

The NIULPE
STUDENT HANDBOOK

DRAFT

Student Book

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Preface

Through the years, power engineering has meant different things to different people. The power engineer in the northern latitudes will generally be more involved in steam generation for heating applications, while comfort cooling might be the primary objective of those in the southern states. The fuel used under power boilers, whether coal, oil, or gas, will also vary depending on the application, geographical location, and availability. More than anything else, the tasks performed on the job have changed a great deal over the years. Most power engineers today, find themselves not only operating boilers and turbines, but also refrigeration plants, air compressors, computer automated systems that control heating, ventilating and air conditioning, and a host of other responsibilities which have found their way into the general job description. In recent years, the Federal Government has started to play a larger role as a regulating body in the power-engineering field. Modern scientific methods are offering a clearer picture of the effects that the burning of fossil fuels have on the environment, and as such, the government seeks to develop acceptable standards that are accurate, useful and fair to any entity that contributes to these atmospheric pollutants.

It has always been necessary to the power engineer to keep up-to-date with changing technologies, and this is more important today than ever. Acceptable and competent standards, adopted on a nationwide basis, will likely become a reality within the next ten years, and the individuals who will be affected by those standards should play a vital role in their development. Standards level the playing field, and ensure that everyone from the business owner to the power engineer are working towards the same goal: Generating power, steam, or refrigeration, safely and efficiently with as little negative impact on the environment as possible.

The NIULPE has this goal in mind when developing testing and certifications for the power engineer. Providing a reasonable measure of competency for the individual, and to those who may employ him or her, is no small task. Gaining and maintaining a national recognition acceptable to all parties has proven elusive in the past, but continues to be the central goal of the organization.

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Introduction

The National Institute for the Uniform Licensing of Power Engineers is a third party licensing agency that acts on a national level to establish standards for firemen and water-tenders, engineers, operators, examiners, instructors, and the licensing agencies currently existing. In addition, NIULPE will accredit courses taught in Power Engineering Technology, which must meet minimum requirements. NIULPE will commission those instructors of power technology and those instructors teaching courses in support of power technology who meet the requirements established by this Institute.

What is NIULPE?

The NIULPE is a third party licensing agency, which acts on a national level for power engineers and those associated with the profession. Registration is purely voluntary on the part of licensing agencies, etc. It is however, the only formal structure through which a person in power engineering may establish a level of national competency and national professional recognition. The NIULPE performs the following major functions:

- 1) Establish and maintain uniform standards as to qualifications for power engineers
- 2) Promote safety in the operation of power generating equipment
- 3) Assist licensing agencies to determine the competence of power engineers through investigations and examinations, which test the qualifications of voluntary candidates for licenses to be issued under the rules of NIULPE
- 4) Grant and issue commissions to the licensing agencies who apply and qualify
- 5) Maintain a registry of all examiners who meet the requirements of NIULPE and are commissioned by NIULPE
- 6) Maintain a registry of all licensing agencies meeting the requirements of NIULPE and are commissioned by NIULPE
- 7) Serve as a clearinghouse to facilitate reciprocity between all licensing agencies
- 8) Publish a standard curriculum for education and guideline for study requirements
- 9) Act as advisor to educational entities engaged in teaching power engineering and technology
- 10) Develop, and keep current, uniform terms and definitions, updating terminology, and eliminating obsolete terms
- 11) Encourage the enforcement and compliance to all codes, laws, and acts assuring the protection of health, life and property

The Power Engineer

A power engineer is best defined as one skilled in the management of energy conversion. A power engineer operates and maintains equipment essential to power generation, heating, ventilation, humidity control, and air conditioning in industrial plants, institutions and other building complexes. They perform in a responsible manner as a technical expert in operating, maintaining and repairing engineering plants consisting of steam boilers, pressure vessels, internal combustion engines, steam engines, steam turbines, gas turbines, refrigeration and air conditioning equipment, generators, motors, pumps, compressors, distillation units and related equipment.

Because the health and safety of many people depend upon the proper operation and functioning of engineering equipment, an engineer must operate and maintain equipment according to country, providence, state, and local laws and codes. As a lower grade power engineer, they are often under the general direction of a chief engineer or engineer holding a higher-grade license, whose license is equal to or above the requirements needed to operate the plant. It should also be understood, especially by those who are just entering the field, that they

are just as likely to be placed under the direction of persons who have no formal training or education in the power-engineering field.

As they advance their licenses through experience and study, they become qualified to take charge of an entire engineering plant operation. Through on-the-job training and application of study courses, a power engineer attains the skills and knowledge required. A power-engineer may advance to many jobs associated with the profession as they become adequately educated and trained.

Under proper engineering direction, they may perform duties of an engineering technician. Those duties could include draftsman, estimator, designer, planner, and the erecting, inspecting and testing of engineering equipment. They may engage in activities connected with research and development, servicing and testing of materials, sales engineering and instructional activities.

When licensed, the power-engineer has a clearly established a level of competency. As experience and education advance their skills, they have the opportunity to improve their level of certification through the six license classifications. Encouragement toward professional advancement is a vital element toward sound personnel policies. Advancement in licensing should move the power-engineer closer to the management team. The power-engineer will undoubtedly acquire a sense of achievement and pride when their license is displayed on the wall of their work area.

Classifications of Licenses

There are six levels of licenses:

- 1) Fifth Class
- 2) Fourth Class
- 3) Third Class Engineer
- 4) Second Class Engineer
- 5) First Class Engineer
- 6) Chief Engineer

Regulations Governing Examinations

An applicant for examination for such licenses shall be required to fulfill the following general requirements for all classifications:

- 1) Complete the required form, stating accurately and in detail all the mechanical and electrical training and experience they have acquired relative to the examination for which they are a candidate

- 2) Satisfy the Examining Board as to their character and ability
- 3) Prove that they have attained the age required
- 4) Take an affidavit as printed on application, attesting that their statements are true
- 5) Answer examination questions presented and obtain a minimum of seventy percent correct responses
- 6) Pay the required fee as prescribed by the licensing agency to which they have qualified

Examinations will be prepared with every attempt to insure fairness to the candidate. Accepted methods, theory, and measurement of tests will be employed. Examinations will be kept valid by revision and up dating as codes and standards require.

Curricula for Examinations

The board will establish a list of subjects covering the experiences and technical knowledge required for each classification. Examinations are based on the proper curricula for all grades. By using the guides and subjects suggested, any candidate can prepare for current examinations.

Fifth Class Power Engineer

Curriculum to cover the low pressure fundamentals

- 1) The two common types of boilers- the fire tube and water tube designs
 - a) Descriptions of each, their characteristics and qualities of a good boiler
- 2) Water tube hot water boilers
 - a) The meaning and description of these terms:
 - i) Low pressure
 - ii) High pressure
 - iii) Section 1 or V ASME Boiler and Pressure Vessel Code
 - iv) Safety relief valve
 - v) Temperature / pressure gauge
 - vi) Air control
 - vii) Flow control
 - viii) Pressure-reducing valve
 - ix) Compression (expansion) tank
 - x) Aqua-stat
 - xi) Diverter fittings
- 3) Cast iron sectional boilers
 - a) The description and characteristics, uses and construction of this design
- 4) Electrical boiler

- a) The description and characteristics, uses and construction of this design
- 5) Boiler fittings
 - a) The meaning and description of these terms:
 - i) Safety valves
 - ii) Testing safety valves
 - iii) Compound gauge
 - iv) Pressure gauge
 - v) Vacuum gauge
 - vi) Pig tail siphon
 - vii) U-tube siphon
 - viii) Water column
 - ix) Try cocks
 - x) Operation gauge glass flat and tubular
 - xi) Water column blow down valves
 - xii) Gauge glass blow down valves
 - xiii) Bottom blowdown valves
 - xiv) Boiler vents
 - 6) Boiler water chemistry
 - a) The meaning and description of these terms:
 - i) Controlling high water
 - ii) Removal of sludge and sediment
 - iii) Controlling chemicals
 - iv) Dumping the boiler
 - v) Surface blowdown
 - vi) Controlling chemicals
 - vii) Foaming
 - viii) Priming
 - ix) Carryover boiler water treatment
 - x) Boiler water contamination
 - 7) Boilers and feedwater treatment
 - a) Describe the measures for treatment of the following:
 - i) Preventing scale
 - ii) Oxygen in the boiler water
 - iii) Feeding chemicals
 - iv) Priming and carryover
 - 8) Fusible plug
 - a) Where the plugs are placed, their purpose, how they are kept in good condition, possible failures, descriptions of types of plugs, installations, when and how often they are renewed.
 - 9) Instrumentation
 - a) The meaning and description of these terms:

- i) Pressure control
- ii) Modulating pressure control operation

10) Draft systems

a) The meaning and description of these terms:

- i) Natural draft
- ii) Mechanical draft
- iii) Forced draft
- iv) Induced draft
- v) Balanced draft
- vi) Measuring draft
- vii) Controlling draft

11) Feedwater systems

a) The meaning and description of these terms:

- i) Feedwater valves
- ii) Feedwater valve operation
- iii) City-water-makeup
- iv) Makeup systems
- v) Automatic makeup system
- vi) Feedwater regulator

12) Low water fuel cut-off

a) The meaning and description of these terms:

- i) Lower water fuel cut-off construction
- ii) Operation of the low water fuel cutoff
- iii) Testing the low water fuel cut-off

13) Fuel oil system

a) The meaning and description of these terms:

- i) Viscosity
- ii) Flash point
- iii) Fire point
- iv) Pour point
- v) Types of fuel oil
- vi) Btu valves
- vii) Fuel oil heaters
- viii) Fuel oil tanks
- ix) Duplex strainer
- x) Fuel oil pump
- xi) Burners and types
- xii) Pressure regulating valve
- xiii) Fuel oil piping
- xiv) Instrumentation for fuel oil systems

14) Boiler operation

- a) Standard operation practices:
 - i) Taking over a shift
 - ii) Boiler start-up and shut-down
 - iii) Blowing down a boiler
 - iv) Low water conditions
 - v) Furnace explosions
 - vi) Preparing for a boiler inspection
 - vii) Boiler lay-up
 - viii) Boiler operation with a broken gauge glass
 - ix) Cleaning the gauge glass
 - x) Correcting a steam-bound pump
 - xi) Hydrostatic test
 - xii) Maintaining a boiler room log

- 15) Dangerous conditions
 - a) When a boiler should not be operated
 - b) What causes boilers to burn-up or explode

- 16) Hot water heating systems
 - a) The meaning and description of these terms
 - i) Natural circulation hot water heating system
 - ii) Forced circulation hot water heating system
 - iii) Water temperature control

- 17) Cooling systems
 - a) The meaning and description of these terms:
 - i) Cooling system principles
 - ii) Cooling system operation
 - iii) Compression system
 - iv) Refrigerants
 - v) Absorption systems
 - vi) Lithium bromide
 - vii) Water system
 - viii) Direct and indirect cooling systems

- 18) Gas system
 - a) The meaning and description of these terms:
 - i) Low pressure system
 - ii) High pressure system
 - iii) Gas piping
 - iv) Regulator
 - v) Blower
 - vi) Manual shutoff valve
 - vii) Mixing chamber
 - viii) Burner piping
 - ix) Pressure

- x) Regulating valve
- xi) Instrumentation
- xii) Combination gas/fuel oil burners

