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S P E NEWS LETTER

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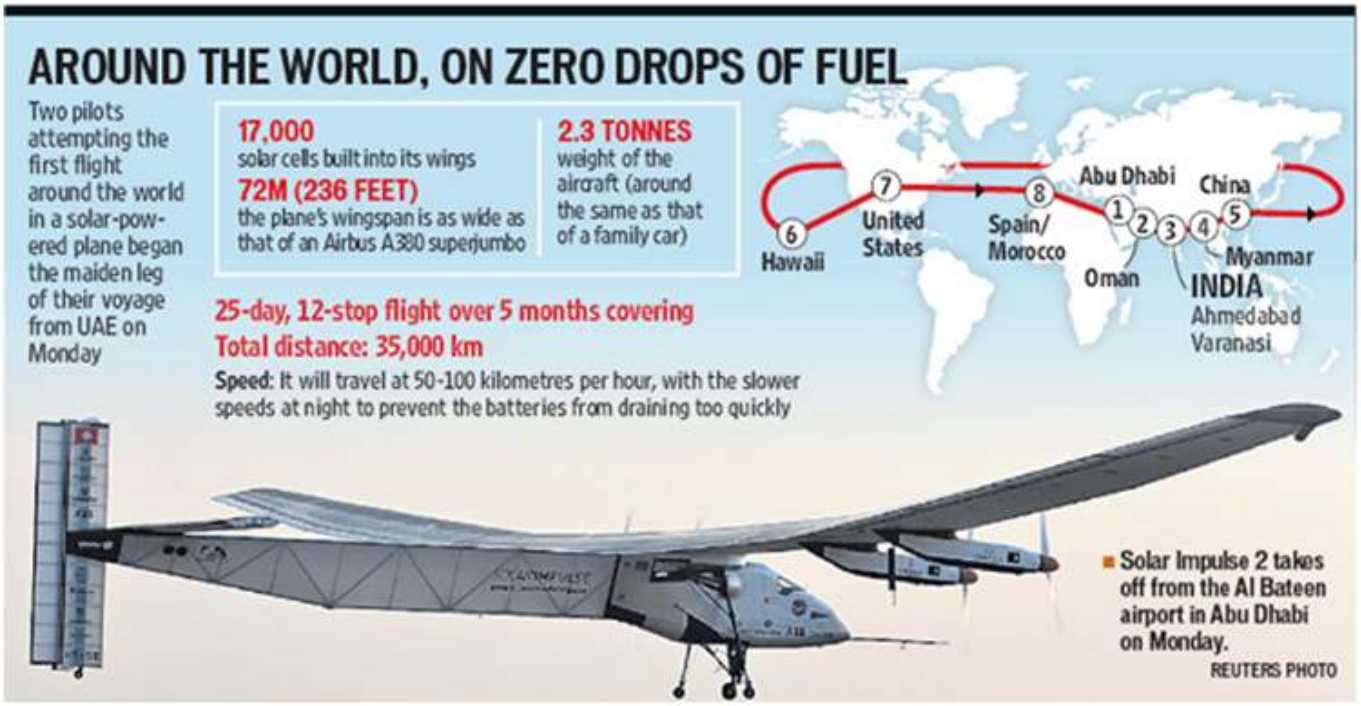

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Er. N. Dinker

OBITUARY

Er. Rishikesh Desai, Life Member of SPE(I) Vadodara left for his heavenly abode on 10 Mar 2015. He did his BE(E) in 1976 from MS University and joined ABB (erstwhile HBB) as trainee and retired as VP (Marketing) in 2012.

His main hobby was painting. His art works include Bollywood Stars, to portraits of people from rural life, still life, scenery, abstract painting and a lot more. He was fond lover of music. He was very popular in ABB and GEB. He was soft spoken and was positive in attitude. In his death, SPE(I) Vadodara has lost a Well-Wisher. May his soul rest in peace. Almighty may give strength to his family members to bear the impact.

Coverpage Theme : Solar Impulse - An airplane running on Solar Energy

From The Chairman's Desk

Last month, Solar Impulse, an airplane on tour around the globe, entirely driven by solar energy, has visited India during its maiden journey around the world. It demonstrated the wide use of solar energy and will help in creating awareness and motivation for the people in the world to use it in their day to day life. This project has proven that it is possible to use solar electric power efficiently on other solar vehicles also like solar cars, buses, bicycles etc. There is limitation of size of solar panels used over the surface of vehicles using roads, but fast development in solar cell technology will make them commercially viable and popular.

We need to recognize the importance of evolving low carbon strategy and use more renewable energy for sustainable growth of our energy sector. However, renewable energy source, particularly solar energy, was much more expensive than conventional energy and hence there were constraints on its utilization. The cost is now falling in this field but it is still higher than conventional energy. However, if we consider the cost of foot prints imposed by carbon emissions, it is more cost effective.

In Budget 2015, the new Government under the leadership of Prime Minister Shri Narendra Modi, has given utmost importance to this fact and has announced revised targets of renewable energy capacity to 1,75,000 MW to be built till 2022. It comprises 100,000 MW of solar, 60,000 MW of wind and 15,000 MW of biomass and small hydro energy. Evidently, solar energy is becoming one of the fastest growing renewable power sources in our country as well as in other countries in the world. The fast increase in the production volume in coming years, will bring down the cost of PV cells and is expected to achieve grid parity sooner than estimated earlier.

The Society of Power Engineers (I), Vadodara Chapter is also keen on spreading awareness in the area of renewable energy and is going to organize the seminar on Solar Energy at the earliest opportunity during this year. Let us all work together in harnessing the Solar energy and reduce dependence on fossil fuels as also reduce carbon emissions.

G. V. Akre

Editorial

After assuming the power in the centre, the new government appears to have swung in to action. The growth rate has started improving considerably. The Tech Savvy Governance is bound to uplift the living standard and the quality of life. Before the end of the tenure, the previous government had cleared thousands of crore worth project, which were on hold for a reason or the other. The huge fund requirement has been arranged by the present government by appropriations in the budget. The industrial sector has started showing improvement in production.

