Chapter 4 – Electrical – Signalling and Telecommunication units

The Electrical department is responsible for safe train operations and maximizing the utilization of fixed and moving assets such as train rakes, locos and tracks etc. At Railway Board level, the Electrical Department is headed by Member (Electrical) who is assisted by three Additional Members for Electrical, Telecommunication and Signalling.

At Zonal level, the Electrical Department is headed by Chief Electrical Engineer who is responsible for Operation and maintenance of Electric Locos, EMU, MEMU, Overhead Head Electrical Equipment (OHE) its Maintenance and operation, Planning, Electrical Coaching stock operation & maintenance and Electrical general power supply, Air conditioning, Diesel Generating set operation and maintenance and Water supply. The Signalling & Telecommunication department is headed by Chief Signal & Telecommunication Engineer (CSTE) who is responsible for maintenance of signaling assets.

The total expenditure of the Electrical Department during the year 2012-13 was `60350.51 crore. During the year, apart from regular audit of vouchers and tenders etc., 589 offices of Electrical and Signalling & Telecommunication department of Railways were inspected by Audit.

This chapter includes one individual paragraph pertaining to Southern Railway regarding avoidable payment of low power factor surcharge due to non-provision of essential equipments in Traction Sub-stations. In this para, Audit commented on Railway Administration's failure to follow mandatory advice of the State Electricity Board for replacement of fixed capacitors by Dynamic Reactive Power Compensation equipments to regulate low power factor which resulted in avoidable payment of surcharge.

4.1 Southern Railway (SR): Avoidable payment of low power factor surcharge due to non-provision of essential equipments in Traction Sub-stations

Failure of SR Administration to comply with the statutory regulation of Tamil Nadu Electricity Board for providing proper power control equipment led to payment of surcharge and compensation totalling to ` 9.77 crore during 2010-13 which is of recurring nature

For running electric trains and Electric Multiple Units (EMUs)[202], SR Administration purchases single phase electricity supply of 110 kilo Volt (kV) electric potential from Tamil Nadu Electricity Board (TNEB). The electricity supply is transmitted by TNEB at Railway's twenty three Traction Substations[203] (TSSs) through their high tension lines. The electricity potential of the supply received from TNEB is stepped down to 25 KV at TSSs. This power supply of reduced electricity potential is fed to Electric Overhead Equipments (OHE) provided over the Railway tracks. The locomotives of trains/ EMUs get power supply of 25 KV from the overhead lines. Each TSS feeds OHE over railway tracks for a distance of about 30 km on either side.

Power factor is the ratio of real power[204] to the apparent power[205]. Power factor is required to be controlled and kept at minimum prescribed limit by the consumers. When traffic load on railway track is low or nil, consumption of electricity stored in overhead wires is less which increases the power factor. Higher/ uncontrolled power factor on account of high/ fluctuating electric potential of electricity affects adversely the transmission lines/equipments of State Electricity Board. For maintaining the Power factor at prescribed limit Railway uses capacitors in TSS.

Tamil Nadu Electricity Board (TNEB) supplies single phase power supply of 110 KV at twenty three Traction Substations[206] (TSSs) over Southern Railway. The electricity supplied is stepped down to 25 KV at TSSs and fed to the overhead traction conductors provided above the track. The locomotives/ Electric Multiple Units (EMUs) get power supply at 25 KV from the overhead lines. The tariff of TNEB stipulates that all High Tension (HT) electricity consumers should control power factor[207] and the average power factor[208] should not fall below 0.9 lag[209]. If

[202] Trains having special types of coaches to facilitate sub-urban traffic
[203] Railway's Units along the track for receipt and distribution of electricity supply.
[204] The real power is actual power being used in a circuit.
[205] The Apparent power is combination of real power and reactive power. The reactive power is the portion of power which returns to the source due to inductive reactance on account of its storage at consumer's end.
[206] Units along the track where high voltage electricity is received by the Railway from State Electricity Boards and fed to Overhead equipments after stepping down the voltage
[207] Ratio of real power to the apparent power
[208] The ratio of total Kilo Watt hours to the total Kilo Volt Ampere hours consumed during the billing months

it falls below the prescribed limit the customers are liable to pay surcharge towards compensation for power factor. SR Administration had installed fixed Capacitors at TSSs to maintain power factor. Non-controlling of power factor damages the transmission lines/equipment of State Electricity Board due to high voltage.

TNEB changed (January 2005) the method for computing power factor by replacing the existing 'lag only' logic criteria by 'lag + lead[210]' logic criteria which would actually reduce line loss and damage of transmission line/ equipments besides distribution of electricity in an efficient and economical manner. This required mandatory provision of automatic power factor correction equipment called Dynamic Reactive Power Compensation equipment (DRPC) at TSSs at an estimated cost of ` 24 crore.

Although the provision made by TNEB for the installation of DRPCs at TSSs was statutory obligation, SR Administration appealed (2006) to the Tamil Nadu Electricity Regulatory Commission (TNERC) to exempt them from the implementation of the systems as the cost involved in the provision of DRPCs was very high. TNERC did not accept SR Administration's appeal but directed (April 2007) TNEB to defer the issue for three years (2007-08 to 2009-10) and advised SR Administration to install DRPCs of suitable specifications within that period.

