

Electrical Equipment - Course 230.2

GENERATORS: PART 10

LABORATORY AC GENERATOR PROJECT

1. OBJECTIVE

On completion of the laboratory ac generator project, the student will be able to:

1. Pre-start check the unit,
2. Run up the unit,
3. Synchronize the unit to the grid,
4. Load the unit,
5. Vary the watt and var loading of the unit,
6. Unload the unit,
7. Shut down the unit.

2. GENERAL DESCRIPTION

2.1 The "Turbine-Generator"

The NTC model 'turbine generator' consists of a 7 hp dc motor, representing the turbine, directly coupled to a 2 kVA, 3 phase, 4 pole synchronous generator and controlled from a manually operated control console.

The speed of the machine is controlled by a dc motor whose speed can be varied from 0-33 rev/s. Since the generator has four poles and is to be connected to a 60 Hz system, then its synchronous speed is 30 rev/s. Figure 1 shows the control panel layout.

Figure 2 shows a schematic layout of the plant. It should be noted that the field excitation is interrupted below 28 rev/s by a speed sensitive relay. Also, the main breaker cannot be closed below 29 rev/s. These features are provided to guard against excitation being applied at too low a speed and the main breaker being closed when the generator is not at or near synchronous speed.

2.2 Electrical Supplies

The console is supplied from a fuse disconnect switch at 3 phase, 208 V, 60 Hz.

