NUCLEAR TRAINING CENTRE

COURSE 134

NUCLEAR TRAINING COURSE

COURSE 134

1 - Level
3 - Equipment & System Principles
4 - TURBINE, GENERATOR & AUXILIARIES

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# Turbine, Generator & Auxiliaries - Course 134

## OBJECTIVES

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At the end of this course you will be able to:

Courses 434, 334 and 234

1. Meet the objectives for the Courses 434, 334 and 234.

134.00-1 Turbine Theory

1. State a working definition of:

   (a) entropy
   (b) enthalpy
   (c) percent moisture
   (d) quality.

2. Sketch and label a Mollier Diagram showing:

   (a) the saturation line
   (b) constant pressure lines
   (c) constant temperature lines
   (d) constant percent moisture lines
   (e) constant degree of superheat lines.

3. On a sketch of a Mollier Diagram, plot the condition line for the steam system in your plant showing:

   (a) outlet of steam generator
   (b) inlet to HP turbine
   (c) outlet of HP turbine
   (d) inlet to moisture separator
   (e) outlet of moisture separator
   (f) inlet to reheater
   (g) outlet of reheater
   (h) inlet to LP turbines
   (i) outlet of LP turbines.

   (Personnel not at a generating station will use Pickering NGS as it is typical of large units.)

4. Explain what is meant by Rankine cycle and Carnot cycle.

5. Calculate Carnot Cycle Efficiency and explain it's significance.

6. Explain the advantages of superheated steam and why superheated cannot be produced in our nuclear steam generators.

7. Explain using an enthalpy-entropy diagram the extraction of useful energy from the steam passing through a turbine stage including:

   (a) initial temperature, pressure and enthalpy
   (b) useful energy extracted
   (c) loss of entropy
   (d) frictional reheat
   (e) exhaust pressure
   (f) actual exhaust enthalpy
   (g) isentropic exhaust enthalpy.

8. Define and explain the significance of:

   (a) stage efficiency
   (b) expansion efficiency
   (c) diagram efficiency
   (d) fixed blade leakage factor
   (e) moving blade leakage factor
   (f) dryness factor.

9. State and explain the factors affecting stage efficiency including:

   (a) expansion efficiency
   (b) diagram efficiency
   (c) fixed blade leakage factor
   (d) moving blade leakage factor
   (e) steam moisture percentage.

10. Explain the significance of carryover from a turbine stage and the significance of carryover from the final turbine stage (exhaust loss).

11. Draw a typical condition line for a multi-stage turbine and indicate and explain:

   (a) initial pressure, temperature and enthalpy
   (b) stage pressures
   (c) pressure drop across throttle valve
   (d) isentropic enthalpy drop for each stage
   (e) actual enthalpy drop for each stage
   (f) exhaust pressure
   (g) exhaust loss.

12. Explain the following:

   (a) Curtiss Stage
   (b) Rateau Stage
   (c) Reaction Stage
   (d) Impulse Stage.

13. Explain the factors influencing the choice of turbine blading including:

    (a) maximum diagram efficiency
    (b) enthalpy drop per stage
    (c) velocity ratio
    (d) steam pressure drop across the stage
    (e) axial thrust
    (f) moisture effects.

14. Explain what is meant by "nozzle governing" and "throttle governing and the advantages and disadvantages of each.

15. Explain how each of the following affects turbine efficiency:

    (a) superheating
    (b) moisture
    (c) moisture separator
    (d) feedheating
    (e) pressure drop in piping and valves.

## 134.00-2 Turbine Operational Performance

1. Define:

    (a) Station Heat Rate
    (b) Turbine Heat Rate
    (c) Derating.

2. Explain why station heat rate and turbine heat rate are not equal.

3. Explain the effects of each of the following on turbine heat rate:

    (a) condenser vacuum
    (b) moisture in steam passing through a turbine
    (c) pressure drop through inlet valves
    (d) boiler pressure
    (e) final feedwater temperature
    (f) blade tip leakage
    (g) air inleakage to condenser
    (h) faulty gland seals or gland seal steam operation
    (i) faulty air extraction system operation.

