Turbine, Generator & Auxiliaries - Course 334

ONTARIO HYDRO NUCLEAR TURBINE TYPES

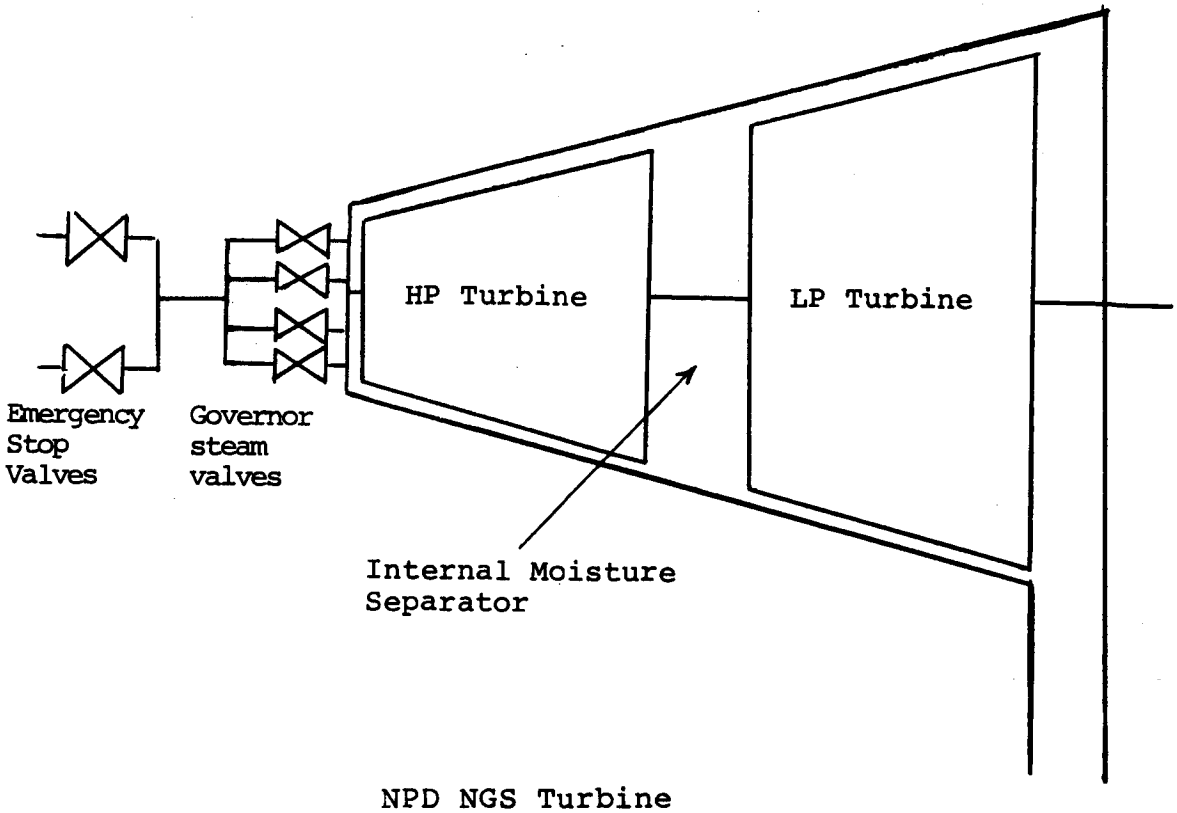
As a review of all we have covered in the course, we will examine each of the generating stations within the nuclear generation division. For each turbine unit, we will look at the topics covered in the course and see how the particular unit is constructed. The topics we will examine are:

1. number of HP and LP turbines,
2. type of steam to HP and LP turbines,
3. type and number of moisture separators,
4. type and number of reheaters,
5. type of turbine blading,
6. type of gland seals,
7. type of governor valves,
8. type of speed governing,
9. type of generator cooling system,
10. type of vacuum raising and maintaining plant,
11. type of feedheating system,
12. steam pressure, steam temperature, speed, generator rated output and generated voltage.

NPD Nuclear Generating Station

1. One single flow high pressure turbine and one single flow low pressure turbine. Both turbines are contained within a common casing.
2. Dry saturated steam enters the high pressure turbine. The HP exhaust is wet steam which passes through an internal moisture separator where the majority of the moisture is removed. The essentially dry steam then enters the LP turbine and exhausts as wet steam to the condenser.