The change which is sweeping the country these days, owes to improvement in bilateral relations with Japan, China, Australia & America. The Vibrant Gujarat Summit, concluded in Gandhinagar in January this year, is also working as a catalyst in the growth rate being projected by the new Govt. Promoting FDI and Disinvestment is also likely to impact the economy positively.

The man power requirement which had slowed down considerably during last three years, also appears to have gained momentum. The campus interview which had taken a back seat have started emerging again. Employment opportunities for the engineers are found to be improving. The requirement of skilled man power is also growing.

The dream projects of the present government like bullet trains, smart cities, express highways etc., if go on stream, will require the man power in bulk.

There are chances that the engineering students passing out with good percentage will receive good pay packages but even those on lower rank, may also find suitable employment.

In a personal capacity, I am invited to various engineering colleges for various academic

assignments. I find that poor employment opportunities in last 2-3 years have proved to be an eye opener for the academic institutions. The incumbent management and the teaching staff of colleges have started realizing that unless the teaching curriculum follow closely the actual practical needs of the industry, the job opportunities for the new pass out will drastically reduce.

The Vadodara chapter of SPE(I) has made an effort in this direction. All the engineering colleges in the state have been informed that experienced engineers of SPE(I) Vadodara will conduct seminar/workshop at their premises on the latest topics in Electrical Engineering with an ascent on case studies and practical problems faced by the industries in their installations. This will also help in propagating the activities of SPE(I) to the academic institutions.

Let us all join hands together to work for academy and bridge the gap between technical institutions and the Industries.

- SM Takalkar

Testing of Electrical Equipment

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Testing means examining the object to verify suitability for performance. These tests may be quite simple or most complex. It may also be useful to pin point the defect / lacuna and course of action required to make it perfect.

Testing is also associated with our life throughout from pre birth to post death. Doctor confirms pregnancy by certain test. Other tests are done to know condition of foetus and mother for any remedial measure to be taken to avoid life threatening.

During life cycle, we undergo various tests. Educational stream starts with admission test. Thereafter weekly, monthly, term-end and year-end tests conducted to verify entitlement for next standard. Human health has blood test, urine test, stool test, ECG, MRI, etc. Job recruitment starts with written test, interview and thereafter performance check for promotion. Business deal is finalized based on performance during meeting. Life partner selection is by meeting, chatting and horoscope matching. Death is also confirmed by examining the body by doctor.

Similarly, testing has a role throughout the life of an equipment. Verification of design is done by type testing before production of equipment. Residual Life Assessment (RLA) is a testing at the end of life of equipment. Testing is also associated with various stages of life of equipment, it is called condition monitoring

Testing is required to observe effect of specific condition/s on particular parameter/s of the object. The object may be plant/ machine/ equipment/ appliance/ gadget/ instrument etc.

The condition may be single or multiple and monitoring parameter may be one or more, depending upon the requirements. The basic aim of the testing is to ascertain satisfactory workability of equipment under different operating conditions prescribed in the standards.

Three stages in the life of an equipment are as under.

Design and Development: This activity is at factory where equipment are produced. This consists of three steps as designing, developing and testing. Each step is handled by respective experts. Type test is done on one specimen of new design to verify the design perfection. This may be a design or destruction test and hence test piece may be discarded. During development, interim testing is done to confirm that the part of job is in order. Finished products undergo routine tests.

Some tests are mandatory as per statutory requirements. Some tests are required as per conditions of quality assurance agency. Some tests are done voluntarily by producers, before dispatch in market, to reduce chances of rejection and to earn reputation for the products.

For customized product some special tests called factory acceptance tests (FAT) are done at factory in presence of representative of purchaser as desired by purchaser and agreed by supplier, as a term of purchase order.

Most of the above routine tests are done by testing expert at factory in testing section having all test facilities. Some specific tests requiring special test setup are done at standard NABL accredited laboratory.

Erection and Commissioning: This is site activity, where equipment/machine is supposed to perform during the life. This includes receiving, unloading, inspection, shifting, storing, assembly, fixing, testing, commissioning

and trial run of the equipment till handing over to O&M Team.

After the assembly and installation at site, commissioning tests are done before taking in regular service. Equipment was already tested in all respect at works before dispatch, but possible damage due to handling as above, has to be ruled out. Here tests have to be done at site where all the test facilities, as at works, may not be available. Indirect tests like checking IR, PI, PD, Tan delta etc. are done to confirm healthiness of equipment.

Operation and Maintenance: This is the site activity for longest span till life of equipment. This is handled by experts in the field. The objective is to manage full time availability of equipment. Team has to monitor operation of the equipment and have to plan and execute maintenance as required. Preventive maintenance may be scheduled maintenance or may be condition based maintenance. In the latter case, periodic monitoring of equipment's condition is required. These are maintenance tests or checks. Now on line condition monitoring equipment are available to have continuous monitoring.

Expert can judge the defect by personal judgment without an aid of any instrument as under.

Sight: Visual inspection: It is possible to find out burnt or over heated terminal or cable, open connection, cracks, displacement of parts, damaged surfaces, dust, water or insects etc.

Sound: Hearing the noise: Rubbing, knocking, indifferent humming sound, may represent misalignment, loose parts, bent shaft, bearing failure, single phasing etc.

Smell: By smelling it is possible to recognize burning or over heating of paper, cotton, enamel, pvc, grease, oil etc and accordingly problem can be assessed.

Sense: By touching the equipment (cut off from supply) one can feel the vibration, temperature, wetness, loose parts / nut bolts etc and evaluate the problem.

Measuring Tan delta, IR, PI, PD, signature analyses etc. are used to detect the problem.

Current: When machine is energized, current is supposed to flow through designated circuit. Therefore, this desired path of current has to be through without breaks/loose connections. Flow of current in the circuit generates heat in the element due to loss of power. At expected locations heat dissipation arrangement is designed to limit temperature rise. This path is tested by current flow at various levels such as normal operation, full load operation, short time high deviation and ultimate level. Last is destructive test for capacity check. This conducting path has generally low impedance. Abnormal heat is produced at loose contact or under capacity part and may fail.