4. Given a design heat balance, compute a Design Turbine Heat Rate for your station.

5. Explain which plant components, operating parameters and flow rates have a major effect on heat rate.

6. Develop a systematic approach to improving a degraded heat rate.

7. Discuss the factors which could cause derating of a turbine-generator unit.

8. List the major factors which could cause a decrease in condenser vacuum and explain how you would differentiate between them.

9. List the major factors which could decrease the efficiency of the feedheating system and how you would differentiate between them.

## 134.00-3 Turbine Operational Problems

1. Discuss the factors affecting the severity of the following operational problems, the possible consequences and the design and operational considerations which minimize their frequency or effect:

   (a) overspeed
   (b) motoring
   (c) low condenser vacuum
   (d) water induction
   (e) condenser tube leak
   (f) blade failure
   (g) expansion bellows failure
   (h) bearing failure or deterioration
   (i) low cycle fatigue cracking.

2. Explain the advantages of using FRF as a hydraulic fluid for turbine control.

3. Explain the precautions which must be exercised with FRF and an electrical-hydraulic control system.

## 134.00-4 Turbine Startup

1. Describe the sequence of events on a unit startup including:

   (a) generator seal oil
   (b) turbine lubricating oil system
   (c) jacking oil pump
   (d) turning gear
   (e) position of governor steam valves, intercept valves and steam release valves
   (f) position of speeder gear
   (g) position of emergency stop valve

1. (Continued)

   (h) temperature in deaerator
   (i) condensate extraction pumps
   (j) boiler feed pumps
   (k) air extraction system
   (l) gland seal system
   (m) condenser cooling water system
   (n) stator cooling system
   (o) hydrogen cooling system
   (p) boiler stop valve position
   (q) condenser vacuum
   (r) lube oil temperature
   (s) runup to operating speed
   (t) synchronizing
   (u) loading of generator.

2. Explain the reason for each of the following in the startup sequence:

   (a) gland seàling system
   (b) air extraction system
   (c) condenser circulating water system
   (d) main lube oil system
   (e) control oil system
   (f) seal oil system
   (g) generator cooling systems
   (h) turning gear.

## 134.00-5 Factors Affecting Startup and Rates of Loading

1. Explain the reasons for each of the following:

   (a) COLD, WARM and HOT startup procedures
   (b) block load on synchronizing
   (c) limitation on rates of loading
   (d) HOLD and TRIP turbine supervisory parameters.

2. Discuss the factors which limit the rate at which a large steam turbine may be started up and loaded including:

   (a) steam pressure
   (b) draining steam piping and turbine
   (c) condenser vacuum
   (d) thermal stresses in casing and rotor
   (e) differential expansion between casing and rotor
   (f) lube oil temperature
   (g) generator rotor temperature
   (h) shaft eccentricity
   (i) vibration
   (j) critical speeds.

## 134.00-6 Reliability and Testing Requirements

1. Explain the hazards of an unterminated turbine overspeed.

2. Discuss the two factors which determine control valve unavailability: valve unavailability and tripping channel unavailability.

3. Discuss the effect of testing frequency on tripping circuit unavailability.

## 134.00-7 Maintenance

1. Outline a program of preparations prior to shutting down a turbine generator unit prior to overhaul.

2. Discuss items which should be examined during overhaul including:

   (a) blading
   (b) glands
   (c) diaphragms and nozzles
   (d) alignment
   (e) thrust bearing
   (f) radial bearings
   (g) casing
   (h) rotor
   (i) casing drains
   (j) evidence of presence of water
   (k) clearances between fixed and moving blades
   (l) shroud clearances
   (m) turbine flange faces.

3. Outline the basic factors to be considered in turbine maintenance.

4. Outline the factors which determine when a major turbine overhaul is scheduled.

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