UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Essential Reliability Services and the	**)**	
Evolving Bulk-Power System—	**)**	**Docket No. RM16-6-000**
Primary Frequency Response	**)**	

COMMENTS OF THE ENERGY STORAGE ASSOCIATION

The Energy Storage Association ("ESA") submits these Comments in response to the supplemental notice for comment issued on August 18, 2017, following the notice of proposed rule issued on November 17, 2016 pertaining to above-captioned docket. ESA acknowledges FERC for its request for supplemental comments on the impact of PFR requirements on electric storage resources. In light of the unique operational characteristics of electric storage resources, ESA respectfully asks FERC to modify its proposed rule to avoid disproportionate burdens on electric storage resources for providing primary frequency response ("PFR") and to ensure market participants can effectively manage electric storage resources for greatest value to the grid. Additionally, ESA recommends that FERC allow each RTO/ISO to choose to make PFR a compensated service as an alternative to requiring PFR capability as an unpriced condition of interconnection agreement.

I. COMMUNICATIONS

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II. ABOUT THE ENERGY STORAGE ASSOCIATION

Since its inception 27 years ago, the ESA has promoted the development and commercialization of competitive and reliable energy storage delivery systems for use by electricity suppliers and their customers. ESA's membership comprises a diverse group of electric sector stakeholders, including utilities, independent power producers, manufacturers of advanced technologies -- such as batteries, flywheels, thermal energy storage, compressed air energy storage, supercapacitors, and other technologies -- component suppliers, and system integrators.

ESA's more than 150 member companies have expertise in transmission- and distribution-level grid operations relevant to energy storage, as well as firsthand knowledge of the regulatory challenges to financing and operating commercial energy storage facilities to realize full system benefits.

III. COMMENTS

Electric storage resources are fundamentally different than generation resources. Electric storage resources not only inject electricity onto the grid but also withdraw electricity from the grid; as such, they are bi-directional, and many advanced storage technologies are capable of instantaneously changing between charge and discharge. Electric storage resources are "always on" and available for service even if they are neither injecting nor withdrawing electricity, although when injecting are energy-limited since they can provide electricity only until their stored energy is depleted. These characteristics make electric storage resources fundamentally different than generators, and those differences are at the heart of ESA's concerns regarding FERC's proposed operational settings for PFR.

FERC's proposed droop and sustained response requirements would impose two adverse conditions on electric storage resources. First, storage resources would bear a disproportionate impact in provision of PFR capability compared to other resources. Second, liabilities stemming from PFR requirements would constrain storage resources from effectively managing their fuel supply (i.e., state of charge), potentially impacting their ability to fulfill service obligations and creating an effective headroom requirement despite FERC's stated intention to avoid doing so. Given that FERC's proposed requirements would not affect other resources in these ways, ESA believes FERC's proposed requirements would be unduly discriminatory.

The following comments are aimed at constructively addressing these two problems. ESA acknowledges FERC for its request for supplemental comments on these topics and believes they can be addressed in a variety of ways.

1. *The performance requirements of the proposed rule create challenges and operational implications for electric storage resources not experienced by other resources.*

FERC's proposed operating settings for droop (i.e., basing the droop parameter on nameplate capacity) and the requirement of sustained response pose challenges and adverse operational implications for electric storage resources. The proposed droop settings in the NOPR would require storage to provide a disproportionate amount of PFR capability. If a storage resource is charging when called to provide PFR, the switch to discharging means that the storage will provide both the injected energy and the removal of an effective “load,” creating a response significantly greater than contemplated in the proposed droop settings. Furthermore, since droop is calculated as a percent of nameplate capacity above a minimum set point, and storage resources lack such a set point, storage resources will be required to provide proportionally greater PFR service. This point is discussed further in Section 4.

Similarly, the proposed requirement for sustained response in the NOPR would pose electric storage resources with excessive wear and tear, degradation of useful life, and non-performance penalties. While electric storage resources can be purpose-built to provide PFR with sustained response, at present market participants do not do so, owing to the lack of compensation for such PFR service. Presently, many electric storage resources manage their state of charge and energy throughput to provide specified market services while attaining a planned unit service life, be that by maintaining optimal depth of discharge or by constraining the periods of input or output at maximum capacity. Requiring sustained response for PFR can force storage resources to operate past their optimal depth of discharge and/or managed levels of energy throughput, thereby reducing their service lives. Additionally, if electric storage resources are called upon to provide sustained response at a moment of low- or zero-charge, then they are liable for non-performance. This point is discussed further in Sections 2 and 5.