Voltage: When equipment is energized, current is not supposed to flow through other than designated path. Therefore insulation is provided throughout the designated path. However, some leakage current flow through the insulation. This current flow may be between conductors or to ground through body. This is undesired path of current through insulation. Insulation resistance is supposed to be very high. Leakage current should be within limit to avoid deterioration / damage to insulation system. This current is proportional to applied voltage and therefore is tested by applying voltage at various level such as rated voltage, normal deviation, short time high voltage and ultimate high level.

Safety: whenever electricity divert from conducting path towards the body of the equipment due to failure or weakness of insulation or by mistake, human or animal may face electrical shock if they come in contact with such faulty equipment. Earthing system is provided for protection under such condition. But it may not serve the purpose unless earthing system, protective relaying and switchgear are properly coordinated and are healthy. Therefore periodic testing of protective system has to be arranged. Most important is earth pit resistance that is likely to change with time and therefore periodic measurement of earthling resistance is very essential and if it is found higher, then the earth pit has to be reactivated.

Performance: Tests are done to estimate various losses, efficiency, input output relation at various loading, speed variation, voltage regulation, temperature rise, etc to interpret the behavior of the equipment under various operating conditions.

Miscellaneous: These tests include mechanical test like vibration, noise, balancing, alignment, rigidity, etc.

Direct loading for testing generates undue stresses and deteriorates object to some extent. Non destructive testing using acoustic emission/ resonance, ultrasonic, infrared, electromagnetic, radiography, magnetic particle etc. are adopted, wherever feasible.

DESIGN OF 132kV/25kV A.C. TRACTION SUBSTATION

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1.0 INTRODUCTION:

1.1 In Electric Traction distribution, a substation serves as an important link in between the power source (utility grid) and the dynamic traction load. When Electric Traction was first introduced in the country, the supply voltage of the traction was 1500V DC Since the distance was short, the DC system worked well. However, with the cross-country track electrification, DC was not found economical as we may need large number of sub-stations. The high voltage (25kV AC) system was therefore introduced. It is evident that it is economical to transmit bulk electrical power at long distances at a higher voltage but it can be economically utilized at a comparatively lower voltage. Thus using HVAC in the overhead lines and LVAC / DC in the engine was found to be the better option.

1.2 Normally, the AC Traction Substations receive power from the utility grid at 66kV, 110kV, 132kV and 220kV with two single phase arrangement.

1.3 The design and engineering aspects of a Traction Substation somewhat differ from the conventional sub-stations of the power utilities. The paper here under tries to bring out salient features of a typical 132/25kV AC Traction Sub-station and high-lights some critical issues related to high level of reliability required for public transportation system.

1.4 The electrified track normally have high traffic density as compared to non-electrified track, particularly the heavy freight and high speed passenger train traffic. The Punctuality of trains is of prime importance in Railway. The reliability of the OHE lines and TSSs play a vital role in meeting the traffic needs.

2.0 PRINCIPLES OF DESIGNING A TRACTION SUB-STATION (TSS):

2.1 Since the Railway Traction is a backbone of Transportation system and economy of this country, the sub-station design should be highly reliable. The grid substations are by and large in a ring main system. However, the traction lines and substations have a limited connectivity. In view of this, the sub-station shall be designed with the following parameters.

a) Equipment used must be electrically and mechanically robust in design and must have high reliability while in operation.
b) Protection devices used in TSS must be swift in sensing an electrical fault and isolating a faulty section from other healthy systems.
c) Wiring and laying of cables must be as simple as possible.
d) Suitable means to access equipment and to handle them must be provided.
e) Control Mechanism openings should be sealed and made vermin proof. As far as possible the entry of moisture should be avoided.
f) Spare arrangements of the Traction power supply in an event of maintenance or repair, must be made in order to ensure continuous supply of power to the Traction load.
g) Spare power generating stations must be kept on standby mode in order to meet any emergency conditions.
h) Additional space for future augmentation in the TSS must be considered by post calculating a forecasted rate of growth in traffic from the current statistics on the rate of growth.
i) Earthing conductors must be of proper ampacity in order to carry maximum short circuit currents for short duration.
j) TSS shall have a link to the Electrical control room and the traffic control room.

3.0 Direct Current Traction Sub-stations (DC TSSs)

3.1 Introduction:

The first electrified railway to run in India utilised 1500V DC supply. This system was employyed for the suburban and mainline sections namely the Mumbai VT-Pune / Igatpuri / Panvel, Diva Jn. to Vasai Jn. of the Central Railways and on the Churchgate-Virar section of the Western Railways.

In the year 1959 when 25kV AC Electric Traction was introduced in India, it was found that for mainline and suburban railways AC Traction offered far more benefits than DC Traction. Therefore, the DC TSSs have now become obsolete. But these days the 750V DC Electric Traction is employed only in Metro Railways and not in Main line and Sub-urban Railways. DC Traction Sub-stations are not discussed here in detail due to the limited scope of their application.

3.2 Functions and the major equipment used in DC TSS.

3.2.1 Functions of a DC TSS are as under:

a) The voltage level of the regional grid is at 132kV or 220kV. The overhead contact line system voltage is 1500V DC. The first and foremost function of a DC TSS is to step down the voltage from the transmission value to the utilisation value.

b) After stepping down the AC Voltage of the grid, it has to be converted from AC to DC before it is fed to the OHE.

c) DC TSSs serve the function of sectionalizing the OHE. This cuts down the length of the section affected either during a planned shut down or during emergency conditions.

3.2.2 Major Equipment in a DC Traction Sub-station are as under:

Major equipment in a DC TSS include:

a) AC Circuit Breakers on the incoming HT lines,

b) A Step down Traction Transformer,

c) Smoothening Equipment,

d) Neon Contactors,

e) DC Circuit Breakers and

f) A Negative Booster Transformer.

