

Karnataka Power Transmission Corporation Limited



MANUAL ON

**Duties of Shift Engineers Incharge of
Sub-Stations (Upto 110 KV)**

KARNATAKA POWER TRANSMISSION CORPORATION LIMITED



MANUAL ON DUTIES OF SHIFT ENGINEERS INCHARGE OF SUB-STATIONS (UPTO 110 KV)

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FOREWORD

Karnataka Electricity Board has converted itself into KPTCL with the objective of providing reliable and quality power to its customers by adopting best practices in Transmission and Distribution ensuring high order maintenance of its technical facilities and adopting the best standards.

In order to achieve the above goal we need to establish new Standards and Practices in Power Supply. We need to utilise the available manpower to the best advantage by imparting the necessary technical knowledge to enable to not only improve the quality of Power Supply but also for better maintenance of the system.

Although circular instructions are issued from time to time regarding the operation of Substations, there are no comprehensive guidelines readily available for the use of the station staff.

In this regard it was contemplated to bring out detailed guidelines for the Shift Engineers incharge of Substations, to enable them to discharge their duties effectively resulting in not only safe operation and maintenance of equipment but also contribute towards ensuring quality and reliable Power Supply to the customers.

It is hoped that these guidelines would be judiciously followed by the Shift Staff for smooth and efficient operation of the Substations.

Chairman & Managing Director,
Karnataka Power Transmission Corporation Limited

PREFACE

In order to have uniformity and to indicate broadly the guidelines in carrying out the shift duties of Sub-Stations (up to 110KV), it was decided to draw up a schedule giving the duties of Shift Engineers of Sub-Stations. A working group consisting of the following Engineers was constituted:-

1. Er. Ganapathy Madhyastha -- Exec. Engineer, Ele., Hoody Division, Bangalore.
2. Er. Keshavamurthy. R. -- Exec. Engineer, Ele., MRT South, Bangalore.
3. Er. Ramesh. B.M. -- Exec. Engineer, Ele., R & D Centre, Bangalore.
4. Er. Sudeendra Kumar. M. -- Exec. Engineer, Ele., Projects, Cauvery Bhavan, Bangalore.
5. Er. Katagihallimath. K.S. -- Exec. Engineer, Ele., R & D Centre, Bangalore.
6. Er. Vasantha Kumar -- Exec. Engineer, Ele., D.G. Plant, Yelahanka, Bangalore.
7. Er. Sathyanarayan. K.R. -- Asst. Exec. Engineer, Ele., PFC/ADB/Cauvery Bhavan, Bangalore.
8. Er. Shivakumar -- Asst. Engineer, 220KV, Station, Hebbal
9. Er. Girish -- Asst. Engineer, Ele., 220KV Station, Hoody
10. Er. Venkatesh -- Asst. Exec. Engineer, Ele., R & D Centre, Bangalore.
11. Er. Ghanti. P.M. -- Asst. Exec. Engineer, Ele., R & D Centre, Bangalore.

The working group after thorough discussions and deliberations came out with the guidelines for Shift Engineers in carrying out the Shift duties. Further these guidelines were scrutinised by the core - group consisting of the following Engineers :-

1. Er. Nagaraja, H.L -- Chief Engineer, Electy., R & D Centre, Bangalore.
2. Er. Chamaraj. A. -- Chief Engineer, Electy., TA & QC, Bangalore.
3. Er. Jagannath Guptha. P.S. -- Technical Adviser to Chairman.
4. Er. Viswanath. Y.K. -- Superintending Engineer, Ele., TA & QC, Bangalore.
5. Er. Sudeendra Kumar. M. -- Exec. Engineer, Ele., Project, Cauvery Bhavan, Bangalore.
6. Er. Keshavamurthy. R. -- Exec. Engineer, Ele., MRT South, Bangalore.
7. Er. Katagihallimath. K.S. -- Exec. Engineer, Ele., R & D Centre, Bangalore.
8. Er. Ramesh. B.M. -- Exec. Engineer, Ele., R & D Centre, Bangalore.
9. Er. Basavaraj. D.C -- Exec. Engineer, Ele., R & D Centre, Bangalore.

