



# CAPACITY BUILDING OF INDIAN LOAD DESPATCH CENTRES

क़ाबिल

CABIL

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Forum of Regulators



# केन्द्रीय विद्युत विनियामक आयोग

## CENTRAL ELECTRICITY REGULATORY COMMISSION



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&  
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### Message

15<sup>th</sup> November, 2018

The Forum of Regulators (FOR) has been taking up various initiatives to nurture growth of independent regulation and empowerment of all stakeholders in the electricity sector. The State and the Central Electricity Regulatory Commissions as well as the Forum of Load Despatchers in India have been providing unflinching support in these endeavors.

The report “Capacity Building of Indian Load despatch centres- CABIL (काबिल)” was endorsed by the FOR standing technical committee in its 21<sup>st</sup> meeting at New Delhi on 08<sup>th</sup> October 2018 and subsequently adopted by the FOR in its 65<sup>th</sup> meeting at Bhubaneshwar on 13<sup>th</sup> November 2018. The report crystallizes the collective wisdom derived from physical visits, deliberations among the practitioners and experts on the subject. Along with the recommendations on the above aspects, the report also presents a roadmap for implementation.

The load despatch centre plays a critical role in the power system and electricity market. Small investments in this faculty would leverage major gains in grid security, reliability, economy, efficiency and sustainability. The functional and financial autonomy of load despatch centre as envisaged in the Electricity Act 2003 needs to be ensured by empowering them with adequate resources in terms of infrastructure (civil, information communication technology, decision support), skilled human resources, sustainable and independent revenue streams and appropriate performance indicators. Institutional capacity building and infrastructure of load despatch centres would lead to a robust and sustainable framework for reliable and economic operation of the Indian electricity grid.

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## **Foreword**

Indian grid is one of the largest synchronous grids and emerging electricity markets in the world. It is also unique due to diversity, federal and decentralized approach of governance in grid management. The mandate regarding load despatch centres in the Electricity Act 2003, introduction of open access, the recommendations post grid disturbance of 2012 and the national commitment towards renewable and clean energy have been the key drivers for capacity development of load dispatching in India. Institutional capacity building of LDCs is essential in view of the complexity, technological interventions, need for optimization and future endeavours. The recommendations of the various committees, task forces constituted by the Government of India, Forum of Regulators and the Forum of Load Despatchers accelerated these efforts. The recent survey of the State, Regional and National Load Despatch Centre reveals that much more needs to be done in order to achieve the envisaged vision.

Institutional capacity building could be seen as a way of promoting and developing good governance. There are multi dimensions to it - tangibles and non-tangibles. The tangibles, hard capabilities include physical assets such as infrastructure, machinery, natural resources, organizational structure and systems, legal frameworks and policies. The intangibles, soft capabilities on the other hand, have to do with skills, experience, creativity, tacit knowledge, values, motivation and culture. The former being physical attracts more attention, the latter being abstract and difficult to measure is often overlooked. Sustainable development requires suitable interventions in all the dimensions.

Institutional capacity building is a long drawn process that can succeed only with clear set of objectives and priorities; long-term vision; transparency, role clarity and accountability; appropriate methodology; awareness, understanding, general buy in, acceptance and committed participation of all the stakeholders; professionals and sufficient time and resources. Execution is challenging, slow and often painful as it encompasses skill upgrading, procedural improvements and organizational strengthening. This report is an outcome of extensive consultation and collaboration with the various stakeholders and is a humble attempt to identify the areas for intervention to evolve a roadmap for developing robust and sustainable institution of load despatching in India.



S.K. Soonee

Chairman  
(FOR Technical Committee Sub-group on  
Load Despatch Centres-Institution building and strengthening)

**जीवने यावदादानं स्थात् प्रदानं यत् ततोऽधिकम् ।**  
( जीवन में जो कुछ लिया है उससे अधिक लौटा सकें )

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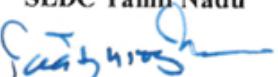
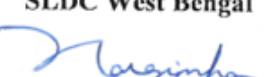
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The Forum of Load Despatchers played a pivotal role in pooling the best practices, conducting surveys on the infrastructure and human resources in LDCs of India and provided a sounding board for deliberation on various issues. The sub-group would like to thank the FOLD secretariat as well as all the FOLD members for their vital contributions.

