Innovative solutions for efficient power transmission systems

HTLS conductor technology

The Indian government has set very high targets for the power sector in the 12th five year plan, besides trying to achieve the target set for the 11th five year plan. Consequently, the transmission network will have to match the installed power generation capacity. But while there has been an increase in demand for Electrical Power Generation & Transmission, there exist a few hindrances, which include:

- High cost to install new Power lines
- Difficulty in acquiring Tower sites – Right of way (ROW)
- Time involved in constructing new Power lines
- Provision for future contingencies

Besides, for optimizing power transfer per unit ROW, the Ampacity of conductors used in the transmission lines has to be raised by technological development. This calls for new generation conductors, which can deliver large quantum of power without any change in the existing tower/foundation designs or minor modifications therein. The solution, therefore, lies in the usage of High Temperature Low Sag Conductor (HTLS) / High Ampacity Conductor.

How does the technology work?
The use of High Temperature and Low Sag (HTLS) Conductors is an attractive method of increasing transmission line thermal rating. The conventional ACSR Conductors are an effective method of withstanding a continuous temperature of 75 deg C to 85 deg C. In case of emergency, for a short duration the conductors can work up to 105 deg C without any sign of deformation. In order to increase the thermal rating of existing lines, one method involves replacing ACSR conductors with special “high-temperature low-sag” (HTLS) conductors having approximately the same diameter as the original ACSR but being capable of operation at temperatures as high as 250 deg C, with less thermal elongation than ACSR. Ideally, these special HTLS conductors can be installed and operated without the need for extensive modification of the existing structures and foundations.

As with ACSR, HTLS conductors typically consist of aluminum wires helically stranded over a reinforcing core. Most of the electrical current flows in the high conductivity, low-density aluminum strand layers. Most of the tension load is in the reinforcing core at high temperature and under high loads. The comparative performance of the HTLS conductors depends on the degree to which the aluminum strand and reinforcing core's physical properties are stable at high temperature and on the elastic, plastic and thermal elongation of the combined HTLS conductor with this HTLS conductors.

Re-conductoring Solutions
The idea of re-conductoring with HTLS conductor is to transfer a large block of power with same right of way (ROW). There is also a need to augment the capacity of the existing transmission lines. Installation of new power lines is very costly and time consuming. It is also difficult to acquire right of way and there is resistance against construction of overhead EHV lines in urban and suburban areas. The best solution, therefore, is Re-conductoring of existing lines with HTLS conductor. The re-conductoring can be achieved by designing a special conductor that has mechanical properties identical to the existing conductor but delivers high ampacity at high temperature. To be precise, the new generation conductors should have the values of maximum sag at maximum temperature, maximum tension at minimum temperature and 36% wind and maximum tension at every day temperature and 100% wind, almost comparable to the values of existing conductors. This will ensure the safety of towers and the foundations of the existing line.

It may be important to note that use of high temperature conductors including HTLS would allow greater current and greater power flow but voltage regulation may suffer if the length of the line is more than 100 km. However, there are ways and means to maintain the voltage level at sending end as well as at receiving end. This can be achieved by providing suitable voltage settings on the power transformers. The majority of the lines of the utilities are more or less in the range of 100 km and therefore the voltage regulation will not matter much even if HTLS conductors are used.

Aspects of Line Material
If the conductor is operated at high temperature, the ampacity will definitely increase. However, the utilities and other power developers would come out with an apprehension regarding the change in line material to be used to carry the conductor on tower.

The insulators & insulator hardware as well as conductor accessories are the most important components of the transmission line. It has to be ensured that they do not deform at the high temperature at which the new generation conductor has to operate. It may be indicated that the hardware fittings and conductor accessories that are suitable to ACSR family of conductors, can be safely used up to the continuous temperature of 150 degC without any deformation, with slight modifications. This is subject to the condition that the physical dimensions of the ACSR conductor and the new generation conductor are almost identical.