Southern Railway Administration initiated action (2007-08) to install DRPCs of RDSO[211] specification and installed DRPC at Bommidi (June 2009) and Tambaram (February 2010) TSSs at a total cost of ` 4.71 crore. After installation of DRPC they noticed (July 2009) that in comparison to existing capacitor, the energy consumption at DRPC was on the higher side[212] as DRPC controls 'lag + lead' situation instead of only 'lag' situation by the fixed capacitor. SR Administration discontinued the installation of DRPCs as in their view the benefit from DRPCs did not match the cost involved. Simultaneously, they approached TNERC twice (2009) and Appellate Tribunal once (2010) with their earlier request.

Southern Railway Administration was, however, not successful in producing before the TNERC (2009) and Appellate Tribunal (2010) any authentic data to substantiate the adverse impact of new logic on the traction system which was resulting in overall energy loss. On the other hand, TNEB proved before the Appellate Tribunal (2010) that the Railway Administration had not studied the total energy loss in the system and the energy consumption had come down in Tambaram and Bommidi TSSs after the installation of DRPCs. They established that the new logic was beneficial due to avoidance of line loss, damage in transmission lines/ equipment on account of over voltage and due to maintenance of distribution system efficiently and economically.

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[209] Lag relates to inductive reactance (When the load is inductive, the inductance tends to oppose the flow of current, storing energy and then releasing it later in cycle. The current waveform lags behind the voltage waveform.)

[210] Lead relates to capacitive reactance (when the load is capacitive, the activity opposite to lag occurs i.e. current waveform leads the voltage waveform)

[211] Research, Design and Standard Organisation

[212] 1100 units per day by DRPC and 80 units per day by fixed capacitor

As a result, the Tribunal observed (November 2011) that Southern Railway, being a Government Organisation, had to act as a role model by obeying statutory obligation towards introduction of new logic as it would improve the quality of supplied power.

Since SR Administration did not provide DRPCs at 21 TSSs up to March 2010 as directed by the TNERC, TNEB started (April 2010) to levy surcharge considering power factor based on new logic criteria. Railway, however, provided (2009 to 2011) as a low cost solution, auxiliary capacitors and automatic switching equipment at moderately loaded TSSs[213] in Salem and Chennai Divisions which controlled power factor to some extent. At eight TSSs which were either highly or moderately loaded, power fluctuation was under control and no surcharge was leviable. However, SR Administration paid surcharge levied by TNEB in respect of 13 lightly loaded TSSs[214] where power factor had been low due to uncontrolled power fluctuations.

During 2010-13, SR Administration paid surcharge totalling ` 9.77 crore in respect of thirteen TSSs including substantial compensation of ` 7.48 Crore paid for four TSSs[215] in respect of which no financial analysis was carried out. The payment is of recurring nature and would continue till the fulfilment of mandatory requirement.

When the matter was taken up with the Railway Administration in May 2013, they stated (September 2013) that-

- TNEB did not provide any proof that DRPC resulted in reduced losses.
- Fixed capacitor bank met the system requirement.
- TNEB did not prove that fixed capacitor was causing a higher voltage in the system and that implication of DRPC would improve the overall voltage profile of the gird in more economical and efficient manner.

Railway's contentions are not acceptable in view of the facts that-

- TNEB furnished a comparative statement of actual readings for energy consumed by the Railway at Bommidi TSS in 2009-10 before and after installation of DRPC to support their claim that provision of DRPC results in reduced losses[216]. Although Railway stated that the energy loss in DRPC was much higher than energy loss in fixed capacitor they could not substantiate their claim that provision of DRPC resulted in increase in system losses[217].
- RDSO had viewed (March 2009) that if traction load varies rapidly there are practical limitations of using fixed High Tension capacitors of higher size/ ratings for achieving near unity power factor. It is evident from the reading at ten lightly loaded TSSs that fixed capacitors cannot meet the system requirements.

[213] TSS feeding a station where number of trains running in the section on electric traction is moderate
[214] TSS feeding a station where running of trains on electric traction is less in the section
[215] Vridachalam, Ariyalur, Vaiyampatti and Tiruchi
[216] Judgement of Appellate Tribunal (Paragraph No.33)
[217] Judgement of Appellate Tribunal (Paragraph No. 35)

- The findings of the Appellate Tribunal were that DRPC is one of the techniques to improve the quality of power due to poor voltage regulation on account of wide variation of load in a very short duration of time[218].

Southern Railway Administration purchases electricity from State Electricity Board which is empowered to make applicable laws/ rules and therefore it is mandatory for the Railway Administration to follow their directives. Further, Railway's appeal has been heard and disposed off in quasi judicial bodies[219]. Moreover, while SR Administration was still paying surcharge for low power factor due to non-provision of DRPCs, other Zonal Railways had installed[220] in their TSSs[221] the DRPCs of RDSO specification. In fact, instead of complying with the statutory regulation of TNEB for providing proper power control equipment, SR Administration opted to pay surcharge as compensation/ penalty which will be an avoidable recurring expenditure.

The matter was brought to the notice of Railway Board in May 2014; their reply has not been received (July 2014).

[218] Judgement of Appellate Tribunal (Paragraph No.37)
[219] Tamil Nadu Electricity Regulatory Commission and Appellate Tribunal
[220] Judgement of Appellate Tribunal (Paragraph No.36)
[221] Such as Lasagoan, Pimperkeda, Nagpur, Bhadii, Maxsi and Mohamed Keda, as mentioned in Judgement of Appellate Tribunal (Paragraph No.36)