A 3-Day Short-Course, July 12-14, 2016
Williamson College of the Trades

This unique, continuing education course focuses on large, field-erected steam generators with a 500,000- to 7-million-pounds-per-hour steam-generation rating. This course is designed to provide a balance of plant tours and classroom sessions which is consistent with the Williamson method of teaching with emphasis on practical and hands-on training. Each of the three days will feature a half day in power plants and a half day in the classroom.

Who Should Attend: Engineers, Managers, and Technicians who are employed by suppliers of equipment for the electric utility industry, new Utility and IPP employees, and anyone interested in learning the basics of Modern Fossil Power Production

Professional Development Hours: 16 PDHs
Cost: $1,000 per participant

Lead Instructor:
Richard F. Storm, PE, President (retired), of Storm Technologies, Inc., Albemarle, NC,
Dick has broad experience in the energy field. After studying power plant technology at Williamson College of the Trades, he worked many years in a variety of positions at several energy creating firms, including results engineer and technical assistant for Babcock and Wilcox Co.; senior service engineer for Riley Stoker Corp.; senior engineer, principal engineer, and operations superintendent at Carolina Power and Light; and vice president of Technical Services at Flame Refractories, Inc. In 1992, he took his lifelong energy experience and founded Storm Technologies, Inc., specializing in serving large electric utilities and heavy industry. He now serves as senior consultant. He is a Registered Professional Engineer in North Carolina and New Jersey, and has written numerous technical papers. He has also been a contributing editor for POWER Magazine, writing on coal combustion for many years, and has been one of the instructors of the Storm Technologies Short Course on Combustion and Performance Improvements of Large Utility Boilers which has been presented to thousands of Utility Engineers over the last 30 years.

Other Instructors:
John Beaudry, PE, Williamson’s Director of Power Plant Technology
John has worked in the power industry since 1973 in a variety of positions, including power generation. He has worked with coal, natural gas, and fuel oil boilers, both once-through and steam-drum types, and has experience with diesel generators and gas turbines. He has played an instrumental role in developing Williamson's Energy Island. He worked ten years as a senior project engineer at the Naval Weapons Support Center in Crane, IN, and six years as an electrical engineer at the University of New Mexico Engineering Research Institute in Albuquerque, NM, where he was responsible for electrical projects at the NORAD Space Command in Cheyenne Mountain, Colorado Springs, CO. He began his time at Williamson in 1989 as an electricity/electronics instructor and has been program director since 1994. In his early years teaching, he worked summers at the PECO Eddystone Generating Station in predictive maintenance. He has a bachelor of science degree in electrical engineering from the University of New Mexico.

Kevin Hatch, Shift Supervisor, System Operations, PJM Interconnection
Kevin graduated in 2008 from Williamson's Power Plant Technology Program. An outstanding student, Kevin was his class' treasurer and secretary, received the Sons of the American Revolution’s Outstanding Citizenship Award, was inducted into the prestigious I.V. Club, and, at Commencement, received the Thomas Gustave Furman ’79 Memorial Award for excellence in the mechanical field, the PECO Energy/Thomas M. Callahan ’79 Memorial Award for reflecting the values of Williamson, the Academic Honors Award for attaining a cumulative average of 3.5 or better, the Good Citizenship Award for receiving no disciplinary points in three years, and
the Jeanette and James R. Clemens ’34 Award for citizenship, leadership, and scholarship. He began work on a bachelor's degree in business administration at Strayer University evenings while still a Williamson student and only needed three classes to finish at the time of his graduation. He then earned a master's of business administration at Penn State Great Valley. Immediately after graduation from Williamson, Kevin began working at PJM Interconnection, where he still works. Over the years he has been a scheduling coordinator, generation dispatcher, power director, master dispatcher, and, now, shift supervisor, System Operations. He currently serves at Williamson on the Power Plant Academic Review Committee and teaches a PJM 101 course on the basics of power grid operations.

Tom Reilly, President, TJR Technical Services
Tom graduated in 1978 from Williamson’s Power Plant Technology Program and went to work at Flame Refractories for 15 years, where he worked with Dick Storm. He then spent five years at Storm Technologies. Next, with his years of industry experience, he became a consultant with his own company TJR Technical Services, Inc., which he still operates. Most of his career has been in fossil-fired utility steam generators, including fabrication of components, boiler rebuilds, inspections, combustion optimization, and operator training, etc. Tom and Dick taught a course on “Combustion and Performance Improvements of Large Utility Boilers” together from 1980-98. Tom has extensive experience as an instructor as well as being recognized as an industry expert. He has written numerous publications and given many presentations at PowerGen and other Power Industry Conferences. An outstanding field service engineer, he studies and prepares for each job he works on. He is sought after by many large manufacturing companies and electric utilities that wish to cost-effectively solve their most difficult problems.

