The Narragansett Electric Company
d/b/a National Grid

RE: Proposed Power Sector Transformation (PST) Vision and Implementation Plan

Docket No. 4780

PREFILED DIRECT TESTIMONY OF

Gregory L. Booth, PE
President, PowerServices, Inc.
On Behalf of Rhode Island Division of Public Utilities and Carriers

April 25, 2018

Prepared by:
Gregory L. Booth, PE
1616 E. Millbrook Road, Suite 210
Raleigh, North Carolina 27609
(919) 256-5901 or (919) 441-6440
gbooth@powerservices.com
Prefilled Direct Testimony of

Gregory L. Booth, PE
PowerServices, Inc.

On Behalf of Rhode Island Division of Public Utilities and Carriers
Docket No. 4780

Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Page Nos.</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.</td>
<td>Introduction</td>
<td>1-6</td>
</tr>
<tr>
<td>II.</td>
<td>Purpose of Testimony</td>
<td>7-10</td>
</tr>
<tr>
<td>III.</td>
<td>Overview of Testimony</td>
<td>11-16</td>
</tr>
<tr>
<td>IV.</td>
<td>Detailed Discussion of Analysis</td>
<td>17-28</td>
</tr>
<tr>
<td>V.</td>
<td>Conclusion and Recommendations</td>
<td>29-33</td>
</tr>
</tbody>
</table>

Appendices GLB-1 Resume of Gregory L. Booth
DIRECT TESTIMONY OF
GREGORY L. BOOTH, PE

I. INTRODUCTION

Q. PLEASE STATE YOUR NAME AND THE BUSINESS ADDRESS OF YOUR EMPLOYER.
A. My name is Gregory L. Booth. I am employed by PowerServices, Inc. ("PowerServices"), located at 1616 E. Millbrook Road, Suite 210, Raleigh, North Carolina 27609.

Q. ON WHOSE BEHALF ARE YOU TESTIFYING IN THIS MATTER?
A. I am testifying on behalf of the Rhode Island Division of Public Utilities and Carriers ("Division").

Q. WHAT DOES YOUR POSITION WITH POWERSERVICES, INC., ENTAIL?
A. As President of PowerServices, Inc., an engineering and management services firm, I am responsible for the direction, supervision, and preparation of engineering projects and management services for our clients, including the corporate involvement in engineering, planning, design, construction management, and testimony.

Q. WOULD YOU PLEASE OUTLINE YOUR EDUCATIONAL BACKGROUND?
A. I graduated from North Carolina State University in Raleigh, North Carolina in 1969 with a Bachelor of Science Degree in Electrical Engineering, and was inducted into the North Carolina State University Department of Electrical and Computer Engineering Alumni Hall of Fame in November 2016. I am a registered professional engineer in twenty-three (23) states, including Rhode Island, as well as the District of Columbia. I am a registered
Q. ARE YOU A MEMBER OF ANY PROFESSIONAL SOCIETIES?
A. I am an active member of the National Society of Professional Engineers (“NSPE”), the Professional Engineers of North Carolina (“PENC”), the Institute of Electrical and Electronics Engineers ("IEEE"), American Public Power Association (“APPA”), American Standards and Testing Materials Association (“ASTM”), the National Fire Protection Association (“NFPA”), and Professional Engineers in Private Practice (“PEPP”). I have also served as a member of the IEEE Distribution Subcommittee on Reliability and as an advisory member of the National Rural Electric Cooperative Association (“NRECA”) Cooperative Research Network, which is an organization similar to Electric Power Research Institute ("EPRI").

Q. PLEASE BRIEFLY DESCRIBE YOUR EXPERIENCE WITH ELECTRIC UTILITIES.
A. I have worked in the area of electric utility and telecommunication engineering and management services since 1963. I have been actively involved in all aspects of electric utility planning, design and construction, including generation, transmission and distribution systems. I have provided services to many regulatory agencies, and some 300 electric utilities. My experience includes work on grid modernization planning and design and implementation ranging from Advanced Metering Infrastructure ("AMI"), Advanced Metering Functionality ("AMF"), Geographic Information System ("GIS") and self-healing circuits to micro-grid installations with battery storage systems. My experience spans all of the Regional Transmission Organization ("RTO") regions on the east coast,
and many others throughout the United States. I have been providing services in Rhode Island and other portions of New England for over 30 years.

Q. HAVE YOU PREVIOUSLY TESTIFIED AS AN EXPERT BEFORE THE RHODE ISLAND PUBLIC UTILITIES COMMISSION?

A. Yes. I have testified before the Rhode Island Public Utilities Commission on numerous matters, including Docket Nos. 2489, 2509, 2930, 3564, 3732, 4029, 4218, 4237, 4307, 4360, 4382, 4473, 4483, 4539, 4592, 4614, 4682, 4770, 4783, D-11-94, and D-17-45. My testimony in Rhode Island has included filed and live testimony on previous Electric Infrastructure, Safety and Reliability Plan Fiscal Year Proposal filings by National Grid in Docket Nos. 4218, 4307, 4382, 4473, 4539, 4592, 4682, and 4783.

Q. HAVE YOU PREVIOUSLY TESTIFIED AS AN EXPERT IN OTHER JURISDICTIONS?

A. I have testified before the Federal Energy Regulatory Commission ("FERC") and numerous state commissions, including in Delaware, Florida, Maine, Maryland, Massachusetts, Minnesota, New Jersey, North Carolina, Pennsylvania, and Virginia.

Q. HAVE YOU RECENTLY TESTIFIED AS AN EXPERT IN NEW ENGLAND CONCERNING GRID MODERNIZATION?

A. Yes. I have testified in Massachusetts in Docket Nos. 15-120, 15-121, 15-122 and 15-123 on behalf of the Office of the Attorney General regarding Grid Modernization Plan dockets, including providing testimony concerning the three Grid Modernization Plans submitted by National Grid in Massachusetts.

Q. DO YOU HAVE OTHER INVOLVEMENT AND EXPERIENCE WITH COMPANIES THAT PROVIDE YOU WITH ADDITIONAL EXPERTISE RELEVANT TO THIS DOCKET?
A. Yes. My electric utility reliability assessment work for: the Rhode Island Division of Public Utilities and Carriers ("Division"); the New Jersey Board of Public Utilities ("NJBPU"); the Pennsylvania PUC; and the Virginia State Corporation Commission ("SCC") over the last ten years has involved working with northeastern electric utilities on an in-depth assessment of reliability enhancement, and the costs associated with such enhancement, including annual construction work plan development for electric utility systems. I have also evaluated and testified in Massachusetts on behalf of the Attorney General’s Office in numerous matters, including four Grid Modernization dockets.

Q. HAVE YOU PREVIOUSLY TESTIFIED AS AN EXPERT BEFORE STATE UTILITY COMMISSIONS AND OTHER REGULATORY AGENCIES?

A. Yes. I have testified on numerous occasions before the FERC, including pre-filed testimony in both wholesale rate matters as well as in electric utility reliability matters and facility connection standards, including Duke Power Company and Dominion Power dockets. I have also testified before the New Jersey Public Utilities Commission, the Delaware Public Service Commission, the Maine Public Utilities Commission, the Maryland Public Service Commission, Minnesota Department of Public Service Environmental Quality Board, Virginia State Corporation Commission, the Pennsylvania Public Utility Commission, North Carolina Utilities Commission, and Rhode Island Public Utilities Commission, and the Massachusetts Department of Public Utilities (in Dockets D.P.U. 11-56, D.P.U. 11-102/11-102A, D.P.U. 13-52, D.P.U. 14-01, D.P.U. 15-120, D.P.U. 15-121, D.P.U. 15-122, and D.P.U. 15-123). My testimony before most of these Commissions has been provided on numerous occasions.