19) Coal systems

- a) The meaning and description of these terms:
 - i) Safety working with coal
 - ii) Hand firing coal
 - iii) Stoker fired
 - iv) Screw-feed stoker
 - v) Under-feed stoker
 - vi) Ram-feed stoker
 - vii) Starting a stoker
 - viii) Banking a fire
 - ix) Burning down a fire

20) Combustion

- a) The meaning and description of these terms:
 - i) Mixtures of combustibles and air
 - ii) Methods of application and how they are controlled
 - iii) The purpose of settings
 - iv) Dampers
 - v) Draft
 - vi) Chimneys or stacks
 - vii) Hand firing methods
 - viii) Perfect combustion
 - ix) Complete combustion
 - x) Incomplete combustion
 - xi) Primary air
 - xii) Secondary air
 - xiii) Automatic combustion controls
 - xiv) Programmer
 - xv) Microcomputer burner control system
 - xvi) Flame scanner & types including infrared and ultra-violet
 - xvii) High fire
 - xviii) Low fire
 - xix) The meaning of turndown ratio

21) Steam systems & steam accessories

- a) The meaning and description of these terms:
 - i) Main steam stop valve
 - ii) Steam valves including globe, gate, ball types, construction and operation
 - iii) Steam traps and strainers including types and construction, testing and placement

- 22) Plant mathematics
- a) A knowledge sufficient to solve and find:
 - i) Total force
 - ii) Area of a circle
 - iii) Pressure
 - iv) Heating surface
 - v) MAWP

- 23) Boiler room safety
- a) How to prevent boiler room accidents
 - b) Preventing boiler room fires
 - c) General boiler room safety rules

Fourth Class Power Engineer
Curriculum to cover the fundamentals

- 1) Fire tube and water tube boilers
 - a) The description, characteristics and qualities of a good boiler
- 2) Stays
 - a) The placement, purpose, types, description, and care of stays. The advantages and disadvantages of various types, potential failures
- 3) Heating surface
 - a) The meaning of these terms:
 - i) Grate surface
 - ii) Fire line
 - iii) Water level
 - iv) Fire tubes
 - v) Water tubes
- 4) The cleaning and inspection of boiler settings
- 5) Starting clean boilers
 - a) The removal and replacement of manhole covers, raising steam pressure, cutting the boiler into a live steam header, banking boiler, and starting after the boiler has been banked
- 6) Dangerous conditions

- a) When a boiler should not be operated
 - b) Causes of boiler explosions
- 7) Drum conditions
- a) The dangers and remedies of the following conditions found in boiler drums:
 - i) Corrosion
 - ii) Pitting
 - iii) Priming
 - iv) Foaming
 - v) Bulging
 - vi) Bagging
- 8) Water column
- a) The placement and function of the column
 - b) How the column is held in place
 - c) The length and care of the column
 - d) What affects column efficiency
 - e) Maintenance
 - f) Valves and cocks needed
 - g) Potential failures
 - h) When and how to test the column
- 9) Water glass
- a) The placement of the glass
 - b) The function of the glass
 - c) How the glass is held in place
 - d) The length of the glass
 - e) Potential failures
 - f) Operating with a broken glass
 - g) How to test the glass
- 10) Steam gauge and siphon
- a) The placement of the gauge
 - b) The principle upon which a gauge operates
 - c) The function care and maintenance of a gauge
 - d) How and when to test a gauge
- 11) Safety valve and rupture-discs
- a) The placement and function of the disc
 - b) Care and maintenance of the discs
 - c) How and when the disc should be tested
 - d) Disc failure
 - e) Pressure adjustment
- 12) Elementary combustion
- a) Mixtures of combustibles and air

- b) Methods of application and how combustion is controlled
 - c) The purpose of settings
 - d) Dampers
 - e) Draft
 - f) Chimneys or stacks
 - g) Hand firing methods heating values of anthracite or bituminous coal
 - h) Oil
 - i) Gas
- 13) Operation of oil or gas burners and electric boilers
- a) Installation
 - b) Starting and stopping oil or gas burners
 - c) Failures
 - d) Controls
 - e) Safety devices
- 14) Operation of stokers
- a) The purpose of the stoker
 - b) Starting and shutting down
 - c) Failures
 - d) Controls
 - e) Safety devices
- 15) Feedwater, piping and valves
- a) Location care and maintenance of piping
 - b) Piping failures
 - c) The reasons for having valves and check valves on piping
 - d) How to keep these appurtenances in good condition
 - e) Reasons for internal pipe
- 16) Blowdown valves piping and tank
- a) The location and purpose of the blowdown valves
 - b) The location and purpose of the blowdown tank
 - c) Care
 - d) Maintenance
- 17) Auxiliaries
- a) Steam non-return valve,
 - b) Expansion joints
 - c) Heaters
 - d) Steam separators
 - e) Sight feed lubricators
 - f) Steam traps
 - i) Float and thermostatic
 - ii) Bucket

- iii) Thermostatic
- g) Reducing valves
- h) Feedwater regulators
- i) Maintenance

18) Pumps

- a) Simplex pumps
- b) Duplex pumps
- c) Vacuum pumps
- d) Centrifugal and gear type pumps
- e) Maintenance
- f) Pump failures

19) Injector

- a) Function and principle upon which the injector operates
- b) Care
- c) Maintenance
- d) Cleaning and inspection
- e) Valves

20) Air compressors

- a) The purpose of air compression
- b) The dangers of operating air compressors
- c) Maintenance

21) Refrigeration

- a) Components and operation including:
 - i) Compressors
 - ii) Condensers
 - iii) Receivers
 - iv) Evaporators
 - v) Purge
 - vi) Expansion valves
 - vii) Charting
 - viii) Liquid
 - ix) Suction
 - x) Discharge
 - xi) Cross over valves
 - xii) Typical locations of equipment
 - xiii) The dangers presented by refrigeration equipment
 - xiv) The care and handling of refrigerants including certification required by the Environmental Protection Agency

22) Feedwater heaters

- a) The types of heaters
- b) The purpose of the heater

- c) The advantages and disadvantages of each type
 - d) Methods of heating feedwater
 - e) Applications
 - f) Potential failures of feedwater heaters
- 23) Steam plant accessories
- a) Back-pressure valves
 - b) Non-return valves
 - c) Throttle valves
 - d) Expansion joints
 - e) Feedwater regulators
 - f) Steam separators
 - g) Sight feed lubricators
 - h) Steam traps
 - i) Reducing valves
 - j) Sprinkler systems
 - k) Function, location, operation and care
- 24) Steam condensers
- a) General knowledge of condensers, where they are typically located
 - b) How and why they are used
 - c) The general care and upkeep of condensers and auxiliaries
- 25) Steam engines
- a) The types of engines
 - b) Setting engine valves
 - c) The purpose of the flywheel
 - d) The eccentric
 - e) The governor
 - f) The cross head
 - g) Lap and lead
 - h) Angle of advance
 - i) Valve travel and cut off
 - j) Methods of lubrication
 - k) Starting and stopping engines
 - l) Maintenance and care
- 26) Steam turbines
- a) Types of turbines
 - b) General knowledge of lubrication systems
 - c) Governors
 - d) Throttle valves
- 27) Electrical equipment
- a) Terms including:

- i) Fuses, cut outs, relays, switches, circuit breakers, purposes and comparative applications
 - ii) Dangerous conditions in the operation of a motor
 - iii) Power lockout procedures
 - iv) Fuses, sizes and ratings
 - v) Ampacity of wiring for lighting circuits
 - vi) Volts, ampere, watt, ohm, DC, AC, electrical conductors
 - vii) Electric insulators
 - viii) The difference between an electric generator and motor
- 28) Operation and maintenance of controls
- 29) Air pollution and ecology
- a) Typical atmospheric pollutants
 - b) The dangers presented by air, land and water pollution
 - c) The responsibility of the power engineer to the community
 - d) Long and short-term effects of pollution on humans and wildlife
 - e) Legal ramifications faced by firms and the power engineer for polluting the environment
 - f) Treating effluents for disposal
- 30) Heating air conditioning and ventilation
- a) Methods of heating or air conditioning
 - b) Water hammer in heating systems
 - c) Piping arrangements
 - d) Radiation
 - e) Vacuum and plenum systems in mechanical ventilation
 - f) Gravity vacuum and plenum systems in mechanical ventilation
 - g) Gravity and vacuum steam systems
 - h) Care and maintenance
- 31) Boiler feedwater treatment and water chemistry
- a) Modern water treatment methods
 - b) The purpose of treating water for boilers
 - c) Towers
 - d) Closed loop systems
 - e) How treatment is applied and controlled
 - f) The dangers of over-treatment and under treatment
- 32) Scale and mud
- a) Where and why mud and scale form
 - b) Prevention
 - c) Effects on efficiency
 - d) Dangers
 - e) Removal of scale and mud mechanically and chemically
- 33) Plant mathematics

- a) The power engineer should have adequate knowledge to perform addition, multiplication and division problems as well as a rudimentary understanding of equations and how they apply to the principles of plant operation theory.
- 34) Plant safety
- a) Should include ECPL (electrical control power lockout) knowledge and understanding. All power engineers should have a complete understanding of how energy is controlled and locked-out before servicing equipment including thermal energy, electrical energy hydraulic energy, steam and water, natural gas, and any other medium that flows under pressure.

Third Class Power Engineer
Curriculum to cover the fundamentals

- 1) The two common types of boilers, the fire tube and water tube.
 - a) The description and characteristics of each type of boiler
 - b) The qualities of a good boiler
- 2) Stays
 - a) Where stays are located within the boiler
 - b) The purpose of stays
 - c) Different types of stays
- 3) The meaning of the following terms
 - a) Grate surface
 - b) Fire line
 - c) Water level
 - d) Fire tubes water tubes
 - e) Heating surface
- 4) Cleaning and inspection of boilers and settings
 - a) Proper procedures for general cleaning and preparation of a boiler or turbine for inspection
- 5) Starting a clean boiler
 - a) Man hole covers, how they are removed and replaced
 - b) Raising steam
 - c) Cutting the boiler into a live steam header
 - d) Banking the boiler and starting after banking

- 6) Dangerous conditions
 - a) When a boiler should not be operated
 - b) The primary cause of overheating and boiler explosions

- 7) The meanings of the following terms
 - a) Corrosion
 - b) Pitting
 - c) Priming
 - d) Foaming
 - e) Bulging and bagging
 - f) Where each of these conditions are usually found
 - g) The dangers presented by these conditions and how they can be remedied

- 8) Water column and glass
 - a) The location and function of the water column and how it is held in place
 - b) The function of the glass
 - c) Maintenance of the column and glass
 - d) Valves and cocks
 - e) When the column and glass is tested
 - f) Blowing down
 - g) Cutting a new glass

- 9) Fusible plugs
 - a) The purpose of the fusible plug
 - b) The location(s) of fusible plugs
 - c) Maintenance of the plugs
 - d) Replacement timetable

- 10) Rupture discs and safety valves
 - a) The description of a safety valve
 - b) Adjustments of the valve for lift and blow-back
 - c) Replacement of the valve
 - d) The function of the valve-(probably the most important safety device on the boiler)
 - e) The description of types of rupture discs.