Stacy Starr, retired Senior Technical Service Engineer at Sunoco
Stacy graduated in 1968 from Williamson’s Power Plant Technology Program. He started his career as a boiler field service start-up engineer for Erie City Iron Works, and then spent 12 years as results engineer for the power plant at the City of Dover, DE. He then worked as a senior process engineer at the Sun Refining and Marketing refinery in Marcus Hook until his retirement in 2003. After retiring, he worked four years as a part-time consultant for a major water treatment company and still consults from time to time. Stacy has worked with boilers up to 2,000# pressure, steam systems, and various make-up water treatment systems.

Course Outline

Tuesday, July 12, 2016

Morning Session (8 a.m.)
- Welcome Remarks by Dick Storm and John Beaudry
- Introduction of speakers and participants
- An overview of America's total energy that is used for thermal powering of our economy, transportation, electricity generation, industrial production heating and cooling of commercial and residential. About 90% of the energy used by the U.S.A. is conventional fossil fuels and nuclear. Most electricity production utilizes “Prime Movers” that utilize the Rankine Steam Cycle, The Brayton Gas Turbine Cycle, or a combination of the two. This opening session will focus on steam power plant equipment and fuels used to generate 90% of the world's electricity (Dick Storm)
- Basic steam generation and pulverized coal boiler fundamentals (Dick Storm)
- Large utility coal boilers overview of the equipment installed in the electric utility industry (Dick Storm)
- Large industrial boilers overview (Tom Reilly)
- Utility coal boiler design gas temperatures, water and steam paths, applied basic thermodynamics for steam generation, boiler circulation, steam purity (Dick Storm)

Lunch, Williamson Dining Room (12 p.m.)

Afternoon Session (1 p.m.)
Field trip and tour of the nearby (about 10 miles) Exelon Eddystone Station where two 400 MW Class C-E/Alstom Boilers are installed and operating. The plant will be toured to show the typical burners, steel, arrangement, and layout of a large electric
utility boiler. Field challenges for installation of updated burners, over-fire air systems, and a general review of the challenges of operating and maintaining a large fossil fuel plant such as Eddystone. The Eddystone Unit #1 is now being demolished after being a pace-setting unit with the highest design thermal efficiency of the time. Eddystone Unit #1 was designed for 5,000 psi steam supply to a cross compound steam turbine with design steam conditions of 1,200 °F main steam with two stages of reheated steam at 1,050 °F. The original design of Eddystone #1 was for a heat-rate of 8,310 BTU/kWh which is about 41% thermal efficiency. Units 3 and 4 are 1,800 psi, 955 °F /955 °F re-heat units. Oil-fired. The unit’s 3 and 4 were built in the early 1970s and are designed for “Peaking” operation.

After the tour we will reconvene in the Williamson classroom or the Eddystone plant assembly room to discuss the equipment and the current challenges to upgrade units of this type for competitive power generation. Such as the typical challenges of making boiler changes to burners and combustion air systems for NOx emissions reductions and fuel flexibility purposes. Tour is expected to last two hours and then the balance of the time in the classroom/assembly room to discuss the unit specifics and the principles of combustion.

- Combustion chemistry and theory (John Beaudry)
- Some experiences of applying the basics for excellence in operations and maintenance for large utility boilers. (Dick Storm and Tom Reilly)
- Typical challenges of water-side deposits, surface replacements, emissions reductions, cycling, and low load operation. (Tom Reilly)

Adjourn about 5 p.m.