Q. HAVE YOU BEEN ACCEPTED AS AN EXPERT BEFORE STATE OR FEDERAL COURTS?
A. Yes. I have been accepted as an expert in the area of electrical engineering and electric utility engineering, construction and reliability matters and the National Electrical Safety Code ("NESC"), National Electrical Code ("NEC"), Occupational Health and Safety Administration ("OSHA"), Electromagnetic Field ("EMF"), and forensic engineering, including standard and customary utility operation practices in the electric utility industry and the electric industry before 17 state and federal courts.

Q. HAVE YOU BEEN INVOLVED DIRECTLY IN GRID MODERNIZATION EVALUATIONS AND/OR IMPLEMENTATIONS FOR OTHER ELECTRIC UTILITIES?

A. Yes. I have provided project oversight for micro-grid Engineering, Procurement and Construction ("EPC") projects for utilities, and numerous solar projects provided by our firm and our individual team members. This has included projects such as the design and project management for the construction of a 7,000 kW solar project in Delaware, and two micro-grid and storage projects in North Carolina. I provided engineering analyses, and completion of a large number of solar impact evaluation studies, solar interconnection evaluation and preparation of formal interconnection agreements, as well as wind farm generation impact studies and design of interconnection facilities for our utility clients, statewide associations representing our utility clients, and directly to solar facility owners, such as Duke Energy Renewables. I have delivered multiple electric utility Grid Modernization Plans and Technology Studies to utility clients. I have been involved in the planning, specifications, bidding, and award process and implementation of Automatic Meter Reading ("AMR")/AMI systems and Supervisory Control and Data Acquisition ("SCADA") systems. I have provided engineering services on advanced relay technology implementation, together with the application of self-healing circuit technology. I have completed many Volt/Var studies and provided engineering for implementation of
Volt/Var optimization using a variety of techniques. I have additionally provided our utility clients with a wide variety of Time Varying Rate ("TVR") designs, including implementation and monitoring of economic benefits.
II. PURPOSE OF TESTIMONY

Q. HAVE YOU REVIEWED THE FILING OF NARRAGANSETT ELECTRIC COMPANY D/B/A NATIONAL GRID (“NATIONAL GRID” OR “COMPANY”) IN THIS MATTER?

A. Yes, I have reviewed the documents the Company has filed to date in Docket Nos. 4770 and 4780, including its responses to data requests.

Q. DID YOU FILE TESTIMONY IN DOCKET NO. 4770?

A. Yes. This testimony is complementary to the testimony I filed in Docket No. 4770.

Q. HOW HAVE YOU ORGANIZED YOUR TESTIMONY?

A. Section I of my testimony provides an introduction and a summary of my background and experience. Section II addresses the purpose of my testimony. Section III provides an overview of my analyses and a summary of my position on certain components or programs contained in the National Grid filing. Section IV is a detailed discussion of my analyses, which includes my assessment and recommendation for components of the National Grid filing. Section V is my conclusion and my recommendations.

Q. WHAT HAVE YOU BEEN ASKED TO REVIEW BY THE DIVISION?

A. Based on my knowledge of the Company’s distribution business gained from my participation in the ISR and SRP Dockets, the Division requested that I review the Company's proposed Power Sector Transformation ("PST") initiatives in Chapter 3 of PST-1 that was originally filed in the Company's rate case Docket 4770, but was later procedurally separated into Docket 4780 by the Commission. In addition to evaluating the grid modernization proposals contained in Chapter 3, the Division also requested that I identify whether there are any initiatives submitted by the Company as a part of its PST
filing that are more appropriately categorized as being a part of the distribution business.

My testimony is intended to address primarily the testimony of Mr. Sheridan, Schedule PST - 1 and, specifically, the Grid Modernization Chapter 3.

Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?
A. My testimony addresses my analysis of the National Grid Power Sector Transformation Plan, Chapter 3-Grid Modernization, to gauge whether or not the investments proposed by the Company are foundational investments of grid modernization that pertain to the core distribution business. My testimony includes observations, recommendations, discussion of comparable programs implemented by other utilities, and my direct experience with Grid Modernization Plan ("GMP") components, programs and implemented technologies. The overall purpose of my testimony is to assist the Division in this filing with additional independent experience and recommendations to the Public Utilities Commission ("PUC") for its consideration and to summarize programs which can be fully or partially supported. My evaluation considers the current foundational investment areas proposed by the Company in the context of the need for a comprehensive, long term GMP that provides transparency to future programs and enables a full consideration of proposed program benefits. I have also utilized my experience and knowledge of the Company’s proposed grid modernization investments in Massachusetts to address potential cost sharing between jurisdictions.

Q. PLEASE EXPLAIN THE REVIEW AND ANALYSIS PROCESS YOU APPLIED IN EVALUATING THE COMPANY’S INVESTMENT IN A MODERN GRID.
A. My review and analysis process involved first an assessment of the materials filed by National Grid in Docket Nos. 4770 and 4780, and how they correspond to the goals of Docket No. 4600. I then evaluated the National Grid components proposed for the
distribution system, which are described as foundational and will clearly require expanded
work force asset management programs and training programs. In my testimony, I will
evaluate the Company’s proposal as compared to industry practices, its Massachusetts
proposals, and most particularly the Docket No. 4600 goals since the Company has
articulated that its modern grid investments will advance the goals of Docket No. 4600,
which it listed as:

i. Provide reliable, safe, clean, and affordable energy to Rhode Island customers over
the long term (this applies to all energy use, not just regulated fuels);

ii. Strengthen the Rhode Island economy, support economic competitiveness, retain
and create jobs by optimizing the benefits of a modern grid and attaining
appropriate rate design structures;

iii. Address the challenge of climate change and other forms of pollution;

iv. Prioritize and facilitate increasing customer investment in their facilities
(efficiency, distributed generation, storage, responsive demand, and the
electrification of vehicles and heating) where that investment provides recognizable
net benefits;

v. Appropriately compensate distributed energy resources for the value they provide
to the electricity system, customers, and society;

vi. Appropriately charge customers for the cost they impose on the grid;

vii. Appropriately compensate the distribution utility for the services it provides;

viii. Align distribution utility, customer, and policy objectives and interests through the
regulatory framework, including rate design, cost recovery, and incentives.

Initially, my assessment will address four basic questions:

(1) Does the component achieve the PUC’s stated objectives for grid modernization?;

(2) Is the proposed component or program an expenditure truly for grid modernization,
or is it simply part of the Company’s “business as usual,” which are those traditional
investments to support safe and reliable service as part of the Company’s ongoing
operations?
(3) Does the proposed component or program represent a benefit to the customer and system?; and

(4) What have been the experiences of other utilities with similar components or programs (lessons learned)?