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| 12    | Suneel Grover      | SLDC, Shimla          |  |
| 13    | Kaushik De         | NLDC, Delhi           | Organisation structure   |
| 14    | Debasis De         | NLDC, Delhi           | Survey on HR and infrastructure  |
| 15    | Harish Rathore     | NLDC, Delhi           |  |
| 16    | A.B. Sengupta      | ERLDC, Kolkata        |  |
| 17    | Ankur Gulati       | NRLDC, Delhi          |  |
| 18    | Akhil Singhal      | NLDC, Delhi           |  |
| 19    | Chandrasekhar      | SLDC Telangana        | Technology roadmap   |
| 20    | M.K. Singh         | SLDC Gujarat          |  |
| 21    | Girish Gupta       | SLDC Chhattisgarh     |  |
| 22    | Neeraj Kumar       | NRLDC, Delhi          |  |
| 23    | Manas Das          | ERLDC, Kolkata        |  |
| 24    | Sheikh Shadruddin  | NERLDC, Shillong      | Analysis of LDC Fees and Charges regulations and orders  |
| 25    | Ramkumar           | SRLDC, Bengaluru      |  |
| 26    | Jyoti Shukla       | WRLDC, Mumbai         |  |
| 28    | Momai De           | NERLDC, Shillong      |  |
| 29    | Virag Shah         | WRLDC, Mumbai         |  |
| 30    | Shailendra Verma   | NLDC, Delhi           | Back up RLDC   |
| 31    | Bindiya Jain       | POSOCO, Delhi         |  |
| 32    | Rajib Sutradhar    | NERLDC, Shillong      |  |
| 33    | S. Konar           | ERLDC, Kolkata        | Financial Statement Analysis   |
| 34    | Rajiv Porwal       | NRLDC, Delhi          |  |
| 35    | K.V.N. Pawan Kumar | NLDC, Delhi           |  |
| 36    | S. S. Raghuvanshi  | WRLDC Mumbai          |  |
| 37    | Samir Saxena       | NLDC, Delhi           |  |
| 38    | S. Usha            | WRLDC, Mumbai         | Roadmap for the Forum of Load Despatchers (FOLD)   |
| 39    | Sachala Mishra     | WRLDC, Mumbai         |  |
| 40    | V. Balaji          | SRLDC, Bengaluru      |  |
| 41    | S. Verghese        | SRLDC Bengaluru       |  |
| 42    | Rakesh Kumar       | NLDC, Delhi           |  |
| 43    | M. Venkateshan     | SRLDC, Bengaluru      | FOLD survey coordination, Situational awareness, Interface of LDCs with stakeholders, Literature survey etc. |
|       |                    |                       |  |
|       |                    |                       |  |
|       |                    |                       |  |
|       |                    |                       |  |
|       |                    |                       | Model regulation on LDC fees & charges   |
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**Chairman of the Sub-Group**

## Acronyms

|        |  |       |  |
|--------|--|-------|--|
| ADS    | Active Directory Service                         | IT&C  | Information Technology and Communication |
| ALC    | Annual LDC Charges                               | ITSO  | Independent Transmission System Operator |
| AMI    | Advanced Metering Infrastructure                 | LAC   | LDC Annual Charges                       |
| ARR    | Annual Revenue Requirement                       | LAN   | Local Area Network                       |
| BAS    | Building Automation System                       | LDCER | LDC Empowerment Reserve                  |
| BESS   | Battery Energy Storage System                    | LFO   | Low Frequency Oscillation                |
| BI     | Business Intelligence                            | LTSO  | Legally Unbundled Transmission Operator  |
| BMS    | Building Management System                       | MDMS  | Meter Data Management System             |
| CCC    | Commercial Coordination Committee                | MOC   | Market Operation Charges                 |
| CCTV   | Closed Circuit Television                        | NAS   | Network Attached Storage                 |
| CERC   | Central Electricity Regulatory Commission        | NHPTL | National High Power Testing Laboratory   |
| CIM    | Common Information Model                         | NLDC  | National Load Despatch Centre            |
| DAS    | Direct Attached Storage                          | NMS   | Network Management System                |
| DCS    | Decision Support System                          | NPSC  | National Power System Conference         |
| DER    | Distributed Energy Resources                     | NPTI  | National Power Training Institute        |
| DER    | Distributed Energy System                        | OCC   | Operation Coordination Committee         |
| DFMD   | Door Frame Metal Detector                        | OT    | Operation Technology                     |
| DG     | Distributed Generation                           | PAT   | Perform, Achieve & Trade                 |
| DMS    | Distribution Management System                   | PCC   | Protection Coordination Committee        |
| DMZ    | De-Militarized Zone                              | PDC   | Phasor Data Concentrators                |
| DR     | Disaster Recovery                                | PoC   | Point of Connection                      |
| DSO    | Distribution System Operator                     | PSDF  | Power System Development Fund            |
| DTS    | Despatch Training Simulator                      | REC   | Renewable Energy Certification           |
| EMS    | Energy Management System                         | REMC  | Renewable Energy Management Centre       |
| ERC    | Electricity Regulatory Commission                | RES   | Renewable Energy Sources                 |
| ESCert | Energy Efficiency Certificate                    | RLDC  | Regional Load Despatch Centre            |
| EV     | Electric Vehicle                                 | RoE   | Return on Equity                         |
| FOLD   | Forum of Load Despatchers                        | SAN   | Storage Area Network                     |
| FOR    | Forum of Regulators                              | SCADA | Supervisory Control and Data Acquisition |
| FRC    | Frequency Response Characteristics               | SERC  | State Electricity Regulatory Commission  |
| HRD    | Human Resource Development                       | SLDC  | State Load Despatch Centre               |
| ICCP   | Inter-Control Centre Communications Protocol     | SOC   | System Operation Charges                 |
| ICER   | International Confederation of Energy Regulators | TCC   | Transmission Coordination Committee      |
| ICPS   | International Conference of Power System         | ToR   | Terms of Reference                       |
| ICT    | Information and Communication Technology         | TSO   | Transmission System Operator             |
| IEGC   | Indian Electricity Grid Code                     | UV    | Under Vehicle                            |
| ISO    | Independent System Operator                      | VIU   | Vertically Integrated Utilities          |
| IDSO   | Independent Distribution System Operator         | WAMS  | Wide Area Measurement System             |

