STANDARDIZATION, INTERCHANGEABILITY AND REGULATIONS WITH REFERENCE TO POWER TRANSFORMER IN INDIAN POWER SYSTEM

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OUT LINE OF PRESENTATION

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1. INTRODUCTION

PRESENT SCENARIO:

- Since independence the growth in Indian Power sector is phenomenal.
- Complexity of the Indian Power System has increased many folds
- Huge generation capacity addition

[Installed Generation capacity 310 GW (as on December 2016)]
- Phenomenal growth of Private Sector Generation (49.42%)
- Commensurate expansion & strengthening of the associated T&D Network

[Transmission network (220kV and above) about 3.5 lakhs Ckm and 7 Nos of HVDC are in operation and one under construction, Transformation capacity (excluding Converter transformers) about 685GVA, Catering to a peak demand of about 135-155GW, Meeting energy requirement of about 3100-3300MU per day]
1. INTRODUCTION

PRESENT SCENARIO:

• Development of inter-regional synchronous ties leading to formation of National grid
  [inter regional transfer capability : 72,350MW at the end of 12\textsuperscript{th} Plan and likely to increase to 118,050 MW at the end of plan period 2017-2022]

• Cross border interconnection with neighboring country (Nepal, Bhutan, Bangladesh & Myanmar)

• Expansion of energy market (10% of total energy consumption traded on Short term)

• Integration of huge quantum of generation from Renewable Energy Sources (3% in 2002, 14% in 2016, likely to increase to 33% by 2022 & 43% by 2027, reduction in hydro & gas share over same period)
1. INTRODUCTION

In such a scenario, ambitious Objective of achieving

- “Reliable, Uninterruptable (24x7), Affordable and Quality Power for All (PFA)” is a challenging task

- The reliability & availability of transformer (one of the most critical and expensive assets) in a power system has important role to play
## 2. TRANSFORMATION CAPACITY ADDITION & COMPENSATION REQUIREMENT

### Installed Capacity, Peak Demand & Energy Requirement

<table>
<thead>
<tr>
<th></th>
<th>By 2021-22</th>
<th>By 2026-27</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>IC</strong></td>
<td>~ 520 GW</td>
<td>~ 640 GW</td>
</tr>
<tr>
<td><strong>Peak Demand</strong></td>
<td>~ 225 GW</td>
<td>~ 320 GW</td>
</tr>
<tr>
<td><strong>Energy Requirement</strong></td>
<td>~ 1600 BU</td>
<td>~ 2150 BU</td>
</tr>
</tbody>
</table>
## 2. TRANSFORMATION CAPACITY ADDITION & COMPENSATION REQUIREMENT

### Transformation Capacity Addition

<table>
<thead>
<tr>
<th>Voltage level / Plan Period</th>
<th>2012-2017</th>
<th>2017-2022</th>
</tr>
</thead>
<tbody>
<tr>
<td>765kV</td>
<td>130GVA [≥ 5times increase over previous plan period (25GVA)]</td>
<td>114 GVA</td>
</tr>
<tr>
<td>400kV</td>
<td>84 GVA [≥ 60% increase over previous plan period(151GVA)]</td>
<td>103 GVA</td>
</tr>
</tbody>
</table>

### Total Transformation Capacity

<table>
<thead>
<tr>
<th></th>
<th>By 2016-17</th>
<th>By 2021-22</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total GVA</td>
<td>~ 685 GVA</td>
<td>~ 980 GVA</td>
</tr>
</tbody>
</table>
2. TRANSFORMATION CAPACITY ADDITION & COMPENSATION REQUIREMENT

Compensation requirement [2017-2022]:

<table>
<thead>
<tr>
<th>Voltage level</th>
<th>Line Reactor</th>
<th>Bus Reactor</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>765kV</td>
<td>31190</td>
<td>9150</td>
<td>40,340 MVAR</td>
</tr>
<tr>
<td>400kV</td>
<td>6274</td>
<td>11586</td>
<td>17,860 MVAR</td>
</tr>
</tbody>
</table>

Dynamic compensation (To provide Dynamic over voltage control i.e providing dynamic stability to Grid under Contingency condition):

- Three (3) SVC expected by the end of 2016-17
- Ten (10) STATCOM likely to be commissioned during the plan period 2017-22
- Limited the number of manufacturers of EHV / UHV class reactors
3. STANDARDIZATION

Standardization is to limit

- The variation of transformer types
- Ratings
- Voltage ratios
- Impedances
- Taping ranges
- Other principal electrical, mechanical and thermal characteristics

The aim of standardization is:

- Minimize system design, operating and capital costs
- Simplify maintenance procedures and requirements, and system planning
- Reduce stock held items
- Optimize spares
4. INTERCHANGEABILITY

- Interchangeability refers primarily to transformers of similar rating, voltage and other technical / operating characteristics from different suppliers designed to have common dimensions and layout, in order to allow them to be physically interchangeable with each other with a minimum of adoption.