Additionally, there must be continued oversight of each proposed component to assure compliance with scope, schedule, and budget. Project changes, expansion and continuation should be continually assessed, since proposed investments are influenced by changes in technology. The continuation of discussions with National Grid regarding grid additions that are approved seems almost essential, given that its modern grid investment in only foundational programs does not demonstrate the long range programs, to be supported over the years, necessary to implement grid modernization technologies and programs.
III. OVERVIEW OF TESTIMONY

Q. WHAT CRITERIA DID YOU CONSIDER IN YOUR EVALUATION, INCLUDING REACHING CONCLUSIONS TO THE FOUR (4) OVERARCHING FACTORS YOU OUTLINED IN SECTION II. OF YOUR TESTIMONY?

A. I considered current industry trends and technology available for grid modernization components, together with the Company's approach. These include, but are not limited to:

a. National Grid's proposed foundational programs;

b. National Grid's reliance on Advanced Distribution Management System ("ADMS") and AMF/AMI;

c. Risk associated with early obsolescence of proposed programs or components;

d. Emerging technologies;

e. Established technologies;

f. Cost effectiveness and evaluation of stated benefits;

g. Operational characteristics of the proposed investments and alignment to grid modernization versus core business and customary practices; and

h. Grid modernization investments and outcomes from other utilities.

Q. OVERALL, DO THE COMPANY'S PROPOSED INVESTMENTS ACHIEVE THE DEPARTMENT'S STATED OBJECTIVES FOR GRID MODERNIZATION IN DOCKET NO. 4600?

A. The Company correctly characterizes the entire group of its proposed investments as enabling technology, particularly for Distributed Energy Resources ("DER") integration, which I consider foundational elements for the continued evolution of the modern grid. These investments are only the first step, albeit an essential step. The Company has taken a prudent approach by advancing these base, but critical, components in their efforts to modernize the grid while meeting the goals of Docket 4600. Overall, I believe that the Company’s proposed investments are enablers of the objectives of the PUC and stakeholders, as articulated in Docket 4600, related to grid modernization, and, in particular, clean energy integration and management.
Q. **DO YOU OBSERVE DEFICIENCIES IN THE COMPANY’S PROPOSED GRID MODERNIZATION COMPONENTS?**

A. My evaluation does not reveal deficiencies in the Company’s proposed components, but rather notes the absence of a comprehensive Grid Modernization Plan ("GMP") which demonstrates both the short and long term initiative programs envisioned in the modern grid by National Grid as it progresses through its own admitted “on-going journey”. I do not dispute the Company has presented a meaningful initial step. What I do find lacking is the presentation of a comprehensive and fully assessed GMP as the required next step in order that the PUC, Division and stakeholders have a view of the future modern grid, its components, and its cost/benefit, so there is not a random and uncoordinated series of programs and technologies initiated on top of the essential foundational investments. Such a GMP would outline the details, technologies, and timeline for implementation, and a plan should be completed before the foundational enabling programs are fully implemented. This second step should have a date certain for completion in the next year, which will appropriately coordinate with the proposed AMI study. A GMP will not only provide the long range vision, but will also mitigate the potential for early obsolescence and unnecessary redundancy. This GMP should not delay the investments the Company has proposed here, but should be in place to guide any second stage of investments as well as any integration with a potential advanced metering infrastructure.

Q. **ONE OF YOUR FOUR OVERARCHING CONSIDERATIONS DISCUSSED EARLIER WAS THE DISTINCTION BETWEEN GRID MODERNIZATION COMPONENTS AND CUSTOMARY OPERATIONAL PRACTICES. CAN YOU PLEASE ELABORATE?**

A. I believe this distinction is consistent with the view of most utilities. A major part of each utility’s operations is the ongoing expenditures (capital and O&M) needed to satisfy a utility’s public service obligation to expand infrastructure in order to provide safe and
reliable service. Programs, plans, and investments are routinely undertaken to meet customer load requirements; reduce costs; replace damaged or worn equipment at the end of its useful life; and maintain safe and reliable service. These ongoing “business as usual” or “core business” plans are customarily funded by customers in the rates they presently pay for service. In fact, as I mentioned earlier in my testimony, the Division specifically requested that my review include identifying the initiatives that are truly core business activities that should be undertaken in the ordinary course of business.

Typically, however, this type of routine investment brings with it new technologies. For example, utilities once prepared engineering diagrams utilizing pen and mylar, but now use computer aided design software, such as AutoCAD. The CAD software introduces newer features and enhanced benefits unavailable with the former pen/mylar medium, but CAD software represents merely the normal evolution of engineering recordkeeping. Thus, the investment is triggered by routine business as usual factors, not “modernization.” Similarly, utilities performing system modeling and studies using state-of-the-art software or GIS system enhancement, while achieving improvements by using a more advanced methodology, still represent the basic operation and maintenance requirements for an electric utility and are not properly thought of as grid modernization programs. These types of enhancements, in my professional opinion, are not components of grid modernization plans any more than using a newer insulator or crossarm technology would be. It is essential for the success and public acceptance of a GMP that it truly represent grid modernization and technology for overall performance and economic benefit, and not merely implement the same functions, but with the latest vintage of comparable technology. Making this distinction between business as usual spending and true grid
modernization was my second step in my assessment of the Company’s investment in a modern grid.

Q. **EXPLAIN HOW THE COMPANY’S CURRENT APPROACH COMBINED WITH YOUR POSITION THEY NEED A MORE COMPREHENSIVE GMP WILL “AVOID EARLY OBSOLESCENCE AND UNNECESSARY REDUNDANCY”?**

A. National Grid has been implementing some modern grid programs and pilots in advance of investing in foundational technology or preparing a comprehensive GMP. If the Company continues investing in single, unrelated programs without a long term strategy, it will most certainly create redundancy or early obsolescence. A modernized grid is driven by integrated technology that allows utilities to monitor, control and manage a dynamic system with increasing numbers of varying loads and generation. Incremental programs deployed by the Company must integrate with existing communications and data systems to avoid additional investment. The Company is correctly beginning its investments in the enabling technologies to create the foundation for a modern grid. All of the Company’s proposed investments, with the exception of Feeder Monitoring Sensor additions, are foundational to a modern grid and represent Step 1 of a GMP. The second step, however, must be a GMP which outlines future programs that are compatible with foundational technology. Additionally, grid modernization expansion should include the quantitative and qualitative benefits of each proposed new technology and how the Grid Side programs can be implemented in a manner most effectively, allowing for a future integration to the ultimate AMF, ADMS, telecommunications and other enabling programs which serve as the foundation.

Q. **WHAT IS THE SIGNIFICANCE OF THE COMPANY’S RELIANCE ON ADMS AND AMF IN YOUR ASSESSMENT?**
A. The Company's proposed grid modernization activities rely heavily on the deployment of ADMS and AMI. The Company discusses this reliance in its Distribution Operations Platform. A utility that utilizes AMI will have a different strategic plan for technology based grid improvements than a utility without AMI. This is due to the multi-functional aspects of AMI, which may be complemented by certain grid technology such as ADMS, and, in other cases, eliminate the need for some aspects of grid investment, such as feeder monitors. Understanding a utility’s strategic decision regarding the timing and penetration of AMI will ultimately impact the scope and cost of associated capital investments.