In addition, the proposed prohibition of resources “inhibiting” response could be interpreted as requiring a disproportionate share of PFR from electric storage resources. As noted above, many advanced storage technologies are capable of instantaneously changing between charge and discharge, meaning that they will respond to changes in frequency more quickly than conventional generators. This fast response at times could resolve frequency deviations so quickly that conventional generators do not have time to respond, which would cause electric storage resources to provide a disproportionate share of PFR and incur a disproportionate cost burden from doing so. This phenomenon is currently being observed for other inverter-based technologies, such as wind, and would be exacerbated with a requirement for inverter-based electric storage resources to provide PFR.

The impacts of FERC's proposed requirements on electric storage resources will vary based on the particular function or service being provided by each resource, which dictates state of charge. A fully- or mostly-charged storage resource will likely be able to meet normal[1] PFR sustained response performance requirements, absent other service obligations, whereas a low- or zero-charged storage resource will likely be unable to do so. [2] Similarly, a fully-charged resource will not be in a charging state when a PFR event occurs. Since PFR events cannot be predicted, electric storage resources cannot plan for them and will generally be in a variety of states of charge when such events occur.

Also, the impacts of proposed requirements will vary for different electric storage technologies. For example, batteries, such as those composed of lead-acid or lithium-ion, generally have optimal depths of discharge for their planned service lives, which will vary by the chemistry used, whereas flywheel and compressed air storage resources' service life is generally unaffected by depth of discharge of cycles.

[1] Based on historical experience. Short-term ancillary services may change to require longer duration response in the future, such as has been observed in the PJM frequency regulation market.
[2] This presumes a downward frequency deviation, where PFR performance requires injection of energy.

Finally, ESA notes that FERC's proposals for deadband or timely response do not pose challenges or adverse operational implications for most electric storage resources. That said, timely response could be a challenge for certain resources, such as compressed air or pumped hydro storage units, which may have a transition time when switching from charging to discharging states.

2. *Sustained response requirements for electric storage resource can adversely impact the grid, particularly by creating risks of non-performance that other resources do not face.*

Because electric storage resources are energy-limited, it is inappropriate to require electric storage resources to provide sustained response. Although technically capable of doing so, an electric storage resource might have other service obligations that are inconsistent with the provision of PFR. For example, an electric storage resource supporting transmission reliability or power quality functions[3] may need to remain at a specified state of charge in the provision of that service and would incur non-performance penalties—and adversely impact the reliability of the grid—if adjusting its state of charge in order to comply with the proposed PFR requirements. Similarly, sustained response requirements could limit an electric storage resource's ability to fulfill energy or ancillary services market obligations. Asset managers would be required to hold back energy for PFR requirements, effectively creating a headroom requirement for electric storage resources[4]–despite the Commission's commitment in the NOPR not to impose a headroom requirement.

[3] At present, it is unclear whether electric storage resources with reliability contracts would be required to go through the generator interconnection process, or whether they would be considered a part of transmission planning.

[4] Headroom usually refers to power capacity. Since storage duration of remaining supply. To ensure a sustained supply, storage resources may operate at reduced power levels (i.e., de-rating), which is akin to a headroom reservation. While operating at higher is energy-limited, the power level of output

Non-energy-limited resources do not face these risks. In addition, these risks would limit what storage resources could offer or deliver to markets, reducing benefits to the grid and ratepayers. As a result, PFR performance requirements for energy-limited and non-energy-limited resources that do not reflect the technical capabilities of both types of resources put energy-limited resources at a disadvantage when competing in wholesale markets (energy, ancillary, capacity) with non-energy-limited resources.

3. Since electric storage resource will provide PFR more frequently than generators that can go offline when idle, storage operators should have means to effectively "go offline."

Since electric storage resources are always "online," as opposed to generating facilities that start-up and shut-down (i.e., go offline), they would be available on a more frequent basis to provide PFR. Since offline resources are not required to provide PFR, electric storage resources would therefore be expected to provide more PFR service as compared to generating facilities that go offline.