- 11) Elementary combustion
 - a) Mixtures of combustibles and air
 - b) Methods of combustion control
 - c) Settings
 - d) Draft- (forced and induced)
 - e) Chimneys and stacks
 - f) Hand firing methods
 - g) The heating value of anthracite and bituminous coal
 - h) Oil
 - i) Gas

- 12) The operation of oil and gas burners and electric boilers
 - a) Installations
 - b) Starting and shutdown
 - c) Care and maintenance
 - d) Dangers
 - e) Controls and safety devices

- 13) The operation of a stoker
 - a) The purpose of the stoker
 - b) Starting a stoker
 - c) Maintenance of a stoker
 - d) Advantages and disadvantages of different types

- 14) Boiler feedwater, piping and valves
 - a) Location of valves
 - b) Piping systems
 - c) Failures of piping and appurtenances
 - d) Valves and their typical locations
 - e) Valve maintenance
 - f) Internal pipe

- 15) Blow down valves, piping and the blowdown tank
 - a) The description of blowdown valves
 - b) The description of blowdown tanks
 - c) Associated piping
 - d) Maintenance

- 16) Auxiliaries
 - a) Steam non-return valve
 - b) Expansion joints
 - c) Heaters
 - d) Steam separators
 - e) Sight feed lubricator
 - f) Steam traps
 - g) Reducing valves
 - h) Feed water regulators
 - i) The function and typical locations of these appurtenances

- 17) Pumps, the description and operation of various types of pumps including
 - a) Simplex pumps
 - b) Duplex pumps
 - c) Rotary pumps
 - d) Centrifugal pumps
 - e) Gear pumps
 - f) Turbine pumps

- g) Vacuum pumps
 - h) Maintenance of pumps
- 18) Injectors
- a) The injector design
 - b) Principle of operation
 - c) Care and maintenance
 - d) Cleaning and inspection
 - e) Associated valves
- 19) Air compressors
- a) General operation and maintenance
 - b) Dangers
 - c) Safety valves
 - d) Water removal from the compressor and air system
- 20) Refrigeration
- a) General refrigeration principles
 - b) Compressors
 - c) Condensers
 - d) Receivers
 - e) Evaporators
 - f) Purge units
 - g) Expansion
 - h) Charging
 - i) Liquid suction
 - j) Discharge
 - k) Cross over valves
 - l) Unloaders
 - m) Federal regulations pertaining to the addition, removal, storage, and disposal of refrigerants as required by 40 CFR part 82. Subpart F “Proper Refrigerant Practices Program” - US Environmental Protection Agency
- 21) Feedwater heaters
- a) Types of heaters
 - b) The purpose of the heater
 - c) Advantages and disadvantages of each type
 - d) Methods of heating feedwater
- 22) Heat engines
- a) General knowledge of types of engines
 - b) Internal and external combustion
 - c) Gas turbines
 - d) Combined cycle units
- 23) Electrical equipment

- a) Fuses
 - b) Cutouts relays and switches
 - c) Circuit breakers
 - d) Applications
 - e) Dangerous conditions presented by electrical equipment
 - f) Motors
 - g) Electrical Control Power Lockout
 - h) Fuses and ratings
 - i) Carrying capacities of wires for lighting circuits
 - j) Volt, ohm, amps, and watts
 - k) Difference between DC and AC current
 - l) Electrical conductors
 - m) Electrical insulators
 - n) Generators and motors
- 24) Air pollution and ecology
- 25) Scale and mud
- a) Where scale and mud are found
 - b) The effect of scale and mud in a boiler and system
 - c) The control and removal of scale and mud
- 26) Boiler feedwater treatment and water chemistry
- a) How water chemistry is controlled
 - b) Chemicals used in the control process
 - c) Dangers of over and under treatment
- 27) Gas turbines, and combined cycles
- a) Thermodynamic principles
 - b) Combined cycle power generation
 - c) Steam turbines
 - d) Heat recovery steam generators
 - e) Gas turbine theory
 - f) Brayton Cycle
 - g) Ranking cycle
 - h) Simple cycle gas turbine
 - i) Gas turbine construction
 - j) Aero derivative
 - k) Heavy duty heat recovery steam generators
 - l) Operating systems
 - m) Function and principles

- 28) Plant mathematics
 - a) Knowledge sufficient to solve any simple problem involving division and multiplication related to power plant equipment and operation
- 29) Plant safety

Second Class Power Engineer
Curriculum to cover the fundamentals

- 1) Types of boilers
 - a) Construction details, how boilers are installed in a setting
 - b) The purpose of each and where they are used to best advantage
 - c) Super-heaters
 - d) Air-preheaters
 - e) Economizers
 - f) Dry pipes
 - g) Internal
 - h) Baffles
 - i) Fusible plugs (types and where they are installed)
 - j) Types of internal feed pipes
 - k) Steam and safety valve outlets
 - l) Caulking tools
 - m) Tube cutters
 - n) Expanders and beading tools
- 2) Stays
 - a) Types of stays
 - b) Where they are used
 - c) The purpose of stays
 - d) Advantages and disadvantages of each type
- 3) Boiler joints
 - a) Types of joints

- b) Riveting and welding procedures
 - c) Where the different types of joints are used
 - d) Relative strength of each type and their locations
 - e) What could go wrong with joints
 - f) Joint testing and tightness
 - g) The meaning of single and double shear
- 4) Boiler and furnace
- a) Washing out a boiler for inspection
 - b) Inspection time tables
 - c) Valves
 - d) Fittings and settings
 - e) Tube, and shell scrapers
 - f) Brushes
 - g) Air and water turbine tools
- 5) Signs of wear
- a) Corrosion
 - b) Pitting
 - c) Grooving
 - d) Fire cracks
 - e) Bulging
 - f) Bagging
 - g) Blistering
 - h) The general causes of these conditions and their remedies
- 6) Water column and glass
- a) The column and glass setting
 - b) Valves and cocks
 - c) Care and maintenance
 - d) Operating in an emergency without a glass
- 7) Steam gauge and siphon
- a) Operating principles
 - b) Where the gauge and siphon are located
 - c) Care and maintenance
 - d) Testing
- 8) Safety valves, relief valves and rupture discs
- a) The purpose of each type of valve
 - b) The location of each type
 - c) Testing
 - d) Care and maintenance
 - e) Potential failures
 - f) Adjustment for lift and blow-back
 - g) Chatter

- h) Drains proper outlet sizing and installation
- 9) Elementary combustion
- a) The difference in the heating value between anthracite and bituminous coal, oil, gas and coke
 - b) The causes and prevention of smoke
 - c) The purpose of the stack damper
 - d) Methods of firing
 - e) The purpose of baffles
 - f) The bridge wall and combustion chamber
 - g) The cause of clinkers
 - h) Reducing clinker occurrence and their removal
 - i) Maintenance and repair
- 10) Soot
- a) The effect of soot on the system
 - b) Prevention and removal
 - c) The operation of soot blowers
 - d) Loss of efficiency due to soot build-up
- 11) Draft
- a) The definition of draft
 - b) How draft is created
 - c) The purpose of draft
 - d) Forced draft, induced draft and natural draft
 - e) Measurement of draft
 - f) Factors affecting draft
 - g) The chimney or stack
- 12) Operation of an oil or gas burner and electric boilers
- a) Starting and stopping the different types of burners
 - b) Safety devices
 - c) Types of oils used for fuel
 - d) Types of burners
 - e) The dangers connected with gas and oil burning installations
 - f) The care and maintenance automatic burner equipment
- 13) Operation of stokers
- a) The types of stokers and how they are started and controlled
 - b) Advantages and disadvantages of each type
 - c) Maintenance of the stoker
 - d) Ash removal
- 14) Feed water piping and valves
- a) Types of valves and piping arrangements
 - b) Care and maintenance

c) Typical installations

15) Pumps

- a) Simplex pumps
- b) Duplex pumps
- c) Rotary pumps
- d) Centrifugal pumps
- e) Vacuum pumps
- f) Gear pumps
- g) Turbine pumps
- h) Starting and stopping a pump
- i) Knowledge of proper operation
- j) Setting valves in steam pumps
- k) Lubrication
- l) Packing, installation and removal
- m) Packing a steam pump

16) Injectors

- a) The principle of operation of the injector
- b) Uses and locations
- c) Care and maintenance
- d) Cleaning
- e) Inspection

17) Air compressors

- a) Starting and stopping a compressor
- b) Details of the cooling system and how it is controlled
- c) Details of lubrication
- d) Dangers in operating air compressors
- e) Controls
- f) Filters and safety devices
- g) Water removal

18) Refrigeration

- a) The refrigeration cycle
- b) Safety head
- c) Expansion
- d) Suction
- e) Discharge
- f) Cross over
- g) Purge units
- h) Liquid and oil valves
- i) The purpose of the condenser, receiver, evaporator
- j) Oil separators

- k) Types of condensers
 - l) Adding and removing ammonia
 - m) Air and non-condensable gas removal
 - n) Defrosting
 - o) Effects of excess oil
 - p) Adding and removing oil
 - q) Types of oil
 - r) Types of packing
 - s) Brine pumps
 - t) Federal regulations pertaining to the addition, removal, storage, and disposal of refrigerants as required by 40 CFR part 82. Subpart F "Proper Refrigerant Practices Program" - US Environmental Protection Agency
- 19) Steam plant accessories
- a) Back-pressure valves
 - b) Non-return valves
 - c) Throttle valves
 - d) Expansion joints
 - e) Feed water regulators
 - f) Steam separators
 - g) Sight feed lubricators
 - h) Steam traps
 - i) Reducing valves
 - j) Sprinkler systems and their function
 - k) Care and operation
 - l) A general knowledge of condensers, where they are located and how they are used
 - m) Condenser auxiliaries
- 20) Feed water heaters
- a) Types of heaters
 - b) The purpose of the heater
 - c) Advantages and disadvantages of each type
 - d) Care and maintenance
- 21) External engines
- a) Types of engines
 - b) Setting valves
 - c) The purpose of the flywheel
 - d) The eccentric
 - e) The governor
 - f) The cross head
 - g) Lead
 - h) Lap
 - i) The angle of advance
 - j) Valve travel and cut-off
 - k) Methods of lubrication

- l) Starting and shutting down
 - m) Care and maintenance
 - n) Engine dangers
- 22) Steam turbines
- a) General knowledge of the lubricating system
 - b) Governors
 - c) Throttle valves
- 23) Internal combustion
- a) Types of engines
 - b) 2 stroke engines
 - c) 4 stroke engines
 - d) Fuels and compression ratios
 - e) Engine construction
 - f) Solid fuel systems
 - g) Lubrication
 - h) Air intake systems
 - i) Exhaust systems
 - j) Injector systems
- 24) Electrical equipment
- a) Definitions of switches
 - b) Rheostats
 - c) Circuit breakers
 - d) Disconnects
 - e) Rotors
 - f) Stators
 - g) Armatures
 - h) Commutators
 - i) Slip rings
 - j) Two and three pole switches
 - k) Volts, ohms, amps, watts
 - l) Series and parallel circuits
 - m) The flow of current
 - n) The definition of magnetism, induction, frequency
 - o) Short circuits
 - p) The ground wire
 - q) How electric current measured
 - r) Joining wires
 - s) Calculations for computing sizes of fuses in lighting and motor circuits
 - t) The dangers connected with the operation of a motor or generator
- 25) Air pollution and ecology
- 26) Heating, air conditioning, and ventilation

- a) Methods and applications
- b) Water hammer and its effects
- c) Piping arrangements
- d) Vacuum and plenum systems in mechanical ventilation
- e) Gravity and vacuum steam systems
- f) Care and maintenance

27) Scale

- a) What scale is and where it is found
- b) Removal of scale
- c) Preventing scale
- d) Dangers of scale build-up on heating surfaces