3. One centrifugal type water separator is located within the common casing between the HP and LP turbine.



NPD NGS Turbine

Figure 13.1

4. Steam reheaters are not used.

5. The high pressure turbine has impulse blading. The low pressure turbine has reaction blading.

6. The high pressure turbine has a steam sealed labyrinth gland. The low pressure turbine has a centrifugal water gland.

7. The turbine has four nozzle type governor steam valves.

8. The speed governor is centrifugal fly-ball.

9. The generator is air cooled.

10. A steam air ejector is used for initial vacuum raising. The vacuum is maintained by motor driven vacuum pumps.

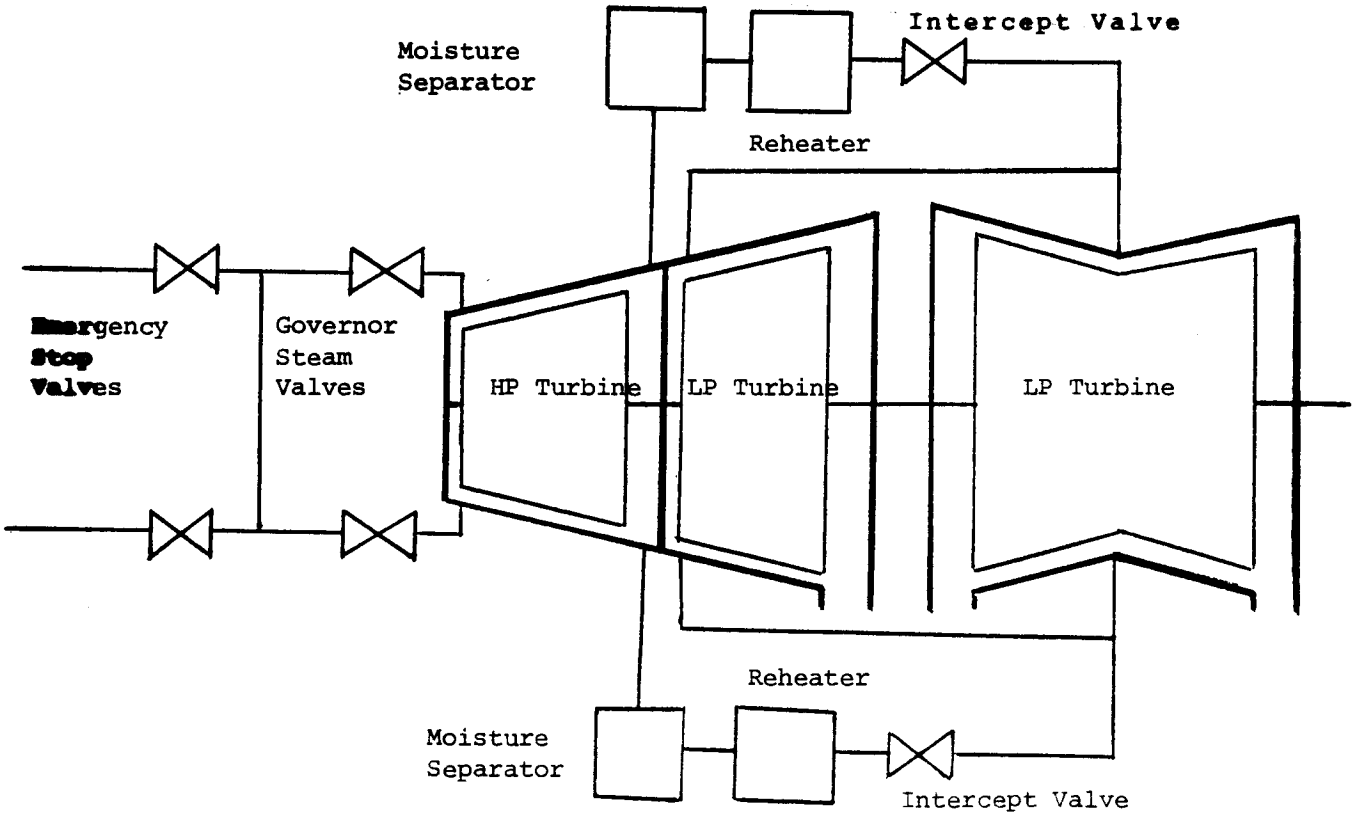
11. A regenerative feedheating system is used with the following feedheaters:

    feedheater drain flash condenser
    one LP feedheater
    gland exhaust condenser
    two HP feedheaters
    preheater internal to the steam generator

12.