Following are the photographs of a DC TSS:

(Indoor Type DC Traction Substation)

(DC Traction Substation initially fully indoor type, later due to TSS capacity augmentation 132kV AC HT Lines were located externally)

4.0 CHOICE AND LOCATION OF THE TSS:

4.1 The Selection of the location of the TSS needs the following reviews.

a) The proposed TSS site must permit bringing in and taking out feeders, both incoming from the utility (66/110/132/220kV) and outgoing 25kV AC. The voltage drop is also calculated for normal and extended field conditions on the basis of given combination of train on UP and Down Tracks.

The power requirement is calculated on the basis of average energy consumption of goods and passenger train. The specific energy consumption is taken for level or lightly graded section. Goods train 11kWh/1000 Gross Tonnage Kilo Meter and 19kwh/1000

Gross Tonnage Kilo Meter (GTKM). The following formulae is used to assess the power requirement.

Power requirement =

(Q*2*Lo*W*60)/(1000*H*Cosϕ)

Where,

Q is energy consumption rate (kWh/1000GTKM)

2*Lo is Substation covering area for double track

W is weight of the train in Tones

H is headway during peak time in minutes (assumed)

Cosϕ is power factor (lagging)

Conversely using the above formulae, "Lo" can be calculated for given rating of traction transformer. We can also calculate number of TSS required for considering a pair of fixed capacity and number of transformers as well as the current carrying capacity of the overhead traction conductor.

b) Access to the TSS from a public road must be easily available and if possible a railway siding must be provided for moving HT equipment in the TSS.

c) The proposed TSS site must be at a level that is a bit above the ground and also should be free from water logging. High flood level may be examined before the selection of the site.

d) The proposed TSS site must be located close to the OHE overlap. Proposed TSS should not be located close to the Railway Station, as Short Type Neutral Sections are introduced at TSSs.

e) In case of an outdoor switchgear, it is necessary to provide a room for control equipment, protective relays, instruments and testing equipment. This room may be unmanned most of the time. The construction should be robust.

f) There must be sufficient space apart from the TSS equipment, for the provision of maintenance staff to work, in case of an emergency.

g) The TSS shall be located on the virgin soil to the extent possible and it should be avoided to locate a TSS on an embankment. However if the TSS is to be located on an embankment, protective walls shall be provided all along the periphery (from the virgin soil level) to avoid soil erosion in the TSS. The foundations of Transformer and other equipment supports/gantry columns should be made in to the virgin soil.

h) Spacing of two TSSs between the sections of electrified route was initially 50 to 80 kilometres, but due increase in the passenger and goods traffic the spacing has been reduced to 40 to 60 kilometres. The spacing between the TSS will be decided as laid down in 4.1 above

5.0 LAYOUT OF THE TSS:

5.1 The main consideration in planning the physical layout of TSS are reliability of the supply, simplicity of the equipment and connections, ease in operation & maintenance and safety to the personnel.

5.2 The equipment in the TSS comprises the following:

a) 220/132/110kV HV switchgear controlling the incoming supply.

b) Step Down Transformers.

c) Switchgear controlling the outgoing 25kV AC supply.

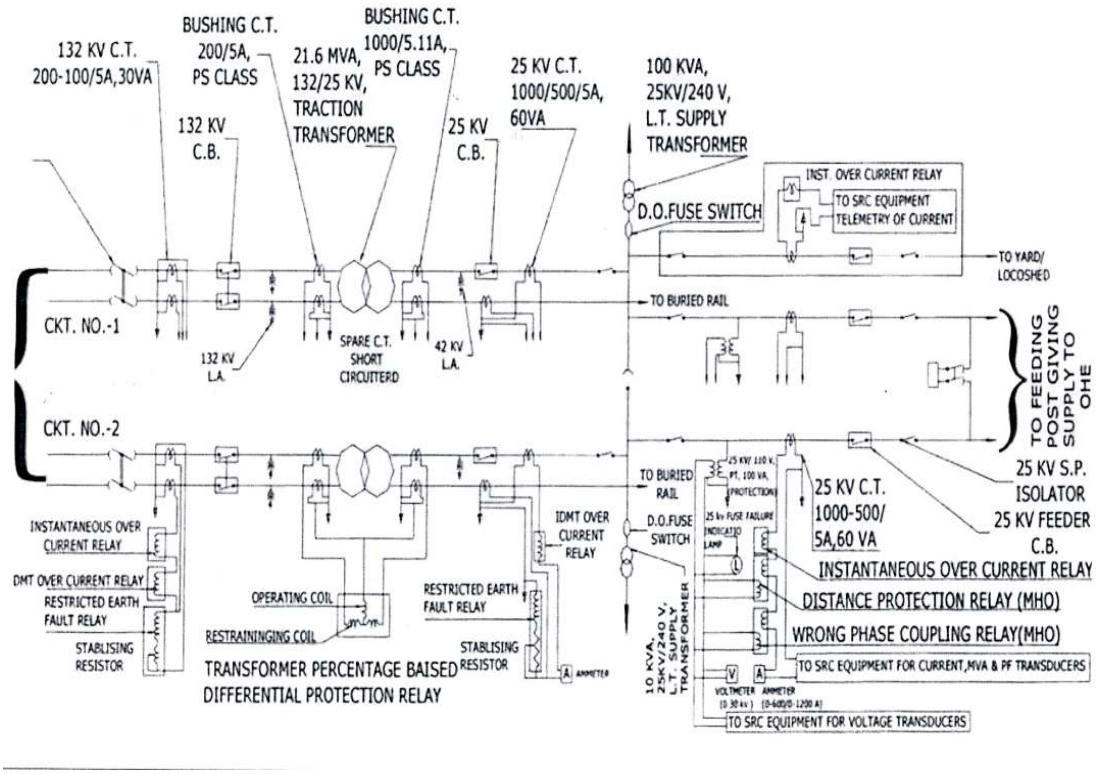
d) Auxiliary apparatus including protective systems and cables.