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For proper operation and maintenance of Sub-Stations to safeguard the costly equipment installed in the Sub-Stations, it is necessary that the Engineers incharge of Shift duties be aware of the various aspects of proper operation. With this in view, it was proposed to issue guidelines in carrying out the Shift duties.

Efforts have been made to cover almost all the aspects of operation by Shift Engineers, but it must be borne in mind that sometimes it may be necessary for the Shift Engineer to use his discretion to suit the equipment in the Sub-Station and the situation.

I express my sincere thanks to Management for their continued support and encouragement in bringing out this manual.

I thank the members of the working group as well as core-group for their valuable efforts and suggestions in finalising this document.

This document need not be taken as final and any comments and suggestions for improvement are most welcome based on which it can be continuously updated.

Chief Engineer, Electy.,
R & D Centre, KPTCL,
K.R.Circle, Bangalore.

Mission Statement

The Mission of the Karnataka Power Transmission Corporation Limited is to ensure reliable quality power to its customers at competitive prices.

The Karnataka Power Transmission Corporation Limited is committed to achieving this mission through :

- ✓ Encouraging best practices in transmission and distribution.
- ✓ Ensuring high order maintenance of its technical facilities.
- ✓ Emphasising the best standards in customer service.

To be the best electricity utility in the Country, the Karnataka Power Transmission Corporation Limited pledges to optimise its human and technical resources for the benefit of all its customers.

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Revision Record

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**GUIDE LINES FOR THE SHIFT ENGINEERS INCHARGE OF
STATIONS (UP TO 110 KV)**

Immediately after taking charge of shift duties, the shift Engineer shall review the log book for operations carried out in the previous shift.

Outgoing shift Engineers shall brief the incoming shift Engineers regarding any important observations/operations and pending line clear permits.

As soon as taking charge, shift Engineer shall observe the points mentioned in the check list of the sub-station.

CHECK LIST :

- a. Communication.
- b. All voltages.
- c. Transformer - tap position.
- d. D.C voltage.
- e. Load on feeders/Transformers.
- f. Pending line clear permits.
- g. Annunciation healthiness.
- h. Any Oil Leakage.
- i. Monitor the LED indication of Power Packs in all Static Relays in Service.

The detailed checkup to be made by the shift incharge after taking over shift duties.

1. D.C. SYSTEM: - 110 V. D.C.

1. Check the battery charging amps so that the station D.C. system voltage is between 118-121 Volts. Measure the specific gravity of three battery cells, it shall be in the range of 1210 ± 5 corrected to 27°C for STANDARD make battery and 1200 ± 5 for EXIDE and AMCO Make Battery. If the values of the Specific Gravity are lower than the values mentioned above, boost charge the Batteries and bring it back to float charge after getting normal values.

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2. During each shift the pilot cells' specific gravity and voltage shall be recorded in the following sequence, with battery charger ON.

Cell Nos: 1-10-20 I Shift.
 2-11-21 II Shift.
 3-12-22 III Shift.

The above cycle shall be continued to cover all the cells. Further cycle as above shall be repeated. The entries shall be made in a battery register.

NOTE :- For every 1°C above 27°C of the electrolyte temperature, 0.7 is to be added to the reading of the Hydrometer for correcting it to 27°C and for every 1°C below 27°C, 0.7 is to be subtracted from the reading of the Hydrometer for correcting it to 27°C, $SG_{27} = SGT + 0.7 \cdot (t - 27)$. where 't' is the temperature of the electrolyte.

Example:-

- Suppose the temperature of electrolyte is 32°C and Hydrometer shows the reading of specific gravity as 1205, then the corrected specific gravity at 27°C will be $1205 + 0.7 \cdot (32 - 27) = 1208.5$.
- Suppose the temperature of electrolyte is 22°C and reading of Hydrometer is 1205 then the corrected specific gravity at 27°C shall be $1205 + 0.7 \cdot (22 - 27) = 1201.5$.

