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Power Engineers And the Industrial Application of Gas Turbines

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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.

Power Engineers broad spectrum of knowledge, skills and experience are not currently well known or understood by many owners and operators in industry. This paper will provide clarity on the depth and breadth of knowledge and experience Power Engineers require to progress in their profession, which makes them extremely valuable to plant operations and maintenance.

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

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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.

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.

Keeping the plant equipment on line and operating correctly was a continual 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 19th Century, Power Engineers gathered and formed a united group for the purpose of information sharing and education of its members, in order to be better prepared and more capable of keeping their equipment and processes operating within 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 drove the growth and development of the educational requirements and levels of certification of Power Engineers.

Regulatory regimes in the areas of safety and environment also grew and developed as a reaction to significant failures of equipment which had created new levels of risk to life, property and the environment in the immediate vicinity of power plants and complex industrial processes. Increased legal requirements for appropriate levels of qualification and training of plant personnel were driven from this also.

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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. SOPEEC 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 (IPECC) is an innovative organization in advising SOPEEC on matters related to examinations, curriculum and syllabi for persons pursuing careers in Power Engineering.

The IPECC 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.

SOPEEC examines five different classes of Power Engineers beginning with 5th Class and progressing through to 1st Class. IPECC is responsible to ensure that the course

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curriculum for Power Engineers aligns with the SOPEEC examination syllabus and makes recommendations to SOPEEC for changes.

- 5th Class deals with low pressure and refrigeration plants and will not be dealt with in this paper. It is recognized in the four western Provinces and three Territories in Canada.
- 4th Class is the entry level in high pressure steam plants.
- 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 or Completion of an approved Refrigeration Operator course + 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 + 4 months' work experience	Evaluation required before applying to write the A exam.
4th Class Examination	A1, B1	3rd Class Marine (Motor) or completed full time 4th Class Power Engineer approved course	Evaluation required before applying to write the B1 exam.

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		or completion of an approved 4th 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 + 12-24 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 + 24-36 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.

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 – 12 to 24 mos.

2nd Class – 24 to 36 mos.

1st Class – 24 – 48 mos.

Total – 60 – 120 mos. 5 to 10 yrs.

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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.]

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Academic Requirements – From SOPEEC Syllabi.

A. 4th Class PE – “Entry Level” of large plant, to Chief Engineer of appropriate size plant. <http://www.sopec.org/Syllabus/FourthClassCurriculum.pdf>

Part A – 3 ½ hour exam	Part B – 3 ½ hour exam
<ol style="list-style-type: none"> 1. <i>Applied Mathematics</i> 2. <i>Elementary Mechanics and Dynamics</i> 3. <i>Elementary Thermodynamics</i> 4. <i>Mechanical Drawing & Admin</i> 5. <i>Industrial Legislation</i> 6. <i>WHMIS</i> 7. <i>Plant Safety</i> 8. <i>Plant Fire Protection</i> 9. <i>Environment</i> 10. <i>Material and Welding</i> 11. <i>Piping and Valves</i> 12. <i>High Pressure Boiler Design</i> 13. <i>High Pressure Boiler Parts & Fittings</i> 14. <i>High Pressure Boiler Operation</i> 15. <i>Feedwater Treatment</i> 	<ol style="list-style-type: none"> 1. <i>15 Prime Movers and Engines</i> 2. <i>Pumps and Compressors</i> 3. <i>Air Compression</i> 4. <i>Lubrication</i> 5. <i>Electricity</i> 6. <i>Controls, Instrumentation and Computers</i> 7. <i>Heating Boilers</i> 8. <i>Heating Systems</i> 9. <i>Heating Boiler and Heating System Controls</i> 10. <i>Auxiliary Building Systems</i> 11. <i>Vapour Compression Refrigeration</i> 12. <i>Absorption Refrigeration</i> 13. <i>Air Conditioning</i> 14. <i>Air Conditioning Systems</i> 15. <i>Boiler Maintenance</i> 16. <i>Types of Plants</i>

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

<http://www.sopec.org/Syllabus/SyllabusThirdClass.pdf>

Each Paper – 3 ½ hour exam

Part A – Paper 1	Part A – Paper 2	Part B – Paper 1	Part B – Paper 2
<ol style="list-style-type: none"> 1. Applied Mathematics 2. Applied Mechanics 3. Thermodynamics 4. Applied Science 5. Industrial Drawings 	<ol style="list-style-type: none"> 1. Industrial Legislation & Codes 2. Code Calculations, ASME 3. Fuels and Combustion 4. Piping 5. Electrotechnology 6. Electrical Calculations 7. Control Instrumentation 8. Industrial Safety and Fire Protection 	<ol style="list-style-type: none"> 1. Boilers 2. Boiler Control Systems 3. Feedwater Treatment 4. Pumps 5. Welding Procedures and Inspection 6. Pressure Vessels 	<ol style="list-style-type: none"> 1. Prime Movers 2. Cogeneration 3. Compressors 4. Refrigeration 5. Special Industrial Equipment 6. Wastewater Treatment 7. Plant Maintenance and Administration

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

<http://www.sopec.org/Syllabus/SyllabusRevisedSecondClass.pdf>

Each Paper – 3 ½ hour exam

Part A – Paper 1	Part A – Paper 2	Part A – Paper 3
<ol style="list-style-type: none"> 1. ASME Code, Sects. I & VIII, Calculations 2. Industrial Administration 3. Applied Mechanics 	<ol style="list-style-type: none"> 1. Thermodynamics 2. Metallurgy 3. Testing of Materials 	<ol style="list-style-type: none"> 1. Boilers 2. Pumps 3. Water Treatment
Part B – Paper 1	Part B – Paper 2	Part B – Paper 3
<ol style="list-style-type: none"> 1. Heat Engines and Prime Movers 2. Lubrication 3. Piping 4. Mechanical Drawing 	<ol style="list-style-type: none"> 1. Power Plant Systems 2. Control Instrumentation 3. Fuels and Combustion 4. Environmental Protection 	<ol style="list-style-type: none"> 1. Electrotechnology 2. Principles of Air and Gas Compression 3. Industrial/Commercial Refrigeration

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

<http://www.sopec.org/Syllabus/SyllabusRevisedFirstClass.pdf>

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

SUMMARY

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

Power Engineers (World Class)

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- National standardization of academic study
- National standardization of academic examination
- Nationally recognized levels of qualification
- Nationally organized (IPE) and regulated by Provinces
- Progressive experience matching academic level
- Broad spectrum of disciplinary study (syllabi).

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 of pressurized systems and boilers
- Thermodynamic engineering
- Fluid dynamics and mechanics
- Technical communications
- Instrumentation and automation
- Industrial electronics
- Workplace hazardous materials handling and emergency response,

Today's industrial plants 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

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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 operation and maintenance of this 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.

Power Engineers' broad based knowledge in all disciplines, along with extensive experience in progressive roles of responsibility, provide them a unique and advantageous perspective with "larger picture" view when operating, troubleshooting and optimizing plant operations. Benefits to this include opportunities for increased efficiencies, longer plant life cycle, prevention of upset conditions, reduction of safety or environmental incidents, reduced down time and plant outages.

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.