**SYMPOSIUM OF THE INDUSTRIAL APPLICATION OF GAS TURBINES COMMITTEE BANFF, ALBERTA, CANADA OCTOBER 2017**

**17-IAGT-305**

# Power Engineers
# And the Industrial Application of Gas Turbines

# IAGT 2017

**Authors:**
**Tim Haaf PE, Treasurer - BC Institute of Power Engineers**
**Eric Steinson PE, President - BC Institute of Power Engineers**
***First Class Power Engineers***

*tim.haaf@bchydro.com*
*esteinson@hotmail.com*

**Recognizing the benefits and application of Power Engineers to plant maintenance and operations utilizing Gas Turbine technologies would be of great value to industrial plant owners, operators and designers.**

The value and benefits Power Engineers bring to plant maintenance and operations of industrial plants are not currently well known or understood by many in industry.

WHO ARE POWER ENGINEERS?

A “Power Engineer” is a technically skilled and knowledgeable professional who is certified and responsible to safely and efficiently operate and maintain equipment and processes that are regulated by boiler and pressure vessel legislation.

…Pan Global Training Systems

A Power Engineer is also defined as a person skilled in the management of energy conversion for the purposes of processes and production operations, heating and ventilating, refrigeration and air conditioning, humidity control and power generation.

# Power Engineers and the IAGT

## HISTORY OF POWER ENGINEERING

Power Engineers are also known as Stationary Engineers, which differentiates them from Engineers operating mobile power plants, locomotives, ships etc. Permanent land based power plants, or stationary plants are the energy suppliers of all forms of industrial, commercial and institutional enterprises.

During the beginning, and expansion of the industrial revolution, power plants were proliferating in all areas of society, including factories, office buildings, stores, hotels and institutions. Many of these plants were quickly installed and much of the equipment poorly designed, and therefore, underwent many failures and shutdowns with losses in power and production.

Managing to keep the plant equipment on line and operating correctly was a never ending challenge, and knowledgeable, qualified operators were in short supply. The pace of construction and growth far outpaced the ability to educate and train operators and maintenance personnel adequately.

In the late 1800's, Power Engineers gathered and formed a united group for the purpose of information sharing and education of their members, in order to be better prepared and more capable of keeping their equipment and processes operating smoothly and to their designed output capabilities, allowing them to safely keep the lights on, and production lines flowing efficiently.

As plants developed in size, complexity and capability, the value of education for the operating engineers became more and more evident and this has driven the growth and development of the educational requirements and levels of certification of Power Engineers.

Regulatory regimes in the areas of safety and environment have also grown and developed as reactionary forces in answer to significant failures of equipment, which have created new levels of risk to life, property and the environment in the immediate vicinity of power plants and complex industrial processes. This too, has driven the legal requirements of appropriate levels of qualification and training of plant operations and maintenance personnel.

## **FAMOUS POWER ENGINEER**

In 1879, Henry Ford left home to work as an apprentice machinist in Detroit. He returned to Dearborn to work on the family farm where he became adept at operating the Westinghouse portable steam engine. He was later hired by Westinghouse to service their steam engines.

In 1891, Ford became an Engineer with the Edison Illuminating Company. After his promotion to Chief Engineer in 1893 he had enough time and money to devote attention to his personal experiments on gasoline engines.

## CERTIFICATION/EDUCATION OF POWER ENGINEERS

Power Engineering certification standards in Canada are regulated under Association of Chief Inspectors (ACI) and examined by Authorities across the country based on examinations developed by the Standardization of Power Engineers Examination Committee (SOPEEC)

All Classes of Power Engineers need to pass the SOPEEC exams prior to being issued a Certificate of Competency.

In obtaining their Certificate of Competency, all classes of Power Engineers require “sign off” for their practical experience qualifying time (Firing Time) by the Chief Engineer of their current plant.

The SOPEEC Committee is a committee delegated by, and responsible to, the ACI. SOPEEDC was formed in 1972 to promote a uniform examination system and improve mobility of Power Engineers across Canada. SOPEEC is a National Committee representing all Canadian jurisdictions and the Federal Department of Employment and Social Development Canada (HRSDC).