e) Station Transformers of 10kVA or 100kVA and 25kV/230 Volts

f) Battery and Battery Charger

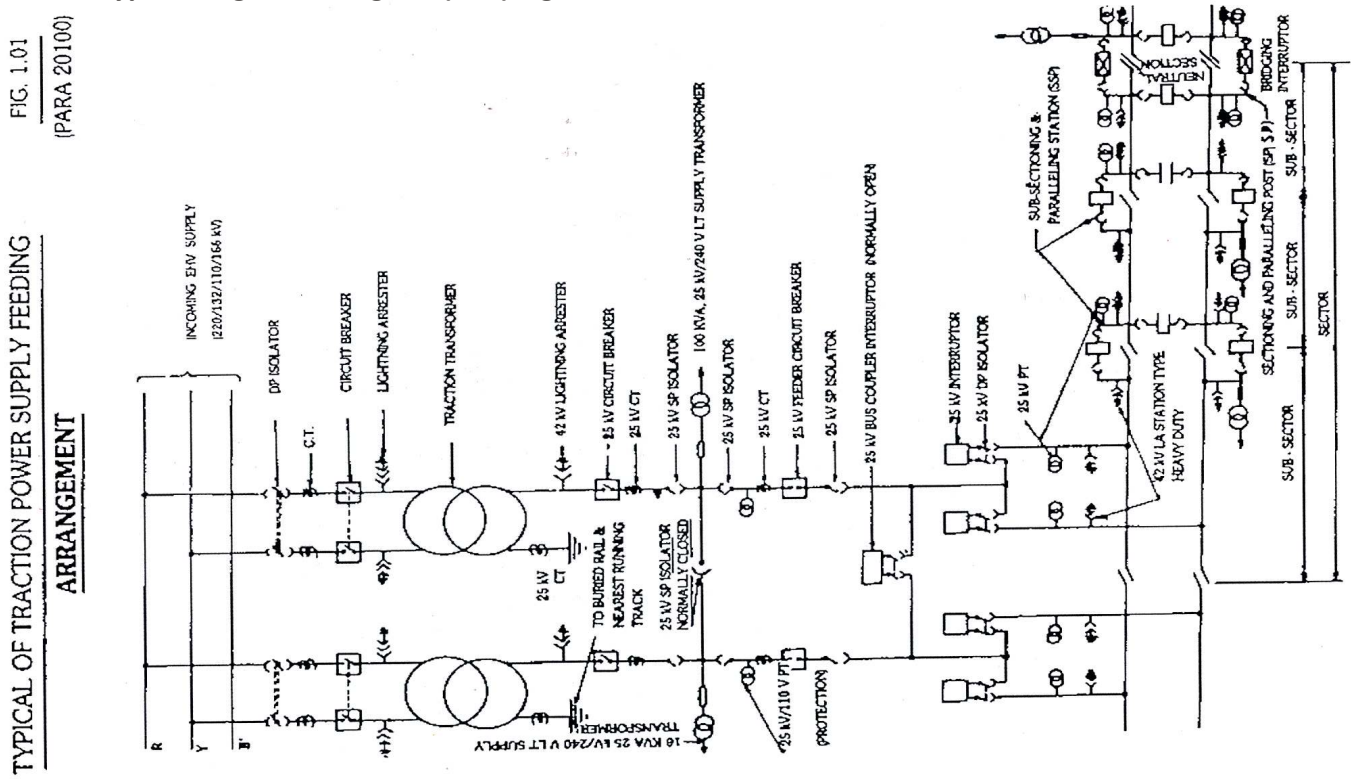
g) Stand by diesel generator for auxiliary supply

6.0 SCHEMATIC DIAGRAM FOR A TYPICAL 132/25kV AC SUBSTATION:



(Schematic Diagram of a 132/25kV AC TSS)

6.1 A Typical single line diagram (SLD) is given hereunder.



(Traction Feeding Arrangement in a 25kV AC TSS)

7.0 BRIEF EXPLAINATION OF THE TSS:

7.1 Following is the setup of the TSS

a) In TSS, a single bus bar arrangement is used where each of the two circuits is provided with its own breaker. Reliability of traction supply is of prime importance and it implies that necessity of duplicate HV feeders is required.

b) A TSS always has two transformer bays each with HV isolators, HV circuit breakers, single phase step down transformers from HV to 25kV and associated 25kV switchgear.

c) In a TSS, at a time only one transformer meets the Traction Load while the other is always kept in standby mode (with H.V. side charged and L.V. side open circuited). The primary windings of the power transformer are connected across the two phases of a three phase system. One secondary terminal of the transformer on the 25kV side is solidly earthed and the other terminal is connected to the catenary through 25kV feeders.

d) The HV isolators are of rotating centre pillar type and the two switches in both the phases are operated simultaneously. The HV breakers consists of two single phase units interconnected mechanically and operated simultaneously. Each of the two transformers and its associated breakers are considered as one unit and the protective system has been designed accordingly.

e) If any of the equipment in one unit is taken out for maintenance, the unit has to be shutdown keeping the other unit in service by opening the double pole isolator located before the HV circuit breaker and after the 25kV breaker. The feeder circuit breaker is provided with a double pole isolator as per earlier practice or with one single pole isolator on either side, so as to permit its cleaning and maintenance to be carried out, without having to shut down the transformer of that bay.

f) A Bus coupler interrupter is also provided so that if either of the two outgoing 25kV feeders develop a fault and requires to be isolated, then it can be done by opening associated isolators. To permit conti-nuance of supply, the bus coupler interrupter may be closed by remote control, with necessary interlocking arrangements so that their operation during loaded condition is avoided. HV double pole isolators are mechanically inter-locked with associated HV circuit breakers, similarly 25kV single pole isolators after the transformer breakers, are interlocked with respective 25kV transformer breakers.

g) The layout of the substation is made keeping into consideration the augmentation of capacity of existing transformer or addition an additional transformer bay. Transformers are always installed on concrete plinths at ground level, while other equipment are always installed on steel structures maintaining adequate clearance above ground. The space required for individual equipment maintenance must be taken into consideration while making a layout drawing and foundation footprint.

h) The substation building shall be designed to provide enough space for control room, battery room and a tool room

(Overall View of an outdoor type 132/25kV AC TSS)

7.2 Bus-bar Layout:

7.2.1 The standardized bay width for a 132kV is 14.0M and 6.0M for 25kV bay. The strung bus on HV side is at a height of 9.35M from ground

level which comprise of 54/3.18mm (28.62mm diameter) ACSR Zebra conductor with a gross area of aluminium of 428mm2. On the 25kV side, 50mm outside diameter aluminium tubular bus bar is provided at a height of 3.8M. Tension on the strung bus is specified as 450kgf and the earth screen wires at 200kgf at 40^{0}C without wind. The maximum span from the last tower to the sub-station gantry is generally limited to 75M. Normally if the distance of the incoming HV line from the grid sub-station is more than 4kM, lightning arresters are provided on the incoming lines at TSSs. However it is better to provide LA on the incoming EHV line gantry of the TSS.