Given the strategic importance of both AMI and ADMS in driving associated grid modernization investments, including communications and cybersecurity, I have performed my analysis of the current proposal based on the need for ADMS and AMF as critical enabling activities or technologies. Although others are testifying in detail, particularly on the AMF, it was essential to my testimony and position on all of the investments proposed for my baseline to be established. Even absent the immediate deployment of AMI, the other foundational technologies should be implemented in order to advance a modern grid.

Q. WOULD YOU SUMMARIZE YOUR OVERVIEW OF THE COMPANY’S PST PROPOSALS IN CHAPTER 3 OF PST-1, AND YOUR POSITION ON THE NEED FOR A LONG TERM GMP?

A. While I am fully supportive of the Company’s first step of investing in a series of foundational programs, the PUC should require that the Company deliver a comprehensive GMP which details the subsequent 5 years of investments, and outlines the long term (10 to 15 year) deployment of technologies. This needs to be developed with the Division and stakeholder to assure that the PUC and all parties understand the long term programs which
everyone supports. It must also be developed recognizing the desirability to have a significant degree of congruency with the programs underway and being implemented in New York and Massachusetts, where coordinated development makes sense. The enabling strategy and programs initially proposed by the Company in this proceeding are well positioned. Absent a long term GMP, however, there is no vision for the next steps once foundational investments are implemented. A strategy comprised of future technologies and programs is an essential roadmap to efficient and meaningful deployment for the highest potential benefit to the consumers and the Company.
IV. DETAILED DISCUSSION OF ANALYSIS

Q. PLEASE DISCUSS HOW YOU HAVE ORGANIZED YOUR DETAILED TESTIMONY ON EACH COMPONENT IN NATIONAL GRID’S POWER SECTOR TRANSFORMATION PLAN CHAPTER 3.

A. The Company’s Schedule PST-1 Chapter 3: Investment in a Modern Grid, classifies investments into on-going grid modernization activities and new grid modernization activities. These classifications demonstrate that National Grid has been incorporating certain technologies, which are often considered part of a grid modernization program, absent a comprehensive plan.

Under their new grid modernization activities category, National Grid proposes seven investment areas. Many of the activities proposed as part of Docket 4780 can be described as core business functions. These programs, plans and investments are routinely undertaken to meet customer load requirements; reduce costs; replace damaged or worn equipment at the end of its useful life; and maintain safe and reliable service. These ongoing “core business” activities are already funded by customers in the rates they presently pay for service. My testimony provides review and analysis of these seven components.

Q. WOULD YOU SPECIFICALLY IDENTIFY THE COMPONENTS OF THE PST THAT YOU ARE NOT ADDRESSING IN DETAIL?

A. Yes. National Grid characterizes all of its proposed programs as foundational, without describing the programs for which they serve as a foundation. Advanced metering functionality and cybersecurity are foundational. Further, the current proposal is to perform a study in coordination with New York. This is a reasonable approach that is supported by the Division. Given the study needs to be performed, my testimony on these
two components is limited to an overview of how they fit into a comprehensive grid modernization plan.

1. System Data Portal

Q. PLEASE PROVIDE AN OVERVIEW OF THE PROPOSED NATIONAL GRID SYSTEM DATA PORTAL.

A. The proposed system data portal is an enabling technology intended to increase DER penetration by providing guidance to DER providers. This portal supports the deployment of Non-Wires Alternatives (NWA) by providing more timely information about potential locations where DER may be a viable alternative to traditional investment.

The portal will give DER providers unified access to existing system data. Over time, the Company proposes augmenting the data with more detailed assessments of hosting capacity and capacity constraints including heat maps and other reports to highlight areas where a DER solution may be cost effective. The Company has a similar portal deployed in their New York jurisdiction.

Q. FROM AN OVERALL PERSPECTIVE, DO YOU SUPPORT THE IMPLEMENTATION OF A SYSTEM DATA PORTAL?

A. Yes. The proposed system data portal is an enabling technology that is a necessary for grid modernization, and specifically integration of clean energy sources. While the system data portal does not in of itself provide a directly measurable benefit to the Customer, by supporting DER providers and lowering the barriers to entry, the system data portal’s impacts should reduce greenhouse gases and lower power cost, which will benefit the Customers and also lead to a more resilient system. A secondary benefit will be realized in those situations where DER integration solves distribution capacity constraints, eliminating
the need for traditional line investments. These benefits would be identified as the Company advances more robust non-wires alternative evaluations.

The Company’s system data portal was deployed in the New York jurisdiction. The Company proposes to use the lessons learned from that deployment to improve deployment in Rhode Island. Due to the distribution planning time frame, it is not possible to determine the magnitude of the NY benefit at this time. However, it is very likely that benefits will accrue over time as DER resources are proposed as NWAs.

The system data portal is truly a grid modernization activity that supports the Rhode Island policy to facilitate and increase DER penetration. It also provides benefits to customers through supporting new wires alternatives. I support the Company’s system data portal proposal as a part of the core function of the utility. In addition, I see no reason why the Company should delay implementation. It would be appropriate for the Company to advance the project further than the initial funding proposal that has already been approved by the Commission in the System Reliability Procurement ("SRP") Docket No. 4756.

Q. DO YOU HAVE ANY OTHER COMMENTS RELATED TO THE COMPANY’S PROPOSED SYSTEM DATA PORTAL?

A. Yes. The Proposed system data portal should evolve over time to best meet the changing needs of the system and the DER providers. It is expected that the first DER projects will have the highest cost-benefit ratio. As DER penetration increases, additional data may assist with finding viable DER projects that have attractive cost-benefit ratios, which should allow the DER deployment to be sustained for a longer duration and at a higher level of penetration. Also, while I support the implementation of the system data portal, I believe the cost estimate provided by the Company for three engineers seems excessive. It
is my view that the Company's proposed annual rate allowance of $700,000 should be reduced by at least 30%.

2. **Automated Metering Functionality**

Q. **WHAT IS YOUR ASSESSMENT OF THE PROPOSED ADVANCED METERING FUNCTIONALITY?**

A. My testimony does not include a detailed analysis of the Company’s AMF proposal. However; AMI is a necessary foundational component of grid modernization. Most grid modernization activities rely on real time data from the electric distribution system. This data is used for a wide range of business and operational activities including, but not limited to, metering, more dynamic outage management, improved outage restoration duration, reduction in lost crew time due to unnecessary travel, Volt-Var Optimization and Conservation Voltage Reduction (VVO/CVR), improved self-healing circuit application, and enhanced system planning. If AMI is not deployed, another method of recording and receiving real-time system data for system operations is required. AMI is a widely used and proven technology which is a foundational and is an enabling component of a modern distribution grid.