**Wednesday, July 13, 2016**

**Morning Session (8 a.m.)**

- Large coal-fueled utility boilers. Combustion airflows to pulverizers, wind boxes, and over-fire air (Dick Storm)
- Measurement instruments and techniques for measuring airflows and calibrating primary elements of combustion airflows (Tom Reilly)
- Flue gas analyses measurement instruments and techniques (Tom Reilly)
- Tour of the Williamson Energy Island boilers, CAT natural gas engine/generator, diesels, boilers, steam turbine, and control room. Williamson’s “Energy Island” is being updated for state of the art “Combined Heat and Power.” Williamson was a true energy island, off the grid from 1890 to the mid 1980s. It has been going through updating since about 2014.
- Why low NOx burners? Combustion dynamics and products of combustion in the furnace. Review boiler flue gas paths and expected temperatures (Dick Storm)
- Competitive power generation from the independent system operator’s view-point. Renewables, coal, natural gas, and nuclear power challenges for reliability and lowest cost power generation (Kevin Hatch)
- Steam-Side and fire-side compatibility. Why certain gas-side temperatures are required to produce desired steam temperatures. Example, furnace exit-gas temperature must be above 2,000 °F to produce 1,000 degree superheat and reheat temperatures, but not so high that the coal ash melts and slags over the gas lanes. (Dick Storm)
- Competitive economics of power generation and economic dispatch of large utility generating plants. Fuel cost is a large component of power production cost at the busbar. Startup times and renewable power must run mandates are also factors. A more involved discussion of competitive generation costs. (Kevin Hatch)
- Common boiler metals that are used today. Review of common boiler metals such as ASME alloys, SA-210, 213-T-22, and common superheater and reheater alloys such as austenitic stainless steels types 304, 321 and 347. An introduction to the modern high chrome alloys T-23 and T-91 including some of the new issues of preheating and post weld heat treatment of the high chrome ferritic alloys. (Tom Reilly)
- Boiler water treatment overview. The importance of precision water treatment and the challenges of today’s cyclic operations. Boiler water wall deposits, corrosion, steam purity, oxygen pitting, flow assisted corrosion, impurities transport from the condenser to the boiler and steam turbine. Water treatment processes and chemicals to mitigate damage. (Stacy Starr, plant water chemistry specialist)
Lunch, Williamson Dining Room (12 p.m.)

**Afternoon Session (1 p.m.)**

Depart from Williamson campus to tour the Logan Coal-Fueled Power Plant located about 20 miles east on the New Jersey side of the Delaware River. Tour the plant for a review of a typical large-coal power plant. This plant is about 200 MW in size and provides extraction steam to the adjoining chemical plant operated by Monsanto. Therefore, it is a large CHP (Combined Heat and Power) facility.

At the conclusion of the Logan Plant tour we will assemble in the plant assembly room or return to Williamson to close the day with Q&A and a couple of short presentations.

Adjourn about 5 p.m.

**Thursday, July 14, 2016**

**Morning Session (8 a.m.)**

Approximately one hour of discussion of the gas turbine plant at the Next Era Power Plant in Marcus Hook:

- Gas turbine combined cycle overview. Why GTCC is so popular today. Efficient, natural gas-fueled, fast-load response, and more. Presentation of Mitsubishi, G-E, Alstom and Siemens gas turbine combined cycle plants. Overview of gas temperatures, gas and steam flows and overall efficiency. (Dick Storm and Tom Reilly)

Approximately 9 a.m., leave Williamson campus for a tour of the Next Era GTCC Plant. The NestEra Gas Turbine, Combined Cycle Plant is in Marcus Hook, PA, about 8 miles from Williamson.

At the conclusion of the tour meet in the plant assembly room or return to Williamson Campus to continue the presentations, Q&A and discussions.

Lunch, Williamson Dining Room (12 p.m.)

**Afternoon Session (1 p.m.)**

- Overview of gas turbine performance. Review of the Brayton cycle and the temperatures, exhaust gas temperatures, and gas turbine performance advancements over the years 1950-current day. (Dick Storm)
- Why combined cycle? Explanation of the combination of Brayton and Rankine cycles for best efficiency. (Dick Storm)
- HRSG’s (Heat Recovery Steam Generators) Typical arrangements and operation. (John Beaudry and Tom Reilly)
- Gas turbine, combined cycle challenges of operation and maintenance. What are today’s typical challenges of high reliability operation/maximum capacity (Tom Reilly)
- HRSG inspections, operational challenges, and duct burners (Tom Reilly)
- Boiler water treatment special precautions required for combined cycle operation concerning oxygen pitting, system upsets, and reasons why precise water quality is critical (Stacy Starr)
- Steam temperatures at low loads and high loads, operational changes to tune and adjust steam temperatures for oil, gas, and coal units. (Dick Storm)
- Combustion airflow minimums as governed by the NFPA (National Fire Protection Association) and the challenges of 25% of full-load, minimum airflow requirement for turn-down on large utility coal boilers
- Review of some boiler codes that apply to power boilers ASME, NFPA (Tom Reilly)
- Review of boiler emissions regulations, MATS, and post-combustion emission technology (John Beaudry and Dick Storm)
- Open discussion to summarize the materials presented, tours, and challenges. Q&A.

Adjourn about 5 p.m.