Proposal for Building Commissioning Services
High School and Elementary School Projects
Centennial School District

Prepared by:
Reynolds Consulting Engineers
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Harrisburg, PA 17111

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February 24, 2012
February 24, 2012

Mr. William R. Gretton III
Assistant Superintendent of Operations
Centennial School District
433 Centennial Road
Warminster, PA 18974

Dear Bill:

We are pleased to submit this proposal for building systems commissioning to the Centennial School District for the existing William Tennent High School and Willow Dale Elementary School, as well as the new Davis and McDonald Elementary School projects. Our in-house team of commissioning experts and professional engineers has the experience, know-how and creativity to ensure that the Centennial School District will have buildings that will meet your operational needs.

Reynolds Consulting Engineers has 13 years of commissioning experience with more than $500 million of public school commissioning projects throughout Pennsylvania. This success is built on a strong team of engineering and commissioning professionals who are dedicated to providing you with the highest level of service possible, and who are on-hand and ready to begin work immediately on your projects.

We appreciate this opportunity to provide you with this proposal and hope it meets with your approval. The single most important aspect of any project is that final product meets your design intent. As commissioning specialists, we ensure that commissioning and testing is carried out correctly by offering an unbiased and independent service to the Centennial School District.

If you require additional information or have any questions, please feel free to contact me at your convenience.

Sincerely,

REYNOLDS CONSULTING ENGINEERS, INC.

Rose Fetter
Director of Business Development
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**Firm Information**

Reynolds Consulting Engineers, Inc.

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**Years in Business**
13

**Firm History**

Incorporated in 1999, Reynolds Consulting Engineers (RCE) is a Harrisburg, Pennsylvania, based firm that focuses on providing engineering and building commissioning services of the highest order. Over the past 13 years, we have provided services for more than $1.7 billion in new and renovated construction throughout the mid-Atlantic region. These projects included K-12 schools, higher education facilities, office buildings, health care facilities, central power plants, museums, high performance athletic facilities, technology intensive laboratory facilities, and correctional institutions.

Staffed with three registered Professional Engineers and four LEED Accredited Professionals, RCE’s building commissioning team takes a hands-on approach. We work with owners to ensure that they have a complete understanding of all testing procedures, as well as the proper training on all building systems and components. RCE is unique because mechanical, electrical and plumbing (MEP) design services are also offered. This experience in designing for MEP systems provides our staff with a different perspective of the entire commissioning process, thus making them more effective advocates for the Owner and providing the Owner with a building that runs more efficiently and meets their needs now and in the future.

RCE provides full-service HVAC, mechanical, electrical, plumbing, and fire protection engineering design, as well as building commissioning services. In order to provide these services a team of professional engineers has been assembled to offer our clients practical, cost effective, and efficient approaches to
the design and commissioning of their facilities, whether it is a new building or one undergoing renovation.

In 2000, RCE made a conscious effort to become more involved in the “green” and sustainable design and construction movement. RCE is a strong believer that sustainable design and construction is an important means of reducing the impact of the construction industry on our ecosystem. By incorporating the use of renewable materials, recycling, lower energy consumption, and minimizing environmental impact, the USGBC’s LEED® program is leading the way in which these principals can be incorporated into real construction projects. To date, we have been, or are currently involved in 46 projects that have either earned LEED certification or have been registered with the LEED program and are currently pursuing certification. Great pride is taken in our ability to work with owners to ensure that their sustainability and certification goals are met, while at the same time providing them with a building that operates efficiently and meets their operational needs.

**Building Commissioning and Retro-Commissioning Services**

Reynolds offers a unique approach to building commissioning and retro-commissioning. Our staff has over 50 years of experience designing and testing heating, ventilation, air conditioning, electrical, lighting, and plumbing systems. This experience allows us to look at the systems as a whole and also gives us a unique perspective on the performance and function of the equipment used in today’s buildings.

The most precise, up-to-date technology and data loggers available for our testing procedures are used. The electronic data loggers provide precise results, thus allowing us to more clearly focus on the performance of complete systems. Additionally, owners are continually given detailed reports, multiple performance tests and building systems inspections are performed, and cost savings documentation is provided.

Our knowledgeable team of experts has provided commissioning services for many different building systems, including the following:

- Heating, ventilation and air conditioning (HVAC)
- Building automation and controls (BAS, DDC, ATC)
- Building envelope (using thermal imaging)
- Electrical systems, uninterruptible power systems and switchgear
- Plumbing
- Life safety (fire detection and suppression systems)
- Security
- Lighting and day-lighting controls
- Acoustics
- Communications (data/CATV/paging/PA)
Memberships and Certifications

We are members of the Building Commissioning Association, the Delaware Valley Green Building Council, Pennsylvania School Boards Association, Pennsylvania Association of School Business Professionals and the U.S. Green Building Council. RCE is a Certified Commissioning Authority through the AABC Commissioning Group.
Section 2: Commissioning Experience

**Similar Project Experience**

Over the past 13 years of business, Reynolds Consulting Engineers (RCE) has developed a reputation, within the Mid-Atlantic region’s school market, as a firm that has expertise in commissioning K-12 projects, and as a firm that achieves excellent results for school districts. RCE has provided building commissioning services for a wide variety of project types including additions and renovations, new construction, and retro-commissioning. Since 1999 over $1.7 billion in new and renovated construction throughout the region has been completed, or is currently in process.

On the pages following this section, project cut-sheets for relevant K-12 project experience is included, as well as a comprehensive list of all K-12 commissioning projects.

**Traditional Test and Balance**

As a part of our commissioning scope, RCE is typically asked to review and approve the air and water system balancing. A common concern with testing, adjusting and balancing (TAB) reports is the status of each piece of equipment when air/water systems are balanced. Procedures proposed by the TAB contractor are reviewed to determine that the operating conditions measured reflect the intended sequence of operation. The contractor’s TAB reports are also verified through checklists and independent testing. A successful HVAC system is dependent upon the coordination between the commissioning agents, automatic temperature controls (ATC) and TAB contractor during construction. This interaction with the TAB contractor gives our staff well-rounded experience and knowledge about the testing, adjusting and balancing process.

**O & M Experience**

RCE understands that the operation and maintenance (O&M) manuals are very important in the long-term usage of your buildings. To ensure that the startup, maintenance schedules, warranties, operations, etc. are included and correct, the set of manuals for your projects will be thoroughly reviewed. This information is then utilized in the formation of functional testing procedures.
Section 2: Commissioning Experience

The scheduling of the O&M training will be overseen to make sure that all the key personnel (owner, maintenance/facility personnel, HVAC design professional, electrical design professional, contractors, and construction manager) and items are included and covered. The format for the O&M training sessions will follow the outlines provided in the O&M manuals.

Again, RCE reviews the set of manuals and ensures that all of the necessary information is included and correct for the project. We check to make sure that all modifications made during the construction phase are included in the manuals. We also ensure that the O&M information is clearly assembled and indexed in the Commissioning Manuals in accordance with ASHRAE Guideline 4-1993.

Energy-Efficient Equipment Design and Control Strategy Optimization

RCE also provides mechanical, electrical and plumbing design services and in all cases attempts to provide our clients with the most energy efficient design possible to meet their operational needs. One example of this was our experience with the Milton Hershey School, where our team designed a multiple fuel cell installation to provide the campus with a noise and pollution free source of electricity and heat.

As commissioning agent, we have frequently provided input on the controls system to ensure that the systems are operating at an optimal level, while still providing thermal comfort to building occupants. Our data loggers have discovered flawed control sequences that otherwise would have gone undiscovered and cost the owners to heat and/or cool the building when it was unoccupied.

One example is when RCE provided a life-cycle cost analysis for a 3,000-ton, water-cooled, centrifugal chiller project at The Penn State Milton S. Hershey Medical Center. This study included establishing a baseline profile of the existing system using the previous year’s daily operating logs. The model compared construction, maintenance and energy costs for four different chiller configurations (two centrifugal chillers; three centrifugal chillers; steam absorption, centrifugal hybrid; and gas engine, centrifugal hybrid).
Section 2: Commissioning Experience

Experience with Environmentally Sustainable Design

RCE has four LEED Accredited Professionals on staff. To date, we have been, or are currently involved in 46 projects that have either earned LEED certification or have been registered with the LEED program and are currently pursuing certification. We take great pride in our ability to work with owners to ensure that their sustainability and certification goals are met, while at the same time providing them with a building that operates efficiently and meets their operational needs.

System Design

RCE also provides MEP design services for select clients in addition to building commissioning services. Our proposed commissioning team members have a combined total of more than 50 years of experience in design and commissioning. Additionally, two proposed team members are registered professional engineers. This ensures that they are intimately familiar with the equipment and systems they are testing and well versed in present codes and standards.

We recently completed three large MEP design projects for the Owen J. Roberts School District and are currently designing an HVAC and domestic hot water system replacement for the Schuylkill Intermediate Unit 29’s Maple Avenue Campus.

IAQ Experience

During the construction of Wrightsville Elementary School, Reynolds worked in conjunction with the installing contractors to ensure the installed materials were being protected from contaminants. This helped to improve the Indoor Air Quality (IAQ) for the project.

RCE recognizes that indoor air quality is a very important aspect of an environmentally friendly design. RCE utilizes a Construction Indoor Air Quality Management Plan. This plan details steps to be addressed such as, filter replacement schedules, materials to use, building air out schedules, etc. We phase the installation of absorptive media, such as insulation, carpeting, and wallboard in order to reduce the chance of contamination. The last part of this plan is the installation of new HVAC filters for all units immediately prior to the owner moving in.
PROJECT OVERVIEW
Oxford School District hired Reynolds Consulting Engineers to provide commissioning services for the conversion of their old high school into a new middle school.

The project called for the renovation of 76,000 square feet and the construction of a new 53,000-square-foot addition. This two-story addition includes classrooms, a library, and a connector link to the existing building. The project also included the demolition of the existing technical education and library wing. The new middle school can accommodate 800 students.

OWNER
Oxford Area School District
Mr. Charles L. Lewis Jr.
Business Administrator
119 South Fifth Street
Oxford, PA 19363
610.932.6607

SERVICES
Building Systems
Commissioning

CONSTRUCTION COST
$20.8 Million
PROJECT OVERVIEW

Pennsbury School District hired Reynolds Consulting Engineers to perform building commissioning for the Makefield Elementary School renovations project.

The school is an historic building veneered by the community but in need of expansion. The school district decided to renovate the existing building with “green” design features and efficient space utilization in order to reduce the need for additional square footage.

The school district is attempting LEED Silver level certification for the project.
PROJECT OVERVIEW
Western Wayne School District awarded Reynolds Consulting Engineers a contract to provide full commissioning services for the new South Elementary School project. The construction cost for this project is estimated to be $15 million.

The new, two-story building will be approximately 102,000 square feet. The school district is attempting LEED Silver level certification for the project.
PROJECT OVERVIEW
The School District of the City of York hired Reynolds for building commissioning services for the McKinley and Jackson Elementary School projects.

The District has a goal of obtaining LEED Silver certification for each project.

Previously, Reynolds performed construction management services for the adaptive-re-use project at the Lindbergh Avenue School.