28) Boiler feedwater treatment and water chemistry

- a) Methods of application and control
- b) Knowledge of impurities in feed water and their affect on a boiler under pressure and temperature
- c) Priming and foaming, causes and remedies
- d) The purpose of a continuous blowdown
- e) Bottom blowing

29) Mathematics

- a) Sufficient knowledge to enable candidate to work problems involving multiplication, division, decimals, measurement, square roots of numbers, powers of numbers, reciprocals, ratio and proportion, and formulas related to power plant equipment

30) Gas turbines and combined cycles

- a) Thermodynamic principles
- b) Heat energy
- c) Power laws
- d) Combustion theory
- e) Gas turbine theory
- f) Brayton Cycle
- g) Ranking cycle
- h) Simple cycle gas turbine
- i) Heat recovery steam generators
- j) Duct burners
- k) Economizers
- l) Fresh air systems
- m) HRSG auxiliary systems

31) Plant safety

First Class Power Engineer
Curriculum to cover the fundamentals

- 1) Steam boilers and generators
 - a) The types of boilers
 - b) Principles, advantages and disadvantages of each type
 - c) Electric cylindrical boilers
 - d) Verticals
 - e) Locomotive boilers
 - f) Water tube boilers
 - g) Fire tube boilers
 - h) Packaged boilers
 - i) Flash boilers
 - j) Scotch marine boilers
 - k) Steam accumulators
 - l) Externally and internally fired boilers
 - m) Super heaters
 - n) Pre-heaters
 - o) Economizers
 - p) Dry pipes internal baffles
 - q) Installations
 - r) Heating surfaces
 - i) Computing heating surfaces
 - ii) Types of heating surfaces relative to horsepower rating
- 2) Boiler construction
 - a) Various types of construction

- b) Plates
 - c) Rivets and welding
 - d) The meaning of pitch percentage of plate strength
 - e) The meaning of percentage of rivet strength
 - f) The unit of section of plate
 - g) How to calculate strength of boiler heads, shells, efficiency of joints and stays
 - h) The description and sketches of joints
 - i) Relative strengths of various joints and how they are computed
 - j) How to calculate combined efficiency of riveted joints
 - k) Computation of working pressure, given tensile strength, factor of safety, thickness, radius of the shell, and efficiency of a joint
 - l) Calculations for the tube ligaments and dished heads
 - m) The staying of flat surfaces, the types of stays, the limitation of stress and allowances for various types of stays
 - n) Constants for different forms and applications of stays, doubling plates
 - o) How to calculate the area of the heads or segments of boilers
 - p) The meaning of
 - i) Shearing stress
 - ii) Tensile stress modulus of elasticity
 - iii) Bursting pressure
 - iv) Working pressure
 - v) Factor of safety
 - vi) Tensile strength
- 3) Boiler settings
- a) Types of settings
 - b) The purpose of the setting
 - c) Radiation
 - d) Bridge walls
 - e) Baffles
 - f) Ignition
 - g) Mixing and deflection arches
 - h) Combustion chambers
 - i) Furnaces
 - j) The meaning of refractory lining, combustion space, dutch ovens
 - k) The importance of sufficient height over grates
 - l) The effect of combustion space on capacity and efficiency.
 - m) How to build or repair bridge walls and setting
 - n) Sketches of typical settings
 - o) Materials and cements used
- 4) Inspection and testing
- a) Washing out shells and tubes, general cleaning and inspection
 - b) Timetables for cleaning and inspection
 - c) Valves, fittings, and settings
 - d) The description of inspection methods, and what is checked

- e) What to look for during an inspection
 - f) Possible defects and how they might be corrected
 - g) Hydrostatic tests and how they are performed
 - h) The purpose and value of inspections
- 5) Fuels
- a) The classification of wood, coals, gas, oil and waste heat
 - b) Coal sampling and analysis
 - c) Comparative heat values of different coals and other fuels
 - d) Applications of various fuels
 - e) Coal storage
 - f) Knowledge of the methods used in handling coal and ashes, losses in handling
 - g) The cause, prevention and removal of clinkers
- 6) Combustion
- a) The combustion process and reactions
 - b) Theory and practice
 - c) Air requirements, supply and control
 - d) Draft measurement and controls
 - e) The description and sketches of various draft gauges
 - f) The purpose of dampers and controls
 - g) The amount of draft needed with under and over fires
 - h) Balanced draft and its practical meaning
 - i) The description of a flue gas analyzer, how and where they are used
 - j) Combustion efficiency and how it is obtained
 - k) The temperatures in the furnace and breeching
 - l) Excess air and its effect on efficiency
 - m) The advantages of forced and induced draft
 - n) Air pollution
 - o) The transfer of heat to boiler water
 - p) How heat is transferred
- 7) Oil and gas burner installations
- a) The types of burners
 - b) The types of oils used in oil burning installations and how they are used
 - c) The dangers presented by oil and gas burning
 - d) The operation and maintenance of automatic equipment
 - e) Sketches of one type of each industrial burner for gas and oil
 - f) A sketch of piping, valves and appurtenances for an oil fired packaged boiler
- 8) Mechanical stokers
- a) Types of stokers
 - b) Principles of operation
 - c) The purpose and description of the different types
 - d) Advantages and disadvantages of each type
 - e) How stokers are operated and maintained

- f) Stoker controls

- 9) Piping
 - a) The computation of sizes for water and steam
 - b) The methods of pipe installation
 - c) The allowance for drainage and friction
 - d) The flow of steam
 - e) Napier's rule
 - f) The sizing of pipe for the suction and discharge of a pump
 - g) Pipe sizing for boiler feed

- 10) Pumps
 - a) A general knowledge of the following pumps
 - i) Simplex
 - ii) Triplex
 - iii) Weir
 - iv) Rotary
 - v) Centrifugal
 - vi) Duplex
 - vii) Vacuum
 - b) Pump installation and lubrication
 - c) The types of water pistons
 - d) Pump performance
 - e) Packing
 - f) Pump calculations including pump sizing for boiler feed
 - g) Pump ratings and over-ratings

- 11) Air compressor systems
 - a) Starting and stopping air compressors
 - b) The details of lubrication
 - c) The purpose of unloaders including descriptions and sketches
 - d) Compound compressors
 - e) Intercoolers
 - f) After coolers
 - g) Air receivers
 - h) Controls
 - i) Filters and safety devices
 - j) Inspections
 - k) The dangers presented by air compressor operation

12) Refrigeration

- a) The cycle theory of how heat is extracted
- b) Common refrigerants and their properties
- c) Direct and indirect systems
- d) Safety head
- e) Condensers
- f) Receivers compressors
- g) Oil separators
- h) Evaporators
- i) Types of condensers
- j) How to operate refrigeration systems
- k) Sketches of systems
- l) Changing or adding oil
- m) Pumping out a system
- n) Defrosting
- o) Annual inspections
- p) Cooling water for compressors and condensers
- q) Ice manufacturing
- r) Ammonia leakage, and correction
- s) Refrigeration capacity and losses
- t) How air is removed from a system
- u) Types of oil used in refrigeration, how it is added and removed
- v) The effect of too much oil in a system
- w) The types of packing found in refrigeration systems
- x) The purpose of brine pumps
- y) Controls, hand and automatic
- z) Absorption systems
- aa) Safety valves and discharge pipes
- bb) Federal regulations pertaining to the addition, removal, storage, and disposal of refrigerants as required by 40 CFR part 82. Subpart F "Proper Refrigerant Practices Program" - US Environmental Protection Agency

13) Steam plant auxiliaries

- a) Economizers
- b) Air preheaters
- c) Feedwater regulators
- d) Feed water heaters
- e) Temperature regulating valves
- f) Flow meters
- g) Return thermostatic and bucket traps
- h) Back pressure valves
- i) non-return valve
- j) Safety valves
- k) Reducing valves
- l) Boiler feed pump

- m) Governors
 - n) Air unloaders
 - o) Expansion joints
 - p) Steam separators
 - q) Oil burners calorimeters
 - r) Ejectors
 - s) Siphon
 - t) Sight feed lubricators
 - u) Descriptions and sketches of each of the above appurtenances
- 14) Feedwater heaters
- a) Types of heaters
 - b) Sketches of the different types
 - c) Fuel savings by preheating feedwater
 - d) Water measurements
 - e) Temperatures and pressures carried on different heaters
 - f) Water seals
 - g) Possible problems encountered in heater operation
- 15) Steam condensers
- a) A general knowledge of the construction of the different types of condensers, together with a knowledge of their auxiliaries
 - b) The advantages of using condensers on various types of engines and turbines
- 16) External engines
- a) A general knowledge of types of engines including
 - i) Simplex
 - ii) Compound
 - iii) Triple expansion
 - iv) Quadruple
 - v) Uniflow
 - vi) Corliss
 - vii) High speed
 - viii) Slide valve
 - b) Specific knowledge of one type of engine
 - c) Governors
 - d) Throttle
 - e) Inertia
 - f) Centrifugal force
 - g) Shafts
 - h) Sketches of governors
 - i) Types of valves
 - j) How to set valves on various types of engines
 - k) Methods of lubrication and application to various parts
 - l) How to start and how to shut down an engine
 - m) Care and maintenance

- n) Dangers of operating engines
- o) How to read and interpret indicator diagrams

17) Steam turbines

- a) A general knowledge of how turbines convert heat energy into mechanical energy and be able to describe
 - i) Bearings
 - ii) Oiling systems
 - iii) Governors
 - iv) Auxiliaries used with turbines
- b) Specific knowledge of dangers relative to starting and stopping a steam turbine

18) Electricity

- a) The meaning of the following terms
 - i) Cycle
 - ii) Phase
 - iii) Starting torque, voltage drop and voltage fluctuation
 - iv) Excitation
 - v) Motor clearance
 - vi) Electrical horse power
 - vii) Auto transformer
 - viii) Starter taps
 - ix) Disconnect
 - x) Inductance
 - xi) Collector rings
 - xii) Slip
 - xiii) Commutators
 - xiv) Switch board
 - xv) Ground wires
 - xvi) Power factor
 - xvii) Peak load
 - xviii) Magnetizing current
 - xix) Circuit breaker
 - xx) No voltage release
 - xxi) Overload relay
 - xxii) Transformer
 - xxiii) Bus bars
 - xxiv) Dynamometer
 - xxv) Frequency reactance
 - xxvi) Resistor
 - xxvii) Synchronism
 - xxviii) Brush rocker
 - xxix) EMF impedance
 - xxx) Interpole
 - xxxi) Lag
 - xxxii) Motor converter rheostat

- xxxiii) The description of the main types of AC motors, characteristics and applications
 - xxxiv) How the various types of motors are started and controlled
 - xxxv) The connection or wiring diagrams for each type of motor
 - xxxvi) The description of an auto transformer
 - xxxvii) Starter
 - xxxviii) Magnetic contactor starter
 - xxxix) Triplex rheostat
 - xl) The care and maintenance of electrical machinery and equipment
 - xli) Troubleshooting, testing and correction of electrical problems
- 19) Heating, air conditioning and ventilation
- a) Methods of control
 - b) Piping installations
 - c) Radiation
 - d) Vacuum and plenum system in mechanical ventilation
 - e) Gravity and vacuum steam systems
 - f) The design, operation and maintenance of systems
- 20) Boiler feedwater conditioning and water chemistry
- a) A general knowledge of the chemical changes that occur when feedwater is heated in a boiler
 - b) Scale, its causes and prevention
 - c) Dangers of impurities in the water
 - d) Carry over
 - e) Embrittlement
 - f) Corrosion
 - g) Methods of conditioning water
 - h) Internal and external treatment
 - i) Hot and cold lime softening
 - j) Zeolite softening
 - k) Demineralization
 - i) Ion exchange
 - ii) Anion exchange
 - l) Supplementary phosphate treatment
 - m) Caustic soda
 - n) Water testing and analysis
 - o) Parts per million
 - p) Grains per gallon
 - q) Soap hardness test
 - r) pH and the relationship of alkalinity to acidity
 - s) Sulfite
 - t) The use of chelants
 - u) The tests for residuals
 - v) Dissolved solids
 - w) The safety aspects of chemical treatment including MSDS safety data sheets and tox numbers