THIS REPORT WAS PREPARED BY THE SUB GROUP OF THE FORUM OF REGULATORS (FOR) STANDING TECHNICAL COMMITTEE. IT WAS ENDORSED BY THE STANDING TECHNICAL COMMITTEE IN ITS 21<sup>ST</sup> MEETING ON 8<sup>TH</sup> OCTOBER 2018 AND BY THE FORUM OF REGULATORS IN ITS 65<sup>TH</sup> MEETING ON 13<sup>TH</sup> NOVEMBER 2018

## **Executive Summary**

**एकै साधे सब सधै, सब साधे सब जाय, रहिमन मूलहिं सींचिबो, कुलैं कलैं अगाय। - रहीम**

The term Load Despatch Centre (LDC) was first time referred in the Electricity Supply Act 1948 vide amendment dated 15<sup>th</sup> October 1991. The subsequent amendment in August 1998 designated the LDC as an apex body and enumerated the roles, responsibilities and powers of LDC for ensuring smooth and integrated grid operation. The Electricity Act 2003 further articulated these provisions and defined real-time operations. The National Load Despatch Centre (NLDC) Rules, March 2005 by Govt. of India enumerated the functions of NLDC in detail.

The Electricity Act 2003 as well as the MoP resolution of 2005, mandated that the Central / State Transmission Utilities shall operate the respective Load Despatch Centres until a Government company or any authority or corporation is notified by the Central/State Government. The amendment of the Electricity Supply Act 1948 and subsequently the Electricity Act 2003 provided for levy and collection of fee and charges as may be specified by the appropriate Electricity Regulatory Commission.

### **Back ground**

The Electricity Act 2003 introduced competition in the power sector by delicensing generation, introducing open access in transmission and emphasizing that Load Despatch Centres must be transparent, neutral and non-discriminate. Under the changed paradigm, the issues related to the institutional arrangement, functional autonomy, revenue streams as well as certification and incentives for human resources were re-examined by the committees / Task Forces constituted by the MoP, GoI.

Pursuant to the recommendations of the Forum of Regulators' report on 'Open Access-Theory and Practice', the Central Electricity Regulatory Commission notified the Regulations on fees and charges for Regional Load Despatch Centre in September 2009. Chairperson CERC and FOR, urged the SERCs to initiate steps to frame regulations for State LDCs based on the principles laid down in the regulations framed by CERC for the RLDC.

All the above initiatives highlighted the critical role played by the LDCs in the entire electricity value chain. The recommendations of the aforesaid committees/task forces were implemented, though with varying degree of success. At the interstate level, Power System Operation Corporation (POSOCO) was formed as a Govt. of India undertaking to operate the NLDC/RLDCs.

The Technical Committee of the Forum of Regulators (FOR) for implementation of Framework on Renewables at the State level, in its 18<sup>th</sup> meeting held at New Delhi on 23<sup>rd</sup> February 2018, was of the view that the institutional capacity building of Load Despatch Centres in India needs fresh impetus in Capacity Building of Indian Load Despatch Centres

Forum of Regulators

view of the fast changing energy landscape. Consequently, a sub-group was constituted to survey and identify the best practices in all LDCs in India and recommend suitable measures and roadmap for institution building and strengthening of the LDCs. The sub-group had members from CERC, POSOCO, SLDCs (Tamil Nadu, Gujarat, Rajasthan, Maharashtra, Telangana, West Bengal, Meghalaya) and the academia. Extensive consultations, survey and research were conducted. This report is a compilation of the work done by the sub-group. It provides suggestions with respect to infrastructure; decision support system; information and communication technology; human resource adequacy and capacity building; revenue model, performance evaluation framework for LDCs. The report also provides model regulations for fees and charges of an LDC along with a roadmap for implementation of various recommendations.

