NEED FOR HIGH PERFORMANCE CONDUCTOR (HPC) / HIGH TEMPERATURE LOW SAG (HTLS) IN POWER TRANSMISSION & DISTRIBUTION SYSTEM

S. K. Ray Mohapatra
Director
Central Electricity Authority
OUTLINE OF PRESENTATION

1. INTRODUCTION

2. VARIOUS OPTIONS AVAILABLE FOR TRANSMISSION OF POWER AND CONSTRAINT

3. TYPE OF OVER HEAD CONDUCTORS IN USE AND NEW GENERATION CONDUCTOR USING EMERGING TECHNOLOGY

4. BENEFIT OF NEW GENERATION CONDUCTOR AND ITS APPLICATION

5. CONCLUSION
1. INTRODUCTION

• The Indian Power system has reached a unique stage of development
• Various reform measures are being taken up by Govt. of India for improvement in the Power Sector.
• Installed capacity: more than 250MW with distributed energy resources and loads.
• Energy requirement met: 2800 - 3000MU per day
• Per capita consumption: 917 units (<2.5 unit per day)
• T&D loss: about 25%
1. INTRODUCTION

• Effective IC: 125-130GW [due to forced shut down / planned shut down / idling of machine due to shortage of fuel (gas / coal) / water]
• Private players have bigger role to play in development of Power Sector.
• Shortage in Energy Requirement
• Shortage in Peak power demand
• Stranded generation due to transmission constraint or due to shortage of fuel / water
• Restriction in Open Access, due to congestion in transmission corridor. Enhancement in ATC in existing corridor can help in meeting additional requirement due to Open access.
1. INTRODUCTION

• Has highest No. of 765 kV substations in the world (about 27 Nos. in operation and likely to go upto 65 by end of 12th Plan)
• 1200kV test station at Bina in MP a landmark achievement for Indian Power system
• Bulk power evacuation from remote generating stations in NER / Chhatishgarh / Odisha has become reality for which high capacity corridor with 400kV D/c line with Quad conductor or 765kV D/C line or +/- 500 kV HVDC or +/- 800kV UHVDC or 1200kV UHVAC is being planned
1. INTRODUCTION

- Started with isolated operation at state level, then regional operation, then interregional operation and ultimately one grid
- Formation of National Grid after synchronisation of Southern Regional grid with NEW grid on December 31, 2013, making one grid one nation
- India has become one of the largest single grids in the world with more than about 250 GW of Installed generation capacity with distributed energy resources and loads and interregional flow of about 40,050MW (July 2014) [likely to touch 73,850MW at the end of 12th Plan and 126,650 at the end of 13th Plan, 98GW by 2034] more than 30,000 ckt kms of transmission network of 220kV and above voltage level.
1. INTRODUCTION

• Have / going to have inter connection with neighbouring countries like Nepal, Bhutan, Pakistan, Srilanka, and Bangladesh for transfer of Power of about 4500MW [500MW to Nepal, 2000MW to Bangladesh, 1000MW to Pakistan and 1000MW to Srilanka].

• In a deregulated environment, with formation of National Grid and development of international ties/grid leading to formation of SAARC grid, which is going to be a reality, the Indian power system is becoming more and more complex and is a challenge for system operator for safe and secure operation of Grid.
1. INTRODUCTION

• The Power grid has to meet two requirements: system operation requirement and market operation requirement.

• Operating frequency band has been tightened to 49.9 to 50.05 (against 49.7 to 50.2)

• Large scale integration of Renewable Energy
1. INTRODUCTION

- Transmission system is the back bone of power system. A healthy transmission distribution network can only provide reliable power supply.
- Generation capacity addition planned for 12\textsuperscript{th} and 13\textsuperscript{th} Plan period: 78GW and 100 GW and IC expected by 2022: 469GW
- Accordingly transmission and distribution network expansion has been planed
- [about 365,000ckm(220kV and above) by 12\textsuperscript{th} Plan
  - \textgreater{}120,000 Ckm by 11\textsuperscript{th} plan (400kV and above)
  - \textgreater{}150,000 Ckm by 12\textsuperscript{th} plan (400kV and above)
  - \textgreater{}250,000 Ckm by 13\textsuperscript{th} plan (400kV and above)]
2. VARIOUS OPTIONS AVAILABLE FOR TRANSMISSION OF POWER AND CONSTRAINT

Mode of Transmission

• Over Head mode
• Under ground cable
• Gas Insulated Transmission Line(GITL) [min RoW, prone to gas leakage, limitation in length]
• High Temperature Super Conducting(HTS) cable [low voltage, high current bulk power transmission at no loss, min. RoW requirement, application limited to short run like highway / railway crossing / last mile connectivity to load centers]

High cost and reactive compensation requirement limits the application of GITL/Cable/Superconducting cable
2. VARIOUS OPTIONS AVAILABLE FOR TRANSMISSION OF POWER
2. VARIOUS OPTIONS AVAILABLE FOR TRANSMISSION OF POWER
Technology Option – an alternative to OH Trans. Line / Under Ground Cable (Gas Insulated Transmission Lines)
GITL Above Ground installation on steel structure over passing streets
Technology Option
Only alternative left is transmission of power on over head lines: either HVDC or UHVAC

Constraint in Over Head Transmission

RoW, environmental issue, forest clearance issue has become a serious challenge for transmission licensees for construction of O/H lines.