OWNER
School District of the City of York
Mr. Bradley Harman
Director of Buildings & Grounds
329 Lindbergh Avenue
York, PA 17405-1927
717.849.1232

PROJECT SQUARE FEET
Jackson ES: 1,130 New Construction
61,650 Renovations
McKinley ES: 350 New Construction
71,000 Renovations

CONSTRUCTION COST
Jackson ES: $10.2 Million
McKinley ES: $8.8 Million
PROJECT OVERVIEW
Reynolds Consulting Engineers was hired by the Owen J. Roberts School District to provide commissioning services for the new, 75,000-square-foot French Creek Elementary School. They are pursuing a LEED EB certification for this project from the USGBC.

Reynolds also commissioned the renovation of the 160,000-square-foot Owen J. Roberts High School. The new North Coventry Elementary School was also commissioned by Reynolds Consulting Engineers.
PROJECT OVERVIEW

Reynolds was hired by the Wallingford-Swarthmore School District to provide HVAC commissioning services for the major additions and renovations to the Strath Haven Middle School.

The 82,965-square-foot renovation portion of the project includes new finishes and systems throughout the existing facility, including new HVAC (ground source heat pumps) and controls, electrical, plumbing and data. The 92,722-square-foot new addition is a large classroom and media center wing.

The project included sustainable design features.
PROJECT OVERVIEW
Reynolds Consulting Engineers was hired to provide building commissioning services for the additions and renovations to the Manheim Township High School.

The project consisted of a new 233,000-square-foot addition, MEP upgrades and finishes to the existing 200,000-square-foot building. RCE provided building commissioning for the HVAC, electrical, plumbing and fire protection systems.

They are attempting the Silver certification from the USGBC’s LEED program.
PROJECT OVERVIEW

Reynolds Consulting Engineers was hired by the Manheim Township School District to provide building commissioning services for the additions and renovations to the Bucher Elementary School. The project consists of a new, two-story 74,000-square-foot addition and renovations to 24,000 square feet of existing building.

They are attempting Silver level certification from the USGBC's LEED program. Sustainable design features include a geothermal system, daylighting, grey water storage, white and vegetative roof, and landfill reduction goals.
PROJECT OVERVIEW
Reynolds Consulting Engineers was hired to commission all of the building systems for this new 42,000-square-foot elementary school. Systems included in the commissioning process were: fire protection, HVAC, plumbing, electrical, and control systems.

The Clearview Elementary School has earned a Gold level LEED certification from the U.S. Green Building Council. This was the first elementary school in Pennsylvania to earn this distinction.
PROJECT OVERVIEW

The School District of Philadelphia hired Reynolds Consulting Engineers to provide building commissioning services for their new Central Administration Building.

The project was an adaptive reuse of the former 890,000-square-foot Philadelphia Inquirer building in center city Philadelphia. The building was gutted and now includes a new Network Operations Center, public meeting rooms and office space for the District’s 1,500 employees.
PROJECT OVERVIEW

Reynolds Consulting Engineers was hired to commission all of the building systems for the Yorktown High School replacement and renovation program.

Phase I of the project consisted of the construction of a new three-story, 55,000-square-foot addition and minor renovations throughout the existing building.

Phase II of the program will include extensive phased demolition of the current facility, and construction of a large addition. The final completed project will encompass 349,000 square feet.

Arlington Public Schools has decided to pursue LEED Certification for the Phase II design and construction project at Yorktown High School.
Pennsylvania Public School Experience

Central York School District
- Central York High School, New Construction

Danville Area School District
- Danville Primary Center, New Construction

Downingtown Area School District
- Pickering Valley Elementary School, New Construction
- Springton Manor Elementary School, New Construction
- West Bradford Elementary School, Retro Commissioning

Eastern York School District
- Wrightsville Elementary School, Addition/Renovation – LEED Silver

Elizabethtown Area School District
- Bear Creek Intermediate Elementary School, New Construction
- East High Elementary School, Addition/Renovation

Hanover Public School District
- Clearview Elementary School, New Construction – LEED Gold

School District of Lancaster
- Ross Elementary School, Addition/Renovation – LEED Silver registered
- Wharton Elementary School, Addition/Renovation – LEED Silver registered

Manheim Township School District
- Bucher Elementary School, Addition/Renovation – LEED Silver registered
- Manheim Township High School, Addition/Renovation – Design 2 – LEED Silver registered

Marple Newtown School District
- District Administration Office, Addition/Renovation
- Marple Newtown High School, Addition/Renovation

Mifflin County School District
- Indian Valley High School, New Construction

Montoursville Area School District
- C.E. McCall Middle School, Addition/Renovation

Owen J. Roberts School District
- District Administration Building, Addition/Renovation
- French Creek Elementary School, Retro Commissioning
- North Coventry Elementary School, New Construction
- Owen J. Roberts High School, Addition/Renovation
- Owen J. Roberts Middle School, Addition/Renovation

Oxford Area School District
- Hopewell Elementary School, Addition/Renovation
- Oxford High School, Retro Commissioning
- Penn’s Grove Middle School, Addition/Renovation

Pennsbury School District
- Makefield Elementary School, Addition/Renovation – LEED Silver registered
Commissioning Projects

School District of Philadelphia
District Administration Building, New Construction

Phipsburg-Osceola Area School District
North Lincoln Middle School, Addition/Renovation

Phoenixville Area School District
Phoenixville Area Middle School, New Construction

Schuylkill IU 29
Maple Avenue Campus, HVAC Replacement

Shikellamy School District
Beck Elementary School, Addition/Renovation, Energy Project

Shippensburg Area School District
District-wide Facilities, Energy Conservation Project

Southeast Delco School District
Academy Park High School, Addition/Renovation

State College Area School District
Ferguson Township Elementary School, New Construction – LEED
Gray’s Woods Elementary School, Retro Commissioning
Panorama Village Elementary School, New Construction – LEED

Wallingford-Swarthmore School District
Strath Haven Middle School, Addition/Renovation
Wallingford Elementary School, Addition/Renovation

Western Wayne School District
South Elementary School, New Construction – LEED Silver registered

Williamsport Area School District
Hepburn Lycoming Elementary School, Retro Commissioning

York City School District
Lindbergh Avenue School, Addition/Renovation – LEED Silver registered
Jackson Elementary School, Addition/Renovation – LEED Silver registered
McKinley Elementary School, Addition/Renovation – LEED Silver registered

Private K-12 Experience

Middle Division Homes
Retro Commissioning

Milton Hershey School
Animal Center, Addition/Renovation
Catherine Hall Middle School, New Construction
Clyde Stacks Visual Arts Facility, New Construction
Copenhaver Student Center, Addition/Renovation
Founders Hall Dining Room and Staff Offices, Renovation
Senior Hall High School, New Construction
Spartan Center, Performance Gymnasium, New Construction
Student Homes, New and Add/Renovation
Transitional Living Homes (2), New Construction
W. Allen Hammond Learning Resource Center, New Construction
Commissioning Projects

Other Projects

Bucknell University
- Academic West Building, New Construction – LEED registered
- Two Fraternity Houses, New Construction – LEED registered

Bucks County Community College
- Upper Bucks Campus Expansion, Addition – LEED Silver registered

Carnegie Library of Pittsburgh
- Brookline Branch, Renovation – LEED registered
- Squirrel Hill Branch, Renovation – LEED registered
- Woods Run Branch, Renovation – LEED registered

Community College of Philadelphia
- Northeast Regional Campus, Addition/Renovation – LEED
- Main Campus, Addition/Renovation – LEED

Delaware County Community College
- Tech Building, New Construction – Construction Phase Services Only

Harford Community College
- Towson University Building, New Construction – LEED registered

Hershey Medical Center
- East Campus Expansion, New Construction – LEED registered
- East Tower Replacement
- Satellite Chiller Plant, New Construction

Pennsylvania Housing Finance Authority
- Headquarters, New Construction – LEED Gold

Siemens
- H&W and L&I Buildings, ESCO Commissioning

Pennsylvania Turnpike Commission
- Plymouth Meeting Turnpike Maintenance Facility – LEED Silver registered
- PTC Data Center
- Trevose Turnpike Maintenance Facility – LEED Silver registered
- Uniontown to Brownsville Turnpike Maintenance Facility – LEED Silver registered

Pennsylvania Association of School Business Officials (PASBO) and Pennsylvania Association of School Administrators (PASA)
- Office Renovation – LEED Silver registered

Pennsylvania State University
- Gary Shultz Childcare Center, New Construction – LEED Silver registered

Thomas Jefferson University
- 901 Walnut Street, New Construction – LEED

University of Pittsburgh
- Benedum Hall, Phase 2, Addition/Renovation – LEED registered

Providence Township
- Municipal Office and Maintenance Facility, New Construction – LEED registered
Qualifications of Commissioning Agent

David Hickey, P.E., LEED AP, CEM, will be your lead Commissioning Agent for your projects. Mr. Hickey has over 17 years of related design and commissioning experience. Since 1999, Mr. Hickey has been involved in over 100 commissioning projects with RCE. Outlined below are some of Mr. Hickey’s relevant qualifications:

- **Experience Commissioning Projects over 100,000 square feet** – Mr. Hickey has provided commissioning agent services for many buildings over 100,000 square feet in size, including the Arlington Public School’s Yorktown High School, a two-phase project totaling 349,000 square feet costing $107 million, LEED registered; School District of Philadelphia’s Broad Street Administration Building, a $65 million project totaling 255,000 square feet; and the Pennsylvania Housing and Finance Agency’s headquarters building, a new LEED Silver, 178,000-square-foot building costing $22 million.

- **Experience in Operation and Troubleshooting of HVAC and Other Building Systems** – Throughout the course of his design engineering and commissioning experience, Mr. Hickey has participated in the troubleshooting and operations of HVAC and building controls systems. As security systems become more prevalent they have come to be included in many commissioning projects. One project of note was the commissioning of the security system for the new $100 million State Correctional Institution at Fayette. Mr. Hickey participated in the troubleshooting of the security system for the entire 600,000-square-foot facility.

- **Field Experience** – In 1999, Mr. Hickey started at RCE as a senior mechanical commissioning associate and senior systems engineer. In these roles, he routinely participated in the actual field verification and functional testing of the various project’s systems.

- **Knowledgeable on Operation and Maintenance Training** – Mr. Hickey routinely participates in the coordination and oversight of the owner’s training activities to ensure that all of the key personnel (owner, maintenance/facility personnel, HVAC design professional, electrical design professional, contractors, and construction manager) and items are included and covered. As the Commissioning Authority, Mr. Hickey has an in-depth understanding of the building’s operation and maintenance items due to his involvement in the functional testing procedures. He brings this knowledge and experience to the training sessions and ensures that the owner’s operations and maintenance personnel are provided the necessary information and training to operate and maintain the building properly.
**Section 3: Commissioning Agent**

- **Experience with TAB for Water and Air Systems** – As a part of the commissioning scope, RCE is typically asked to review and approve the air and water system balancing. This interaction with the testing, adjusting and balancing (TAB) contractors has given Mr. Hickey a well-rounded knowledge about the TAB process.