7.2.2 The Maximum current density in copper bus-bar and connections in direct contact with air should be such that maximum permissible temperature of 70^{0}C is not exceeded (maximum hot spot temperature not exceeding 75^{0}C). The current density generally adopted for outdoor copper bus-bar is 2A/mm2. For Aluminium bus-bars current density is considered as 75% that of copper. The maximum permissible current density under short circuit conditions should not normally exceed 100 times the permissible density.

The insulators, bus-bars and connections should not be stressed to more than ¼ of the breaking load or 1/3 of their elastic limit, whichever is lower.

7.3 Clearances: During installation of TSS, the minimum clearances in the air (in mm) shall be as per table 1 below :

	25kV	132kV	220kV
Between Phases	NA	3000	4000
Between One Phase and Earth for rigid conduction	500	1300	2100
Between any point where man may be required to stand nearest			
a) Unsecured conductor in air	3000	4000	5000
b) Secured conductor in air	2000	4000	5000
c) Minimum height of the bus bar	3800	4600	5500

7.4 Characteristics of Traction Transformers:

7.4.1 To cater the peaks in the demand, the transformers shall be capable of withstanding non-recurring over loads of 50% for 15minutes and 100% for 5minutes after the transformer has reached a steady temperature on continuous operation at full load. Bushings with built in current transformers are provided on the primary / secondary sides. The maximum efficiency of a Traction Transformer is specified at about 50% of full load.

7.4.2 To reduce short circuit currents higher percentage impedances i.e. 12 ±5% is specified. Off load tap changing from +10% to -15% in steps of 5% is provided on low voltage sides. The temperature rise over an ambient temperature of 50^{0}C for 100% over load for 5 minutes or 50% overload for 15 minutes (after continuous full load operation), is specified not to exceed 50^{0}C for winding (resistance measurement) and 40^{0}C for oil by thermometer.

7.4.3 In Traction applications as many as 200 short circuit/earth faults with fault currents varying in between 40% to 100% of the dead short circuit value, can occur in a month. This generates stresses on transformer windings accompanied by a temperature rise. Therefore in Traction Transformer specifications, it is always indicated that transformers shall be subjected to frequent short circuits during normal operation.

7.5 Characteristics of switchgear and other equipment:

7.5.1 The choice of switchgear is governed by the maximum short circuit MVA which is called upon to deal with and also in some degree upon its relation to the system of which it forms a part. The exact value of rupturing capacity of the switchgear is rather difficult to estimate because of the complicated nature of the systems. Magnitude of possible fault currents depends on many factors which may vary from hour to hour on a large interconnected system. The extreme conditions are given here under:

a) Severe Short Circuit at times of heavy load and lagging power factor and,

b) A Mild Short Circuit at times of a Light load and leading power factor.

7.6 Insulation Levels for the equipment and the insulation co-ordination:

7.6.1 The insulation level of any apparatus used in TSSs is characterized by the two test voltages which the apparatus can withstand i.e. the crest value of the impulse voltage and the RMS value of one minute, power frequency withstand voltage. These withstand voltages characterize the strength of the apparatus as to their capability of withstanding dielectric stresses.

7.6.2 Insulation Co-ordination consists of the steps taken to prevent damage to the electrical equipment due to over voltages and to localize flashovers when they cannot be economically prevented to points where they will cause least damage. This is achieved by the necessary co-relation between the insulation strength of the electrical apparatus and the characteristics of the protective devices such as non-linear lightning arresters against over voltages, which may be of atmospheric origin or generated within the system itself. Thus insulation co-ordination involves the design of not only of the individual equipment but of the complete system.

7.6.3 The equipment three phase voltage for the 25kV single phase system would be 44kV and the corresponding system highest voltage will be 10% more i.e. 48kV. This corresponds to the IEC standard system highest voltage of 52kV. The basic insulation level for this system highest voltage is 250kV impulse withstand and 95kV power frequency withstand.

7.6.4 As the flashover voltage of bushings should not be higher than the flashover voltage of the windings (to prevent internal damages to the windings due to surges), bushings are fitted with arcing horns.

7.6.5 The amplitude of incoming surges are kept as low as possible by protecting the incoming lines with arresters and gaps or by adequately screening the incoming feeders by earth wires.

7.6.6 The insulation levels as specified in IEC are determined with a view to obtaining co-relation with protection level of the over voltage protective devices. A protective device is characterized by its impulse protection level which appears across its terminals. The major difference in rating of the lightning arresters and other equipment is on account of the fact that for arresters, the voltage across individual arresters is of prime importance rather than phase to phase voltage. The rated voltage of the lightning arrester is taken as 80% of the system highest voltage for effectively earthed systems or the system highest voltage itself for non-effectively earthed system.

8.0 PROTECTION SCHEMES EMPLOYED IN TRACTION SUB-STATIONS (TSS):

8.1 The different types of protection relays used in TSS are differential relay, restricted earth fault relay on the primary or secondary side, Buchholz relay, winding temperature tripping relay, oil temperature relay.