It is indeed possible to "turn off" electric storage resources for the purposes of PFR provision, insofar as storage can be intentionally disabled from responding to frequency deviations without physically disconnecting from the grid. Software and power controls can specify a logic for when storage resources should or should not respond to frequency deviations. For example, asset managers could specify that units not respond to frequency deviations: when idle (i.e., neither charging nor discharging), within a certain state of charge (e.g., fully discharged), when unscheduled in energy and ancillary services markets, or based on other operational states or a combination

footnote continued
determines power levels for a shorter amount of time theoretically could avoid headroom reservation and manage energy limitations, commitments at fixed time intervals in wholesale markets (e.g., one hour) preclude that option. Reserving headroom, then, is the only way for electric storage resources to prepare to meet the Commission's requirements.

thereof. However, it is not clear from the NOPR whether such settings would be considered as “inhibiting” PFR in violation of the Commission’s proposal.

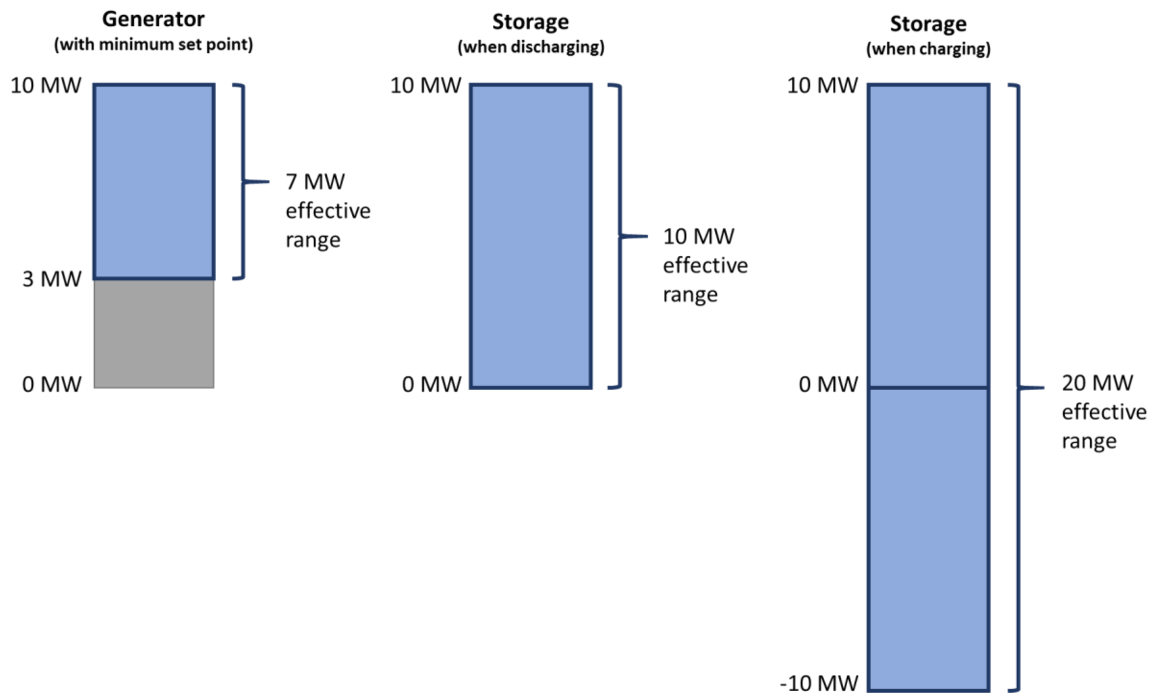
Thus, storage resources should have means to effectively “go offline,” similar to generating resources on shut-down, so as not to always have the obligation to respond to frequency. The language “Whenever the Large Generating Facility is operated in parallel with the Transmission System” in Section 9.6.2.1 should be interpreted to mean providing services to the grid and should exclude simply being idle.

4. *Without a minimum set point, electric storage resources will be required to provide a greater proportional response to frequency deviations than generators.*

“Minimum set point” specifies an output level below which a generator cannot operate in a stable fashion and must go offline. Minimum set points are generally defined by RTOs/ISOs in organized wholesale markets and are determined by resource owners/operators as a physical resource parameter.