Healthy trip in preclose and postclose condition to be checked for all panels (if provided) before closing of the breakers by pressing the designated push button. If the trip circuit is not healthy, the same shall be reported.

In case of 110/66/33 KV panels having trip circuit supervision relays 195 CA, 195 CB, 195 CC, 295 CA, 295 CB, 295 CC, are operated, these indicate that the trip circuit is faulty and the same shall be reported.

2. TRANSFORMER :

The shift Engineer should ensure that the transformer shall not operate at load current in H.V. Side more than the rated capacity and observe for the healthy humming sound of the transformer. Any abnormality is to be reported.

Check whether cooling fans are running(if provided) when the winding temperature of transformer is above the pre-set temperature for cooling fans to operate. -In case the fans are not running then they shall be switched on manually and non-operation of auto system shall be reported. If the winding temperature is below the pre-set value, check the operation of fans by switching on manually. Any defect shall be reported.

- ★ During tap change, the shift-in-charge shall observe the sound of the transformer and also operation of Drive mechanism during tap change. Any abnormality to be reported, and no further tap change be made till the clearance is given by the Maintenance Engineer. Also, verify whether the tap position indicated in the control room and tap position at tap changer are one and the same.
- ★ While operating the tap changer, extreme tap positions are to be avoided, however, if required, the transformer can be brought to Tap NO.1 or the highest Tap i.e., 17, as the case may be, but operation of the Tap changer to the lowest and highest Tap shall be done manually, even if the tap changer is operating electrically, to avoid the possibility of damage due to failure of the Inter-locking system.

The winding/oil temperature of the transformer shall not be abnormal with reference to the load and ambient temperature. Difference in the oil and winding temperature indicator of the transformer shall not be more than 10^oc.If it is more it shall be reported.

The oil level of the transformer as shown by the magnetic oil gauge (if provided) should be corresponding to the oil temperature of the transformer. This can be checked from the temperature mark indicated on the magnetic oil gauge of main tanks and window oil level indicator of tap changer. If not, matter be reported.

- ★ Applicable for OLTC.

Check the breather for the following :-

- a. The colour of silicagel shall be blue and oil level in the oil cup shall be to the marked level.

Check the relief vent pipe for the following :-

- a. No oil shall be visible in the sight glass wherever provided on the relief vent pipe. If visible, the matter shall be reported.
- b. The diaphragm provided on the top of relief vent pipe should be intact. If not, matter be reported.

In case of high oil temperature/high winding temperature alarm is received, it indicates that the oil temperature or winding temperature is approaching the set limits. Normally a difference of 5°C/10°C is kept between the setting for alarm and setting for tripping. If this alarm is received then the following shall be checked.

ONAF COOLED TRANSFORMER :-

Check whether all the fans are running. Any fans, which are not running shall be switched on. If any fans are defective, the load will have to be restricted to avoid unnecessary tripping of the transformer. Defects to be reported.

ONAN COOLED TRANSFORMER :-

- a. If the load on the transformer is more than the rated load, the load should immediately be restricted to rated load duly intimating the EXECUTIVE ENGINEER/SUPERINTENDING ENGINEER. If the winding/oil temperature rise is corresponding to the load and ambient temperature, then the trend of the rise is to be observed. If the rate of rise is abnormal, then the load should be reduced to prevent tripping of transformer and Executive Engineer informed.
If the rate of rise is not abnormal, the transformer can be operated up to rated current on H. V. Side keeping watch on the temperature of the transformer.
- b. In the event of the operation of BUCHHOLTZ ALARM/ BUCHHOLTZ TRIP/OLTC BUCHHOLTZ/SURGE TRIP/DIVERTER TRIP/PRV TRIP the transformer is to be isolated from the system immediately. Where the Buchholtz trip is not connected to trip the H.V/L.V. breaker, both the H.V. & L.V. breakers shall be hand tripped. In case Breaker is not provided immediate action be taken to isolate the Transformer by getting the Incoming Line opened at the source Station.