- **Experience in Energy Efficient Design and Control Strategy Optimization** – RCE also provides mechanical, electrical and plumbing design services and in all cases attempts to provide owners with the most energy efficient design possible that will meet their operational needs. One example of this was Mr. Hickey’s experience with the Milton Hershey School where a multiple fuel cell installation was designed to provide the campus with a noise and pollution-free source of electricity and heat.

- **Experience Monitoring and Analyzing System Operation Using Controls and Stand-Alone Data Loggers** – Throughout the course of RCE’s commissioning experience both energy management control systems and stand-alone data loggers have been used to provide information for functional testing procedures. When given the choice, data loggers were preferred: as they are independent of the system. However, Mr. Hickey has experience using both data loggers and the energy management control system and is open to working with the District utilizing both as tools in the commissioning process.

- **Experience with Indoor Air Quality Testing Procedures** – Often, Mr. Hickey and RCE provide guidance to owners on indoor air quality as it relates to LEED credits. At the Wrightsville Elementary School project, Mr. Hickey worked with the District to provide the required air quality testing to meet option 2 of the Construction IAQ Management Plan (C 3.2.)

- **Excellent Verbal and Written Communication Skills** – The ability to communicate verbally and in written format with the various parties involved in a commissioning project, including owners, design professionals and contractors are integral to the whole commissioning process. As the leader of RCE’s commissioning team, Mr. Hickey has learned the importance of communication and has developed into an effective and straight-forward communicator.

- **Experience Writing Commissioning Specifications** – Mr. Hickey and the rest of the RCE commissioning team write individualized, project specific commissioning specifications for each project.
Section 3: Commissioning Agent

- **Education and Continuing Education** – As you will see on his resume, Mr. Hickey holds a degree in Bachelor of Architectural Engineering, with a mechanical emphasis, from Penn State University. Mr. Hickey is a Professional Engineer in Pennsylvania and Virginia, a LEED Accredited Professional, and a Certified Energy Manager.

- **Independent Contractor** – Mr. Hickey is an independent commissioning authority. Neither Mr. Hickey nor RCE have any ties or relationships to any general contractor, prime contractor, construction manager, or design professional that may be involved in the Centennial School District projects. Mr. Hickey will work independently from the design and construction teams and report any results, findings and recommendations directly to the District.
Organizational Chart and Resumes

Below is a detailed project team organizational chart. Following the organizational chart are detailed resumes of the key personnel.

**David Hickey, P.E.**
Lead Commissioning Agent

Responsibilities:
- Commissioning oversight & coordination
- Develop Cx. Plan and functional test procedures
- Functional testing of equipment

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**David Burkett, P.E.**
Sr. Mechanical Commissioning Agent

Responsibilities:
- Observation of construction and installation
- Functional testing of mechanical equipment

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**Jeffrey Smeiles**
Commissioning Technician

Responsibilities:
- Witness system start-up
- Assemble System Manual
- Review O&M materials
- Witness training

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**Alan Rosenberry**
Electrical Commissioning Agent

Responsibilities:
- Observation of construction and installation
- Functional testing of electrical & lighting equipment

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**Jim Decker**
Plumbing Commissioning Agent

Responsibilities:
- Observation of construction and installation
- Functional testing of plumbing equipment

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*Designates LEED® Accredited Professional or LEED Green Associate*
David Hickey, P.E., LEED AP, CEM
Lead Commissioning Agent

Education:
- Bachelor of Architectural Engineering – Mechanical Emphasis, Pennsylvania State University, 1995
- Registered Professional Engineer in Pennsylvania, 2000
- LEED Accredited Professional, 2001
- Certified Energy Manager – Association of Energy Engineers, 2009

Years of Experience: 17

Project Responsibilities:
As the lead commissioning agent, Mr. Hickey oversees the entire commissioning process for all projects and participates in and reviews higher-level mechanical and electrical systems testing. He is responsible for overseeing all commissioning activities, particularly testing, training and coordination of meetings.

Reference:
Mr. Stephen Nicholson
Technical Support Services Coordinator
Fairfax County Public Schools
703.246.6260

Mr. Curt Dove
Project Manager
Arlington Public Schools
703.228.7738

Relevant Experience:
Hanover Public School District, Hanover, PA
Building Commissioning of New 42,000 s.f. Clearview Elementary School
Gold Level LEED Certified Project
Construction Cost: $6.3 Million

School District of Philadelphia, Philadelphia, PA
Building Commissioning of New District Administration Building
Construction Cost: $65 Million

Eastern York School District, Wrightsville, PA
Building Commissioning of New 80,000 s.f. Wrightsville Elementary School
Silver Level LEED Certified Project
Construction Cost: $11 Million
David Hickey, P.E., LEED AP, CEM
Lead Commissioning Agent

Milton Hershey School, Hershey, PA
Building Commissioning of New High School, Middle School, Learning Resource Center, Performance Gymnasium, Catherine Hall, Central Operations, Founders Hall, Memorial Hall, Central Power Plant, Visual Arts Facility and Student Homes
Total Construction Cost: $99 Million

PA Housing Finance Agency, Harrisburg, PA
Building Commissioning of New 178,000 s.f. Downtown Office Building
Gold Level LEED Certified Project
Construction Cost: $22 Million

Fairfax County Public Schools, Fairfax, VA
Building Commissioning of Edison High School School Additions/Renovations
Building Commissioning of New L.L. Coates Elementary School
Building Commissioning of New Laurel Hill Elementary School
Building Commissioning of Lacey Elementary School Additions/Renovations
Building Commissioning of Franconia Elementary School Additions/Renovations
Building Commissioning of Westlawn Elementary School Additions/Renovations
Total Construction Cost: $161 Million

Arlington Public Schools, Arlington, VA
Building Commissioning for Phase I and Phase II Expansion and Renovation of Yorktown High School
Registered for LEED Silver Level Certification
Construction Cost: $107.9 Million
Building Commissioning of Arlington Traditional School
Construction Cost: $4.7 Million
Building Commissioning of Claremont Elementary School
Construction Cost: $3 Million
Building Commissioning of Swanson Middle School
Construction Cost: $5.2 Million
Building Commissioning of H.B. Woodlawn Elementary School
Construction Cost: $2.3 Million
Building Commissioning of Nottingham Elementary School
Construction Cost: $5 Million
Retro-commissioning of Gunston Middle and Jamestown Elementary Schools

Carnegie Library of Pittsburgh, Pittsburgh, PA
Building Commissioning of Renovated Brookline, Squirrel Hill and Woods Run Branch Libraries
Registered for LEED Certification
Construction Cost: $9 Million
Dave Burkett, P.E., LEED AP
Mechanical Commissioning Agent

**Education:**

- Bachelor of Mechanical Engineering Technology, University of Pittsburgh, 1983
- Registered Professional Engineer in Pennsylvania, 1989 and Maryland, 1994
- LEED Accredited Professional, 2004

**Years of Experience:** 29

**Project Responsibilities:**

As the mechanical commissioning agent, Mr. Burkett is responsible for the pre-functional and functional testing of the project’s systems to make sure they perform within the designated ranges. He also is responsible for reviewing the installation, required testing and as-built drawings for the systems, develops the relevant systems manuals, and participates in the O&M training.

**References:**

Mr. Bradley Harman  
*Director of Buildings and Grounds*  
School District of the City of York  
717.849.1232

Mr. Roger Madron  
*Director of Buildings and Grounds*  
Oxford Area School District  
610.932.6608

**Relevant Experience:**

**Oxford Area School District, Oxford, PA**  
*Building Commissioning of Additions/ Renovations to Penn’s Grove Middle School, Hopewell Elementary School and Oxford High School*  
Construction Cost: $81.3 Million

**School District of the City of York, York, PA**  
*Building Commissioning of Additions and Renovations at Jackson and McKinley Elementary Schools*  
Registered for LEED Silver Level Certification  
Construction Cost: $19 Million

**Central York School District, York, PA**  
*Building Commissioning of New 350,000 s.f. Central York High School*  
Construction Cost: $48.5 Million
Western Wayne School District, South Canaan, PA
Building Commissioning of New South Elementary School
Registered for LEED Silver Level Certification
Construction Cost: $15.4 Million

School District of Lancaster, Lancaster, PA
Building Commissioning of Additions/Renovations of Wharton Elementary School
Registered for LEED Silver Level Certification
Building Commissioning of Additions/Renovations of Ross Elementary School
Registered for LEED Silver Level Certification
Construction Cost: $16 Million

Manheim Township School District, Lancaster, PA
Building Commissioning of New High School
Registered for LEED Certification
Building Commissioning for Bucher Elementary School
Registered for LEED Silver Level Certification
Construction Cost: $63.7 Million

Downingtown Area School District, Downingtown, PA
Building Commissioning of New Pickering Valley Elementary School
Building Commissioning of New Springton Manor Elementary School
Registered for LEED Silver Level Certification
Total Construction Cost: $87 Million

Montgomery County Public Schools, Rockville, MD
Building Commissioning of Addition project at Brookhaven Elementary School
Building Commissioning of Addition project at Harmony Hills Elementary School
Building Commissioning of Addition project at Rock View Elementary School
Building Commissioning for Replacement of Cannon Road Elementary School
Registered for LEED Silver Level Certification
Construction Cost: $41.7 Million

Bucks County Community College, Newtown, PA
Building Commissioning of the Upper Bucks County campus expansion project
LEED Registered for Gold Level Certification
Construction Cost: $13 Million

Community College of Philadelphia, Philadelphia, PA
Building Commissioning of the Main Campus Expansion Projects
LEED Registered for Silver Level Certification
Construction Cost: $6.2 Million
Alan Rosenberry  
**Electrical Commissioning Agent**

**Education:**
- Mechanical Drafting Diploma – Franklin County Vo-Tech, 1980
- Mechanical Drafting Design Technician – Thompson Institute, 1987

**Years of Experience:** 25

**Project Responsibilities:**
As the electrical commissioning associate, Mr. Rosenberry is responsible for the pre-functional and functional testing of the project’s electrical systems to make sure they perform within the designated ranges. He also is responsible for reviewing the installation, required testing and as-built drawings for the systems, develops the relevant systems manuals, and participates in the O&M training.