The Interprovincial Power Engineering Curriculum Committee (IPEEC) is an innovative organization in advising the SOPEEC on matters related to examinations, curriculum and syllabi for persons pursuing careers in Power Engineering.

The IPEEC is an open membership committee to enhance networking with the Community and Industry.

Provincial and Territorial regulations require a specified amount of experience in a recognized qualified plant, at progressive levels of responsibility commensurate to the level of qualification sought, along with:

- Successful completion of an approved course from a recognized educational institution, or,
- Successful completion of an approved distance education/correspondence course.

# Power Engineers and the IAGT

SOPEEC examines five different classes of Power Engineers beginning with 5th Class and progressing through to 1st Class. IPEEC is responsible to ensure that the course curriculum for Power Engineers aligns with the SOPEEC examination syllabus and makes recommendations to SOPEEC for changes.

- 5th Class is recognized in the four western Provinces and three Territories in Canada.
- 1st Class is recognized as the highest achievement of Power Engineering and a person holding this level can be Chief Power Engineer or Shift Engineer of any registered plant in Canada.

## PRACTICAL EXPERIENCE OR "FIRING TIME"

At each progressive examination for qualification level, or stage of qualification being sought by a Power Engineer, a minimum amount of experience is required in a position of responsibility commensurate with the qualification desired. Plant ratings are based upon plant energy capacity as stated in their design in either Kilowatts (Kw) or Horsepower (HP) rating.

| **Class** | **Exams (3.5 hrs. ea.)** | **Prerequisites** | | **Evaluation Requirement** |
|---|---|---|---|---|
| Refrigeration Operator | A1 | Refrigeration Mechanic<br>**or**<br>Completion of an approved Refrigeration Operator course<br><br>+ 6 months' work experience | | Evaluation required **before** applying to write the A exam. |
| 5th Class Examination | A1 | Completion of 5th Class Power Engineer approved course<br><br>+ 4 months' work experience | | Evaluation required **before** applying to write the A exam. |
| 4th Class Examination | A1, B1 | 3rd Class Marine (Motor)<br>**or**<br>completed full time 4th Class Power Engineer approved course<br><br>**or**<br>completion of an approved 4th | | Evaluation required **before** applying to write the B1 exam. |

| | | | | |
|---|---|---|---|---|
| | | Class correspondence course + 6 to 18 months work experience | | |
| 3rd Class Examination | A1, A2, B1, B2 | 2nd Class Marine (Motor) **or** 3rd Class Marine Steam **or** 4th Class Power Engineer Certificate + 12-36 months' work experience | | Evaluation required **before** applying to write the B2 exam. |
| 2nd Class Examination | A1, A2, A3, B1, B2, B3 | 1st Class Marine (Motor) **or** 2nd Class Marine (Steam) **or** 3rd Class Power Engineers + 24 months' work experience | | Evaluation required **before** applying to write the B3 exam. |
| 1st Class Examination | A1, A2, A3, A4, B1, B2, B3, B4 | 1st Class Marine (Steam) **or** 2nd Class Power Engineer + 30 - 45 months' work experience | | Evaluation required **before** applying to write the B4 exam. |

**As Quoted From**

***BC Safety Standards Act***

**POWER ENGINEERS, BOILER, PRESSURE VESSEL AND REFRIGERATION SAFETY REGULATION**

**What a first, second, third or fourth class power engineer may do**

**20** (1) A first, second, third and fourth class power engineer's certificate of qualification entitles the holder to be

(a) chief engineer of a plant with a corresponding or lower class,

(b) shift engineer of a plant up to one class higher than the class of the certificate, or

(c) a person in charge of any type or size of refrigeration plant.

(2) The holder of any class of power engineer's certificate of qualification may perform the duties authorized for the holder of a power engineer's certificate of qualification of a lower classification.

(3) An individual who holds a power engineer's certificate of qualification that is one class lower than that required for

(a) chief engineer of a plant may act as an assistant chief engineer of the plant, or

(b) shift engineer of a plant may act as an assistant shift engineer of the plant.