The PFR requirements proposed in the NOPR would result in electric storage resources providing a greater magnitude of response for a given frequency deviation than conventional generating facilities of equal nameplate capacity that have a minimum set point, compounding the inequities noted above arising from the speed of response from electric storage resources. Electric storage resources are stable and responsive at all output levels and do not have a minimum set point constraint. Without a minimum set point, and with the ability to withdraw electricity (and therefore operate at “negative” output levels), electric storage resources would have to provide a greater operating range for PFR than generators of similar nameplate capacity (see Figure 1). As a result, asset managers would need to limit the rate of output of storage resources to reserve headroom in anticipation of meeting significant PFR performance requirements, reducing their ability to manage a storage resource's state of charge.

Figure 1 Illustrative Comparison of Operating Ranges of Generator and Storage



Some adverse impacts of the proposed PFR requirements on electric storage resources could be reduced if operators of electric storage resources could establish a minimum set point for the provision of PFR service. The implementation of such a minimum set point would change an electric storage resource's response to frequency deviations by reducing the amount of service provided. The implementation of a minimum set point would: (1) limit the provision of PFR for electric storage resources to a megawatt ("MW") range, i.e., between a minimum value and the nameplate injection capacity of the electric storage resource; and (2) create a range to be used in lieu of nameplate capacity as the basis of the droop curve, i.e., reduce the expected proportional MW response to frequency deviations below that of other generating facilities of equivalent nameplate capacity for a given percentage droop).

While ESA in its previous comments recommended consideration of a minimum set point for storage, the concept of a minimum set-point does not have a meaningful analogue in actual storage operations. It would be an arbitrary setting intended to ensure a proportional share of PFR contribution relative to other resources. For that reason, one possible storage minimum set point for the purposes of PFR provision would be based on the average set point of all assets online at any given time, in order to try to achieve similarity in the amount of PFR service able to be provided across the resource types. This is nevertheless an imperfect solution to what is, at heart, an operational paradigm that presumes the characteristics of generators.

5. *Inadequate state of charge should exempt electric storage resources from requirements for sustained response.*

"Inadequate state of charge" refers to a situation where an electric storage resources does not have enough stored energy to meet a defined obligation for injection or withdrawal at a specified capacity. In the case of PFR, an electric storage resource that does not have enough stored energy to provide sustained frequency response at required capacity when a frequency deviation occurs would be said to have an inadequate state of charge.[5] ESA requests that FERC adopt the foregoing definition of this term to provide consistency across balancing authorities.

[5] This description presumes downward frequency deviations. Some frequency deviations are upward; in that case, an electric storage resource that does not have enough ability to store more energy to provide sustained frequency response at required capacity (i.e., because they are fully or nearly fully charged) would be said to have an inadequate state of charge.

The adverse impacts of the proposed PFR requirements on electric storage resources could be minimized if inadequate state of charge was defined as an explicit operational constraint relieving electric storage resources from providing sustained response when in that "inadequate" state. Inadequate state of charge should be an allowance akin to those already specified for generators in the proposed tariff language of Section 9.6.4.2. Operators of electric storage resources should not be required to specify in their interconnection agreements a parameter value for inadequate state of charge, any more than generators need specify details on "ambient temperature limitations, outages of mechanical equipment, or regulatory requirements."[6]

6. *Interference with state of charge management will reduce electric storage operational capabilities and can increase unit wear and tear.*

State of charge management is central to effective electric storage unit operations. Electric storage resources would be less capable of providing committed or desired services and would experience increased or excessive wear and tear if not allowed to maintain a desired range of charge.

To be clear, there is not some specific range of state of charge that would enable an electric storage resource to provide PFR without possible adverse impacts. Since electric storage is an energy-limited resource, storage operators are continually managing their units' state of charge to be able to meet anticipated service needs in subsequent time periods, and those state of charge management strategies will vary according to planned services. For example, a storage resource providing frequency regulation may seek to maintain a state of charge near 50% so as to equally enable

[6] *Essential Reliability Services and the Evolving Bulk-Power System—Primary Frequency Response*, Notice of Proposed Rulemaking, 157 FERC ¶ 61,122 (2016) at P 52.

both up- and down-regulation in future intervals; a storage resource providing peak capacity may seek to maintain a state of charge near 100% so as to provide maximum duration during peak periods; and a storage resource assisting with generator curtailment avoidance may seek to keep a state of charge at some level below 100%. If a single storage unit plans to provide multiple services, then state of charge management strategies may be complex and/or change over time. Unless planned for as a compensated service, whereby PFR would be pursued and factored into active state of charge management, PFR provision inherently interferes with state of charge management.