**Reference:**
Mr. Tom Koch  
*Plant Manager*  
Manheim Township School District  
717.569.8231

**Relevant Experience:**
- **Manheim Township School District, Lancaster, PA**  
  *Building Commissioning of New High School Registered for LEED Certification*  
  *Building Commissioning for Bucher Elementary School Registered for LEED Silver Level Certification*  
  Construction Cost: $63.7 Million

- **Phoenixville Area School District, Phoenixville, PA**  
  *Building Commissioning Services for the New Phoenixville Area Middle School*  
  Construction Cost: $45 Million

- **Montgomery County Public Schools, Rockville, MD**  
  *Building Commissioning of Addition project at Brookhaven Elementary School*  
  *Building Commissioning of Addition project at Harmony Hills Elementary School*  
  *Building Commissioning of Addition project at Rock View Elementary School*  
  *Building Commissioning for Replacement of Cannon Road Elementary School Registered for LEED Silver Level Certification*  
  Construction Cost: $41.7 Million
Saint Clair Area School District, Saint Clair, PA
Building Commissioning Services for Saint Clair Area Elementary/Middle School
Performance Contract
Construction Cost: $1.5 Million

Abington Heights School District, Clarks Summit, PA
Building Commissioning Services for Newton-Ransom Elementary, Abington Heights Middle and Abington Heights High Schools for Performance Contract
Construction Cost: $4.9 Million

Queen Anne's County Public Schools, Sudlersville, MD
Building Commissioning of New Sudlersville Middle School
Registered for LEED Silver Level Certification
Construction Cost: $26 Million

Fairfax County Public Schools, Fairfax, VA
Building Commissioning of Coppermine Elementary School
Building Commissioning of Laurel Hill Elementary School
Total Construction Cost: $39 Million

Pennsylvania Department of General Services, Harrisburg, PA
DMVA Stryker Brigade Readiness Centers, Numerous Locations
Construction Cost: $40.6 Million

Pennsylvania Department of General Services, Harrisburg, PA
Building commissioning of a New Science and Classroom High Technology Building at Lincoln University
Construction Cost: $25 Million

PA Turnpike Commission, Harrisburg, PA
Commissioning of the Tier III Data Center TIP Building including voice and data systems
Construction Cost: $36.7 Million
**Education:**
- Associates Degree – Engineering/Mechanical Technologies, Saint Francis University, 1995
- American Society of Plumbing Engineers Member

**Years of Experience:** 17

**Project Responsibilities:**
As the plumbing commissioning agent, Mr. Decker is responsible for the pre-functional and functional testing of the project’s plumbing systems to make sure they perform within the designated ranges. He also is responsible for reviewing the installation, required testing and as-built drawings for the systems, develops the relevant systems manuals, and participates in the O&M training.

**Reference:**
Mr. Ron Nobile  
*Physical Plant Director*  
Elizabethtown Area School District  
717.367.1521 ext 2926

**Relevant Experience:**
- **Elizabethtown Area School District, Elizabethtown, PA**  
  *Building Commissioning Services of New Bear Creek Intermediate School*  
  Construction Cost: $17.8 Million

- **Wallingford-Swarthmore School District, Wallingford, PA**  
  *Building Commissioning Services at Strath Haven Middle School*  
  Construction Cost: $41 Million

- **Montoursville Area School District, Montoursville, PA**  
  *Building Commissioning Services at C.E. McCall Middle School*  
  Construction Cost: $15 Million

- **State College Area School District, State College, PA**  
  *Building Commissioning of New Mount Nittany Elementary School, Building Commissioning of New Ferguson Township Elementary School*  
  *Both Registered for LEED Silver Level Certification*  
  Construction Cost: $25.9 Million
Milton Hershey School, Hershey, PA
Building Commissioning of Transitional Living Buildings
Construction Cost: $22 Million

Montgomery County Public Schools, Rockville, MD
Building Commissioning of Addition project at Brookhaven Elementary School
Building Commissioning of Addition project at Harmony Hills Elementary School
Building Commissioning of Addition project at Rock View Elementary School
Building Commissioning for Replacement of Cannon Road Elementary School
Registered for LEED Silver Level Certification
Construction Cost: $41.7 Million

Pennsylvania Department of General Services, Harrisburg, PA
Building Commissioning of New High Technology Classroom Building
Construction Cost: $25 Million

Pennsylvania Department of General Services, Harrisburg, PA
Building Commissioning of PennDOT Materials Testing Laboratory
Construction Cost: $8.3 Million

Shikellamy School District, Shamokin, PA
MEP Design for Elementary School
Construction Cost: TBD

Harrisburg School District, Harrisburg, PA
Plumbing Design for Extensive Additions and Renovations to John Harris High School
Construction Cost: $45.2 Million

Fairfax County Public Schools, Fairfax, VA
Plumbing Design for Additions/Renovations to Edison High School
Construction Cost: $35 Million

Central Dauphin School District, Harrisburg, PA
Plumbing Design for Additions/Renovations to Swatara Middle School
Plumbing Design for Additions/Renovations to Linglestown Middle School
Plumbing Design for Additions/Renovations to Central Dauphin East Middle School
Plumbing Design for Additions/Renovations to Central Dauphin Middle School
Construction Cost: $70 Million
Education:
- Bachelor of Science in Engineering, Mechanical Concentration – Messiah College, 2010
- Certified Engineer-in-Training

Years of Experience: 2

Project Responsibilities:
As the commissioning technician, Mr. Smeiles is responsible for witnessing equipment start-up by the contractors and reviewing contractor submittals. He is responsible for assembling the commissioning report and systems manual.

Reference:
Mr. Ron Nobile  
*Physical Plant Director*  
Elizabethtown Area School District  
717.367.1521 ext 2926

Relevant Experience:
School District of the City of York, York, PA  
*Building Commissioning of Additions and Renovations at Jackson and McKinley Elementary Schools*  
*Registered for LEED Silver Level Certification*  
Construction Cost: $19 Million

School District of Lancaster, Lancaster, PA  
*Building Commissioning of Wharton Elementary School*  
Construction Cost: $9.5 Million

Elizabethtown Area School District, Elizabethtown, PA  
*Building Commissioning of New Bear Creek Intermediate Elementary School*  
Construction Cost: $17.8 million

Pennsbury School District, Fallsington, PA  
*Building Commissioning of Additions/Renovations to Makefield Elementary School*  
*Registered for LEED Silver Level Certification*  
Construction Cost: $13 Million
Understanding of Your Projects

The Centennial School District is requesting building commissioning services for the following projects:

- **William Tennent High School** - A newly constructed/renovated facility completed in September, 2011 and fully occupied by students/staff at that time. Total construction costs were in excess of $60 million and included new HVAC, electric, plumbing, and controls throughout the 409,000-square-foot building.

- **Willow Dale Elementary School** – A newly constructed/renovated facility completed in September, 2011 and fully occupied by students/staff at that time. Total construction costs were in excess of $17 million and included new HVAC, electric, plumbing, and controls throughout this 135,000-square-foot building.

- **Davis Elementary School** – Currently under construction and scheduled to be occupied by students/staff in September, 2012. This is a totally new, 130,000-square-foot facility with all new systems and a construction value of approximately $26 million.

- **McDonald Elementary School** – Currently under construction and scheduled to be occupied by students/staff in February, 2013. This is a totally new, 130,000-square-foot facility with all new systems and a construction value of approximately $26 million.

Systems to Be Commissioned

After carefully reviewing the information contained in your Request for Proposal, Reynolds Consulting Engineers (RCE) understands that the Centennial School District would like the Commissioning Agent to verify the functional test results of the following systems:

1. Central building automation systems
2. Central boiler system
3. Central chilled water system
4. Fan powered variable air volume and standard variable air volume boxes
5. Secondary system hot and chilled water pumps
6. Variable frequency drives on the pumps and all the differential pressure sensors
7. Rooftop and indoor air handling units
8. Air/water flow checks on 30% of fan powered variable air volume and standard variable air volume boxes and associated reheat coils, as well as fan coil units, exhaust fans and supply fans
9. Make-up air units (ventilation) and energy recovery ventilation units
10. Kitchen hood exhaust fans and kitchen makeup air units
11. Kitchen walk-in refrigerators and freezers and gas-fired equipment.
12. Pool dehumidification units
13. Interlocks between HVAC controls and non-HVAC equipment
14. Water systems including but not limited to water heater, re-circulating pumps and plumbing fixtures
15. Access control/security and video surveillance system

**Approach to Commissioning Services**

RCE believes that building commissioning services are essential to the efficient design, construction and operation of today’s modern school facilities. The term commissioning has, in the past, referred to the process of testing, adjusting and balancing (TAB) the building’s heating, ventilation and air conditioning (HVAC) system. Today the term building commissioning recognizes and encompasses the integration of all the building’s systems and their performance, which can have a substantial impact on energy efficiency, occupant comfort and performance and safety.

As demonstrated by the fact that basic building commissioning services are a prerequisite in the U.S. Green Building Council’s LEED for Schools program and that another credit can be earned through more in-depth commissioning services, the acceptance of commissioning as a vital part of the design and construction process is growing and in some places becoming standard operating procedure for both new construction as well additions and renovations.

RCE views building commissioning as a quality assurance tool to ensure that building owners have a building that has been designed and constructed to meet their operational requirements and that it can be maintained and operated at peak efficiency. At RCE our building commissioning process focuses on the documentation, training, and verification of the performance of the building’s systems to specifically ensure that the finished building operates in accordance with the Owner’s documented project requirements and the construction documents.

The most important part of the building commissioning process is the functional testing. This is the only way to verify the performance of the building as a whole and ensure the Owner’s design intent has been met. We utilize our experience as design professionals to design realistic functional performance tests that evaluate the ability of the various components and the systems as a whole to meet the Owner’s Project Requirements. RCE designs detailed, step-by-step
Section 5: Project Approach

procedures for conducting the functional performance tests on each piece of equipment and system. The Basis of Design (BOD) and the Owner’s Project Requirements (OPR) documents will be utilized to assist us in the creation of these test procedures. Each procedure will specifically identify acceptable tolerances and set point limits for the specified equipment.

It is important to utilize a more passive testing method for the functional tests. RCE prefers to use data loggers to retrieve the information needed for the functional test reports, as opposed to using the Building Management System. We have experienced a number of test results where our data loggers have provided correct results and the installed Building Management System provided contradictory information.

Lastly, the commissioning process for these projects should focus on ensuring that the overall end product meets the District’s operational needs, and helping to create an educational space that is conducive to learning and high-achievement. By creating an atmosphere of teamwork and cooperation among all design team members, construction phase contractors, sub-contractors, suppliers, and installers, we can facilitate this process.

Proposed Scope of Work

Below is a detailed description of procedures and scope of services RCE would employ in providing building commissioning services for the District’s projects.

Assemble Commissioning Team – RCE will gather the members of the commissioning team including the Owner, architect, engineer, and construction manager for a scoping meeting to provide an overview of the commissioning process and outline each party’s responsibilities.
Section 5: Project Approach

**Develop Commissioning Plan** – The commissioning plan is the road map for the commissioning process and notes all commissioning activities, requirements for testing, and criteria for acceptance. This plan details the activities of all members of the commissioning team, including roles and responsibilities. Additionally, the commissioning plan will note all of the building systems and equipment to be commissioned. A commissioning schedule will be included, which corresponds to the project’s construction schedule. The schedule will include planned commissioning activities including data collection, data analysis, pre-functional testing, functional testing, seasonal testing, and follow-up.

**Attend Project Meetings As Needed** – RCE’s commissioning team will attend project meetings on an as-needed basis.

**Coordinate the Commissioning Related Work** – RCE is responsible for coordinating all of the work related to commissioning for each project.

**Coordinate Controls Integration Meeting** – RCE, Owner, architect, and engineers will review the current control sequences and interlocks to ensure that integration issues and responsibilities are clearly defined.

**Coordinate and Direct the Commissioning Process and Work** – RCE will logically, efficiently and sequentially communicate the commissioning process with the Owner and contractors. This will ensure that all commissioning activities are incorporated into the project schedule.

**Plan and Conduct Commissioning Meetings** – As needed, RCE will plan and conduct any commissioning meetings between Owner, architect, engineers, or contractors.