HP turbine inlet:	2760	kPa(a) and 230°C
HP turbine exhaust:	280	kPa(a), 131°C and 11% moisture
LP turbine inlet:	270	kPa(a), 131°C and .5% moisture
LP turbine exhaust:	5	kPa(a) and 33°C
Speed:	3600	rpm
Output:	22	MW(e)
Voltage:	13,800	volts

Douglas Point Nuclear Generating Station



Douglas Point NGS Turbine

Figure 13.2

1. One single flow high pressure turbine, one single flow low pressure turbine and one double flow low pressure turbine.

2. Dry saturated steam enters the high pressure turbine. The HP exhaust is wet steam which passes to moisture separators where the majority of the moisture is removed. The essentially dry steam then enters a live steam reheater where it is heated approximately 70°C above the saturation temperature. This superheated steam then enters the LP turbine and exhausts as wet steam to the condenser.

3. Two centrifugal type water separators. (One separator located in each of the two exhaust lines from the HP turbine.)

4. Two tube in shell live steam reheaters (one reheater in each of the two HP turbine exhaust lines downstream of the moisture separators).

5. The high pressure turbine has impulse blading. The low pressure turbines have reaction blading.

6. The HP turbine gland is a combination of steam labyrinth gland and water gland. The LP turbine glands are water glands.

7. The turbine has two throttle type governor steam valves.

8. The speed governor is centrifugal flyball.

9. The generator rotor is hydrogen cooled; the generator stator is water cooled.

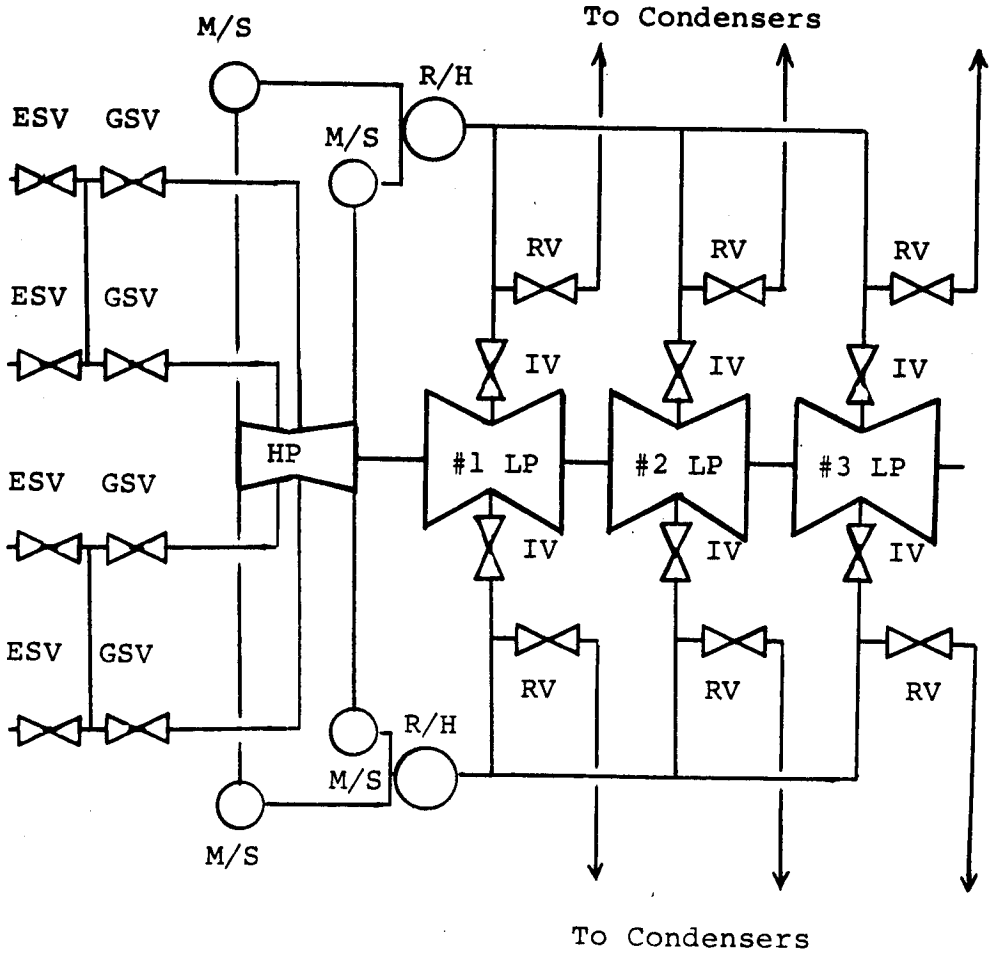
10. A steam hogging ejector is used for initial vacuum raising. The vacuum is maintained by steam maintaining ejectors.