Additionally, as previously discussed, some electric storage resources may have optimal states of charge to attain a planned service life. PFR provision can also constrain operators of storage resources from effective management to ensure their assets' planned lifetimes, such as by exceeding optimal depth of discharge. Generally, such adverse wear and tear is associated with excessive depletion of charge (e.g., less than 20%), although for some technologies excessive accumulation of charge (e.g., greater than 80%) can also have adverse impacts. Such adverse impacts are associated with electrochemical storage technologies and differ by specific chemistry and system architecture.

7. *Exempting electric storage from PFR when at specified states of charge could mitigate some adverse issues, although others would remain.*

In lieu of some of the preceding methods to accommodate storage resources, operators of electric storage resources could specify an operating range outside of which electric storage resources would not be required to provide and/or sustain PFR. Doing so would prevent the excessive wear and tear impacts on electric storage resources, as well as potentially mitigate inadequate state of charge for sustained response. Such an operating range would be based on state of charge, either in the form of a threshold (e.g., no PFR below 33% or above 67% state of charge) or in the form of an allowed range relative to the planned state of charge at the end of a given interval (e.g., no PFR greater than +/- 5% from planned state of charge). It would not be possible simply to base such an operating range on manufacturer specifications, as storage use cases are complex. It might be possible to specify such an operating range at the time of interconnection and include the operating range in the interconnection agreement; such a specification would depend on each unique situation. In that case, a mechanism to be able to modify the range, if the resource's use case changed, would be important. The operating range could be communicated to the relevant balancing authority by whatever means other info is communicated.

However, even with this approach to mitigate adverse impacts of PFR requirements, electric storage resources would continue to face constraints on state of charge management and a reduction in capability to provide other energy and ancillary market services, primarily as a result of the unpredictable nature of PFR events.

8. *FERC should consider exempting electric storage resources from PFR requirements.*

In light of the complications associated with applying PFR requirements to electric storage resources, FERC could exempt electric storage resources from the proposed PFR performance requirements in the same way that it has exempted nuclear power generators, as suggested in ESA's previous comments. While FERC may consider many of the previously discussed ways of avoiding unduly discriminatory burdens on electric storage, they are inherently imperfect approaches to the fundamental tension between energy-limited flexible storage operations and the uncertainties of PFR service. As a variation on this theme, FERC could alternatively retain the requirement for electric storage resources to have PFR capability but not impose the proposed droop and sustained performance requirements on electric storage resources. ESA suggests that FERC could also avoid requiring specification of PFR performance requirements for all resources altogether in interconnection agreements, leaving those decisions to the RTOs/ISOs and interconnection customers, as a means of avoiding unduly discriminatory impacts.

9. *ESA shares the concerns of small generators regarding application of the proposed LGIA requirements to the SGIA.*

As nearly all advanced energy storage resources to date have been interconnected via the SGIP/SGIA, ESA explains that the forgoing discussion regarding electric storage resources in the LGIA also apply in the SGIA. Moreover, small storage resources share the concerns of small generating facilities that face the disproportionate costs in installing additional equipment to meet incremental requirements for the provision of PFR.

10. *ESA respectfully requests FERC to allow RTOs/ISOs to choose to provide compensation for PFR service as an alternative to specifying required PFR technical capabilities as a condition of interconnection.*

ESA believes price formation for PFR service would be a more effective means of meeting NERC requirements, serving as a more economically efficient alternative to specifying technical requirements for PFR performance for the diversity of current and future energy technologies participating in wholesale markets. As discussed in ESA's previous comments, a market clearing price for PFR service could be based on the cost of the selected resource facing the highest marginal cost for providing the necessary quantity of service, thus ensuring maximal economic efficiency and just and reasonable rates. Electricity markets elsewhere have proven the possibility and benefits of compensating PFR service; the United Kingdom's grid operator last year procured 200 MW of Enhanced Frequency Response from batteries and is expected to save £200 million over a period of 4 years.[7]

At the same time, doing so would compensate market participants for their incremental capital costs, opportunity costs, and operational costs for providing PFR. Doing so would improve energy market price formation (where costs of PFR provision are effectively recovered) and allow all market participants to make optimal operational decisions for their resources—including effective management of state of charge for electric storage resources.