**Receive and Review O&M Manuals, Contractor Start-up and Checkout Procedures** – The operation and maintenance (O&M) manuals are very important in the long-term usage of the building. We review the set of manuals and ensure that the start-up, maintenance schedules, warranties, operations, etc. are included and correct for the project. RCE will work with contractors and design engineers until clarity has been obtained, in writing. This information will be used to write detailed testing procedures before start-up.
Section 5: Project Approach

Perform Site Visits – RCE will perform site visits as necessary to observe system installations, attend job-site meetings and assist with discrepancy resolution.

Review TAB Execution Plan – RCE will review the testing, adjusting and balancing plan.

Oversee Construction and Start-up of the Control System – Before TAB is executed, RCE will review and approve the start-up checklists of the control system to be used for TAB.

Approve Air and Water Systems Balancing – RCE will approve the air and water balancing results through separate field verification and sampling of results. This information will be prepared in a verification report along with an action list of all deficiencies. These items will be passed along to the owner and design team for review.

Design and Witness Functional Testing Procedures for Specified Systems and Equipment – RCE will develop performance test procedure documents. These documents describe the step-by-step procedures that will be used to test the equipment once it is operational. With assistance from the Contractors, Reynolds will design a detailed, step-by-step procedure for conducting the functional performance tests on each piece of equipment and system. Each test procedure is unique to the project and is based on the actual design and control sequences that are to be used for that project. The procedures will be submitted to the Architect/Engineer for review. RCE and the design professional will review any system that fails to pass the functional test phase of the commissioning program. If the failed system requires a functional retest, the responsible party (contractor or design professional) shall be charged for the retesting procedures. Any necessary retesting will be performed until satisfactory results are achieved.

Perform Seasonal Testing of Specified Systems – RCE will return to provide functional testing of equipment during the season that the system is used. Often times a system that lays dormant for months after start-up will need adjustments in order to work as designed.

Maintain Master Deficiency and Resolution Log – RCE will maintain a commissioning concern list throughout the course of the project. This list will document any issues discovered, responsible party, actions taken, and final resolution. The log will be reviewed on a regular basis with all involved parties.

Coordinate Training – The operation and maintenance training will be coordinated to make sure that all key personnel (Owner, maintenance/facility personnel, HVAC design professional, electrical design professional, contractors, and construction manager) and items are included and adequately covered.
Prepare the Final Commissioning Report – A copy of the finalized Commissioning Report will be provided, including a list of participants and roles, brief building description, overview of commissioning and testing scope, and a general description of testing and verification methods. RCE will include a signed letter of certification verifying the adequacy of the equipment, documentation and training meeting the contract documents. The report will include a list of non-compliance items and recommendations. It will also include the following:

- Commissioning plan
- Progress reports
- O&M material reviews
- Training records
- Test schedules
- Functional test results
- Trend log analysis

Prepare the Systems Manual – An indexed Systems Manual will be supplied in electronic and paper formats. It will include the following:

- As-built sequences of operation for all equipment as provided by the design professionals and contractors, including time-of-day schedules and schedule of frequency, and detailed points listings with ranges and initial set points
- Installed equipment nameplate information
- Ongoing operating instruction for all energy and water saving features and strategies
- Functional test results, blank test forms, and recommended schedule for ongoing benchmarking
- Seasonal operational guidelines
- Recommendations for recalibration frequency of sensors and actuators by type and use
- Single line diagrams of each commissioned system
- Troubleshooting table for ongoing maintenance of the Owner’s project requirements

Near-warranty End Period Review – RCE will return to the site nine months into the 12-month warranty period to review any issues or concerns related to the original and seasonal commissioning. At that time, facilities staff will be interviewed to identify issues or concerns with the operation of the building. Reynolds will assist facility staff in developing reports and documents. We will provide suggestions for improvement and record any changes in the O&M manual. Any issues that may fall under warranty or the original construction contract will be identified.
Section 5: Project Approach

**Distribution of Tasks**

We have outlined responsibilities for our proposed team on the following tables broken down by project phase.

<table>
<thead>
<tr>
<th>Commissioning Duties</th>
<th>David Hickey</th>
<th>David Burkett</th>
<th>Al Rosenberry</th>
<th>Jim Decker</th>
<th>Jeff Smeiles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assemble Cx Team</td>
<td>✔</td>
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<tr>
<td>Develop Cx Plan</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attend Project Meetings (As Needed)</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Controls Integration Meeting</td>
<td>✔</td>
<td>✔</td>
<td></td>
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<td></td>
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<tr>
<td>Plan and Conduct Cx Meetings</td>
<td>✔</td>
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<td></td>
<td></td>
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<tr>
<td>Review O&amp;M's, Start-up and Checkout Procedures</td>
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<td>✔</td>
</tr>
<tr>
<td>Site Visits</td>
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<td>✔</td>
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<tr>
<td>Functional Testing</td>
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<td></td>
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<tr>
<td>Seasonal Functional Testing</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintain Cx Concern List</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
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<td>✔</td>
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<tr>
<td>Coordinate Training</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>Prepare Systems Manual</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Prepare Final Cx Report</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Near Warranty End Period Review</td>
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<td>✔</td>
<td></td>
<td>✔</td>
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</tr>
</tbody>
</table>

**Travel and On-Site Staffing**

As noted in Section 3 of this proposal, David Hickey is assigned to the position of lead commissioning agent for this project. As such, he is the leader of the RCE commissioning team. He will serve as the main point of contact and will be the RCE representative to attend the bulk of required meetings. As soon as work begins, Mr. Hickey will delegate responsibilities to the rest of the RCE team, as demonstrated in the tables above.
Section 5: Project Approach

RCE will attend job conferences on a regular basis in order to stay up to date on the project and answer any questions that may arise. Once the equipment begins to arrive on-site, particularly at Davis and McDonald Elementary Schools, RCE will begin to make more frequent visits to the site in order to inspect the equipment, and as the equipment installation progresses, RCE will revisit the site to monitor the installation.

The majority of the time that RCE spends on-site will occur once the systems have been started-up and the functional testing begins. They will maintain an on-site presence throughout the completion of the commissioning process. Once the project is completed, RCE will remain available to the District to assist in the trouble shooting of any problems that might arise.

Commissioning Effort

The effort and number of hours required to properly commission the projects is determined by the complexity and number of pieces of equipment to be commissioned. We have provided a lump sum estimate for the required commissioning effort for each project based upon the information we have at this time.
Section 6: Work Product

We have provided the requested work product on the following pages.

**Executed Commissioning Plan**

Our commissioning plan for the Yorktown High School project is on the following pages. It was written by our lead commissioning agent, David Hickey, P.E., LEED AP, and CEM.

**Completed Pre-functional Checklist**

Following the commissioning plan is a pre-functional test checklist from a public school project. The checklist was written for the project by lead commissioning agent, David Hickey, P.E., LEED AP, and CEM.

**Executed Functional Test Procedure Form**

Following the pre-functional checklist is an actual, executed functional test procedure form from a public school project. The functional test procedure was written for the project by lead commissioning agent, David Hickey, P.E., LEED AP, and CEM.
Executed Commissioning Plan
COMMISSIONING PLAN

For

Yorktown High School
Arlington Public Schools
Arlington, VA

January 15, 2010

Prepared By

Reynolds Consulting Engineers, Inc.
353 Markle Drive
Harrisburg, PA 17111
Commissioning Plan

Summary

The Commissioning Plan—the plan provides direction for the commissioning tasks during construction. The plan focuses on providing support for the commissioning process and provides format for the application of the commissioning process.

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1. Overview

1.1 Abbreviations and Definitions

The following are common abbreviations used in this document.

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<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A/E-</td>
<td>Architect / Engineer</td>
</tr>
<tr>
<td>BAS-</td>
<td>Building Automation System</td>
</tr>
<tr>
<td>CA-</td>
<td>Commissioning Agent</td>
</tr>
<tr>
<td>CM-</td>
<td>Construction Manager</td>
</tr>
<tr>
<td>Cx-</td>
<td>Commissioning</td>
</tr>
<tr>
<td>Cx Plan-</td>
<td>Commissioning Plan document</td>
</tr>
<tr>
<td>EC-</td>
<td>Electrical Contractor</td>
</tr>
<tr>
<td>FPT-</td>
<td>Functional Performance Test</td>
</tr>
<tr>
<td>GC-</td>
<td>General Contractor</td>
</tr>
<tr>
<td>HVAC-</td>
<td>Heating, Ventilation, and Air Conditioning</td>
</tr>
<tr>
<td>MC-</td>
<td>Mechanical or HVAC Contractor</td>
</tr>
<tr>
<td>PC-</td>
<td>Plumbing Contractor</td>
</tr>
<tr>
<td>PM-</td>
<td>Owner’s Project Manager</td>
</tr>
<tr>
<td>Subs-</td>
<td>Subcontractors</td>
</tr>
<tr>
<td>TAB-</td>
<td>Test and Balance Contractor</td>
</tr>
</tbody>
</table>

1.2 Purpose of the Commissioning Plan

The purpose of the commissioning plan is to:

Provide direction for the commissioning process during construction, particularly providing resolution for issues and providing details that cannot be, or were not, fully developed during design, such as participation of various parties of this particular project, actual lines of reporting and approvals, coordination, etc.

This plan does not provide a detailed explanation of required testing procedures. Additionally, this plan does not provide extensive narrative on all commissioning concepts, as may be provided in other commissioning guides.

1.3 Commissioning Scope

Commissioning is a systematic process of ensuring that all building systems perform interactively according to the design intent and the owner’s operational needs. The commissioning process shall encompass and coordinate the traditionally separate functions of system documentation, equipment startup, control system calibration, testing and balancing, performance testing and training. This is achieved by testing through construction, acceptance and the warranty period with actual verification of performance.

The commissioning program will implement the following fundamental best practice commissioning procedures in order to comply with LEED fundamental and additional commissioning activities:

- Engage a commissioning agent independent of the design team.
- Review design intent and basis of design documentation. The Owner shall document the Owner’s Project Requirements (OPR). The design team shall develop the Basis of Design (BOD). The Owner and design team shall be responsible for updates to their respective documents.
• Review construction documents prior to the beginning of the construction document phase and near the completion of the construction document phase.

• Include commissioning requirements in the construction documents.

• Develop and implement a commissioning plan.

• Verify installation, functional performance, training and documentation.

• Complete a final commissioning report.

• Develop a systems manual with information needed to understand and optimally operate the commissioned systems.

• Review building operation with O & M staff within one year of the construction completion date and resolve any outstanding commissioning related issues.

Commissioning during the construction phase is intended to achieve the following specific objectives according to the Contract Documents:

• Verify that applicable equipment and systems are installed according to the manufacturer’s recommendations and to industry accepted minimum standards and that they receive adequate operational checkout by installing contractors.

• Verify and document proper performance of equipment and systems.

• Verify that O&M documentation left on site is complete.

• Verify that the Owner’s operating personnel are adequately trained.

1.4 Commissioned Systems

The following systems are to be commissioned:

1. Building Automation and Automatic Temperature Control System (BAS), including remote monitoring through the graphical user interface using a standard Web browser (this excludes any security-related control systems or interlocks).