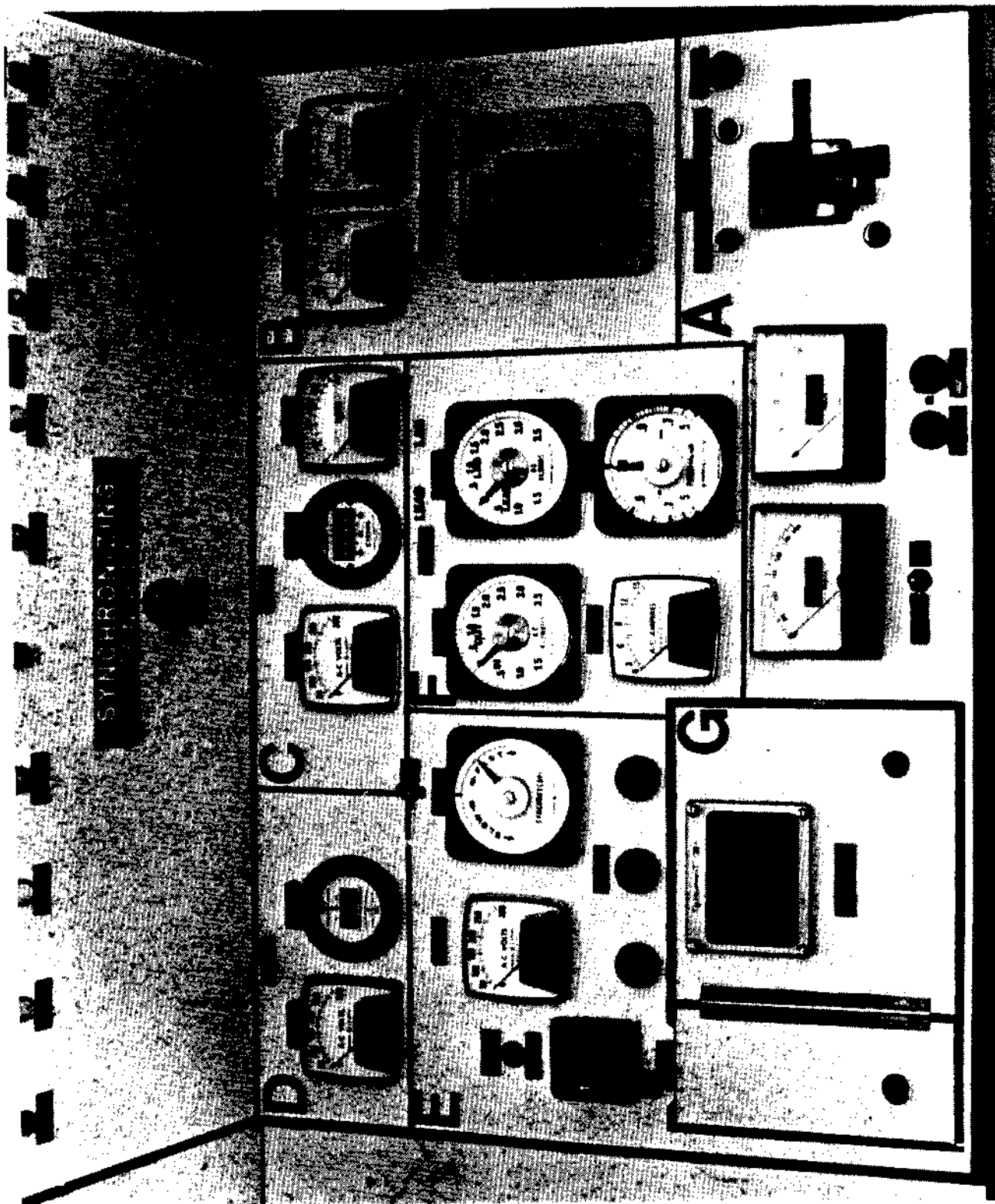


Figure 1: Photograph Showing the Control Panel Layout of the Training Synchronizing Model