Transformer shall be isolated from system by opening the respective H.V/L.V isolators and intimate the concerned.

The transformer is not to be energized till the same is thoroughly rectified.

In the event of operation of DIFFERENTIAL/REFR protection of the transformer, the transformer is to be isolated from the system immediately. The Shift-in-charge shall carryout the visual observation for any damage of equipment such as H.V, L.V, Bushings, L.A's, C.T.'s, Cable and Transformer. The relief vent diaphragm is to be checked. The maintenance Engineer is to be informed immediately. The transformer is not to be energized till both the transformer and the differential relay are tested and the possibility of internal damage to the transformer is ruled out.

In the event of such an outage of transformer, power supply for the station auxiliary shall be arranged from alternate source in consultation with O&M officers.

In the event of transformer tripping on H.V. side O / C and E / F relays only, the following are to be checked :-

- a. If tripping is due to over current as a result of over loading, the transformer can be charged after shedding the excess load.
- b. If it is due to non tripping of the out going feeder breaker even though the relay has operated, then the transformer can be charged after opening the defective breaker. The defect be reported.
- c. Before charging the transformer, all feeder breakers are to be disconnected. In the event of the transformer tripping again on charging, the same should not be re-energized till the same is rectified.
- d. If the tripping of Transformer is due to defective winding temperature indicator, replacement should be arranged immediately. Till the replacement is received, the transformer is to be run on reduced load. The defective winding temperature indicator is to be reported for replacement.

However, if all other conditions are normal then the temperature rise may be due to some abnormality in the transformer, in which case, the matter is to be reported and the transformer should not be energized till it is checked.

3. BREAKER :-

The Shift in-charge shall check the following incase of MOCB/ABCB/SF - 6 breakers:-

The low oil level and oil leakage shall be checked in case of MOCB and the same should be reported.

The closing spring of 110/66/33 KV breaker should be kept in-charged condition.

Air/gas pressure in case of ABCB and SF-6 breakers shall be checked and if low, it shall be maintained at correct level. The normal operating/gas pressure for some of the breakers are given below :-

	<u>Air</u>	<u>Gas</u>
1. 110/66 KV ABB	20.5Kg/sqcm.	7 Kg/sqcm
2. 110/66 KV Crompton	15 Kg/sqcm	5-6 Kg./sqcm
3. 110/66 KV BHEL		7 Kg./sqcm

NOTE : The Shift in-charge shall verify the correct operating pressure of the breaker installed at the sub station as indicated in the name plate.

In case of centralized air pressure system, it shall be checked and if it is low it shall be maintained at the correct level. Some typical values are given below:-

110 KV HBB DCF/DCVF ABCB - 30/16 Kg./sq cm.

Hydraulic oil pressures in case of hydraulic oil operated breakers shall be checked and if low, shall be maintained at correct level as per name plate.

The shift in-charge shall get the moisture drained from the air bottles of the SF - 6 breakers and compressed air plant installed in compressor room/breaker in day shift.

If any leakage is observed in hydraulic/pneumatic system it shall be reported for immediate action.

If the Air/SF-6 gas pressure in 110/66/33 KV breakers observed is low and also Air/SF-6 low gas pressure alarm is observed in annunciator panel, it shall be

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reported immediately. In case of severe leakage, the shift in-charge shall open the breaker at his discretion.

In the event of failure of supply at the sub station having single source of supply, the 110/66 KV Breaker, controlling the transformer shall be tripped and all 33/11 KV breakers shall also be tripped. The tap position of the transformer shall be brought to Tap No.5 (Normal Tap) manually.

After restoration of supply, the transformer is charged only if the voltages are within the permissible limits. The transformer can be charged and load can be taken gradually by switching on the feeders one by one. The tap position can then be changed corresponding to the required 33 KV and 11 KV Voltages.

If the 110/66 /33 KV Station is having alternate source of supply and incase the main source has failed and proved faulty, after obtaining the concurrence of Load Despatch, change over to the alternate source to be made after opening the breaker and GOS of faulty incoming main source.