2. All major, and minor equipment of the heating, ventilating, air conditioning, and refrigeration (HVAC&R) systems.

3. Lighting and daylighting controls.

4. Domestic hot water systems.

1.5 Forms and Reports

The GC, MC and EC provide start-up forms and checklists for their respective systems. Startup reports are submitted upon completion.

The MC provides hydronic piping, duct leakage, and duct cleaning test reports.

The BAS Contractor provides a control checkout plan including a point-to-point checkout form. The BAS Contractor intends to utilize a hard copy of the WebCTRL equipment checkout form, including date stamp and technician signoff for each control point.

The TAB Contractor provides sample forms to be used in the preparation of the TAB reports.

The TAB Contractor provides a completed NEBB “Systems Ready to Balance Checklist” prior to the TAB work for any HVAC system.

The TAB Contractor provides completed and certified TAB reports.

The GC and subcontractors provide the Operations and Maintenance Manuals.
The GC provides a schedule for each training session.

The GC submits an outline of instructional program for demonstration and training, including a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Each training module shall include instruction for the following: Basis of System Design, Operational Requirements, and Criteria; Documentation; Emergencies; Operations; Adjustments; Troubleshooting; Maintenance; and Repairs. Refer to Specification Section 01820.

Functional performance test forms are developed by the CA based on the approved sequences of operation. The CA provides the final commissioning report and systems manual.

2. **General Building Information**

Project: Yorktown High School
Arlington Public Schools
Location: Arlington, VA

3. **Commissioning Team Data (primary parties)**

**Arlington Public Schools:**
- Owner

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Phone</th>
<th>E-Mail</th>
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<tbody>
<tr>
<td>William O'Connor</td>
<td>Director of Design and Construction</td>
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<td></td>
</tr>
<tr>
<td>James Meikle</td>
<td>Director of Maintenance</td>
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<td></td>
</tr>
<tr>
<td>Steve Stricker</td>
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</tr>
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</table>

**Reynolds Consulting Engineers:**
- Commissioning Agent

<table>
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<tr>
<th>Name</th>
<th>Position</th>
<th>Phone</th>
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</thead>
<tbody>
<tr>
<td>Jim Horst, P.E.</td>
<td>President</td>
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<tr>
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**J. Vinton Schafer & Sons, Inc.:**
- Construction Manager

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<tr>
<th>Name</th>
<th>Position</th>
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<tbody>
<tr>
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<td>Vice President</td>
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<td><a href="mailto:jenkins@jvschafer.com">jenkins@jvschafer.com</a></td>
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<tr>
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<tr>
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</table>
**EEK Architects / GHT Limited Consulting Engineers / Sustainable Design Consulting:**
- Architect / Engineer / LEED Consultant

<table>
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<tr>
<th>Name</th>
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<tbody>
<tr>
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<td><a href="mailto:sodonnell@eekarchitects.com">sodonnell@eekarchitects.com</a></td>
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</tr>
</tbody>
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**Hess Construction & Engineering Services:**
- General Contractor

<table>
<thead>
<tr>
<th>Name</th>
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</thead>
<tbody>
<tr>
<td>Drew Cohen</td>
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</tr>
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</table>

**Shapiro & Duncan, Inc.:**
- Mechanical Contractor

<table>
<thead>
<tr>
<th>Name</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Dave Britschge</td>
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**AERO Integrated Solutions, Inc.:**
- Building Automation System Contractor

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Dan Knox, P.E.</td>
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<tr>
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</table>

**Metro Test and Balance, Inc.:**
- TAB Contractor

<table>
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<tr>
<th>Name</th>
<th>Position</th>
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</thead>
<tbody>
<tr>
<td>Jim Kelleher</td>
<td>Vice President</td>
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<td></td>
</tr>
</tbody>
</table>

**Ennis Electric:**
- Electrical Contractor

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
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<tbody>
<tr>
<td>Jim Hunter</td>
<td>Project Manager</td>
<td>571-437-0473</td>
<td></td>
</tr>
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</table>
4. Roles and Responsibilities

4.1 Team Members

The members of the commissioning team consist of the Commissioning authority (CA), the Project Manager (PM), the designated representative of the owner’s Construction Management firm (CM), the General Contractor (GC or Contractor), the Architect and Design Engineers (particularly the Mechanical Engineer), the Mechanical Contractor (MC), the Electrical Contractor (EC), the Test and balance contractor (TAB) representative, the Building Automation System Contractor (BAS), any other installing subcontractors or suppliers of equipment. The Owner’s facilities staff is also a member of the commissioning team.

4.2 General Management Plan

The CA was hired by the Owner. In general, the CA coordinates and performs the commissioning activities and reports to the Owner. All members work together to fulfill their contracted responsibilities and meet the objectives of the Contract Documents. Refer to the management protocols section below.

4.3 General Descriptions of Roles

General descriptions of the commissioning roles are as follows:

- **CA:** Coordinates the Cx process, oversees and documents performance tests.
- **CM, PM:** Facilitate the Cx process.
- **GC:** Facilitates the Cx process; coordinates and supervises work of subcontractors. The GC is responsible to provide the primary supervision support and labor required for start-up, testing, and commissioning.
- **Design Professional:** Perform contracted construction observation, approve O&M manuals and shop drawings, and assist in resolving problems; produce the Design Intent Document which establishes a baseline of performance for equipment and systems, documents assumptions for equipment and system sizing/loads, provides criteria for testing conducted during the commissioning process, and provides information on the intended operation of equipment and systems.
- **Subs:** (HVAC, Plumbing, Electrical and TAB Contractors) Facilitate the Cx process; complete system installation and operational checkout; ensure HVAC / Plumbing / Electrical equipment start-up and training are completed; assist in conducting functional performance tests; provide all testing and documentation as required by the construction documents.
- **BAS:** (BAS Contractor) Facilitates the Cx process; completes BAS installation and operational checkout; assists in conducting functional performance tests; ensures CA and training are completed for operation of BAS.
- **Mfr:** The equipment manufacturers and vendors provide documentation to facilitate the commissioning work and perform contracted startup.
- **Owner:** Facilitates and supports the Cx process and gives final approval of the Cx work.
5. **Commissioning Process**

This section sequentially details the commissioning process by commissioning task or activity.

5.1 **Initial Commissioning Meeting**

At the start of the construction-phase, the initial commissioning meeting will be held with the entire commissioning team in attendance. This meeting will be for the purpose of reviewing the complete commissioning process including system flushing and testing; testing, adjusting, and balancing (TAB) work of HVAC systems; functional performance testing; acceptance testing; mechanical and electrical system orientation and inspections; O&M submittals; and owner training sessions.

*Meeting conducted 5/14/2009; Minutes issued 5/19/2009*

5.2 **Equipment Start-Up and TAB Coordination Meetings**

Thirty (30) days prior to startup of the primary HVAC equipment, the CA meets with the CM, PM and Contractors and develops a detailed commissioning schedule. Prior to this meeting, the Contractors obtain the manufacturer’s installation, startup and checkout data, including actual field checkout sheets used by the field technicians from each subcontractor.

Prior to commencing testing and balancing work, the TAB Contractor shall submit a completed NEBB “Systems Ready to Balance Checklist”. A TAB Coordination Meeting will be held to review this checklist and discuss the TAB schedule.

5.3 **Final Commissioning Plan**

The CA finalizes the draft Cx Plan using the information gathered from the initial commissioning meeting. The commissioning schedule is developed based on the Contractor’s preliminary schedule. The HVAC Contractor prepares a preliminary schedule for Division 15 pipe and duct system testing, flushing and cleaning, equipment start-up and TAB start and completion for use by the PM and CA. The schedule is fine-tuned as construction progresses.

5.4 **Miscellaneous Meetings**

The CA attends selected planning and job-site meetings in order to remain informed on construction progress and to update parties involved in commissioning. The CM and GC shall provide the CA with information regarding change orders and any RFI that may affect commissioning equipment, systems or the commissioning schedule. The CA may review construction meeting minutes, change orders or RFIs for the same purpose.

Necessary meetings between various commissioning team parties will be scheduled by the CA, through the CM, as required.

5.5 **Miscellaneous Management Protocols**

The following protocols will be used on this project.

<table>
<thead>
<tr>
<th>Issue</th>
<th>Protocol</th>
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<tbody>
<tr>
<td>For requests for information (RFI) or formal documentation requests:</td>
<td>The CA goes through the CM.</td>
</tr>
<tr>
<td>For minor or verbal information and clarifications:</td>
<td>The CA goes direct to the informed party.</td>
</tr>
<tr>
<td>For notifying contractors of deficiencies:</td>
<td>The CA documents deficiencies through the CM in the form of a Commissioning Action List. The CM, with input from the PM, will decide how to proceed with each action list item.</td>
</tr>
</tbody>
</table>
For scheduling training: The CA may provide input for the training, but does not do any scheduling. The GC submits an outline of instructional program for demonstration and training, including a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module.

For scheduling commissioning meetings: The CA selects the date and schedules through the CM.

For making a request for significant changes: The CA has no authority to issue change orders.

For making small changes in specified sequences of operations: The CA may make small sequences of operations changes to improve efficiency or control or to correct deficiencies, through the responsible contractor, but shall document the change and provide all changes of specified sequences to the CM and PM.

5.6 Progress schedule

The CA regularly communicates with all members of the commissioning team, keeping them apprised of commissioning progress and scheduling issues through email, progress reports, etc.

The CA will keep all commissioning materials in an organized notebook.

5.7 Initial Submittals and Documentation

5.7.1 Standard Submittals

The CA reviews approved submissions relative to commissioning issues expressed in the contract documents, not for general contract compliance (which is the Design Professional’s responsibility). The CA will review approved equipment submittals for manufacturer and model numbers and compare with installed equipment. The CA will review submittals for the Building Automation System for compliance with the OPR and BOD, and provide comments to the A/E.

CA Comments issued on 7/21/2009 for Submittal 15900-001.


5.7.2 Special Submittals, Notifications and Clarifications

The Design Professional notifies the CA of any new design intent or operating parameter changes, added control strategies and sequences of operation, or other change orders that may affect commissioned systems.

The BAS Contractor provides the CA a full points list with details for completing the controls checkout.

Prior to performing contracted start-up tests, the GC and subcontractors shall provide the CA full details of the start-up procedures.

Prior to commencing testing and balancing work, the TAB Contractor shall submit a completed NEBB “Systems Ready to Balance Checklist”. A TAB Coordination Meeting will be held to review this checklist and discuss the TAB schedule. As phases of the TAB work are completed in accordance with the construction phasing plan, the draft TAB report is provided to the CA with full explanations of approach, methods, results, data table legends, etc. The final TAB report is provided to the CA upon completion.

These submittals to the CA do not constitute compliance for submittals for the O&M manuals. Documentation requirements for the O&M manuals are as required in the contract documents.

The CA may request additional design narrative from the Design Professional and from the BAS Contractor depending on how complete the documentation was which was provided with the bid documents. The CA may submit written RFIs to the GC through the CM, or address them directly for clarifications, as needed.
5.8 Prefunctional Checklists

Prefunctional checklists are important to ensure that the equipment and systems are hooked up and operational and that functional performance testing may proceed without unnecessary delays. Each piece of commissioned equipment receives prefunctional checkout by the CA. In general, the prefunctional testing for a given system must be successfully completed prior to formal functional performance testing of equipment or subsystems of the given system.