It will be a worthwhile exercise to carry out type tests on such conductors along with the hardware and conductor accessories. This will ensure the suitability of hardware available in the market for deploying them on the new generation conductor. If the conductor is to be operated at temperatures beyond 150 degC, temperature rise test on clamp connectors may be a better option. It may be very important to know that the surface temperature of the clamp connector is never equal to the surface temperature of the conductor.
This is because of the simple reason that the amount of current handled by the clamps/connectors per unit cross section is much less compared to the conductor. Besides, due to bigger surface area, the heat gained by the clamp connectors through conduction is much less compared to the heat dissipated by the clamps/connectors in the air.

If mechanical strength is a criterion, the material used in the manufacture of the conductor can also be used in the clamp connector. As far as ferrous hardware components are concerned, no change is necessary in them unless mechanical strength requires reconsideration. If the configuration of line insulators is changed, there will be a corresponding change in hardware. For example, use of long rod insulators, polymeric insulators etc.

Different Solutions with HTLS

HTLS offers several solutions for the fast growing power sector that needs greater power transfer capability per unit cost of ROW. Some of these include:

• Upgrade of Old Lines

**STACIR Conductor** One of the 132 kV lines of APTRANSCO is strung with ACSR Wolf Conductor having maximum current rating of 362 Amp. Since the line is getting overloaded, change of conductor by higher size is required. This will require strengthening of tower and foundation. The high temperature conductor INVAR STACIR 30/7/2.59 is having almost the same mechanical properties of ACSR Wolf conductor but can carry 845 Amp. at 2100C. Here, the sag of this conductor is also less than that of the sag of existing ACSR Wolf conductor. Hence, existing tower and foundation need not be changed. By use of such conductor utilities like APTRANSCO can re-conductor the line and increase the ampacity and power transfer capability.

**ACSS Conductor** In one of the substations of MSETCL in Mumbai, the ACSR Twin Moose Bus conductor is strung. The maximum current carrying capacity of the Bus is 1500 Amp. R. Infra has planned expansion of their network and would like to draw additional power from the Bus of MSETCL. The capacity of Bus will have to be increased at least up to 3000 amp. This means that existing ACSR Twin Moose conductor will have to be replaced by Quad ACSR Moose Conductor. MSETCL may not allow this, as they may have to change the gantry structures.

It is therefore proposed that Twin ACSS Curlew Conductor could replace Twin ACSR Moose conductor. The sag tension calculations along with the temperature rise calculations suggest that Twin ACSS Curlew conductor can deliver 3000 Amp plus current at about 1600C. Since, the mechanical parameters of ACSR Moose Conductor & ACSS Curlew conductor are very much comparable, replacement will be very easy. The job can be accomplished with a minimum down time.

**New Line Solutions**

Today, the emphasis is on transfer of large blocks of power with a minimum unit ROW. Even though there is reluctance on the part of utility to change their tower designs and foundation designs, the new entrants in the power sector in general and the transmission sector in particular are like to utilize high temperature conductor for maximizing the power transfer capability. It may be interesting to know that with small change in the existing tower designs, like raising the height by 1 M to 2 M or providing extensions etc, high temperature conductors can easily be deployed without infringing the statutory clearance requirement. Even if new towers are designed and prototype tests are conducted on them, the amount spent on design & testing will be offset by the cost of additional power transferred on the line. The gestation period will be very small. Besides, such tested tower designs can be reused or can be traded.

**Conclusion**

HTLS Conductor Technology is dedicated to the demanding task to solve the growing structural and capacity problems of electricity networks. Sterlite Technologies has been in the forefront of developing and offering this technology to its customers, as a result of which they are able to increase the capacity of their transmission and distribution networks without the need to modify the structure and/or foundation of existing towers.

Today, Sterlite is a significant contributor to the global power sector through indigenous manufacture of a complete range of power transmission conductors at extra high voltages (400kV to 800kV), high voltages (66kV to 220kV) and power distribution conductors (11kV- 33kV). As an industry leader, Sterlite is committed to research and product development. Sterlite actively explores the latest technologies to develop conductors that have an ability to increase the current carrying capacity of existing lines and to significantly improve the overall economics on new lines.