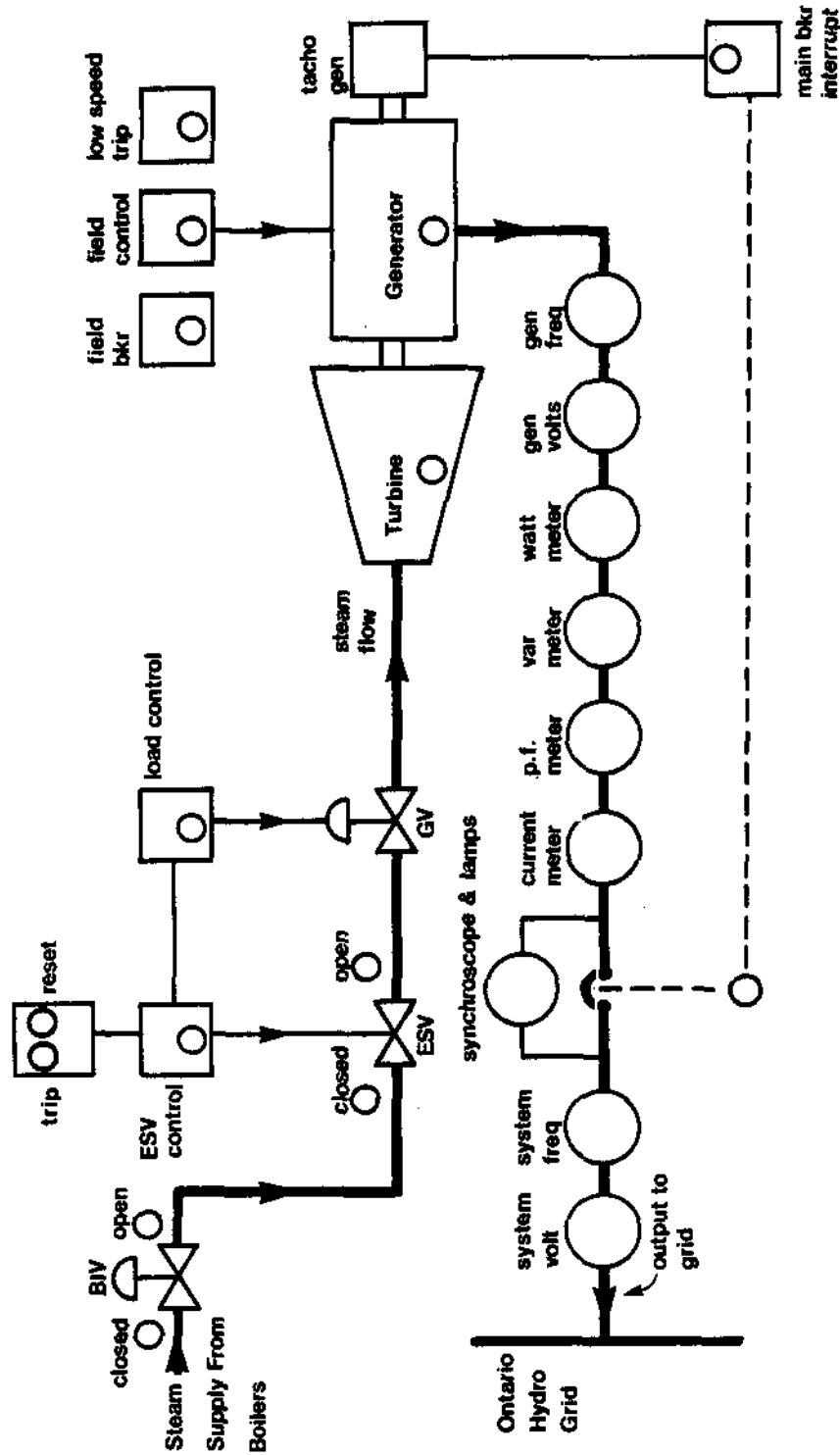


Figure 2: Diagram Showing the Schematic or Flow Diagram of the NTC Training Synchronizing Model

3. PRE-START CONDITIONS, TURBINE GENERATORS

Before a turbine generator can be run up to its operating speed, many pre-start conditions have to be satisfied.

These include:

- a) All outstanding permits and work authorizations have been surrendered.
- b) All isolations have been removed, pin boards updated with all isolations having been completed and checked.
- c) All electrical, pneumatic and hydraulic services are available.
- d) Main, auxiliary and emergency trip oil systems having been tested.
- e) Steam governor valves and ESV's having been tested.
- f) Steam conditions, temperature and pressure at specified values.
- g) Turbovisory readouts, for example, eccentricity and differential expansion are within specified limits. This will involve a warming up time.

4. PRE-START CONDITIONS, NTC TEST GENERATOR

Before the NTC test generator can be run up to its operating speed, the following pre-start conditions have to be satisfied. These conditions are detailed, in this lesson, on a check/operate/check basis which is the normal operating procedure at a power plant.

4.1.1 Check -

- synchroscope selected "OFF".
- field breaker switch selected, "OPEN".
- main breaker control selected, "OPEN".
- boiler isolating valve BIV switch selected "CLOSED".

4.1.2 Close supply disconnect switch.

Check -

- system voltage meter indicates. V
- system voltage meter indicates. Hz
- synchronizing lights "ON".
- boiler isolating valve BIV closed light is "ON" (Block H).
- turbine ESV/governor control is in the minimum position.
- ESV closed light in "ON" (Block H).

4.1.3 Select the boiler isolating valve BIV switch to open.

Check BIV closed lights "OFF" and open lights "ON" (Blocks I & M).

4.1.4 Reset trips - Emergency Stop Valve
- Overspeed.

Check Overspeed indication light "OFF".

5. UNIT RUN-UP

5.1 When the pre-start conditions covered in Section 4 have been satisfactorily completed, the unit can be run-up.

5.1.1 Open slowly the ESV's by selecting ESV and governor control switch to "Increase".

Check -

- ESV min light "OFF" (Block I).
- ESV closed light "OFF" (Block I).
- Turbine running light "ON" (Block I).
- rev/s meter indicates (Block C).

5.1.2 Increase "turbine generator" speed steadily up to approximately 28 rev/s and hold. (On a full sized turbine-generator specific checks would be performed, eg, oil pressures and flows bearing noise and vibration). Check turbine and generator are running smoothly.

Check -

- Main breaker low speed interrupt light on Block 'E'.
- ESV/governor transfer permissive (Block I).

5.2 Exciting the Generator

5.2.1 Check that the generator speed at 28 rev/s.

5.2.2 Close field circuit breaker.

5.2.3 Check field circuit breaker closed indication.

5.2.4 Raise excitation to 0.5A.

5.2.5 Check -

- field current ammeter indicates 0.5A.
- field voltmeter indicates. V
- generator stator produces an output voltage of approx. 160V. V
- raise speed to 30 rev/s.

NOTE: Any deviations from normal must be investigated and corrected before proceeding further.