Prefunctional checklists are primarily static inspections and procedures to prepare the equipment or system for initial operation (e.g., labels and identification affixed, meters and gages in place, fan belts aligned with proper tension, sensor calibration documentation, etc.). However, some start-up checklist items entail simple testing of the function of a component, a piece of equipment or system (such as measuring the voltage imbalance on a three phase pump motor). When available, checklists should be augmented or combined with the manufacturer’s start-up checklist.

5.8.1 Start-up Plan

The CA assists the commissioning team members responsible for startup in developing detailed start-up plans for all equipment. The equipment start-up plans will be developed as follows:

- The Contractor obtains manufacturer installation, startup and checkout data, including actual field checkout sheets used by the field technicians and manufacturer’s representatives.

- For systems that may not have adequate manufacturer startup and checkout procedures, particularly for components being integrated with other equipment, the contractor should provide the added necessary detail and documenting format to the CA.

5.8.2 Execution of Checklists and Startup

The contractors and vendors schedule startup and initial checkout with the CM and CA at the Equipment Startup Coordination Meeting.

To document the process of startup and checkout, the site technician performing the line item task checks off items on the start-up and manufacturer field checkout sheets, as they are completed. Only individuals having direct knowledge of a line item being completed shall check or initial the forms.

5.8.3 Deficiencies and Non-Conformance

The Contractor clearly lists any outstanding items of the start-up procedures that were not completed successfully at the bottom of the procedures form or on an attached sheet. The CA works with the CM and contractors to correct and retest uncompleted items. The installing contractor or vendors correct all areas that are concern or incomplete according to the checklists and tests.

5.8.4 Controls Checkout Plan

The BAS Contractor provides a control checkout plan including a point-to-point checkout form. The BAS Contractor intends to utilize a hard copy of the WebCTRL equipment checkout form, including date stamp and technician signoff for each control point.

The BAS Contractor shall indicate the portion of the controls checkout plan that should be completed prior to the TAB Contractor using the controls system for TAB work. This will be reviewed at the TAB Coordination Meeting.
5.9 Development of Functional Performance Test and Verification Procedures

5.9.1 Overview

Functional performance testing is the dynamic testing of systems (rather than just components) under full operation (e.g., the variable frequency drive is tested interactively with the air handling unit functions to see if the fan ramps up and down to maintain the static pressure setpoint). Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, power failure, etc. The systems are run through all of the control system’s sequences of operation and components are verified to be responding as the sequences state. The CA develops the functional test procedures in a sequential written form.

5.9.2 Development Process

The CA reviews the specific test procedures to verify proper operation of each piece of equipment and system, using the testing requirements in the Specifications and other sources. The CA obtains clarification, as needed, from contractors and the Design Professional regarding sequences and operation to develop these tests. Functional performance testing and verification may be achieved by manual testing (persons manipulate the equipment and observe performance) or by monitoring the performance and analyzing the results using trend log capabilities or by stand-alone data loggers. The CA reviews acceptance tests and determines what further testing may be required to comply with the Specifications. Redundancy is minimized.

5.10 Execution of Functional Testing Procedures

5.10.1 Overview and Process

The CA prepares the functional tests. For any given system, prior to performing functional testing, the CA and BAS Contractor must wait until start-up has been completed confirming that the system is ready for functional testing. The control system is tested before it is used to verify performance of other components or systems. Air and water TAB shall be completed with discrepancies and problems remedied before functional testing of the respective air- or water-related systems. Testing proceeds from components to subsystems to systems and finally to interlocks and connections between systems. Equipment and systems shall be tested and commissioned in a peak season to observe full load performance. Initial commissioning shall be done as soon as construction Phase I is completed. Commissioning for additional equipment will be conducted following construction Phases II and III. During the warranty period, the CA shall complete seasonal testing (tests delayed until weather conditions are closer to the system’s design).

5.10.2 Deficiencies and Retesting

The CA documents the results of the test. Corrections of minor deficiencies identified are made during the tests at the discretion of the CA. The CA records the results of the test on the procedure or test form. Concern or non-conformance issues are noted and reported to the CM. The Contractors shall correct non-conformance issues and notify the CA upon completion of the corrective work. The CA schedules retesting through the CM. Decisions regarding non-conformance and corrections are made at as low a level as possible, preferably between CA or CM and the contractors. The CA gives final approval on each test.

The CA works with the CM and PM to test aspects of opposite season performance that could not be verified during initial performance testing. The MC shall provide support for seasonal testing as required.

5.10.3 Facility Staff Participation

The Owner’s facilities operating staff are encouraged to attend and participate in the testing process.
5.11  O&M Manuals and Warranties

Prior to substantial completion, the CA shall review the O&M manuals for systems that were commissioned. The CA will communicate deficiencies in the documentation to the CM, PM or A/E, as requested. The CA also reviews each equipment warranty and verifies that all requirements to keep the warranty valid are clearly stated. This work does not supersede the Design Professional’s review and approval of the O&M manuals.

5.11.1 Commissioning Record

The CA will compile, organize and index the following commissioning data by equipment into labeled, indexed and tabbed, three-ring binders. The final commissioning report shall include an executive summary, list of participants and roles, brief building description, overview of commissioning and testing scope and a general description of testing and verification methods. For each piece of commissioned equipment, the report should contain the disposition of the commissioning agent regarding the adequacy of the equipment, documentation and training meeting the contract documents in the following areas:

1. Equipment meeting the Basis of Design
2. Equipment meeting the equipment specifications
3. Equipment ensuring proper installation
4. Functional performance and efficiency
5. O&M documentation
6. Operator training.
7. All outstanding non-compliance items shall be specifically listed.
8. Recommendations for improvement to equipment or operations, future actions, commissioning process changes, etc. shall also be listed. Each non-compliance issue shall be referenced to the specific functional test, inspection, trend log, etc. where the deficiency is documented. The functional performance and efficiency section for each piece of equipment shall include a brief description of the verification method used (manual testing, BAS trend logs, data loggers, etc.) and include observations and conclusions from the testing.

5.11.2 Systems Manual

The CA will compile, organize and index the following commissioning data by equipment into labeled, indexed and tabbed, three-ring binders. The Systems Manual shall include the following:

1. Final version of the Design Professional’s Basis of Design.
2. System single line diagrams.
3. As-built sequences of operations, control drawings and original setpoints.
4. Operating instructions for integrated building systems.
5. Recommended schedule of maintenance requirements and frequency, if not already included in the project O&M manuals.
6. Recommended schedule for retesting of commissioned systems with blank test forms from the original Commissioning Plan.
7. Recommended schedule for calibrating sensors and actuators.

5.12 Training and Orientation of Facility Personnel

The CA shall attend the training of the PM’s operating personnel for commissioned equipment and systems and confirm that equipment and systems have been adequately demonstrated. Sufficient advanced notice from the GC will be required to ensure the availability of owner representatives for demonstration and training.

The contractors shall coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. The instruction program is submitted after the operation and maintenance data has been reviewed and approved by the A/E. Refer to Specification Section 01820 for training module content requirements.
The installing contractor shall demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment. The instructional program shall include individual training modules for each system and equipment not part of a system, as required by individual specification sections, and as follows:

1. Motorized doors, including overhead coiling doors and overhead coiling grilles.
2. Equipment, including stage equipment, projection screens, waste compactors, foodservice equipment, residential appliances, laboratory fume hoods, basketball standard winch control, gymnasium curtain, telescoping bleachers, etc.
3. Fire-protection systems, including fire alarm, smoke control and fire-extinguishing systems.
4. Intrusion detection systems.
5. Conveying systems, including elevators.
6. Laboratory equipment, including laboratory piping.
7. Heat generation, including boilers, pumps, and water distribution piping.
8. Refrigeration systems, including chillers, cooling towers, condensers, pumps, and distribution piping.
9. HVAC systems, including air-handling equipment, air distribution systems, and terminal equipment and devices.
10. HVAC instrumentation and controls.
11. Plumbing equipment.
12. Electrical service and distribution, including transformers, switchboards, panelboards, and motor controls.
13. Packaged engine generators, including transfer switches.
14. Lighting equipment and controls.
15. Communication systems, including intercommunication, clocks and programming, voice and data, television equipment, and auxiliary sound systems.
16. Pool equipment.

The Contractor shall record each training module separately, including classroom instructions and demonstrations, board diagrams, and other visual aids. Training sessions shall be video recorded on DVD media by the respective contractor.

The instructional program for demonstration and training will be conducted in accordance with the approved instructional program outline. This training shall include a full explanation of the O&M manuals, and hands-on training.

5.13 Warranty Period

During the warranty period, seasonal testing and other deferred testing required is completed. The CA coordinates this activity. Tests are conducted by the CA, witnessed by facilities staff, and deficiencies corrected by the appropriate contractors. The A/E shall coordinate resolution of design non-conformance and design deficiencies identified during warranty-period commissioning. Any final adjustments to the O&M manuals and record drawings due to the testing shall be made by the respective contractor.

In addition the CA will return to the project approximately 10 months into the 12 month warranty period. During this visit the CA will review with facility staff the current building operation and the condition of outstanding issues related to the original and seasonal commissioning.
Completed Pre-functional Checklist
# WATER SOURCE HEAT PUMP PREFUNCTIONAL CHECKLIST

## PC-WSHP-13 WATER SOURCE HEAT PUMPS

### 1. Requested documentation submitted

<table>
<thead>
<tr>
<th>Check</th>
<th>Equip Tag</th>
<th>HP-5</th>
<th>HP-6</th>
<th>HP-5</th>
<th>HP-6</th>
<th>HP-5</th>
<th>HP-6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area Served</td>
<td>B211</td>
<td>B212</td>
<td>B213</td>
<td>B214</td>
<td>B215-B217</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manufacturer's cut sheets</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Performance data (coil data, etc.)</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Installation and startup manual and plan</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sequences and control strategies</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O&amp;M manuals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 2. Model verification

1 = as specified, 2 = as submitted, 3 = as installed. Check if Okay. Enter note number if deficient.