11. A regenerative feedheating system is used with the following feedheaters:

    stator water coolers
    air ejector condenser
    gland exhaust condenser
    drain cooler
    three LP feedheaters
    deaerator
    two HP feedheaters
    preheater internal to the steam generator

12. HP turbine inlet: 3880 kPa(a) and 248°C
HP turbine exhaust: 410 kPa(a), 144°C and 12% moisture
LP turbine inlet: 400 kPa(a) and 221°C
LP turbine exhaust: 3.5 kPa(a), 25°C and 12% moisture
Speed: 1800 rpm
Output: 220 MW(e)
Voltage: 18,000 volts

Pickering Nuclear Generating Station A



ESV = Emergency Stop Valve
GSV = Governor Steam Valve
M/S = Moisture Separator
IV = Intercept Valve
RV = Release Valve
R/H = Reheater

Pickering NGS-A Turbine

Figure 13.3

1. One double flow high pressure turbine and three double flow low pressure turbines.

2. Dry saturated steam enters the high pressure turbine. The HP exhaust is wet steam which passes to moisture separators where the majority of the moisture is removed. The essentially dry steam then enters a live steam reheater where it is heated approximately 75°C above the saturation temperature. This superheated steam then enters the LP turbine and exhausts as wet steam to one of the condensers located under each LP turbine.

3. Four centrifugal type water separators (one separator located in each of the four exhaust lines from the HP turbine).

4. Two tube in shell live steam reheaters (one reheater on each side of the turbine receives the combined exhaust from two moisture separators).

5. The high pressure turbine has reaction blading. The low pressure turbines have reaction blading.

6. The HP and LP turbine glands are steam sealed labyrinth glands.

7. Four throttle valves are used for governor steam valves.

8. The speed governor is centrifugal flyball.

9. The generator rotor is hydrogen cooled; the generator stator is water cooled.

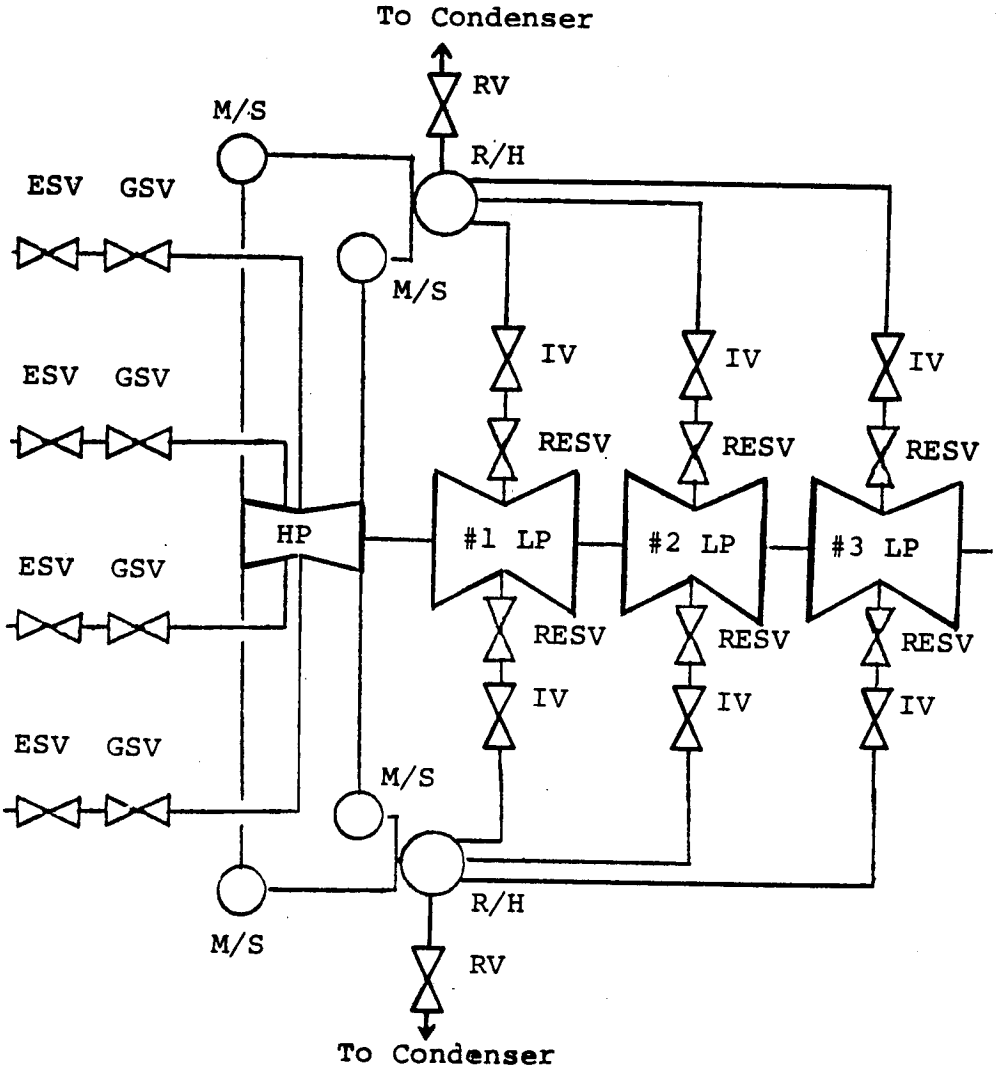
10. Three motor driven screw type vacuum pumps are used for vacuum raising; one of these pumps is used for maintaining vacuum with the other two in standby.