Q. **DO YOU HAVE ANY OTHER COMMENTS RELATED TO THE COMPANY’S PROPOSED AUTOMATED METERING FUNCTIONALITY?**

A. Yes. The decision to deploy AMI is a foundational decision that should be part of any GMP. I support the adoption of AMI with the assumption that it is part of the GMP. In supporting AMI, however, I also believe it is important for feeder monitoring sensors to have a significantly reduced role. If the Company intends to implement AMI, then alternative technologies, such as remote feeder sensors, are redundant and not necessary once AMI is deployed.
3. Feeder Monitoring Sensors

Q. PLEASE PROVIDE AN OVERVIEW OF THE PROPOSED NATIONAL GRID FEEDER MONITORING SENSORS.

A. The proposed feeder monitoring sensors provide real-time data from the electric distribution system that may support several grid modernization activities. Although the technology of these sensors continues to improve, they fundamentally provide a subset of the data that an AMI deployment can provide due to the sheer number of AMI meters versus the relatively small number of feeder sensors which could realistically be deployed.

Q. FROM AN OVERALL PERSPECTIVE, DO YOU CONCUR WITH THE PROPOSED FEEDER MONITORING SENSORS?

A. Although the Company has already deployed many of these sensors, I do not support a continued major deployment if AMF (AMI meters) is adopted. There is no indication that these sensors add any benefit beyond the deployment of AMF. Feeder monitoring sensors are simply redundant, and provide far less comprehensive information across all consumers than AMF deployment will.

Although the feeder monitoring sensors could be supportive of grid modernization, an AMI deployment is a superior solution, because AMI supports more grid modernization capabilities and is truly foundational. Investment in feeder monitoring sensors would be redundant once AMI is deployed. Even with a rapid deployment of the Sensors, the benefits would have a limited duration before an AMI deployment. To the extent feeder monitoring sensors are expanded beyond those existing, the Company should be required to show what are justified in light of the pending proposal to deploy AMI.
4. Control Center Enhancements

Q. PLEASE PROVIDE AN OVERVIEW OF THE PROPOSED NATIONAL GRID CONTROL CENTER ENHANCEMENTS.

A. The proposed Control Center Enhancements activity encompasses several distinct projects including: DSCADA and ADMS; RTU Separation; and GIS Data Enhancement. The end result of these activities is a dedicated DMS that is separate and distinct from transmission operations. The Company currently uses a single SCADA system to support operations, but does not operate a DMS.

Distribution Management and operation, like transmission operations, is a core business function. Plans and investments to enhance the distribution operations through the creation of a DMS are considered ongoing “core business” activities which are already funded by customers in the rates they presently pay for service. The DMS is a core business function that is an enabling technology that can be leveraged and enhanced by grid modernization projects.

Q. COULD YOU PROVIDE AN OVERVIEW OF THE PROPOSED ENHANCEMENTS TO CREATE SEPARATE DISTRIBUTION AND TRANSMISSION SCADA SYSTEMS AND DATA?

A. Yes. This activity includes DSCADA and ADMS, and RTU Separation. A bright line distinction between distribution and transmission data and modeling is proposed. Distribution system data will be split from transmission system data by separating the field RTUs that capture the data and send it to the SCADA system. In addition to enabling dedicated DSCADA, a secondary benefit from creating a bright line separation between transmission operations and distribution operations is that it eliminates FERC Critical
Infrastructure Protection ("CIP") oversight, and its associated risks and costs, from distribution operations.

The DSCADA system, for distribution only, provides a platform for advanced modeling of the distribution system that does not currently exist. New distribution network models, based on the as operated distribution system conditions, form the basis of the proposed ADMS. The ADMS would be interfaced to other systems, including the GIS.

Maintaining RTUs for the purpose of providing distribution information is a function that resides within a utility’s ongoing core business activity and, although is not a grid modernization activity, it is certainly an enabling technology for enhanced grid capabilities. The development and use of ADM applications is also a natural progression of core business activities that should be funded by customers in the rates they presently pay for service.

Q. COULD YOU PROVIDE AN OVERVIEW OF THE PROPOSED GIS ENHANCEMENT?

The ADMS models and applications are intended to reflect actual and projected system conditions, including the status of various distribution line devices. The proposed enhanced GIS data is the source for this information, and would provide accurate and timely information for modeling and display.

The Company’s proposed GIS data enhancement is also a natural progression of core business activities. GIS Data is the baseline data mapping software used by utilities to locate system assets and identify attributes. Funding for GIS would be accomplished through the basic rates customers pay for service.
Q. DO YOU SUPPORT THE COMPANY’S PROPOSED CONTROL CENTER ENHANCEMENTS?

A. Yes. I support the proposed control center enhancements as part of the Company’s core business responsibilities. These enhancements will provide a platform from which future grid modernization activities will be supported.

Q. WOULD YOU CATEGORIZE THE GIS ENHANCEMENTS, RTU SEPARATION, AND DSCADA AS CORE BUSINESS FUNCTIONS OR GRID MODERNIZATION?

A. They are core business functions. They are activities the Company should be implementing as a part of their core distribution business. I do not believe it is appropriate for the Company to define these as grid modernization activities. They should be implementing these initiatives with the enhanced technology available, and seeking cost recovery in the normal course of the distribution business, as they do with other distribution functions.

5. Operational Data Management

Q. PLEASE DESCRIBE THE COMPANY’S PROPOSED OPERATIONAL DATA MANAGEMENT.

A. Like the Control Center Enhancements, the proposed Operational Data Management is comprised of several activities. Many of the existing information systems currently work somewhat independently of one another. The proposal calls for a more unified and well-defined communication infrastructure to facilitate easier data exchange between the various information systems.

An Enterprise System Bus ("ESB") is the first proposed component of Operational Data Management. This is a layer of connectivity between systems that contains intelligence
about the systems and the data and provides automation, validation, and integration capability.

Data Management and Analytics is the second proposed component of Operational Data Management. This is a complex system of data collection, data storage, and information analysis tools that are interfaced together. The Company’s proposed solution uses PI Historian, a data lake, and advanced analytics to provide the Data Management and Analytics capability.

Q. DO YOU SUPPORT THE COMPANY’S OPERATIONAL DATA MANAGEMENT PROPOSAL?

A. Yes. The Operational Data Management is a grid modernization project that builds upon the Company’s core business capabilities. The collection and analysis of system data is critical to operating and maintaining a grid. For example, system data provides current status for efficient operation, signals abnormalities so expedient action can be taken, and is used to determine where system reliability improvements should be implemented. These are core functions in distribution system operations. In addition, robust Operational Data Management ("ODM") is critical to achieve the stated goals of the PST and facilitate grid modernization due to the interoperability of advanced technologies that require more data points, communication portals, and device control. ODM provides a more sophisticated platform for core business operations while accommodating future needs of grid modernization. It is one area of investment that must be prudently implemented to manage step changes in technology while achieving long term ADMS functionality, benefits in system reliability, economic operations, and customer engagement.
6. Telecommunications

Q. PLEASE DESCRIBE THE COMPANY’S PROPOSAL FOR TELECOMMUNICATIONS.

A. The telecommunication proposal is less defined than other proposals, and suggests that consideration will be given to various models without providing details of the consideration. The Company recognizes that investments are required to support Grid Modernization, but does not provide a basis for the enhancements proposed.

In the absence of a comprehensive telecommunication plan, any telecommunication investment is subject to being obsolete, redundant, or not compatible with the telecommunication requirements of other grid modernization systems.

Q. DO YOU HAVE SPECIFIC RECOMMENDATIONS ABOUT THE COMPANY’S PROPOSAL FOR TELECOMMUNICATIONS?

A. Yes. As a part of the its Grid Modernization Plan, the Company should include a chapter that addresses possible communication solutions in light of system conditions and current and future needs to support the wide array of potential Grid Modernization programs and activities.