- 21) Plant mathematics
 - a) A knowledge of fractions, decimals, percentage and square roots
 - b) Knowledge of how to find the area and circumference of a circle
 - c) The volume of a cylinder
 - d) An understanding of the relationship between the sides of right angle triangles
 - e) Knowledge of the method of solving problems relating to a chain of gears, pulley sizes, rope blocks, screw jacks, and levers
 - f) An understanding of the factor of evaporation, equivalent evaporation, latent heat, total heat, and a definite understanding of the problem involving the extraction or supply of heat in heating water or making ice
 - g) How to solve problems in heat supplied and extracted
 - h) How to compare boiler performances
 - i) How to solve problems involving heat calculations of steam production, boiler efficiency and horse power
 - j) How to find the horse power of an engine from an indicator diagram
 - k) How to solve problems in heat supplied and heat extracted and how to compare boiler performances
 - l) Heat calculations in steam production
 - m) How to solve problems involving specific gravity
 - n) Calculations involving steam pressure on areas
 - o) Stay calculations
 - p) Cost of operation calculations

- 22) Chemistry and physics
 - a) Fundamentals as applied to power plant theory and practice

- 23) Knowledge of the ingredients and qualities of oils
 - a) Filtration
 - b) Storage of oils

- 24) General knowledge
 - a) The British Thermal Unit (BTU)
 - b) Foot pound
 - c) Latent heat
 - d) Specific gravity
 - e) Specific heat
 - f) Mechanical equivalent
 - g) Inertia
 - h) Convection
 - i) Matter
 - j) Momentum
 - k) Siphon
 - l) Clearance pockets
 - m) Ton of refrigeration
 - n) Axial flow

- o) Dynamic
 - p) Static
 - q) Chlorofluorocarbon refrigerants
 - r) Propane
 - s) Atomic weight
 - t) Barometer
 - u) Hydrometer
 - v) Boyles law
 - w) Capillary
 - x) Oscillation
 - y) Center of gravity
 - z) Cohesion
 - aa) The velocity-speed-acceleration-conversion ($^{\circ}\text{F}$ - $^{\circ}\text{C}$ - $^{\circ}\text{R}$)
 - bb) Mean effective pressure
 - cc) Density
 - dd) Back pressure
 - ee) Oxidation
 - ff) Thermal efficiency
- 25) Internal combustion
- a) 2 stroke engines
 - b) 4 stroke engines
 - c) Fuels and gasses
 - d) Compression ratio
 - e) Construction
 - f) Solid fuel systems
 - g) Lubrication systems
 - h) Air intake systems
 - i) Exhaust systems
 - j) Injector systems
 - k) Care and maintenance
- 26) Gas turbines and combined cycles
- a) Thermodynamic principles
 - b) Heat energy
 - c) Power laws
 - d) Combustion theory
 - e) Gas turbine theory
 - f) The Brayton cycle
 - g) Ranking cycle
 - h) Simple cycle gas turbine
 - i) Gas turbine construction
 - j) Aero derivative
 - k) Combustion systems and arrangements
 - l) Gas turbine compressor system
 - m) Gas turbine cooling system

- n) Turbine blade cooling system
- o) The environmental aspects
- p) Gaseous fuels
- q) Coal gasification
- r) The bearing system
- s) The lubrication system
- t) Heat recovery steam generators
- u) The operating system
- v) The principles of operation
- w) Duct burners
- x) Economizers
- y) Fresh air systems
- z) HRSG auxiliary systems

27) Plant safety

Chief Power Engineer
Curriculum to cover the fundamentals

- 1) Steam boilers
 - a) Types of boilers including
 - i) Waste heat
 - ii) Incinerators
 - iii) Cylindrical
 - iv) Vertical
 - v) Horizontal
 - vi) Locomotive
 - vii) Fire tube
 - (1) Straight and bent tube
 - b) Packaged boilers
 - c) Flash boilers
 - d) Scotch marine boilers
 - e) Re-heat and integral furnace boilers
 - f) Steam generators, (modern central stations)
 - g) Monotone
 - h) Forced circulation
 - i) Radiant
 - j) Mercury boilers
 - k) Sketches and descriptions of each of the above
- 2) Steam boiler construction
 - a) Various forms of construction
 - b) Plates, rivets, stays, braces, joints, factors, welding, (used under ASME code)
 - c) The meaning of shearing
 - d) Tensile stress

- e) Modules of elasticity
 - f) Bursting pressure
 - g) Working pressure
 - h) Factor of safety
 - i) Tensile strength
 - j) The meaning of pitch
 - k) Percentage of plate and rivet strengths
 - l) Unit section of plate
 - m) How to calculate the strength of boiler heads, shells, stays, the efficiency of joints
 - n) Descriptions and sketches of joints
 - o) The relative strengths of various joints and how they are calculated
 - p) How to calculate combined efficiency of riveted joints
 - q) The computation of working pressure given the tensile strength, factor of safety, thickness and radius of the shell, plus the efficiency of the joints
 - r) How to stay flat surfaces including the types of stays
 - s) Allowances for limitation of stresses and constants for various types of stays and doubling plates
 - t) How to calculate the area of the heads of segments of boilers
- 3) Steam boilers settings
- a) Radiation and bridge walls
 - b) Ignition
 - c) Mixing and deflection arches
 - d) Baffles
 - e) Combustion chambers and furnaces, including sketches and descriptions of the various types
 - f) Refractory lining
 - g) Dutch ovens
 - h) Extension front
 - i) The importance of sufficient heights over the grates
 - j) The effect of combustion space on the capacity and efficiency
 - k) How to build or repair bridge walls and settings
 - l) Materials and cements used in settings
 - m) Cyclone primary furnaces
 - n) Solid refractory
 - o) Air cooled or water cooled walls
 - p) Water screens, slag tap, dry bottom and hopper bottom furnaces
- 4) Inspection and testing
- a) Washing out tubes and shells
 - b) General cleaning and inspection procedures relative to the shell
 - c) The time table for cleanings and inspections
 - d) The cleaning and inspection of settings, auxiliaries, valves and fittings
 - e) A description of the methods used and parts checked during and inspection
 - f) How to inspect, what to look for, possible defects and how they are corrected
 - g) Hydrostatic tests and how they are applied

5) Fuels

- a) Classifications of
 - i) Wood
 - ii) Coal
 - iii) Gas
 - iv) Oil
 - v) Waste heat
- b) Coal sampling and analysis
- c) Proximate and ultimate analysis
- d) Dulong's formula
- e) Comparative heat values of various coals and other fuels
- f) The storage of coal and other fuels
- g) Losses in handling fuels
- h) The advantages and disadvantages of each type of fuel

6) Combustion

- a) The fundamentals of combustion chemistry
- b) Processes and reactions
- c) Combustible constituents of various fuels
- d) Theoretical and actual weight of air required per pound for combustibles
- e) Flue gases and their analysis
- f) The flue gas analyzer apparatus
- g) The automatic flue gas recorder
- h) Combustion efficiency and how it is obtained
- i) Excess air and its effect on efficiency
- j) The value of CO₂, CO and O₂ readings
- k) Air requirements, supply and control
- l) Temperatures, measurement and controls in the furnace passages and breeching.
- m) Smoke and its causes
- n) The measurement and prevention of smoke
- o) Smoke density recorder
- p) The ringelmann chart
- q) Losses due to
 - i) Combustibles in the ash
 - ii) Moisture in the fuel
 - iii) Moisture from combustion of hydrogen
 - iv) Moisture in the air
- r) Radiation plus heat absorbed by the boiler or a complete heat balance

7) Draft

- a) Natural draft
- b) Chimneys and stacks, including sizes and types
- c) Empirical chimney formulas
- d) Mechanical draft
- e) Induced draft

- f) Forced draft
 - g) Prat, Evase, or Thermix systems
 - h) Balanced draft systems and controls
 - i) The measurement of draft
 - j) Descriptions and sketches of various draft gauges
 - k) The amount of draft needed under and over fire; (also in the passages of various settings and depending on the fuel and methods of burning)
 - l) Fans
 - i) Types of fans
 - ii) Fan controls
 - m) Breechings and damper systems, including descriptions and sketches
- 8) Oil and gas burner installations
- a) The different types of burners
 - b) Heat values
 - c) Methods of burning fuel oil and gaseous fuels
 - d) The dangers connected with oil and gas burning installations
 - e) A description of controls
 - f) How to operate and maintain automatic burner equipment
 - g) Sketches of industrial burner for gas and oil
 - h) Sketches of oil burning plant layouts
- 9) Mechanical stokers
- a) The various types of stokers including
 - i) Overfeed
 - ii) Underfeed
 - iii) Chain grate
 - iv) Vibrating grate
 - v) Spreader stokers
 - vi) Sprinkler stokers
 - b) The principles of stoker operation, and comparisons of different types
 - c) Sketches of different stokers
 - d) How stokers are operated, maintained, and repaired
 - e) Feed and driving mechanisms
 - f) Problems associated with stokers
- 10) Pulverized coal systems
- a) The types of pulverized systems
 - b) Storage or central
 - c) Direct or unit
 - d) Horizontal and vertical dryers
 - e) Different applications and sketches of pulverized systems
 - f) Feeders including
 - i) Vertical
 - ii) Horizontal
 - iii) Tangential

- iv) Cyclone
- v) Inter-lube burners and feeders
- g) Vertical and horizontal pulverizers and dryers

11) Coal handling and ash handling equipment

- a) Manual
- b) Conveyors
- c) Scraper flight
- d) Buckets
- e) Belt aprons
- f) Grab buckets
- g) Telepherage systems
- h) Coal crushers and breakers
- i) Hoppers and coal valves
- j) Internal and external storage by pile, silo or bunker
- k) Coal weighing lorries
- l) Sketches and descriptions of coal handling systems
- m) Ash handling including
 - i) Manual
 - ii) Gravity hydraulic
 - iii) Submerged cross bar
 - iv) Pneumatic
 - v) Skip hoist and steam jet conveyor
- n) Simple and compound cyclone fly ash collectors including sketches and descriptions

