resource;

[5] Form EIA-860 detailed data request: http://www.eia.gov/electricity/data/eia860/index.html

[6] Docket No. RM 02-12-000 paragraph 75.

[7] NERC GADS minimum reporting threshold is greater than or equal to 20 MW starting in January of 2013.

> Using Adequate Level of Reliability metrics to determine generation resource contributions to reliability

The RAS determined that establishing a generator threshold criterion based on characteristics that may change over time or characteristics that may be considered vague would not be practical and would lack technical merit. Therefore, this alternative is not being pursued by the RAS.

### 3.5.5 Technical Alternative E Discussion

The RAS also considered the alternative of keeping Inclusions I2 and I4 as currently defined without proposing enhancement or changes. This would maintain the current filed Inclusion I2 and I4 without enhancement as represented below:

> Inclusion I2 consisting of generating resources (s) with gross individual nameplate rating greater than 20 MVA or gross plant/facility aggregate nameplate rating greater than 75 MVA including the generator terminals through the high side of the step-up transformer (s) are connected at a voltage of 100 kV or above.
>
> Inclusion I4 identifies as part of the bulk electric system dispersed power producing resources with aggregate capacity greater than 75 MVA (gross aggregate nameplate rating) utilizing a system designed primarily for aggregating capacity, connected at a common point at a voltage of 100 kV or above.

Lacking an implementable technical alternative, the RAS agrees that the generator threshold contained in the proposed BES definition provides for a practical implementation that avoids potentially significant changes to registration.

## 3.6 Generator Threshold Recommendation

The request by the BES Standard Drafting Team regarding the generator threshold assumes that a technical justification exists or can be developed to establish such a threshold. At this point, the RAS believes that this assumption may be flawed since no information has been reviewed to date suggesting that such a technical justification exists or can be developed.

The Reliability Assessment subcommittee recommends the selection of Alternative E to the Bulk Electric System Standards Drafting Team.

The RAS also recommends that all generators, regardless of size, including those facilities beyond the scope of NERC Statement of Registry Criteria, Version 5, be required to submit modeling data to the appropriate Planning Coordinator to ensure accurate coverage of the facility in the development of local, regional, and interconnection wide models.