The enhancement in power transmission capacity in existing corridor, reduction in losses and optimization of Right of Way (RoW) etc. of electric network is the need of hour.
2. VARIOUS OPTIONS AVAILABLE FOR TRANSMISSION OF POWER AND CONSTRAINT

Effective and efficient way of transmission:

1. Optimum use of existing corridors (by uprating / upgrading)
   - Application of Series compensating devices to increase power transfer capability.
   - Up-gradation of the existing AC transmission lines to higher voltage using same RoW
   - Re-conductoring of the existing AC transmission line with higher ampacity conductors.
2. VARIOUS OPTIONS AVAILABLE FOR TRANSMISSION OF POWER & CONSTRAINT

2. Planning and design of new corridors for bulk power transmission system with high MW power transfer per meter ROW:

- High Capacity (Quad/Triple bundle) 400 kV Transmission Lines,
- +/- 500 kV HVDC
- Multi-circuit 400 kV
- 765 kV Double Circuit line
- Multi circuit multi voltage lines
- +/- 800 kV UHVDC & 1200 kV UHVAC systems

3. Reduction in Loss
4. Reduction in LCC
220kV S/C Chukha - Birpara line Upgraded with 400/220kV Multi circuit line in Jaldapara Sanctuary without felling of single tree
3. TYPES OF OVER HEAD CONDUCTORS IN USE & NEW GENERATION HPC

Conductor Plays an important role in transmission system

- Quantum of Power Flow
- Reduction in loss
- Design of transmission line towers

The conductor constitute about 30-40% of line cost
3. TYPES OF OVER HEAD CONDUCTORS IN USE & NEW GENERATION HPC

• Another 30-40% of line cost depend on conductor (i.e. cost of towers, foundation etc.) which depends on (a) wind load, (b) tension load, (c) height of tower (max. sag depends on conductor) (d) conductor configuration (e) line loadability depend on conductor size, environmental condition and maximum permissible operating temperature of the conductor.
3. TYPES OF OVER HEAD CONDUCTORS IN USE & NEW GENERATION HPC

• Current carrying capacity of conductor depends on (a) Conductor Diameter (b) resistance (c) surface condition (d) ambient / environmental condition (ambient temperature, wind speed, solar radiation) (e) maximum permissible conductor temperature. [Basic of current carrying capacity: Heat generated due to current (I*I*R) and solar radiation = Heat dissipated by way of convection and radiation]

• ACSR (75 degC) and AAAC (85 degC) are being commonly used conductors for transmission of Power on over head lines for transmission and distribution system.
3. TYPES OF OVER HEAD CONDUCTORS IN USE & NEW GENERATION HPC

- New technologies are emerging and there is need to adopt them rationally to suit India’s Transmission and Distribution Sector.
- New generation HTLS Conductor / HPC is one of the emerging technologies that could help electric power delivery system for efficient transmission & distribution of energy.
- HPC can reduce losses at the same time enhance power flow under normal as well as under emergency condition.
- (Operating temp > 100 can go up to 150-200 deg C) under normal condition and >150 can go up to 250-300 deg. C under emergency condition (400 hrs in a day / 10 hrs per year over 40 years of life)
4. BENEFIT OF NEW GENERATION CONDUCTOR AND ITS APPLICATION

(a) Enhancement in transmission capacity in existing corridor [series compensation can increase the transmission capacity by about 20-30% ONLY unlike HPC, which can increase capacity by 100%] maintaining same Ground Clearance

(b) Reduction in tower loading (replacing Quad conductor by twin conductor configuration)

(c) Reduction in tower height due to low sag
(d) Reduction in transmission losses unlike conventional conductors due to low resistance

Upgradation of existing system by replacement of old conductors in substations / generating stations to meet enhancement in load / addition of Generating Units without replacement of existing structure.
5. CONCLUSION

SOME OF THE QUESTIONS LIKELY TO BE RAISED / APPREHENSION OF USERS:

- Cost of new technology driven conductors
- Effect of High Temperature conductors on (a) Insulators (composite / porcelain / glass insulators) (b) on clamps / conductor hardware fittings
- Manufacturing capability in India
- Indigenous availability of suitable hardware fittings for HPC conductor
- Handling and stringing of conductors
5. CONCLUSION

SOME OF THE QUESTIONS LIKELY TO BE RAISED / APPREHENSION OF USERS:

• Requirement of skilled manpower and Tools and tackles for stringing of conductor
• Impact on environment

Hope in this one day Seminar most of the questions will be answered. As such, a judicious decision may be needed while selecting a particular type of conductor for transmission and distribution system keeping in mind the benefits and Life Cycle Cost (LCC).
THANK YOU
5. HTLS / HIGH PERFORMANCE CONDUCTORS

• HTLS conductors [Aluminium Conductor Composite Core (ACCC), Thermal Alloy Conductor Steel Reinforced (TACSR), Aluminium Conductor Steel Supported (ACSS), and Gap Type Thermal Alloy Steel Reinforced (GTACSR) Conductor etc.]

• Indigenous availability is going to be added advantage.
2. VARIOUS OPTIONS AVAILABLE FOR TRANSMISSION OF POWER

- Use of copper (1880s), Aluminium (1895-1900), ACSR (1907-1910), AAAC [alloy of Aluminium-Magnesium-Silicon] (1940s), New Alloy [High Temperature, low sag, increased conductivity, vibration resistant] in 1970s-1980s