12) Piping

- a) Pipe computations for handling water, steam, gas, and oil
- b) How piping is installed
- c) Allowances for drainage and friction
- d) The flow of steam through a pipe
- e) Napier's rule
- f) Briggs's rule
- g) Babcock's rule
- h) Shitzgrass's rule
- i) Fritsoche's rule
- j) Pipe sizing for pump suction and discharge
- k) Pipe sizing for boiler feed
- l) Pipe fittings
- m) Expansion joints
- n) U- bends
- o) Flanges and gaskets
- p) Piping layouts including
 - i) Sketches
 - ii) The location of valves and piping
- q) Pipe hangers
- r) Roll anchors and brackets

s) Pipe coverings

13) Pumps

- a) General descriptions of the following types
 - i) Simplex pumps
 - ii) Duplex pumps
 - iii) Triplex pumps
 - iv) Weir pumps
 - v) Rotary pumps
 - vi) Centrifugal pumps
 - vii) Vacuum pumps
- b) A specific knowledge of two types of pumps
- c) Knowledge of the proper operation and maintenance of pumps
- d) Where pumps are found, and how they are installed
- e) Pump lubrication
- f) Types of water pistons
- g) Packing used with pumps, and how it is installed
- h) Pump capacities and applications
- i) Dynamic head
- j) Friction head
- k) Velocity head
- l) Calculating the size of a pump for a feed line to a boiler at rating and over-rating

14) Air and gas compressor systems

- a) A general knowledge of various types of compressors
- b) Compressor efficiency
- c) Isothermal and adiabatic compression
- d) Air compressor valves including
 - i) Automatic valves
 - ii) Mechanical valves
 - iii) Descriptions and sketches
 - iv) Care and maintenance
- e) Speed regulation
- f) Governors on steam or diesel engines
- g) Constant speed
- h) Unloaders including closed and open intake
- i) Discharge and clearance pocket
- j) Descriptions and sketches
- k) Intercoolers
- l) After coolers
- m) Receivers
- n) Cooling systems including descriptions and sketches
- o) Lubrication including
 - i) Types of oils
 - ii) The danger of too much oil
 - iii) Adding and removing oil

- p) Safety devices
- q) Inspection and overhauls
- r) The dangers associated with compressor operation
- s) The installation and general layout of air compression systems
- t) Gas compression including
 - i) Natural
 - ii) Illuminating
 - iii) Gas absorption process
 - iv) Vapor recovery
 - v) Stabilization and refractionation
- u) The application of compressed air
- v) Free air
- w) Standard air
- x) Heat of compression
- y) Volumetric efficiency
- z) Compression efficiency
- aa) Mechanical and overall efficiency
- bb) Dew point and humidity

15) Refrigeration

- a) The refrigeration system
- b) The theory of how heat is removed from one place to another
- c) Common refrigerants and their physical properties
- d) Direct and indirect systems
- e) Description and sketches of
 - i) Safety head
 - ii) Cylinder
 - iii) Valves
 - iv) Safety valves
 - v) Condensers
 - vi) Receiver
 - vii) Compressor
 - viii) Oil separator
 - ix) Evaporator
- f) Flow equipment including
 - i) Automatic purgers
 - ii) Dehydrators
 - iii) Heat exchangers
- g) Types of condensers
- h) Descriptions and sketches of
 - i) Condensers
 - ii) Hand expansion valves
 - iii) Automatic expansion valves
 - iv) Thermostatic expansion valves
 - v) Low side float
 - vi) High float

- i) Types and descriptions of compressors including
 - i) Single and double acting compressors
 - ii) Rotary compressors
 - iii) Centrifugal compressors
 - iv) Steam jet compressors
- j) Types and descriptions of evaporators including
 - i) Flooded type
 - ii) Dry expansion
 - iii) Convection type
 - iv) Forced draft
- k) Electrical controls and control valves
- l) Back pressure and temperature controls
- m) Constant pressure valves
- n) Snap action valves
- o) Check valves water and regulating valves
- p) High pressure and low water cut-outs
- q) Pressure relief devices
- r) Lubrication including
 - i) The selection of oils
 - ii) Pour point
 - iii) Viscosity
 - iv) Cloud point
 - v) Moisture content
 - vi) The effects of too much oil on the system
- s) Compressor drives including
 - i) Electric
 - ii) Steam
 - iii) Diesel
 - iv) Gas engine
- t) Operation and maintenance of compressor systems
- u) Starting and stopping a system
- v) Pumping out
- w) Defrosting
- x) The dangers associated with refrigeration systems
- y) Air in the system, and removal
- z) Locating ammonia leaks, and correcting
- aa) Annual inspections and overhauls
- bb) Compressor calculations including
 - i) Cylinder displacement
 - ii) Volumetric efficiency
 - iii) Power requirements for condensers
- cc) Brine in refrigeration
- dd) Chemistry
- ee) Brie pumps
- ff) Corrosion control
- gg) Congealing

- hh) Hold over tanks and eutectic plates
 - ii) Liquid cooling and ice making
 - jj) Absorption systems including sketches and descriptions of
 - i) Intermittent systems
 - ii) Continuous and electrolux
 - kk) The current refrigeration code
 - ll) Federal regulations pertaining to the addition, removal, storage, and disposal of refrigerants as required by 40 CFR part 82. Subpart F “Proper Refrigerant Practices Program” - US Environmental Protection Agency
- 16) Steam plant auxiliaries
- a) Super-heaters
 - b) Economizers
 - c) Air preheaters
 - d) Feed water regulators
 - e) Feed water heaters
 - f) Temperature regulating valves
 - g) Impulse
 - h) Flow meters
 - i) Condensate returns
 - j) Steam traps including
 - i) Float and thermostatic traps
 - ii) Thermostatic traps
 - iii) Expansion traps
 - iv) Dump traps
 - v) Differential traps
 - vi) Siphon traps
 - vii) Bucket traps
 - k) Valves including
 - i) Back pressure types
 - ii) Non-return valves
 - iii) Safety valves
 - iv) Motor operated valves
 - v) Reducing valves
 - l) Boiler feed pumps
 - m) Governors
 - n) Air unloaders
 - o) Expansion joints
 - p) Steam separators
 - q) Calorimeters
 - r) Oil burners
 - s) Ejectors
 - t) Siphons
 - u) Sight lubricators
 - v) Forced lubricators
 - w) Hydrostatic lubricators

- x) Automatic expansion valves
- y) Simple steam lick
- z) Thermostat and diaphragm valves
- aa) Meters
- bb) Steam accumulators
- cc) Internal drum steam washers or separators
- dd) Descriptions and sketches of all of the above

17) Practical knowledge of the types of

- a) Super-heaters
- b) De-super-heaters
- c) Re-heaters
- d) Purifiers
- e) Attemperators
- f) Performance and controls
- g) Safety devices
- h) Advantages and disadvantages of different types
- i) Economy

18) Feed water heaters

- a) Types of heaters including descriptions and sketches of
 - i) Open types
 - ii) Closed types
 - iii) Extraction types
- b) Deaerators
- c) Trays filters
- d) Oil separators
- e) Back pressure valves
- f) Water seals
- g) Meters
- h) Temperatures and pressures carried on heaters
- i) Fuel savings when using feedwater heaters
- j) Care and maintenance

19) Economizers and air pre-heaters

- a) Descriptions and sketches of the different types of economizers and air pre-heaters
- b) Locations
- c) Soot removal and soot blowers
- d) Heat balance diagrams

20) Steam condensers

- a) The principle of operation of steam condensers
- b) Parallel flow
- c) Counter current
- d) Low level
- e) Barometric

- f) Low and high vacuum
- g) Centrifugal entrainment
- h) Air ejectors
- i) Cooling ponds and towers
- j) Types of water
- k) Natural and mechanical cooling towers

21) External engines

- a) A general knowledge of the types of engines including
 - i) Simple engines
 - ii) Compound engines
 - iii) Triple expansion engines
 - iv) Quadruple engines
 - v) Uniflow engines
 - vi) Corliss engines
 - vii) High speed and slide valve engines
- b) A specific knowledge of one type of engine
- c) Governors including
 - i) Throttle
 - ii) Transformer
 - iii) Inertia
 - iv) Centrifugal
 - v) Cut-off
 - vi) Including sketches and descriptions of two types
- d) Types of valves including
 - i) Corliss valves
 - ii) Wheel-lock valves
 - iii) Simple slide valve
 - iv) Balanced valves
 - v) Poppet valves
- e) How to set valves on various types of engines
- f) Methods of lubrication and the application to various parts of an engine
- g) Positive pressure and hydrostatic cylinder lubricators
- h) Centrifugal crank pin oilers and chain oiling
- i) How engines are started and how they are shut down
- j) Care and maintenance of engines
- k) The dangers presented in the operation of engines
- l) Indicators and indicator diagrams including how to interpret them
- m) Indicated horse power
- n) Brake horse power
- o) Prony brake
- p) Mechanical efficiency cycle
- q) Heat balance of an engine

22) Steam turbines

- a) The principle of operation of a steam turbine

- b) Classifications of steam turbines
 - c) A general knowledge of different types including
 - i) Impulse
 - ii) Râteau
 - iii) Curtiss
 - iv) De Laval
 - v) Terry
 - vi) Kerr
 - vii) Sturtevant
 - viii) Coppus-reaction
 - ix) Parsons
 - x) Allis Chalmers
 - xi) Westinghouse
 - xii) Brown Boveri
 - xiii) Ljungstron
 - xiv) General Electric
 - xv) Worthington
 - d) Compound, exhaust steam, mixed, back pressure and pass out or bleeder turbines
 - e) Specific knowledge of one type of turbine
 - f) Sketches showing compounding by pressure and velocity in impulse and reaction turbines
 - g) Assembly of blades
 - h) Nozzles
 - i) Diaphragms in various forms
 - j) Dummy pistons
 - k) Kingsbury thrust bearings
 - l) Turbine glands and gland sealing
 - m) Hydraulic, carbon ring and labyrinth glands
 - n) Lubrication including forced and combined
 - o) Automatic regulating valves for auxiliary oil pumps, descriptions and sketches
 - p) Types and properties of oils used in turbines
 - q) Sketch of a forced lubrication system
 - r) Oil filters and purifiers
 - s) Govrnors and governing including descriptions and sketches
 - t) Emergency stops and controls including descriptions and sketches
 - u) A general knowledge of installation
 - v) Pre-heating and drainage of turbines
 - w) Starting and stopping turbines
 - x) Inspection and overhauling turbines
 - y) Turbine troubles and how they are corrected
 - z) Erosion of blading
 - aa) Stresses in turbine rotors
 - bb) Critical speed of turbine rotors
- 23) Electricity
- a) A practical knowledge of electromagnetism

- b) Terms including
 - i) Ohms
 - ii) Coulomb
 - iii) Joules and Kirchoffs laws
- c) The laws of induction
- d) Self-inductance
- e) Mutual inductance
- f) Current in revolving loop
- g) Direct current generators
- h) Field frames
- i) Magnetic poles and windings
- j) Armature core and windings
- k) Commutator brush
- l) Rigging and brushes
- m) The sine curve
- n) Commutating and excitation
- o) The characteristics of series, shunt and compound generators
- p) The operation of machines in parallel
- q) Starting and control of DC generators
- r) Direct current motors, different types, characteristics and applications
- s) The effect of armature reaction
- t) How to install brush rigging and brushes on DC motors
- u) The starting and control of DC motors
- v) Types of controls and connection diagrams
- w) No voltage release
- x) Overload release
- y) Alternating current generators
- z) Types of alternators including
 - i) Single and polyphase
 - ii) Revolving armature
 - iii) Revolving field induction
 - iv) Self excited
 - v) Separately excited
 - vi) Slow or high speed
- aa) How alternating current produces a revolving magnetic field
- bb) The mechanical construction of
 - i) Rotors and stators
 - ii) Slip rings
 - iii) Bush gears
 - iv) Dampers or amortisseur windings
- cc) Exciters
 - i) How they are started, controlled and stopped
- dd) The meaning of
 - i) Phasing out
 - ii) Synchronizing
 - iii) Operating in parallel