Q. DO YOU SUPPORT THE COMPANY’S PROPOSAL FOR TELECOMMUNICATIONS?

A. Yes, conditioned upon a conformance to a more comprehensive plan and initially completing a comprehensive telecommunications study in advance of deployment. The Company’s telecommunications proposal supports the achievement of the Commission's stated objectives for grid modernization. The proposal is truly for grid modernization, while also enhancing the support for many core business activities, such as DSCADA. The telecommunications proposal provides benefits to the system and to customers by enabling
customer engagement. Other utilities that have performed comprehensive telecommunication studies have avoided stranded or otherwise unnecessary investment. I, therefore, recommend a telecommunications study be completed first as part of the telecommunications system deployment.

### 7. Cybersecurity

**Q. WHAT IS YOUR ASSESSMENT OF THE COMPANY’S CYBERSECURITY PROPOSAL?**

**A.** My testimony does not include a detailed analysis of the Company’s cybersecurity proposal. However, almost every aspect of grid modernization depends on additional communications capability, and many of these technologies touch elements of the distribution system or customer equipment. Customers expect that their personal information, including usage patterns, is protected and kept private. According to the NIST, smart grid cybersecurity must address both inadvertent compromises of the electric infrastructure, due to user errors, equipment failures, and natural disasters, as well as deliberate attacks, such as from disgruntled employees, industrial espionage, and terrorists.

The Company’s proposed risk-based framework shares elements of NERC’s Risk Based Assessment methodology used to help protect the bulk electric system. The proposal calls for a phased roll out.

**Q. DO YOU SUPPORT THE COMPANY’S CYBERSECURITY PROPOSAL?**

**A.** I am not prepared to endorse the Company’s proposal, but rather support a well-defined cybersecurity and privacy protection plan which should be prepared before components are installed and connected to the system. The cybersecurity plan should be based on an understanding of the specific new technologies and communication systems introduced to
the distribution system, should identify any potential vulnerabilities, and should include mitigation plans for these vulnerabilities. A cybersecurity and privacy protection plan helps the Company prudently manage potential risks associated with grid modernization systems. The Company's cybersecurity plan should be developed in a manner consistent with its Massachusetts GMP proposal. In addition, I support the proposal described in Division testimony of Mr. Balaban in Docket 4770 for an audit of Company investments in information technology, including cybersecurity.
V. CONCLUSION AND RECOMMENDATIONS

Q. WOULD YOU SUMMARIZE YOUR CONCLUSIONS OF THE ANALYSIS OF THE NATIONAL GRID INVESTMENT IN A MODERN GRID PROPOSAL AND YOUR RECOMMENDATIONS?

A. Yes. The following Table 1 outlines each component of the Company’s proposal and my recommendation regarding acceptance of the program or component in whole, as modified, or as not accepted. It is my professional opinion that what I have provided in this table is an appropriate and prudent initial phase in establishing a modern grid. Table 2 outlines those currently active programs the Company has discussed which are being implemented as part of its core business and funded within the annual ISR Plan. Eventually, these programs need to be recognized, along with many others, to be considered as part of a comprehensive GMP. The programs within Table 2 have already been accepted in whole or in part as a component of a pilot project.

Table 1: Component Recommendations

<table>
<thead>
<tr>
<th>National Grid Balanced Costs and Benefits</th>
<th>Accepted</th>
<th>Accepted with Conditions</th>
<th>Not Accepted</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. System Data Portal</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Advanced Metering Functionality*</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Feeder Monitoring Sensors</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>4. DSCADA</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>5. RTU Separation</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. GIS Data Enhancement</td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>7. Enterprise Services (ESB)</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. PI Historian</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Data Lake</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Advanced Analytics</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Telecommunications IT/OT</td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>12. Cybersecurity**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. OMS</td>
<td></td>
<td></td>
<td>X</td>
</tr>
</tbody>
</table>

* The pending proposal is to perform a coordinated AMI study with New York. Any final definitive opinions will need to wait for an evaluation of the study.
** Cybersecurity is not addressed in detail in this testimony.
Table 2: Currently Active Programs

<table>
<thead>
<tr>
<th>National Grid Balanced Costs and Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Automated Field Devices</td>
</tr>
<tr>
<td>2. Power Flow / Fault Analysis</td>
</tr>
<tr>
<td>3. DER &amp; Load Forecasting</td>
</tr>
<tr>
<td>4. Power Quality Analysis</td>
</tr>
<tr>
<td>5. VVO/CVR Pilot</td>
</tr>
</tbody>
</table>

Q. WOULD YOU FURTHER EXPLAIN TABLE 2, AND HOW THESE PROGRAMS SHOULD BE ADDRESSED, IF AT ALL?

A. These currently active programs have been evaluated within the ISR Plan and have been accepted. They do, however, have a correlation to both the core business and transition to a modern grid. As I have previously testified, some are simply the natural progression of applying the latest technology to a core business function, while others may become a true portion of grid modernization. These ongoing programs will need to be addressed in some way in the transition to a modern grid and their role defined in a grid modernization plan.

Q. DO YOU HAVE A SPECIFIC RECOMMENDATION CONCERNING THE CURRENTLY ACTIVE PROGRAMS, THOSE PROPOSED BY THE COMPANY, AND THOSE PROGRAMS THAT HAVE NOT BEEN IDENTIFIED?

A. Yes. I recommend the acceptance of all the Company’s proposed investments, with the exception of reducing the cost of the system data portal and eliminating further Feeder Monitoring Sensor additions. These are all foundational to a modern grid and represent Step 1 of a GMP. I then recommend the completion of a comprehensive GMP, with collaboration between the Division and stakeholders. The currently active programs and all proposed future programs should be incorporated in the proposed GMP with comprehensive analysis, discussion and individual cost-benefit analysis. This GMP would then be assessed along with the results of the AMI study through the regulatory process. The resulting GMP would ultimately receive acceptance as National Grid’s roadmap to
future grid modernization investments. This GMP should be completed in parallel with
the AMI study that was proposed, such that the GMP and AMI and being considered
together. This GMP, the AMI study, and ISR Planning should be considered in an integral
way, so as to make the capital component of multi-year planning transparent and consistent
within a long range plan vision. I also recommend that the Company move forward in the
ordinary course of business with the initiatives that I believe are core business; namely, the
GIS enhancements, RTU separation, and DSCADA. This structure also allows tracking of
individual programs or projects, ensuring that scopes and budgets are met, and providing
an opportunity for enhancements or re-direction as technologies evolve.

Q. DID YOU ANALYZE THE COMPANY'S INVESTMENT LEVELS FOR THE
NEXT FIVE YEARS?

A. I analyzed the Company's investment budgets and cost estimates based on its proposal.
These cost estimates appear developed using a sound methodology and conservative cost
estimating, with the exception of the system data portal. The costs are also consistent with
my experience and cost estimates proposed in other jurisdictions. However, the Company
will have a significant level of overlap, dependency, and crossover of costs not only
between the various foundational components, but between their operating jurisdictions
that are making similar investments. It is important to recognize that the Company has
outlined four distinct grid modernization plans in Massachusetts, for instance, which are
still pending approval. Therefore, true synergy between Company jurisdictions may or may
not exist in the short term. As a result of the interdependency of many components, both
the costs and benefits of any singular component will be difficult to clearly and singularly
define.
Q. DO YOU HAVE A SPECIFIC RECOMMENDATION IN REGARD TO BUDGETING?