8.2 In addition to these relays, there are three special types of protective relays used in TSSs, viz the Mho Relay, Instantaneous Over Current Protection, Wrong Phase Coupling Relay, High Speed Inter Tripping Relay and Pantograph Flashover Protection Relay. These are briefly discussed below:

a) MHO Relay:

A Mho Relay works on for a normal impedance of 25kV AC OHE and a phase angle during normal operation in between 30 to 40 degrees for the protection against earth faults when the fault impedance angle goes to 75 degrees. This relay works on the principle of discrimination between the phase angle of the fault impedance and the normal working impedance of the Traction Power System. This relay is mainly used for protection against distant earth faults.

b) Instantaneous Over Current Protection Relay:

This relay provides primary protection to the OHE on earth faults in the vicinity of the feeding posts, this relay is provided only on the 25kV AC side. The current setting of the relay may correspond to about 200% of the continuous current rating of the traction transformer.

c) Wrong Phase Coupling Relay:

This relay is also a "Mho" Type relay which has a maximum torque angle of 75 degrees which is not adequate for protection against wrong phase coupling of the two different phases at the neutral section or at the feeding post during extended feed condition. Therefore, an additional Mho Relay is provided with a maximum torque set at 125 degrees.

d) High Speed Inter Tripping Relay:

In an event of the failure of the TSS, supply temporarily can be obtained from adjacent substations by closing the bridging interrupters at sectioning post. Under such an emergency condition, wrong phase coupling may be caused at the overlap opposite the failed TSS by the pantograph's current collector pan carbon strips on the locomotive resulting into the tripping of 25kV CB at any of the two TSS through wrong phase coupling relay (Mho). This may result into the formation of an arc at the overlap due to which OHE may be severely damaged. To avoid the tripping of the feeder circuit at the other TSS, an inter-tripping relay is used.

e) Pantograph Flashover Protection Relay:

Pantograph Flashover relay is provided for the protection of OHE from flash over at the insulated overlap in front of the Traction Sub-station (TSS), when a Pantograph passes from a live OHE to a dead OHE across the overlap. This relay opens the closed feeder circuit breaker to prevent the melting down of the OHE. One relay is provided for the monitoring of one line only.

9.0 AUXILIARY POWER SUPPLIES AT TRACTION SUB-STATIONS AND SWITCHING STATIONS:

9.1 During the installation of traction substation an auxiliary power supply is required for following purposes:

a) To charge the substation batteries which provide supply to the control the various switchgear control panels, oil testing equipment etc.

b) To provide substation general switchyard lighting, operation of hand tools, welding etc.

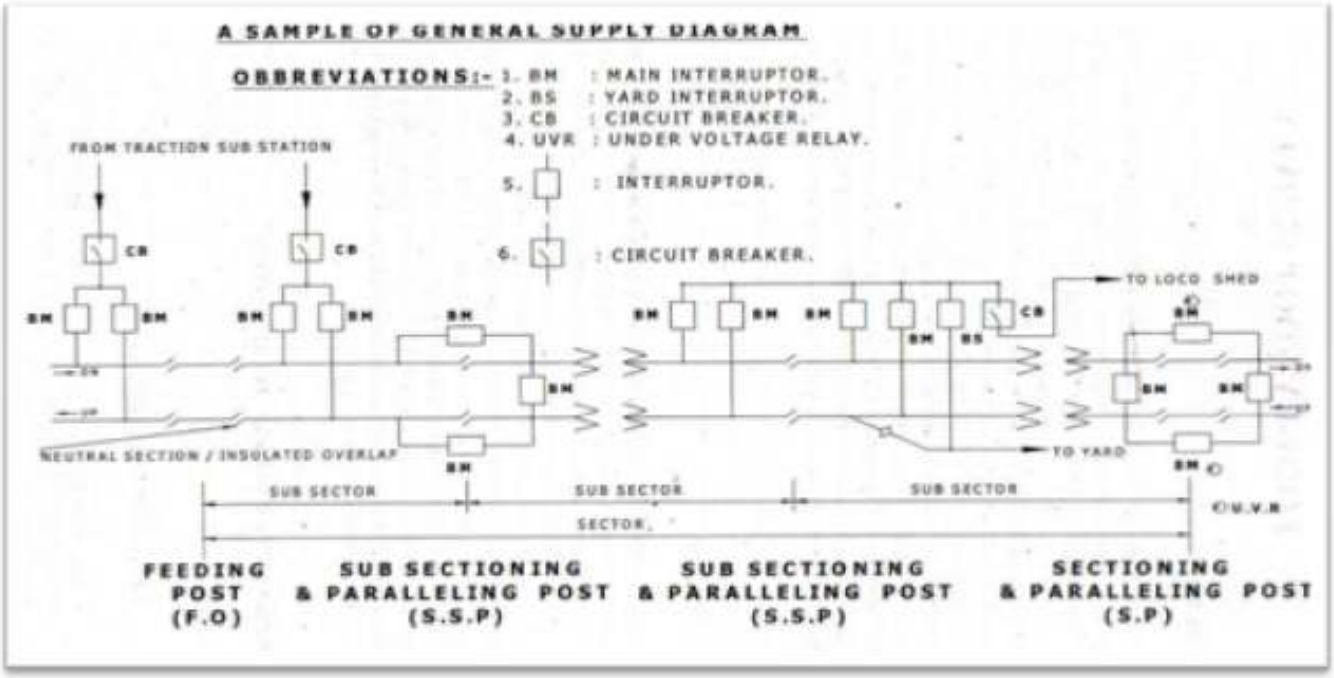
c) To provide power to the oil filtration plant.

Normally 100kVA Auxiliary transformers are installed in sub-stations and 10kVA rating auxiliary transformers are installed at Railway Stations.

9.2 The location of the Traction Sub-station or Feeding Post (FP) are normally as follows:

a) 25kV with booster transformer and return conductors (40 to 50 kilometres)

b) 25kV without booster transformer (80 to 100 kilometres)



(Diagram of 25kV AC FP, SP and SSP)

9.3 Sectioning Post (SP):

9.3.1 The conventional Neutral Section at the sectioning and paralleling post is 5.5m Long, the Electric Locomotives coast dead through this section. The site of the location of the Neutral Section with proper care so that an Electric Locomotive can negotiate this distance without coming to a halt under it, accordingly Neutral Section should be located on a straight track and at a sufficient distance from the stop signal. The main function of the SP is, if the 25kV AC supply is interrupted from one feeding post, emergency 25kV AC supply can be taken from neighbouring TSS.