11. A regenerative feedheating system is used with the following feedheaters:

    gland exhaust condenser
    drain cooler
    three LP feedheaters
    deaerator
    two HP feedheaters
    preheater internal to steam generator

12. HP turbine inlet: 4030 kPa(a) and 251°C
HP turbine exhaust: 508 kPa(a), 150°C and 11% moisture
LP turbine inlet: 442 kPa(a) and 224°C
LP turbine exhaust: 5 kPa(a), 33°C and 9% moisture
Speed: 1800 rpm
Output: 540 MW(e)
Voltage: 24,000 volts

Bruce Nuclear Generating Station A



ESV = Emergency Stop Valve
GSV = Governor Steam Valve
M/S = Moisture Separator
R/H = Reheater
IV = Intercept Valve
RV = Release Valve
RESV = Reheat Emergency Stop Valve

Bruce NGS-A Turbine

Figure 13.4

1. One double flow high pressure turbine and three double flow low pressure turbines.

2. Dry saturated steam enters the high pressure turbine. The HP exhaust is wet steam which passes to moisture separators where the majority of the moisture is removed. The essentially dry steam then enters a live steam reheater where it is heated approximately 65°C above the saturation temperature. This superheated steam then enters the LP turbine and exhausts as wet steam to one of the condensers located under each LP turbine.

3. Four centrifugal type water separators (one separator located in each of the four exhaust lines from the HP turbine). Two auxiliary separators on the HP turbine.

4. Two tube in shell live steam reheaters (one reheater on each side of the turbine receives the combined exhaust from two main moisture separators).

5. The high pressure turbine has reaction blading. The low pressure turbines have reaction blading in all stages except the first stage which is an impulse stage.

6. The HP and LP turbine glands are steam sealed labyrinth glands.

7. Four throttle valves are used for governor steam valves.

8. The speed governor is electric using a toothed wheel and proble for speed sensing.

9. The generator rotor is hydrogen cooled; the generator stator is water cooled.

10. A steam hogging ejector is used for initial vacuum raising. The vacuum is maintained by steam maintaining ejectors.

11. A regenerative feedheating system is used with the following feedheaters:

    gland exhaust condenser
    air ejector condenser
    drain cooler
    three LP feedheaters
    deaerator
    one HP feedheater
    preheater external to steam generator

12. HP turbine inlet: 4240 kPa(a) and 254°C
HP turbine exhaust: 923 kPa(a), 176°C and 9% moisture
LP turbine inlet: 835 kPa(a) and 238°C
LP turbine exhaust: 4.2 kPa(a), 30°C and 8% moisture
Speed: 1800 rpm
Output: 788 MW(e)
Voltage: 18,500 volts

ASSIGNMENT

1. For the turbine at your station (those not assigned to a generator station should use Pickering NGS-A) describe the unit using the twelve points in this lesson.

R.O. Schuelke