A. Yes. The feeder monitoring sensors should be eliminated from the budget to the extent AMF will be deployed over the next 3 years. Also, as I testified earlier, the system data portal costs appear to be overstated by 30 percent and should be reduced accordingly.

Q. HOW DO YOUR RECOMMENDATIONS AND ADJUSTMENTS IMPACT THE BUSINESS CASE?

A. The Company should be required to resubmit a future business case, predicated on those recommendations which are accepted by the PUC, within a new GMP to be completed over the next two years. The Company would use a cost-benefit analysis for each new program that is not foundational.

Q. DO YOU HAVE ANY OTHER CONCLUSIONS OR SUMMARY RECOMMENDATIONS?

A. Yes. Throughout time, buzzwords have been applied to many programs, whether paradigm shift, smart grid, or grid modernization or other terminology which may be applied to the simple process of utilities growing and enhancing their ability to provide low cost, safe, and reliable power supply. Throughout the United States, many utilities have been embracing grid modernization for decades, and are actively and continually applying the latest technologies for the enhancement of their utility systems without the necessity of special rate relief or encouragement by utility commissions. The non-regulated consumer- and municipally-owned utilities, for obvious reasons, have, in many cases, been the leaders of technology implementation. Some of the regulated utilities have also been leaders in this area without encouragement from the regulatory bodies or special rate relief.
Rhode Island is clearly one of New England’s leaders in Power Sector Transformation, including Grid Modernization. At the core of my recommendations is the need for the process to be collaborative between the regulators, the consumers, stakeholders and the utility. Grid modernization should be a winning value proposition for all participating parties, and should not be looked on by any one of the stakeholders as one party wins and another party loses. Rhode Island has long had a strong capital projects planning and assessment process, and I suggest a similar grid modernization plan is a natural extension and does not require special regulatory treatment. Lastly, I strongly recommend that National Grid and the stakeholders take advantage of the lessons learned by their counterparts, regardless of whether those counterparts are in New England, or are other regulated and non-regulated utilities. The reality has been that the smaller systems have been more nimble and have been able to successfully deploy technologies across their entire system, and this provides excellent information to be relied upon by the larger utilities for improving their selection of technologies, processes, and implementation.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes it does.
AFFIDAVIT OF GREGORY L. BOOTH, PE

Gregory L. Booth, does hereby depose and say as follows:

I, Gregory L. Booth, on behalf of the Rhode Island Division of Public Utilities and Carriers, certify that testimony, including information responses, which bear my name was prepared by me or under my supervision and is true and accurate to the best of my knowledge and belief.

Signed under the penalties of perjury this the 25th day of April, 2018.

[Signature]
Gregory L. Booth

I hereby certify this document was prepared by me or under my direct supervision. I also certify I am a duly registered professional engineer under the laws of the State of Rhode Island, Registration No. 8078.

[Stamp]
Gregory L. Booth, PE
APPENDIX-1
RESUME OF
GREGORY L. BOOTH, PE, PLS
President
PowerServices, Inc.
Gregory L. Booth, PLLC

Gregory L. Booth is a registered professional engineer with engineering, financial, and management services experience in the areas of utilities, industry private businesses and forensic investigation. He has been representing over 300 clients in some 40 states for more than 50 years. Mr. Booth was inducted into the North Carolina State University Electrical and Computer Engineering Alumni Hall of Fame in November of 2016 based on his accomplishments in the field of engineering.

Mr. Booth has been accepted as an expert before state and federal regulatory agencies, including the Federal Energy Regulatory Commission, the Delaware Public Service Commission, the Florida Public Service Commission, the Minnesota Department of Public Service Environmental Quality Board, the Maine Public Utilities Commission, the Massachusetts Department of Public Utilities, the New Jersey Board of Public Utilities, the North Carolina Utilities Commission, the Pennsylvania Public Utility Commission, the Rhode Island Public Utilities Commission, and the Virginia State Corporation Commission. He has been accepted as an expert in both state and federal courts, including Colorado, Delaware, District of Columbia, Florida, Georgia, Kansas, Maryland, Minnesota, Missouri, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Puerto Rico, South Carolina, Texas, Virginia, West Virginia, Virgin Islands, and Wisconsin, and numerous Federal Court jurisdictions. Mr. Booth has provided expert witness services on over 500 tort case matters, and over 50 regulatory matters. Investigation and testimony experience includes areas of wholesale and retail rates, utility acquisition, territorial disputes, electric service reliability, right-of-way acquisition and impact of electromagnetic fields and evaluation of transmission line options for utility commissions.

Additionally, Mr. Booth has extensive experience serving as an expert witness before state and federal courts on matters including property damage, forensic evaluation, fire investigations, fatality, and areas of electric facility disputes and Occupational, Safety and Health Administration violations and investigations together with National Electrical Code and National Electrical Safety Code and Industry Standard compliance.

The following pages provided are the education and experience from 1963 through the present, along with courses taught and publications.
RESUME OF 
GREGORY L. BOOTH, PE, PLS

Mr. Booth is a Registered Professional Engineer with engineering, financial, and management experience assisting local, state, and federal governmental units; rural electric and telephone cooperatives; investor owned utilities, industrial customers and privately owned businesses. He has extensive experience representing clients as an expert witness in regulatory proceedings, private negotiations, and litigation.

PROFESSIONAL EDUCATION:
NORTH CAROLINA STATE UNIVERSITY; Raleigh NC, Bachelor of Science, Electrical Engineering, 1969

PROFESSIONAL HONORS:
Inducted into North Carolina State University Department of Electrical and Computer Engineering Alumni Hall of Fame in November 2016.

REGISTRATIONS:
Registered as Professional Engineer in Alabama, Arizona, Colorado, Connecticut, Delaware, District of Columbia, Florida, Georgia, Kansas, Maryland, Minnesota, Mississippi, Missouri, New Hampshire, New Jersey, North Carolina, Oklahoma, Pennsylvania, Rhode Island, South Carolina, Texas, Commonwealth of Virginia, West Virginia, and Wisconsin
Professional Land Surveyor in North Carolina
Council Record with National Council of Examiners for Engineering and Surveying

EXPERIENCE:

1963-1967
Transmission surveying and design assistance, substation design assistance; distribution staking; construction work plan, long-range plan, and sectionalizing study preparation assistance for many utilities, including Cape Hatteras EMC, Halifax EMC, Delaware Electric Cooperative, Prince George Electric Cooperative, A&N Electric Cooperative; assistance generation plant design, start-up, and evaluations.

1967-1973
Transmission line and substation design; distribution line design; long-range and construction work plans; rate studies in testimony before State and Federal commissions; power supply negotiations; all other facets of electrical engineering for utility systems and over 30 utilities in 10 states.