9.4 Sub-sectioning and Paralleling Post (SSP):

9.4.1 In between a feeding post and a sectioning post, a number of intermediate sub-sectioning and paralleling posts are inserted in the OHE to provide remote controlled switches for facilitating and repairing faulty sections. If a fault occurs, isolating the faulty section without isolating the healthy line becomes necessary. Thereby allowing Electric Locomotives to utilize power and run under a healthy 25kV AC line till the fault on the faulty 25kV AC section gets cleared.

10.0 CONCLUSION

10.1 A Traction Substation has different features as compared to the grid substation, for the reason that sources of power are limited.

10.2 The Traction Transformers and other equipment in the TSS have different specifications and operating conditions as compared to the grid substations.

10.3 The punctuality and the smooth running of the Electrified Railway stock depends much on the reliability of the TSSs.

List of New Members during Quarter

Sr. No.	G.R. No.	Name	Member	Sr. No.	G.R. No.	Name	Member
1	2195	Pandit Mrunal S	Member	4	2198	Dhruv Jimit S	Member
2	2196	Bhanderi Siddharth K	Member	5	2199	Rathod Chirag D	Member
3	2197	Patel Chandrakant D	Life Member	6	2200	Yadav Kailash C	Life Member

Random Thoughts

- N. Dinker

In the last issue of 'SPE NEWS LETTER', under the caption 'Random thoughts', a write up was presented, the treatment of which was not in a conventional way but in a somewhat different perspective. The topic, to recall, was Energy Conservation- 'within' (internal)

Energy is an all comprehensive term encompassing various forms; an attempt was made in the article to draw a distinction between 'external' and 'internal' energy, as the latter being rarely discussed in any seminars or forums.

Now, moving further from a 'general' term to a specific term, an attempt is made to focus and identify 'physical light' (external) to 'spiritual light' (internal) to us.

This article may be apt and appropriate at this point of time, as the year 2015 is designated by the United Nations as the year of light and light Technologies. Light is precious, it helps to dispel darkness. In the physical (external) domain, a lot of contribution is made by scientists for our understanding of light. Beyond this, Research on light has facilitated the correction of human vision; it has given technology like optoelectronics, fiber optics, lasers and light emitting diodes. Lasers have made medical surgery easy, painless and affordable.

Now, let us go beyond 'physical light (external) to 'internal light' which is the main intention of this write up. While the external light dispels darkness, the internal light removes ignorance. One who experiences this, becomes enlightened. It is in the domain of knowledge and self-realization. This light shows new paths, transforms human kind and Society and has an everlasting effect on the mind and soul of a person.

Physical (external) and spiritual (internal) light, both are essential for leading a full-fledged and balanced life - and let us all strive for it.

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To kindle 'a thought' for analysis of our readers, an anecdote is narrated below.

One bright evening, a lion with his family i.e. a lioness and their two cubs, went on a stroll from their din in the dense forest. The cubs were very excited to move about in the company of their parents, dancing and frolicking. After some time darkness fell and in the meanwhile all their joys were shattered due to a mishap, both the cubs fell in a deep pit camouflaged by cunning poachers. The cubs started crying loudly as they could not come out of the deep pit. The lioness, their mother, also became emotionally wrecked as she could not do anything to rescue them other than advising the cubs not to cry and to remain calm.

One cub died in the pit due to unknown reasons. The second cub, however, struggled and struggled and with a quick and great effort jumped out of the pit. It went straight to the mother and started crying loudly, hugging her and uttered - ***Thank you Mom, for your advice***

The mother was simply astonished by the cub's thanks giving words because the cub was a born deaf.

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Analysis

The anecdote is based on a real event or a structured one, is not known. Regardless of this, the important points that strike are when and if we compare an analogous situation with human beings.

1. The modern man, including his working wife, find little time to be in the company of their children and when the children get an opportunity, they feel they are in the seventh heaven. There is, therefore, some scope for improvement on the part of parents.
2. Generally, the children are in the fore front and they face the disasters. Though they suffer physically many a time, the parents, particularly mother suffers more mentally.
3. Children (particularly young only) have great faith in their parents and believe & obey their advice in toto without any thought. This is debatable point as to what is the correct course. In the anecdote the cub that followed the advice of the mother died - the exact reasons for this is not known to us - as to whether it was having any precarious deficiencies, and if so, ruling out the advice of mother as the cause.
4. Physical disabilities (in this case deafness). Human beings, with physical disabilities may not worry or bother over but must try to adjust. At times, it may turn out to be a blessing in disguise

Our readers may give a thought to this anecdote and draw their inferences and if possible, any conclusion as I feel, it is a thought provoking one.

Chapter's Activity

- On 20 Feb 2015 a presentation on Industrial Safety-Arc Flash Hazard & Its Mitigation was arranged at GETRI Auditorium. The speaker was Shri Hemant Vasavada, Ex. IPCL and Technical trainer. He deleberated on Arc Flash and Analysis of it, Safety Rules & Guide Line of Work Place & Employee. He presented video clippings of Remote Racking of Panels, Arc Flash Flame Retardant Clothe etc.

  The presentation was well appreciated by all the members present in the Auditorium.

- On 20 Mar 2015 the Chapter organized a talk on the topic of Union Budget-2015 Analysis. The learned speaker was Shri Niraj Majmundar, renowned Chartered Accountant of Vadodara. In his speech, he covered the topics of Taxation and Budget allocations for agriculture, Infrastructure development, Education, Defence, Welfare schemes, Renewable Energy and Tourism. He informed that GoI is about to develop consensus among the states for the introduction of GST. He expected GST to be around 16%. Once introduced, GST will remove anomaly in taxation at state level and discourage cross-state sales of goods services. He termed the Budget as a bold and progress oriented. The lecture was well received by the audience.

Request for Donation

The Vadodara Chapter is leading chapter of SPE(I). In addition to the swelling membership, consistency of activities makes the chapter unique. With rising cost of commodities and other items, the Chapter needs funds all the time. An appeal is, therefore, made to all the readers to generously give donations to the Vadodara Chapter of SPE(I). All the donations will be properly receipted duly acknowledged in the SPE NEWS LETTER.

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