<table>
<thead>
<tr>
<th>Equip Tag</th>
<th>HP-5</th>
<th>HP-6</th>
<th>HP-5</th>
<th>HP-6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manuf.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Trane</td>
<td>Trane</td>
<td>Trane</td>
<td>Trane</td>
</tr>
<tr>
<td>2</td>
<td>GEH024</td>
<td>GEH018</td>
<td>GEH018</td>
<td>GEH024</td>
</tr>
<tr>
<td>3</td>
<td>GEH024-17T01A</td>
<td>GEH018-17T01A</td>
<td>GEH018-17T01A</td>
<td>GEH024-17T01A</td>
</tr>
<tr>
<td>Serial #</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>W08F30899</td>
<td>W08F306xx</td>
<td>W08F30710</td>
<td>W08F30712</td>
</tr>
<tr>
<td>Supply</td>
<td>800</td>
<td>520</td>
<td>520</td>
<td>800</td>
</tr>
<tr>
<td>Airflow, CFM</td>
<td>800</td>
<td>520</td>
<td>520</td>
<td>800</td>
</tr>
<tr>
<td>Fluid Flow Rate</td>
<td>6.1</td>
<td>4.6</td>
<td>4.6</td>
<td>6.1</td>
</tr>
<tr>
<td>GPM (25% PG)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>6.1</td>
<td>4.6</td>
<td>4.6</td>
<td>6.1</td>
</tr>
<tr>
<td>Cooling Capacity, MBH</td>
<td>25.3 tot / 19.1 sens</td>
<td>18.7 tot / 14.2 sens</td>
<td>18.7 tot / 14.2 sens</td>
<td>25.3 tot / 19.1 sens</td>
</tr>
<tr>
<td>Heating Capacity, MBH</td>
<td>22.1 tot / 16.2 sens</td>
<td>17.4 tot / 11.7 sens</td>
<td>17.4 tot / 11.7 sens</td>
<td>22.1 tot / 16.2 sens</td>
</tr>
<tr>
<td>Cooling SAT</td>
<td>51.6 DB / 49.4 WB</td>
<td>49.5 DB / 46.9 WB</td>
<td>49.5 DB / 46.9 WB</td>
<td>51.6 DB / 49.4 WB</td>
</tr>
<tr>
<td>Heating SAT</td>
<td>24.0</td>
<td>17.0</td>
<td>17.0</td>
<td>24.0</td>
</tr>
<tr>
<td>Volts/Ph/A</td>
<td>277 / 1 / 1.5+9.9A</td>
<td>277 / 1 / 0.8+8.1A</td>
<td>277 / 1 / 0.8+8.1A</td>
<td>277 / 1 / 1.5+9.9A</td>
</tr>
<tr>
<td>Motor HP</td>
<td>1/3</td>
<td>1/8</td>
<td>1/8</td>
<td>1/3</td>
</tr>
</tbody>
</table>

*Scheduled and submittal conditions: Cooling - 86 EWT / (68) 70 EDB / 59.6 EWB, Heating – 45 EWT / 68 EDB*

### 3. Installation Checks

<table>
<thead>
<tr>
<th>Check</th>
<th>Equip Tag</th>
<th>HP-5</th>
<th>HP-6</th>
<th>HP-6</th>
<th>HP-5</th>
<th>HP-6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cabinet and General Installation</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permanent labels affixed</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Casing condition good: no dents, leaks, door gaskets installed</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Boot between duct and unit tight and in good condition</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Vibration isolation equipment installed, including spring isolation hangers for suspended units</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Maintenance access acceptable for unit and components</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Cabinet thermal insulation properly installed</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Insulation blanket installed below suspended unit</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

---

RCE JOB #XX-XXXX  PC_WSHP13_1
# WATER SOURCE HEAT PUMP PREFUNCTIONAL CHECKLIST

<table>
<thead>
<tr>
<th>Check</th>
<th>Equip Tag-&gt;</th>
<th>HP-5</th>
<th>HP-6</th>
<th>HP-6</th>
<th>HP-5</th>
<th>HP-6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Filters installed and construction filters removed</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>Piping and Coils</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Piping properly labeled</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Piping properly insulated</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Condensate trap installed with sufficient depth</td>
<td></td>
<td>X</td>
<td>X</td>
<td>PUMP</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>All coils are clean and fins are in good condition</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Manual isolation valve, strainer, 2-way control valve, P/T plug, union, flexible hose, and drain valve with hose end connection installed in supply piping per drawings</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Manual isolation valve, calibrated balancing valve, P/T plug, union, and flexible hose installed in return piping per drawings</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>ATC sensors installed in locations per BAS drawings</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>Fans and Dampers</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply fan area clean</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Supply fan and motor properly lubricated</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Duct mounted outside air damper closes tightly</td>
<td></td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Ducts</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No apparent severe duct restrictions</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Balancing dampers installed as per drawings</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Ducts properly insulated</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>Electrical and Controls</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power disconnects in place and labeled</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>All electric connections tight</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Proper grounding installed for components and unit</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>All control devices and wiring complete</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td><strong>Final - Startup report completed with this checklist attached</strong></td>
<td></td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>

--END OF CHECKLIST--
PROJECT: XXXXXXX School

UNIT DESIGNATION: Heat Pump (HP-13) SERVING: Classroom 213

SEQUENCE OF OPERATION

The heat pump (HP) is controlled by the Building Automation System (BAS). The BAS will index the HP to the Preoccupancy, Occupied and Unoccupied cycle. The HP will operate in the Preoccupancy, Occupied and Unoccupied modes as follows:

PREOCCUPANCY MODE: During the preoccupancy mode the HP will heat or cool the space to its respective heating or cooling setpoint by first energizing the unit's supply air fan. The HP will heat or cool the space per the occupied sequence. Once the setpoint has been reached, the HP fan and DX system will cycle to maintain the space preoccupancy setpoint. The duration of the preoccupancy mode will be an adjustable schedule.

OCCUPIED MODE: The HP fan is on and runs continuously. The controller maintains the room temperature set point (75°F cooling and 70°F heating, adjustable). The controller cycles the unit's reversing valve and compressor to maintain the room temperature setpoint.

UNOCCUPIED MODE: The HP is controlled using the Unoccupied space temperature set point (65°F and 80°F, adjustable). The HP fan will be off when the space temperature is between the heating and cooling Unoccupied set point. The controller will cycle the HP fan, reversing valve and compressor to maintain the Unoccupied temperatures. An unoccupied over ride switch will be located in General Office 103. When this switch is depressed, while the system is in the unoccupied mode, the zone will be indexed to the occupied mode for a select period of time. Upon completion of the over ride time, the system will be returned to the appropriate mode.

DEHUMIDIFICATION MODE: When the space relative humidity rise to above the maximum setpoint (60% adjustable), the BAS will index the HP to the dehumidification mode. The unit will be indexed to cooling. If the space temperature drops below the heating setpoint, the unit's internal controls will modulate the control valve to the reheat coil to maintain the setpoint temperature. When the space relative humidity drops below the setpoint, the HP will be returned to the Occupied Mode.

ALARMS: When the space relative humidity rise to above the maximum setpoint (60% adjustable), as sensed by a wall mounted humidity sensor, an alarm will be sent to the BAS. When the space CO₂ level is greater then 700 PPM (adjustable) above the referenced outdoor CO₂ level, as sensed by a CO₂ monitor in the space and external reference at the exterior of the building, and alarm will be sent to the BAS.

OPERATIONAL TREND LOGS

HOBO data loggers will be used to measure unit's supply temperature, space temperature and space humidity in the space served by the HP. The purpose of the logger is to record space temperature and humidity over time and corresponding discharge air temperature. Results will show actual space environmental conditions to compare with desired performance as well as occupied /unoccupied temperature conditions. The deployment of logger should be for a minimum of 48 hours to record a minimum of two (2) separate occupancy cycles.
FUNCTIONAL PERFORMANCE TESTING

1 Record the following information pertaining to the deployment of the data Logger.

SA Logger # **T224**
Rm Logger # **T227**

2 Record the space sensor displayed "set points" for the HP.

- Room Clg Set point: **71 °F**
- Room Htg Set point: **70 °F**
- Room RH Set point: **60 %**
- Night setback Set point: **65 °F**
- Night setup Set point: **82 °F**
- Room Temp @ BAS: **74.25 °F**
- Room RH @ BAS: **19.3 %**
- Rm CO₂ Level @ BAS: **429 PPM**
- Actual Rm Temp: **72.9 °F**

3 The **occupied** time of day schedule for the HP as displayed at the BAS Workstation is:

A 5:00 AM to 6:00 PM
B **Monday** (day) thru **Friday** (day)

**SPACE OPERATING STATUS**

**PERFORMANCE IN THE UNOCCUPIED MODE OF OPERATION**

4 Tests will be conducted "seasonally" during periods where considerable heating and cooling is required to maintain set points. Functional performance of the HP will be determined utilizing data logger results. Indicate below the season that the initial data logger tests were run.

- **SUMMER**
- **WINTER**

5 Complete items "A" or "B" below in accordance with the season indicated above.

A data logger test will be conducted to prove season temperature maintenance. Attach data logger results to final report.

6 A Were the summer occupied and unoccupied temperatures indicated in item #2 above maintained? _____ Yes _____ No (confirmed by data loggers)

B Were the winter occupied and unoccupied temperatures indicated in item #2 above maintained? _____X_____ Yes _____ No (confirmed by data loggers)

7 **Special Observations:** Unit was in Holiday (Unoccupied) Mode for 12/23/09 through 12/27/09.

8 The results of the performance testing for the Heat Pump, HP-13 are in compliance with the project specifications and the BAS approved sequences.

Yes **X** No
Section 7: References

Oxford Area School District

- Mr. Charles L. Lewis, Jr.
  Business Administrator
  119 South Fifth Street
  Oxford, PA 19363
  610.932.6607
  Projects: $20.8 million Penn’s Grove Middle School
            $20.7 million Hopewell Elementary School

Pennsbury School District

- Mr. Thomas Gillette
  Director of Physical Plant and Facilities
  134 Yardley Avenue
  Fallsington, PA 19058
  215.428.4164
  Project: $13 million Makefield Elementary School

Western Wayne School District

- Ms. Rose Emmett
  Business Manager
  2132 Easton Turnpike
  South Canaan, PA 18459
  570.937.4270
  Project: $15.4 million South Elementary School

School District of the City of York

- Mr. Bradley Harman
  Director of Buildings and Grounds
  329 Lindbergh Avenue
  York, PA 17405
  717.849.1232
  Projects: $10.2 million Jackson Elementary School
            $8.8 million McKinley Elementary School
            $2.8 million Lindbergh Avenue School
Section 8: Fee Proposal

Listed below is a lump sum fee and hourly rates for each of your buildings if awarded separately. However, we’ve also provided three combinations of discounted lump sum fees by grouping the facilities.

<table>
<thead>
<tr>
<th>LUMP SUM FEE*</th>
<th>TOTAL HOURS</th>
</tr>
</thead>
<tbody>
<tr>
<td>William Tennent High School</td>
<td>$38,675</td>
</tr>
<tr>
<td>Willow Dale Elementary School</td>
<td>$27,033</td>
</tr>
<tr>
<td>Davis Elementary School</td>
<td>$25,081</td>
</tr>
<tr>
<td>McDonald Elementary School</td>
<td>$25,081</td>
</tr>
</tbody>
</table>

*Discounted lump sum fee for William Tennent and Willow Dale combined – $54,458

*Discounted lump sum fee for Davis and McDonald combined – $40,662

*Discounted lump sum fee for all four projects combined – $92,870

<table>
<thead>
<tr>
<th>Hourly Rate for Additional Services</th>
</tr>
</thead>
<tbody>
<tr>
<td>Senior Engineer</td>
</tr>
<tr>
<td>Commissioning Agent</td>
</tr>
<tr>
<td>Commissioning Technician</td>
</tr>
</tbody>
</table>

The Lump Sum Fees above include all reimbursable expenses. We understand that we will not be reimbursed additional amounts for the following expenditures:

- Accounting
- Telecommunications
- Postage
- Transportation/Lodging
- Parking
- Photocopying
- Office Supplies
- Miscellaneous Supplies