Compensating PFR would be aligned with recent recommendations from the Department of Energy ("DOE"), which has recently underscored the critical importance of price formation associated with essential reliability services, including PFR. In its August 2017 *Staff Report on Electricity Markets and Reliability*, DOE recommended improved valuation of essential reliability services:

> "Valuation of Essential Reliability Services (ERS): Where feasible and within its statutory authority, FERC should study and make recommendations regarding efforts to require **valuation of new and existing ERS by creating fuel-neutral markets and/or regulatory mechanisms that compensate grid participants** for services that are necessary to support reliable grid operations. Pricing mechanisms or regulations should be fuel and technology neutral and centered on the reliability services provided. DOE should provide technical and policy support that strengthen and accelerate these efforts."[8] (emphasis added)

[7] "Faster and smarter: Enhanced Frequency Response," *National Grid Connecting* website, 4 Oct 2016, available at http://nationalgridconnecting.com/faster-smarter-enhanced-frequency-response/
[8] U.S. Department of Energy, *Staff Report to the Secretary on Electricity Markets and Reliability*, Aug 2017, available at

ESA respectfully requests FERC consider the DOE's recommendations for improved price formation and/or compensation for essential reliability services like PFR.

Moreover, some organized electricity markets have begun consideration of a PFR market product. In 2016, CAISO began exploring price formation for PFR service, which included an analysis of the various price components of a PFR product.[9] However, CAISO's stakeholder process for developing this concept is on hold, pending a resolution in the instant docket. Similarly, PJM is presently in the middle of a stakeholder process on PFR that includes as an objective: "Discussions on potential compensation mechanisms associated with providing primary frequency response capability."[10]

Were the proposed rule to be finalized in its current form, it would effectively undermine price formation. By requiring all resources seeking interconnection to have PFR capability, and by establishing performance settings in the interconnection agreement, the rule proposed by FERC would soon create and maintain a supply of PFR in each RTO/ISO greater than market need. By sustaining oversupply conditions through regulations, FERC would constrain each RTO/ISO from seeking price formation for PFR, in line with the recent recommendations of DOE.

Therefore, ESA respectfully requests that FERC direct RTOs/ISOs to pursue price formation or other means of compensation for PFR service instead of making it an uncompensated requirement of interconnection. Alternatively, ESA respectfully requests

footnote continued
https://energy.gov/sites/prod/files/2017/08/f36/Staff%20Report%20on%20Electricity%20Markets%20and%20Reliability_0.pdf

[9] Section 4.2.2. in California ISO, *Frequency Response Phase 2 – Issue Paper*, 15 Dec 2016, available at http://www.caiso.com/Documents/IssuePaper_FrequencyResponsePhase2.pdf

[10] PJM Interconnect, *Primary Frequency Response (PFR) Senior Task Force Charter*, 28 July 2017, available at http://pjm.com/-/media/committees-groups/task-forces/pfrstf/20170725/20170725-item-03-pfrstf-charter-post-meeting.ashx

that FERC allow each RTO/ISO to choose to proceed with price formation for PFR service as an alternative to specifying PFR performance requirements as a condition of interconnection. Doing so would respect the region-specific preferences of each RTO/ISO while still ensuring adequate availability of PFR for system reliability.

IV. CONCLUSION

Electric storage resources are capable of providing PFR effectively, provided that it is a compensated service. Because the proposed requirements PFR service would pose disproportionate burdens on storage resources, ESA disagrees with FERC's proposal to make PFR capability an uncompensated condition of new interconnection. ESA is particularly concerned that FERC's specification of required PFR settings and performance may present unique burdens to advanced electric storage resources should PFR service then be required as an uncompensated service subsequently by either FERC or RTOs/ISOs. ESA respectfully requests that FERC modify its proposal to accommodate the technical attributes of electric storage resources and avoid undue or discriminatory burdens on storage, as well as loss of benefits to the grid and ratepayers, that will otherwise occur.

Respectfully submitted,

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CERTIFICATE OF SERVICE

I, Anne O'Hanlon, hereby certify that the foregoing Comments were served via electronic mail to the service list.

Dated in Boston, MA this 10th day of October 2017.

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