(4) An individual who holds any class of power engineer's certificate of qualification may act as an assistant engineer.

[en. B.C. 134/2009, s. 25.]

**Progressive experience – "Firing Time"**

Experience is gained at levels of responsibility commensurate with education.

**Firing time requirements**

4th class – 6 mos. to 1 year

3rd Class – 6 to 36 mos.

2nd Class – 15 to 24 mos.

1st Class – 18 – 45 mos.

**Total – 45 – 120 mos. (4 to 10 yrs.)**

# Power Engineers and the IAGT

**Academic Requirements – From SOPEEC Syllabi.**

**A. 4th Class PE – "Entry Level" of large plant, to Chief Engineer of appropriate size plant.**

| Part A – 3 ½ hour exam | Part B – 3 ½ hour exam |
|---|---|
| 1. *Applied Mathematics*<br>2. *Elementary Mechanics and Dynamics*<br>3. *Elementary Thermodynamics*<br>4. *Mechanical Drawing & Admin*<br>5. *Industrial Legislation*<br>6. *WHMIS*<br>7. *Plant Safety*<br>8. *Plant Fire Protection*<br>9. *Environment*<br>10. *Material and Welding*<br>11. *Piping and Valves*<br>12. *High Pressure Boiler Design*<br>13. *High Pressure Boiler Parts & Fittings*<br>14. *High Pressure Boiler Operation*<br>15. *Feedwater Treatment* | 1. *15Prime Movers and Engines*<br>2. *Pumps and Compressors*<br>3. *Air Compression*<br>4. *Lubrication*<br>5. *Electricity*<br>6. *Controls, Instrumentation and Computers*<br>7. *Heating Boilers*<br>8. *Heating Systems*<br>9. *Heating Boiler and Heating System Controls*<br>10. *Auxiliary Building Systems*<br>11. *Vapour Compression Refrigeration*<br>12. *Absorption Refrigeration*<br>13. *Air Conditioning*<br>14. *Air Conditioning Systems*<br>15. *Boiler Maintenance*<br>16. *Types of Plants* |

**B. 3rd Class PE – Journeyman Level of large plant (Control Room Operator) to Chief Engineer of appropriate size plant.**

**Each Part – 3 ½ hour exam**

| *Part A – Paper 1* | *Part A – Paper 2* | *Part B – Paper 1* | *Part B – Paper 2* |
|---|---|---|---|
| 1. *Applied Mathematics*<br>2. *Applied Mechanics*<br>3. *Thermodynamics*<br>4. *Applied Science*<br>5. *Industrial Drawings* | 1. *Industrial Legislation & Codes*<br>2. *Code Calculations, ASME*<br>3. *Fuels and Combustion*<br>4. *Piping*<br>5. *Electrotechnology*<br>6. *Electrical Calculations*<br>7. *Control Instrumentation*<br>8. *Industrial Safety and Fire Protection* | 1. *Boilers*<br>2. *Boiler Control Systems*<br>3. *Feedwater Treatment*<br>4. *Pumps*<br>5. *Welding Procedures and Inspection*<br>6. *Pressure Vessels* | 1. *Prime Movers*<br>2. *Cogeneration*<br>3. *Compressors*<br>4. *Refrigeration*<br>5. *Special Industrial Equipment*<br>6. *Wastewater Treatment*<br>7. *Plant Maintenance and Administration* |

**C. 2nd Class PE – Supervisory Level at large plants – Can be Chief Engineer at appropriate sized plant**

**Each Part – 3 ½ hour exam**

| *Part A – Paper 1* | *Part A – Paper 2* | *Part A – Paper 3* |
|---|---|---|
| 1. *ASME Code, Sects. I & VIII, Calculations*<br>2. *Industrial Administration*<br>3. *Applied Mechanics* | 1. *Thermodynamics*<br>2. *Metallurgy*<br>3. *Testing of Materials* | 1. *Boilers*<br>2. *Pumps*<br>3. *Water Treatment* |
| ***Part B – Paper 1*** | ***Part B – Paper 2*** | ***Part B – Paper 3*** |
| 1. *Heat Engines and Prime Movers*<br>2. *Lubrication*<br>3. *Piping*<br>4. *Mechanical Drawing* | 1. *Power Plant Systems*<br>2. *Control Instrumentation*<br>3. *Fuels and Combustion*<br>4. *Environmental Protection* | 1. *Electrotechnology*<br>2. *Principles of Air and Gas Compression*<br>3. *Industrial/Commercial Refrigeration* |