- iv) Division of load
- ee) Torque including
 - i) Starting
 - ii) Pull in
 - iii) Pull out
- ff) Descriptions of starting equipment and connection diagrams
- gg) Voltage regulation and regulators
- hh) AC motors and theories
- ii) Slip
- jj) Running speed no load and full load
- kk) Squirrel cage rotors wound rotors
- ll) Single phase synchronous motors
- mm) Convertors, including construction, characteristics and applications
- nn) Multi-speed squirrel cage motors

- oo) Classifications of AC motors including
 - i) Open type
 - ii) Semi-enclosed
 - iii) Totally enclosed
 - iv) Fan cooled
 - v) Enclosed ventilation
 - vi) Vertical motors
- pp) Starting and controlling AC motors, including types of controls and connection diagrams
- qq) No voltage release
- rr) Overload release
- ss) Diagrams and sketches of switch gear, circuit breakers, relays, rheostats, switchboards, instrument transformers, bus bars, and disconnects
- tt) Connection diagrams for switchboards and motor converter sets
- uu) Meters including the fundamentals and applications of
 - i) Ohmmeters
 - ii) Voltmeters
 - iii) Ammeters
 - iv) Wattmeters
 - v) watt-hour meters
 - vi) frequency meters
 - vii) synchrosopes
- vv) The meaning of power factor, and the factors controlling power factor, the effect on generators, motors and lines, and how power factor is improved, calculations
- ww) Transformers, including the principle of operation, core and shell types, the construction of core and coils, cooling, windings and connections
- xx) Electrical losses and regulation
- yy) Electrical calculations and conversion factors including horse power ratings and speeds of motors and generators. Comparisons with boiler and engine horse power
- zz) Ratings of circuit breakers
- aaa) Computation of motor sizes, generators or transformers for various applications

- bbb) Service factor
- ccc) A general knowledge of electric boilers and their construction, controls and operation
- ddd) Lubrication including oil ring, grease closures for all, and roller bearings
- eee) Inverters and batteries

24) Testing and measuring apparatus including descriptions and sketches of

- a) Coal meters
- b) Fluid meters
- c) Steam flow meters and recorders
- d) Bourdon pressure and vacuum gauges
- e) Draft gauges
- f) Recording draft and vacuum gauges
- g) Thermometers
- h) Pyrometers
- i) Flue gas analyzer apparatus
- j) CO₂ recorders
- k) Calorimeters
- l) Bailey smoke density recorders
- m) Counters
- n) Tachometers
- o) Dynamometers
- p) Prony brakes
- q) Boiler control panels

25) Ecology

- a) Ecosystems
- b) Water quality control
- c) General criteria for all waters
- d) Water treatment
- e) Waste-water treatment
- f) Sterilization
- g) Air quality control
- h) Impurities in the air
- i) Sources of air impurities
- j) Particulate matter

26) Heating air conditioning, and ventilation

- a) The fundamentals of control and measurement
- b) Electric and pneumatic control circuits
- c) Zone and unit controls
- d) Controller types
- e) Actuator types
- f) Valves and relays
- g) Piping, fans and duct work
- h) Vacuum and plenum systems in mechanical ventilation

- i) Radiation, gravity and vacuum steam systems
- j) Different designs, installation, operation and maintenance
- k) Descriptions and sketches of HVAC systems

27) Feedwater conditioning and water chemistry

- a) The causes and prevention of scale as well as the dangers it presents
- b) Impurities generally found in raw waters
- c) Characteristics and chemical formulas
- d) Methods of conditioning including internal and external treatment
- e) Hot and cold lime soda
- f) Zeolite systems
- g) Demineralization
 - i) Ion exchange
 - ii) Anion exchange
- h) Phosphate treatment
- i) Caustic soda and its application
- j) Water analysis including parts per million, grains per gallon, tests, soap hardness
- k) pH and the relationship between alkalinity and acidity
- l) chloride, sulfite, phosphate, total dissolved solids and the use of chelants
- m) The purpose and value of main and continuous blowdown, how it is controlled and measured
- n) The meaning of carry-over, priming, foaming, embrittlement, corrosion, grooving and how each is prevented
- o) Sketches of one form of external treatment

28) Rating, efficiency, and testing of steam boilers

- a) The heat output in steam units
- b) Units of evaporation including actual evaporation, factor of evaporation and equivalent evaporation
- c) Horse power rating including
 - i) The ratio of heating surface to performance
 - ii) Efficiency
 - iii) The rate of combustion per grate surface
 - iv) The rate of combustion per pound of fuel
 - v) The heat transferred per square feet of heating surface
 - vi) The heat liberated per cubic feet of furnace volume

(1) Unit testing, comparison with standard or guaranteed results
- d) Recording of data and the results of a boiler test run

29) Plant mathematics

- a) The knowledge of how to find the area and circumference of a circle and the volume of a cylinder, pyramid and cone. Should also include the volume of the frustums of pyramids and cones, how to find the area of the segment and zone of a sphere
- b) Knowledge of algebra of simultaneous and quadratic equations and logarithms
- c) A working knowledge of problems as covered in boiler construction and repair through the use of the A.S.M.E code or jurisdiction code

- d) An understanding of the relationship between the sides of right angle triangles
- e) Knowledge of the methods of solving problems relating to a train of gears, pulley sizes, rope blocks, screw jacks, levers, wheel and axles
- f) A thorough understanding of latent heat, and total heat, including problems involving the extraction or addition of heat relative to heating water or making ice or steam
- g) How to solve problems involving heat calculations of steam production, boiler efficiency and horsepower and boiler performance comparisons
- h) How to find the horsepower of an engine from an indicator diagram, by a Prony brake or a dynamometer
- i) How to solve problems involving specific gravity and specific heat
- j) Boyles's law
- k) Charles's law
- l) The parallelogram of forces
- m) Newton's law
- n) How to solve questions involving economy of operation relative to fuel and labor costs
- o) How to calculate heating surface and horsepower ratings of various types of boilers

30) Physics, mechanics and chemistry

- a) Knowledge and understanding should include
 - i) Matter, force, weight, two or three acting at a point
 - ii) Triangles, polygons and parallelograms of force
 - iii) Movements, parallel forces
 - iv) Couples, center of gravity
 - v) Work, mechanical advantage, velocity ratio, energy, power and efficiency
 - vi) Friction, velocity, acceleration, inertia
 - vii) Transmission of motion and power
 - viii) Hydraulics, machines, levers, pulleys, wheel and axles, inclined planes
 - ix) Heat, measurement of heat and expansion rates
 - x) Guy Lussac's law
 - xi) The theory of siphon and barometer
 - xii) Losses in power and heat transmission through modern steam plants
 - xiii) Joules equivalent
 - xiv) Chemistry
 - xv) Quantitative Laws
 - xvi) Colloids
 - xvii) Periodic law
 - xviii) The structure of the atom, atomic weights of elements related to combustion
 - xix) A general knowledge of such metals as copper, brass iron, magnesium, calcium, zinc, aluminum, lead, antimony, nickel, steel, and the alkali metals lithium, sodium and potassium

31) Internal combustion

- a) 2 stroke engines
- b) 4 stroke engines
- c) Fuels used
- d) Compression ratios

- e) Construction details
 - f) Solid fuel systems
 - g) Lubrication systems
 - h) Air intake systems
 - i) Exhaust systems
 - j) Injector systems
 - k) Care and maintenance on and off line
 - l) Descriptions and sketches of internal combustion engine systems
- 32) Gas turbines and combined cycles
- a) Thermodynamic principles, heat energy, power laws, and combustion theory
 - b) Gas turbine theory
 - c) The Brayton Cycle
 - d) The Ranking Cycle
 - e) Simple Cycle gas turbine
 - f) Gas turbine construction
 - g) Aero derivative
 - h) Heavy duty industrial combustion systems and arrangements
 - i) Annular combustion systems
 - j) Silo type combustion systems
 - k) Can annular combustion system
 - l) Gas turbine compressor systems
 - m) Cooling systems
 - n) Turbine blade cooling systems
 - o) Environmental aspects
 - p) Gaseous fuels
 - q) Coal gasification
 - r) Solid fuels
 - s) Bearing systems
 - t) Lubrication systems
 - u) Heat recovery steam generators
 - v) Operating systems, functions, and principles of operation
 - w) HRSG low pressure section, intermediate section, high pressure section and components
 - x) Duct burners
 - y) Economizers
 - z) Fresh air systems
 - aa) HRSG auxiliary systems
 - bb) Descriptions and sketches of combined cycle units
- 33) Management
- a) The human factor
 - b) Methods of management
 - c) Time and motion studies
 - d) Work analysis
 - e) Work improvement
 - f) Records charts and diagrams

g) Work sampling and quality control

34) Economics

- a) Elementary economic concepts
- b) The evolution of economic activity
- c) Economic systems
- d) Production
- e) Organization
- f) Marketing
- g) Risk transportation
- h) Consumption
- i) Supply and demand
- j) Money credit and banking
- k) The true value of money
- l) Distribution of income
- m) Population problems, labor problems
- n) Public utilities

35) Maintenance programs

- a) The meaning and scope of maintenance control
- b) Developing yardsticks and benchmarks for measurement
- c) Principles of control
- d) Forecasting
- e) Preventative maintenance programs
- f) Work authorization
- g) Planning
- h) Routing
- i) Material control
- j) Tool control
- k) Scheduling

36) Supervision

- a) Human relations
- b) The art of supervising
- c) Controlling manpower
- d) Establishing controls
- e) Work procedures
- f) Establishing training, safety, work schedules
- g) Reports and follow-up
- h) OSHA instructions

37) Technical writing

- a) How to write a business letter
- b) Memoranda
- c) Data sheets
- d) Writing technical explanations

- e) Report writing
- f) Gathering data
- g) Formatting
- h) The use of different types of reports
- i) Reading of related subject matter

38) Practical knowledge of various types of steam power plants

- a) Simple non-condensing
- b) Elementary condensing
- c) Turbo-alternator plants
- d) Central stations
- e) High-pressure plants
- f) Super pressure plants
- g) Plant layout
- h) Layout, heat distribution and cycle by description and sketch

39) Lubrication

- a) Types of oils including
 - i) Vegetable
 - ii) Animal
 - iii) Mineral
- b) Physical tests and applications
- c) Lubricating methods including
 - i) Oil cups
 - ii) Telescopic oil rings
 - iii) Centrifugal
 - iv) Pendulum
 - v) Hydrostatic
 - vi) Sight feed
 - vii) Forced feed
 - viii) Gravity
 - ix) Compressed air feed
 - x) Filters and by-pass systems

40) Erection

- a) Foundations
- b) Layout
- c) Form building
- d) Templates
- e) Lining up engines
- f) Methods of bedding shaft
- g) Fitting
- h) Testing alignment
- i) Grouting
- j) Assembly
- k) Adjustment, and testing

- 41) Real property improvement
 - a) The nature and scope of real property improvement
 - b) Determining the value of property and equipment
 - c) Inventory
 - d) Depreciation
 - e) Estimating endurance and use
 - f) Control of repair and rehabilitation

- 42) Computer literacy
 - a) Spreadsheets
 - b) Word processing
 - c) Project managing
 - d) Time management