- | | | |
|--------|--|---------|
| 5.2.5 | Raise excitation to 0.7A. | _____ |
| 5.2.6 | Check output frequency at 60 Hz. | _____ |
| 5.2.7 | Check output voltage as 208V. | _____ V |
|
 | | |
| 5.3 | <u>Synchronizing</u> | |
| 5.3.1 | Re-check generator frequency at 60 Hz. | _____ |
| 5.3.2 | Check system voltage and generator voltage are the same and, if necessary, adjust the generator voltage by altering the field current. | _____ |
| 5.3.3 | Check system frequency and generator frequency are the same. | _____ |
| 5.3.4 | Adjust, if necessary, the generator frequency to the system frequency by altering the speed of the generator. | _____ |
| 5.3.5 | Switch on the synchroscope. | _____ |
| 5.3.6 | Check - | |
| | - system voltage and generator voltage. | _____ |
| | - system frequency and generator frequency. | _____ |
| | - using the synchroscope, note whether the generator is running FAST or SLOW. | _____ |
| 5.3.7 | By adjusting speed, raise frequency above 60 Hz and check synchroscope indicates FAST. | _____ |
| | Lower frequency below 60 Hz and check synchroscope indicates SLOW. | _____ |
| 5.3.8 | Adjust speed carefully to make the synchroscope run slowly in the FAST direction. | _____ |
| 5.3.9 | Check system and generator voltages, adjust if required. | _____ |
| 5.3.10 | Close main breaker when synchroscope indicates just before the zero degrees position and synchronizing lights are dark. | _____ |
| 5.3.11 | Check main circuit breaker light indicate closed (Block I). | _____ |

6. LOADING THE GENERATOR

6.1.1	Check generator active power output wattmeter reads zero or a small positive reading.	
	Generator reactive power meter reads approximately zero.	
	Generator stator ammeter reads approximately zero.	
6.1.2	Load generator by increasing prime mover power input which will give an increase WATT output. At the same time, increase the excitation field current to ensure generator var output remains at zero or slightly lagging.	
	Raise active power output to 2.0 kW by increasing prime mover output.	
	Raise reactive power output to 1.0 kvar by increasing field current.	
6.1.3	Check field current.	A
	Active power output (load).	kW
	Reactive power output (load).	kvar
	Load Current.	A
	Output voltage.	V
6.1.4	Increase excitation to 1.2 A. Note vars (lead or lag).	kvars
	Decrease excitation to 0.7 A. Note vars (lead or lag).	kvars
6.2	<u>Load Angle δ Checks</u>	
6.2.1	Reduce the load to zero and set the stroboscope to LINE frequency and position it so the light shines on the calibrated disc on the end of the machine shaft. The disc is calibrated in mechanical degrees at 5 deg. intervals. Note the initial shaft angular position.	°
6.2.2	Increase the output power to 2.0kW at 1.0 pf and note the angular position.	°

6.2.3 Increase the excitation to give a load of 2.0 kW and 1.0 kvar lag and note the angular position.	°
6.2.4 Decrease the excitation to give a load of 2.0 kW and 1.0 kvar lead and note the angular position.	°
6.2.5 As the generator has 4 poles, the change in rotor angle in	
6.2.2 is electrical degrees	°
6.2.3 is electrical degrees	°
6.2.4 is electrical degrees	°
<u>7. OFF LOADING AND SHUTDOWN GENERATOR</u>	
7.1.1 Reduce watt load to zero and at the same time, reduce the excitation to reduce var load to zero. Whilst unloading, maintain a pf of approximately 1.0	
7.1.2 Reduce load further until generator motors slightly	
7.1.3 Check watt indicates "import" and var meter indicates "lead"	
7.1.4 Open main circuit breaker	
7.1.5 Check -	
- generator circuit breaker open	
- generator speed is less than 30 rev/s	
7.1.6 Switch off synchroscope	
7.1.7 Reduce generator field to minimum	
7.1.8 Open generator field breaker	
7.1.9 Reduce generator speed to zero	
7.1.10 Check generator speed at zero	
7.1.11 Close Boiler Isolating Valve, BIV	

7.1.12 Check -

- ESV/governor at minimum indication ON
- field breaker open
- B.I.V. closed

7.1.13 Open main disconnect switch

8. NOTES

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