**D. 1st Class PE – Manager Level – Can be Chief Engineer at Any Size Plant**

| ***Part A – Paper 1*** | ***Part A – Paper 2*** | ***Part A – Paper 3*** | ***Part A – Paper 4*** |
|---|---|---|---|
| *Applied Thermodynamics and Plant Cycles* | *Principles of Applied & Fluid Mechanics* | *Applied Engineering Technologies* | *Power Plant Operations* |
| ***Part B – Paper 1*** | ***Part B – Paper 2*** | ***Part B – Paper 3*** | ***Part B – Paper 4*** |
| *Legislation and Codes for Industrial Equipment* | *Safety, Loss, and Environmental Program Management* | *Inspection, Maintenance and Repair Practices* | *Business and Workforce Management* |


## SUMMARY

With ever tightening constraints around safety, environmental, financial, and commercial values, it is becoming increasingly vital to monitor and operate industrial processes within the boundaries and limits of their design as well as legal permitted limits and continue to maintain social license as well as commercial advantage.


Gas Turbines, HRSG's, Once through Steam Generators,

- High speeds, temps and pressures
- Low temps and pressures (refrigeration for LNG cryogenic etc)
- Challenging products
  - Superheated steam
  - Gases, - H2, etc
  - Chemicals
- High throughputs (reduction of bottlenecks)
- Close clearances, corrosion allowances,
- Exotic material components
- Computer controls, QA/QC,
- Efficiencies and productivity

Canadian Power Engineers (World Class)

- National Standardization of Academic Examination
- Nationally recognized levels of qualification
- Nationally organized (IPE) and regulated by Provinces

# Power Engineers and the IAGT

- Progressive experience matching academic level
    - Broad spectrum of disciplinary study. (SOPEEC Syllabi: http://www.sopeec.org/index.php/home/whats-new/sopeec-syllabus/

Examples

- Power Plant Operations and Maintenance Management
- Energy conversion via prime movers i.e. Gas, Steam, Wind, Hydro etc.
- Thermodynamic engineering
- Fluid Dynamics and mechanics
- Instrumentation and automation
- Safety and Environment.

Canadian Power Engineers have Nationally Standardized certification and solid practical, theoretical, and technical knowledge and experience in:

- Power plant operations and management
- Industrial Legislation and safety and environmental management
- Maintenance to pressurized systems and boilers
- Thermodynamic engineering
- Fluid dynamics and mechanics
- Technical communications
- Instrumentation and automation
- Industrial electronics
- Workplace Hazardous Materials handling and emergency response,

## FINAL SUMMARY

Today's industrial plants utilizing gas turbines, are made up of a collection of extreme service equipment built to handle the high speeds, temperatures, and pressures required to produce products of challenging specifications in processes demanding exact standards at tremendous throughputs. Close clearances, high tolerances, corrosion resistant, highly complex parts containing exotic alloys and catalysts, have allowed processes to evolve with increased efficiencies and higher productivity. These processes are now computer controlled and monitored to very tight limits with final oversight provided by highly skilled and qualified Operators. The benefits associated with the utilization of Power Engineers in the operations and maintenance of these equipment are recognized and numerous. Improved safety and availability, increased efficiency, tighter control of process/product parameters, improved response to condition upsets, improved product quality, reduced operating costs, and longer life cycle of plant equipment are some of the many.

The employment of Power Engineers to operate this complex technical plant equipment for all industrial and commercial processes aligns with world class best practices and simply makes good business sense.