Check the 110/66 KV incoming voltage and keep the transformer tap relevant to tap mentioned on nameplate. To avoid frequent tap change of the transformer, the voltage on 33 KV and 11KV side to be maintained between 31 KV to 34 KV and 10.5KV to 11.5KV respectively.

In the event of high voltages, which are likely to be experienced in OFF LOAD periods, particularly during the night hours, the 33 KV, & 11KV voltages may be allowed upto 35 KV and 11.5 KV respectively after bringing the transformer to TAP NO. 1.

In the event of fault on any feeder, if the concerned breaker fails to trip and instead incoming breaker or HV breaker clears the fault, then that particular feeder breaker is to be tripped manually and is not to be charged till the defect is rectified by the maintenance Engineer.

The Shift in charge should also keep a watch on the voltage and the load during the shift and take remedial measures in the event of any abnormal increase/decrease in the voltage.

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The Shift-in-charge shall check the healthiness of the Energy Meters. The PT supply in all the three phases be checked by operating the selector switch.

In the event of tripping of 110/66/33 KV breakers provided on the feeder on distance/back up protection, the feeder can be test charged provided no abnormal conditions are observed in the vicinity and after communicating with the other end (if communication is available).

CAPACITOR BANK :-

The capacitor banks should be switched OFF whenever the bus voltage is more than 110% of rated values.

GOS for the capacitor bank should not be operated when it is in charged condition.

The capacitor should not be switched ON within 5 minutes of switching OFF so that the capacitors are discharged to a safe value before re-energisation.

In the event of capacitor bank breaker lockout connected to the bus side, the incoming supply shall be isolated. In case Breaker is not provided immediate action be taken to isolate the Capacitor by getting the Incoming Line opened at the source Station. The capacitor bank shall be isolated after 10 minutes of opening of incoming supply.

As the capacitor banks remain in charged condition even after taking out of circuit, for considerable period of time, it is essential that they are discharged before carrying out any work on them. Capacitor to be discharged after 10 minutes of opening.

LINE CLEAR PERMITS:-

Before issuing line clear permit the shift in-charge should himself see that the concerned breaker is OFF and all the phases of isolators have been disconnected & earth blade is switched on wherever necessary. Then only, the line clear permit should be signed. Display prominently HOLD BOARD at relevant places and issue LINE CLEAR to authorised persons.

An entry is made in the log sheet or Register to the effect that the apparatus and mains under the permit have been made dead, on no account shall the apparatus and mains again be made live until the return by the Supervisor of the 'Permit - to - work'.

Where Sub-permits are issued by the Supervisors to competent persons working in different sections, such Sub-permits should only be accepted for cancellation by the Supervisor and under no circumstances should the Permit Issuing Officer, of the original permit, accept Sub-permit for cancellation.

Similarly, after return of line clear and before switching on the feeder, the shift in-charge should ensure that all earthing and earth blade have been removed and isolators have been put-on and all the three phases of the isolators make proper contacts.

GENERAL :

1. Hourly readings of all the Meters of feeders and transformer panels shall be recorded correctly. Also record D.C. Voltage, Charging and Load Current in the log sheets.
2. At 00.00 hours the KWH readings of all the feeders and transformer panels shall be taken and energy consumption calculated and recorded along with peak loads.
3. Any rectification and important observation made during the shift should be recorded.
4. During any trippings on fault of the Feeders/Bank observe for arcing if any, in the neutral earth connection of the transformer shall be recorded and reported.
5. Whenever the feeders/banks trip, all the relay indications have to be clearly recorded in the logbook before resetting the relays namely, Phases, Zones, Instantaneous/time delay etc. Chronologically.