- The policy of standardization & interchangeability would reduce the variability & simplify the design of transformers and associated fittings & accessories etc. leading to reduction in purchasing & other front end costs and delivery time.
5. REGULATIONS

• CEA (Technical Standard for Construction of Electric Plants and Electric lines) Regulations 2010 is under revision

Draft document addresses

• Basic insulation levels of transformer windings (at par with equipment for 220kV and above) & bushing
• Requirement of OLTC & Tertiary winding

• Fire fighting system (Nitrogen Injection based, and/or High Velocity Water Spray System) for > 2000MVA transformer

• RIP- Resin Impregnated Paper / RIS- Resin Impregnated Synthetic bushing as an alternative to OIP bushing

• Short Circuit withstand test
5. REGULATIONS

• Use of K-class oil / easter oil (synthetic / natural easter) upto 400kV
• Use of Controlled Switching Device (CSD) for 400kV and above voltage class transformer and reactor for reducing switching transients & inrush current

(CSD shall come into picture during energization / de-energization of CB and shall remain bypassed for rest of the time.)
• Provision of Fibre Optic Sensors for hot spot monitoring in addition to WTI & OTI
• Fast depressurization system in addition to Pressure Relieve Devices (PRDs)
• Condition monitoring practice (CBM/RCM)
• Use of modern diagnostic tools (on line & off line)
6. NEED OF STANDARDIZATION & STRONG EFFECTIVE REGULATION AND INITIATIVES BEING TAKEN IN THAT DIRECTION

- One can not imagine Power system without transformation of voltage
- The transformer is a critical and expensive component of a power system.
- The utility expect trouble free operation during entire service life (35-40 years)
- The utilities / purchasers as well as the manufacturers have important role to play
- Transformer basically consists of magnetic system comprising of core of CRGO steel (2/3/4/5 limb core), Conducting system (comprising of winding & conductor), cooling system (cooling fans, pumps, radiators), Dielectric system (oil, cellulose insulation – conductor insulating paper- kraft paper, thermally upgraded kraft paper, nomex, pressboard, permawood meeting the required insulation levels) and fittings and accessories (Tank, Tap changer, bushings, WTI, OTI, Buchholz relay, dehydrating breather, PRD, conservator, oil level indicator, bushing CTs etc.).
6. NEED OF STANDARDIZATION & STRONG EFFECTIVE REGULATION AND INITIATIVES BEING TAKEN IN THAT DIRECTION

(a) Lot of components in a transformer and most of the components are out sourced

(b) Manufacturing process involves lot of manual intervention.

(c) The quality of transformer depends on material that goes into manufacturing

(d) Manufacturing process & manufacturing environment
(The quality & cost of material plays an important role as majority of parts or components like bushing, tap changer, tank body, radiators, insulation, copper, core material, oil etc are outsourced)

(e) Source of material, sub-vendors & skilled manpower likely to change over time
• They play important role in maintaining consistency in quality of the product
The technical specification of transformer is not uniform across the utilities in the country. Wide variation in technical requirement, even for same rating

- Transformers of same rating / class designed differently even for same user

- Even for same specifications, manufacturer reviews design for successive tender considering prevailing market condition and thereby make changes in transformer architectural features and general arrangements

- This practice leads to increase in design & manufacturing cycle time, cost, human efforts and inventories.
6. NEED OF STANDARDIZATION & STRONG EFFECTIVE REGULATION AND INITIATIVES BEING TAKEN IN THAT DIRECTION

(g) The role of Private Players is increasing in Generation (about 49.42% as on December 2016)

(h) Since Introduction of TBCB in the year 2012, the role of Private players also increased in Transmission sector

- In TBCB process, capability of the bidder to execute the project evaluated primarily based on the financial strength / capability only

- No technical evaluation neither at RfQ or at RfP stages
- Detail technical specification does not form part of the RfP document except some broad technical requirements.
- In view of above, Standardization and introduction of strong & effective Regulation is very much required.
INITIATIVES

• Ministry of Power has constituted a committee in CEA taking representation from utilities and manufacturers to standardize specifications of Power Transformers

• Standardization and interchangeability are the two main objective of the committee

• Simplify the design process and reduce the inventory, cost and the delivery period

• Facilitate replacement of existing transformers of same rating, but of different makes without modification of foundation block.
The document intends to cover following broad areas:

1. Standardization of basic design & engineering Specification including fitting & accessories [GTP including basic insulation level, MVA rating of transformer at various voltage levels, standardized loss (Fixed loss - No load, full Load & auxiliary loss), tap changer, tertiary winding, types of bushing]

• Optimum value of transformer losses be specified for each standard rating of transformers in consultation with manufacturers

• The quoted weights of active materials can be compared with standardized loss. Specifying the losses for GT of Hydro Generating Stations would be difficult
6. NEED OF STANDARDIZATION & STRONG EFFECTIVE REGULATION AND INITIATIVES BEING TAKEN IN THAT DIRECTION

2. Quality Plan
   – Material Quality & characteristic
   – Stage inspection of material & manufacturing process
   – Basic manufacturing facility

   • Manufacturing environment (clean, dust free and humidity controlled environment),
   • Routine & Acceptance tests etc.

3. Standardization of Contract Drawing including GA drawing, control schemes (cooler control, tap changer control), foundation plan

4. Design Review

5. Transportation, Erection, testing and commissioning

6. Condition monitoring
7. CONCLUSION

• The Reliability and availability of transformer (one of the most important and expensive asset in a power system) plays an important role in the operation of a power system.

• Emphasis needs to be laid on improved design, Quality Control during manufacturing, use of right components / accessories, maintenance.

• Standardization, interchangeability & strong effective Regulations are the need of hour.

• The ultimate objective is to bring uniform practice across the utilities and to reduce variability, cost and the delivery period.
THANK YOU FOR YOUR ATTENTION