1973-1975
Directed five departments of Booth & Associates, Inc.; provided engineering services to electric cooperatives and other public Booth & power utilities in 23 states; provided expert testimony before state regulatory commissions on rates and reliability issues; in accident investigations and tort proceedings; transmission line routing and designs; generation plant designs; preparation and presentation of long-range and construction work plans; relay and sectionalizing studies; relay design and field start-up assistance; generation plant designs; rate and cost-of-service studies; reliability studies and analyses; filed testimony, preparation and teaching of seminars; preparation of nationally published manuals; numerous special projects for statewide organizations, including North Carolina EMC. Work was provided to over 130 utility clients in 23 states, PWC of the City of Fayetteville, NC, Cities of
Wilson, Rocky Mount and Greenville are among the utilities in which I have provided engineering services in North Carolina during this time frame. Services to industrial customers include Texfi Industries, Bridgestone Firestone, Inc and many others.

1994-2004

Responsible for the direction of the engineering and operations of President Booth & Associates, Inc. for all divisions and departments. The engineering work during this time frame has continued to be the same as during 1974 through 1993 with the addition of greater emphasis on power supply issues, including negotiating power supply contracts for clients; increased involvement in peaking generation projects; development of joint transmission projects, including wheeling agreements, power supply analyses, and power audit analyses. The work during this time frame includes providing services to over 200 utility clients across the United States, including NCEMC and NRECA.

2004-Present

Providing engineering and management services to the electric President industry, including planning and design. Providing forensic engineering, product evaluation, fire investigations and accident investigation, serving as an expert witness in state and federal regulatory matters and state and federal court.

2005-Present

Providing engineering and management services to the electric President industry, including planning and design and utility acquisition. PowerServices, Inc. Providing forensic engineering, product evaluation, fire investigations and accident investigation, serving as an expert witness in state and federal regulatory matters and state and federal court.

WORK AND EXPERTISE:

ELECTRIC UTILITIES:

- All aspects of utility planning, design and construction, from generation, transmission, substation and distribution to the end user.
- System studies, including long-range and short-range planning, sectionalizing studies, transmission load flow studies, system stability studies (including effects of imbalance and neutral-to-earth voltage), environmental analyses and impact studies and statements, construction work plan, power requirements studies, and feasibility studies.
• Fossil, hydro, microgrid, wind, and solar generation plan analysis, design, and construction observation.
• Transmission line design and construction observation through 230 kV overhead and underground, including interface with DOT and other utilities.
• Switching station and substation design and construction observation through 230 kV.
• Distribution line design and staking, overhead and underground, including interface with DOT and other utilities.
• Design of submarine cable installations. (Transmission and distribution)
• Supervisory control and data acquisition system design, installation and operation assistance.
• Load management system design, installation and operation assistance.
• Computer program development.
• Load research and alternative energy source evaluation.
• Field inspection, wiring, and testing of facilities.
• Relay and energy control center design.
• Mapping and pole inventories.
• Specialized grounding for abnormal lightning conditions.
• Ground potential rise protection.
• Protective system/relay coordination.
• Grid Modernization Plan development, regulatory testimony, and implementation
• Pole Attachment Agreements, rate design, and testimony

**UTILITY OPERATIONS:**
• Storm assessment services., including interface with DOT and other utilities
• Regulatory testimony on storm response.
• Storm Response Plan development.
• Operations, including outage management and Call Centers.
• Outage management and operations enhancement services and testimony.

**GENERATION DESIGN / FAILURE ANALYSES:**
• Intermediate and peaking generation (gas and oil fired through 400 MW).
• Peaking generation (diesel and gas through 10,000 kW)
• Wind generation.
• Solar (PV) generation.
• Hydroelectric generation.
• Microgrid, including energy storage.

**TELECOMMUNICATION: UTILITIES:**
• Subscriber and trunk carrier facilities design.
• Stand-by generation and DC power supplies
• DC-AC inverters for interrupted processor supplies.
• Plant design and testing.
• Fiber optics and other transmission media.
• Microwave design.
• Pole attachment designs and make-ready design.
• Pole Attachment Agreements and rental rates calculations.
• Regulatory testimony.
**FINANCIAL SERVICES:**
- Long-term growth analyses and venture analyses.
- Lease and cost/benefit analyses.
- Capital planning and management.
- Utility rate design and service regulations.
- Cost-of-Service studies.
- Franchise agreements.
- Corporate accounting assistance.
- Utility Commission testimony (State and Federal)

**FORENSIC ENGINEERING:**
- Compliance with NESC, NEC, OSHA, IEEE, ANSI, ASTM and other codes and industry standards, including DOT standards.
- Equipment and product failure and analysis and electrical accident investigation (high and low voltage equipment).
- Stray voltage, electrical shocking, and electrocution investigations.
- Building code investigations.
- New product evaluation.
- MCC, MDP failure analysis and arc flash analysis
- Electrical fire analysis

**INDUSTRIAL/ELECTRICAL ENGINEERING:**
- Building design (commercial and industrial).
- Building code application and investigation. (NFPA and NEC)
- Electric thermal storage designs for heating, cooling, and hot water.
- Standby generation and peaking generation design.
- Electric service design (residential, commercial, and industrial).

**INSTRUCTIONAL SEMINARS AND TEXT:**
- Seminars taught on arc flash hazards and safety, including National Electrical Safety Code regulations for utilities.
- Courses taught on Distribution System Power Loss Evaluation and Management.
- Courses taught on Distribution System Protection.
- Text prepared on Distribution System Power Loss Management.
- Text prepared on Distribution System Protection.
- Seminars taught on substation design, NESC capacitor application, current limiting fuses, arresters, and many others electrical engineering subjects.
- Courses taught on accident investigations and safety.
- Courses taught on Asset Management.
- Courses taught on OSHA and Construction Safety.

**TESTIMONY AS AN EXPERT:**
- Concerning property damage or personal injury before courts in Colorado, Delaware, District of Columbia, Florida, Georgia, Kansas, Maryland, Minnesota, Missouri, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Puerto Rico, South Carolina, Texas, Virginia, West Virginia, Virgin Islands, and Wisconsin.
FIELD ENGINEERING:

- Transmission line survey and plan and profile.
- Distribution line staking.
- Property surveying.
- DOT highway relocation design.
- Relay and recloser testing.
- Substation start-up testing.
- Generation acceptance and start-up testing.
- Ground resistivity testing.
- Work order inspections.
- Operation and maintenance surveys.
- Building inspection and service facility inspection.
- Construction Management
  - Generation
  - Transmission
  - Substation
  - Distribution
  - Building Electrical Installations
  - GSA construction projects
  - NASA construction projects
  - University construction projects

PROFESSIONAL ORGANIZATIONS:

a. National Society of Professional Engineers (NSPE)
b. Professional Engineers in Private Practice (PEPP)
c. National Council of Examiners for Engineering & Surveying (NCEES)
d. Professional Engineers of North Carolina (PENC)
e. National Fire Protection Association (NFPA)
f. Associate Member of the NRECA
g. NRECA Cooperative Network Advisory Committee (NRECA-CRN)
h. The Institute of Electrical and Electronics Engineers (IEEE)
   (Distribution sub-committee members on reliability)
i. American Standards and Testing Materials Association (ASTM)
j. Occupational Safety and Health Administration (OSHA) Certification
k. American Public Power Association (APPA)
l. American National Standards Institute (ANSI)