- 43) Plant safety

National Engineer / Examiner
Curriculum to cover the fundamentals

- 1) The purpose of licensing and certifications
 - a) The authority of licensing agencies, and the authority of examiners
- 2) Knowledge of laws
 - a) Plans pertaining to licensing, permits, and codes
- 3) Counseling and advising candidates
 - a) Preparation for the examination
 - b) Evaluating experience of candidates, including education and desires of candidates
 - c) Advising and counseling on availability of educational materials, courses, and schools
- 4) Maintenance of required records
 - a) Examination papers, scores, and interviews
- 5) Evaluations
 - a) The definition of an evaluation
 - b) Feedback of information from the evaluation to improve candidate's instruction
 - c) Training and instructors
- 6) Professional ethics
 - a) The examiner shall be
 - i) Just
 - ii) Courteous
 - iii) Honest and professional
 - iv) Confidential and scrupulous in relations with candidates
 - v) Loyal to licensing agencies and other plans
 - b) The examiner shall
 - i) Conduct business with the properly designated authority
 - ii) Practice democratic procedures
 - iii) Cooperate with candidates
 - iv) Observe and realize the candidates worth and dignity
 - v) Observe the proper line of authority
 - vi) Avoid interfering in the affairs of colleagues and associates
- 7) Subjective evaluation
 - a) Errors in grading procedures and evaluations
 - b) How to prevent errors
 - c) Oral quizzes
 - d) Performance tests
 - e) Written examinations
 - f) Determining comprehension
 - g) Semantics

- 8) Objective evaluation (measurement)
 - a) Instructional, and administrative purposes
 - b) Measuring with the examination
 - c) Percentile-rank grading
 - d) Percentile group grading
 - e) Percentage grades
 - f) Standard scores

- 9) Examinations for measuring qualification
 - a) Validity, reliability, objectivity, comprehensiveness, discrimination, ease of administration
 - b) To measure all important items, conditions under which the exam is given, clear and concise items for each type of item
 - c) Checking all test items for the characteristics of a good exam
 - d) Making a scoring key
 - e) Proving the examination

- 10) Test administration
 - a) Preparing for candidates
 - b) Physical conditions of the examination room
 - c) Examinations
 - d) Paper
 - e) Pencils
 - f) Tools
 - g) Examination instructions
 - h) Orientations
 - i) Putting candidates at ease
 - j) Grading examinations
 - k) Post-test procedures
 - l) Improving the examination

N.I.U.L.P.E. National Technical Instructor
Curriculum to cover the fundamentals

- 1) Power engineer career development
 - a) Understanding progression in the career
 - b) Duties
 - c) Responsibilities
 - d) License and certification requirements
 - e) Safety practices
 - f) Codes
 - g) Regulations
 - h) Plans
- 2) Pertinent information, publications, etc.
- 3) Preparing lectures
 - a) Revising material for discussions, and demonstrations
- 4) Preparing lesson plans
 - a) Order and method of instruction
 - b) Using available course material
 - c) Syllabi
 - d) Instructor guides
- 5) Presenting and explaining information
 - a) Theory and skills to trainees
 - b) Lectures on theoretical, practical and academic phases of the course
 - c) Leading class discussions
 - d) Demonstrating techniques and procedures, using training aids such as equipment models, mock-ups, graphics, training films and film strips
 - e) Using effective questioning techniques

- f) Adapting procedures to fit learning situations and individual needs and differences
 - g) Motivating students appropriately
- 6) Guiding student performance in skills and problems, individual training during plant tour, laboratory or study sessions
- 7) Evaluation
- a) Using quizzes written examinations and performance examinations
- 8) Classroom management
- a) Seating
 - b) Temperature
 - c) Lighting
 - d) Ventilation
 - e) Discipline
 - f) Attendance records
 - g) Requisitions and supplies
- 9) Advising and counseling student-trainees
- a) Occupational opportunities
 - b) Educational and training opportunities
 - c) Organizing group study classes to meet occupational training needs and licensing requirements
 - d) Maintaining required educational service records
- 10) Conducting on-the-job training in power engineering and related functions
- 11) Indoctrinating unit supervisory personnel in current teaching methods and instructional techniques

Qualifications for N.I.U.L.P.E. Licenses

Student Engineer's Permit (twelve month limited)

- 1) Minimum age – 18
- 2) Education – High school diploma / GED, or equivalent and then week boiler safety course
- 3) Experience – none
- 4) Examination – written, oral, or practical when necessary (safety exam)
- 5) Maximum prime mover HP (unsupervised) – 500 HP
- 6) Maximum boiler size (supervised) – 30 BHP HP – 150 BHP low pressure
- 7) Maximum refrigeration or air conditioning (supervised) – 100 ton

Note: This is an entry-level permit, and is currently administered by local municipalities. You must check with the local NIULPE board and/or municipalities for schooling and requirements. The temporary permit is good for one year allowing adequate time to acquire a *Fifth* class license or *Fourth* class license. This is not a NIULPE Certificate.

Fifth Class Engineer (low Pressure)

- 1) Minimum age – 18
- 2) Education – High school diploma / GED, or equivalent or trade school
- 3) Experience – 6 months approved training.
- 4) Examination – Written, (oral or practical when necessary)
- 5) Maximum boiler size (unsupervised) – 30 BHP, HP – 150 low pressure
- 6) Maximum refrigeration or air conditioning (unsupervised) – 100 ton

Note: This is a Low Pressure boiler license related to heating and process plants, which do not exceed total capacity of 150 BHP.

Fourth Class Engineer (low pressure)

- 1) Minimum age – 18
- 2) Education – High school diploma / GED or equivalent and 3 credit hours of boiler training
- 3) Experience – 6 months, and approved training.
- 4) Examination – Written, (oral or practical when necessary)
- 5) Maximum prime mover HP – (unsupervised) – 500 HP
- 6) Maximum boiler HP (unsupervised) – 35 BHP, HP unlimited low pressure
- 7) Maximum refrigeration or air conditioning (unsupervised) 100 ton

Note: With 6 credit hours of an approved classroom training and two years experience, this can constitute the first half of an apprenticeship program.

Third Class Engineer (high pressure)

- 1) Minimum age – 19
- 2) Education – High school diploma / GED or equivalent and 6 credit hours of boiler training
- 3) Experience – Two years.
- 4) Examination – Written (oral or practical when necessary)
- 5) Minimum time in previous grade – one year
- 6) Maximum prime mover HP (unsupervised) – 1000 HP
- 7) Maximum boiler HP (unsupervised) – 300 BHP, HP – unlimited low pressure
- 8) Maximum refrigeration or air conditioning (unsupervised) – 500 ton

Note: With 12 credit hours of approved training and four years experience this can constitute a full apprenticeship program.

Second Class Engineer

- 1) Minimum age – 20
- 2) Education – High school diploma / GED or equivalent
- 3) Experience – Three years.
- 4) Examination – Written (oral or practical when necessary)
- 5) Minimum time in previous grade – one year
- 6) Maximum prime mover HP (unsupervised) – 2500 HP
- 7) Maximum boiler HP (unsupervised) – 600 BHP, HP unlimited low pressure

Note: boiler ratings in pounds per hour (more common for large boilers, may be calculated by multiplying rated boiler horsepower by 345)

First Class Engineer

- 1) Minimum age – adult
- 2) Education – High school diploma / GED or equivalent
- 3) Experience – Four years.
- 4) Examination – Written (oral or practical when necessary)
- 5) Maximum prime mover HP (unsupervised) – 7500 HP
- 6) Maximum boiler HP (unsupervised) – 1500 BHP, HP – unlimited low pressure

Chief Engineer

- 1) Minimum age – adult
- 2) Education – High school diploma / GED or equivalent
- 3) Experience – Five years.
- 4) Examination – Written (oral or practical when necessary)
- 5) Minimum time in previous grade – one year
- 6) Maximum prime mover HP – unlimited
- 7) Maximum boiler HP – unlimited
- 8) Maximum refrigeration or air conditioning – unlimited

Examining Engineer

- 1) Education required – Bachelors degree or equivalent
- 2) Experience required – twelve years
- 3) Prerequisite – NIULPE and NIULPE Chief Engineer's License
- 4) Examination required – Written

Technical Instructor

- 1) Education required – Bachelors degree or equivalent
- 2) Experience required – Twelve years
- 3) Prerequisite – NIULPE and NIULPE Chief Engineer's License
- 4) Examination required – Written

N.I.U.L.P.E. Non-discrimination Policy

The National Institute for the Uniform Licensing of Power Engineers and all jurisdictions, local boards and individual commissioned examiners under the N.I.U.L.P.E. standards, shall admit persons of any race, color, sex, national and ethnic origin to all of the rights, privileges, programs and activities generally accorded or made available to participants in the N.I.U.L.P.E., certification program. N.I.U.L.P.E., and all jurisdictions, local boards and individual commissioned examiners under the N.I.U.L.P.E. standards program does not discriminate on the basis of race, color, sex, national and ethnic origin in administration of its policies and including the administering of exams and issuing of license certifications, jurisdictions, local boards and commissioned examiners are required to give and/or provide an oral exam in lieu of the written exam in the language of the applicant, if the applicant is unable to read and write English, and upon sufficient advance notice of the applicant's inability to read and write English. This policy does require that the applicant for exam must meet all of the requirements under the N.I.U.L.P.E. standards.

N.I.U.L.P.E. ADA (Americans with Disabilities Act) Policy

The ADA defines an "individual with a disability", as a person who has a physical or mental impairment that substantially limits one or more major life activities; (e.g. seeing, hearing, speaking, walking, breathing, performing manual tasks, learning, caring for oneself, or working). The National Institute for the Uniform Licensing of Power Engineers and all jurisdictions and individual commissioned examiners under the N.I.U.L.P.E. standards, shall provide people with disabilities, all of the rights, privileges, programs and activities generally accorded or made available to participants in the N.I.U.L.P.E. certification program. N.I.U.L.P.E, and all jurisdictions and individual commissioned examiners under the N.I.U.L.P.E standards program does not discriminate on the basis of disability in administration of its policies and including the administering of exams and issuing of license certifications. Jurisdictions, local boards and commissioned examiners are required to give and/or provide an oral exam or other accommodations in lieu of the standard written exam. The exam must be conducted in a building that meets the accommodations required under the ADA law. This policy does require that the applicant for exam must meet all of the requirements under the N.I.U.L.P.E

N.I.L.U.P.E. State and Jurisdictional Boards

Alaska
Alabama
Arizona
California
Connecticut
District of Columbia
Florida
Georgia
Kansas
Illinois
Indiana
Iowa
Louisiana
Maryland
Michigan
Minnesota
Mississippi
Missouri
Nebraska
Nevada
New Hampshire
New York
North Carolina
Ohio
Pennsylvania
Rhode Island
South Carolina
Texas
Tennessee
Virginia
Washington
Wisconsin

Summary

In summary, the National Institute for the Uniform Licensing of Power Engineers will:

- 1) Establish a voluntary standardization and certification program on a national scale working through and with existing licensing bodies
- 2) Establish such a program where none now exist
- 3) Establish five grades of licenses
- 4) Allow for reciprocity between states
- 5) Assist states to write licensing programs
- 6) Disseminate information and standards
- 7) Revise and update as technology demands
- 8) Commission examining engineers
- 9) Commission instructors
- 10) Evaluate and issue credentials of accreditation to those instructional agencies meeting criteria established
- 11) Permit states not having state codes to obtain NIULPE license codes
- 12) Place into effect standards and guidelines authored by those within the profession of power engineering
- 13) Serve all in power engineering regardless of affiliation