DO'S

1. Display "HOLD" or "LC" or "LOAD SHEDDING" or "BACK FED" Boards wherever necessary both at control room & out door yard on the concerned equipment/line.
2. Before opening any Isolator, ensure that the concerned circuit breaker is in open condition, ensure all the 3 phases of the Isolator are fully open.
3. Before charging any line/equipment after return of line clear permits, ensure that there are no other line clear permits and NO BACK FEED CERTIFICATES are pending on the same line/equipment & also all earthings have been removed. Before closing the Isolator of any Feeder/Equipment ensure that the concerned Breaker is in open condition.
4. Whenever there is a fire hazard in the station, first ensure that power supply to the complete zone is cut off. Then start fighting the fire using the fire extinguishers available in the Station. Also call nearest Fire Station if necessary.
5. Before energising any power transformer, bring the tap of that Transformer to normal tap position.
6. Whenever Bank/Incomer Breaker trips, hand trip all the concerned outgoing feeder breakers before test charging the Bank/Incomer Breaker.
7. Keep vigil on overvoltage/overloading of equipments.
8. Keep Circuit Breakers open whenever D.C. Supply failure is observed till it is rectified.

Don'ts

1. Do not open any G.O.S. on load, without opening circuit breaker.
2. Do not close any G.O.S. before opening the concerned Circuit Breaker during change overs.

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3. Do not open G.O.S. before tripping the concerned Circuit Breakers for issuing L/C on feeders.
4. Do not operate Breakers when air and gas pressure is below operating value.
5. Do not operate G.O.S. and Circuit Breakers manually without wearing safety gloves etc.
6. Do not close earthing blades of G.O.S. unless respective Circuit Breakers and G.O.S. are open and also ensure that there is no back feeding on the line.
7. Do not keep Power Transformer in charged conditions during abnormal readings of winding and oil temperature.
8. Do not allow workmen to attend any work without line clear and without the equipment being perfectly earthed and after discharging the equipments (Such as L.A's, Capacitor, U.G.Cables etc.) duly taking precaution that safety devices are used.
9. Do not issue L.C. on EHV lines without obtaining NO BACK FEED CERTIFICATES from the other end.
10. Do not use bare fingers or hands to determine whether a circuit is alive.
11. Do not issue L.C. permit by just hand tripping the Breaker.
12. Do not test charge Power Transformer in case it trips on Buchholtz Relay/ Differential Relay/REFR.
13. Do not neglect any annunciation until the problem is set right.
14. Do not test charge any line or equipment without resetting the concerned relays and annunciation.
15. Do not forget to switch on the Battery Charger after attending to problems related to D.C. Supply.
16. Do not leave the premises until the Station Charge is properly handed over to the next Shift-in-charge.

17. Don't leave the Transformer in Charged condition during Single Phase condition on the H.T. Side.

List of the Equipments required for Station Shift Operations :-

- | | |
|---------------------------------|------------------------------|
| 1. Rain coat | 3 Sets. |
| 2. Torch | 1 No. with 3 cells capacity. |
| 3. Grounding Sticks | 3 Nos. |
| 4. Cutting pliers | 2 Nos. |
| 5. Screw driver | 1 Set of all sizes. |
| 6. Multimeter | 1 No. |
| 7. Adjustable Screw spanner | 1 No. |
| 8. Calculator | 1 No. |
| 9. Centre zero D.C. Cell Tester | 1 No. |
| 10. Rubber Hands Gloves | 1 Pair. |
| 11. Hydrometer | 1 Set. |

CONSUMABLE ITEMS :

- | | |
|---|-----------|
| 1. Dettol | 1 Bottle. |
| 2. Torch Cells | 5 Cells. |
| 3. PVC Insulation Tape | 2 Rolls. |
| 4. Cotton Waste | 5 Kgs. |
| 5. Cheese Cloth | 5 Mts. |
| 6. HRC Fuse/Cartridge of different capacity | 2 Nos. |
| 7. Petroleum Jelly | 1 Kg. |
| 8. Phenyl | 1 Bottle. |
| 9. First Aid Kit | 1 Set. |

BIBLIOGRAPHY

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- ii) Crompton & Greaves Instruction Manual for Installation / Commissioning / Maintenance of SF₆ Breakers.