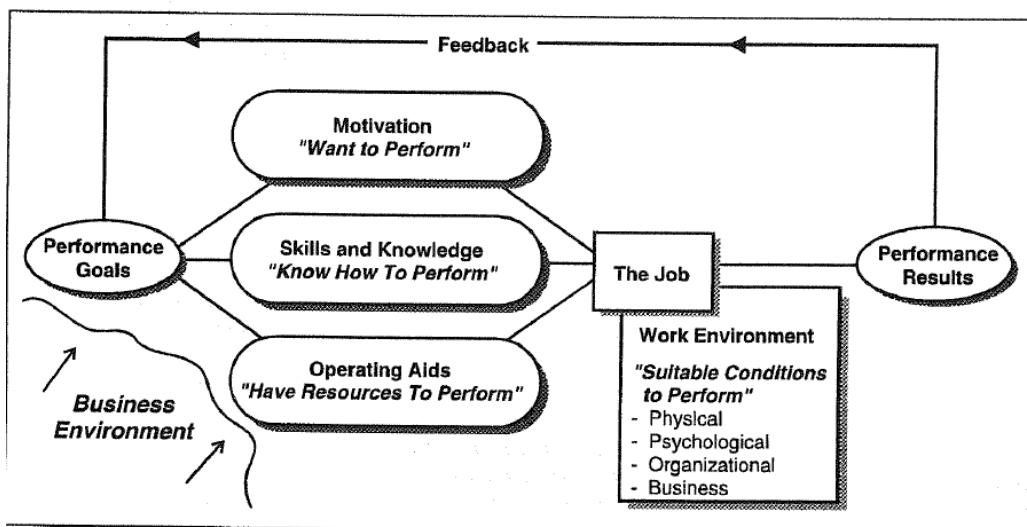


Figure 1: Human Performance in control centre [Source: CIGRE EL. No.174, Oct 1997]

### Emerging challenges

The LDCs would be expected to meet the emerging challenges due to renewed thrust on electricity for all, consumer expectation of uninterrupted reliable and quality power supply; expanding footprints of the grid; interconnection of Indian grid with neighbouring countries; large scale integration of Renewables, Distributed Energy Resources, Electric Vehicles; deployment of automation & secondary control, flexibility, optimization, security constrained economic dispatch; deployment of advanced techniques for visualization and situational awareness; introduction of new products in the electricity markets; evolving regulations for flexibility services, Qualified Coordinating Agency, Aggregators, Renewable Energy Certificate mechanism, Perform Achieve and Trade mechanism, Battery Energy Storage Systems; Prosumers; envisaged segregation of carriage and content; establishment of Distribution System Operators; introduction of General Network Access; financial products; derivatives etc. Consequently, the interactions of LDCs with different stakeholders in the Electricity Supply Industry viz. generating companies, transmission licensees, distribution licensees, coordination forums, planners, policy makers, quasi-judicial bodies, judicial bodies, academia,

multilateral agencies, technical bodies, consultants, vendors, international ISOs/TSOs would further evolve and intensify.

### **Diversity**

An organogram for a typical LDC with a detailed list of existing and envisaged functional activities has been suggested. Depending on the complexity of the system being handled by the LDCs, thirteen (13) LDCs could be considered as ‘Large; Ten (10) LDCs could be considered as ‘Medium LDC’ and the remaining nineteen (19) LDCs could be considered as ‘emerging LDC’. Several ‘emerging LDCs’ would gradually grow to become ‘Medium LDC’ while several ‘medium LDCs’ would become ‘Large LDC’. Nevertheless, for discharging the real-time functions, the LDCs need to be equipped with appropriate operating aids, enabling infrastructure, resources and environment.

### **Civil infrastructure**

The control room with 24x7 operations and collaborative nature of activities makes the space requirement of an LDC distinct from the regular office complexes. The sub-group recommends establishment of an independent and state of the art premises for the LDCs with adequate space for future expansion. Multiple conference/meeting rooms, multiple video conference facilities and robust communication infrastructure for data and speech communication are required. The ceiling height as well as the length & breadth of the control room should be sufficient to accommodate multiple large video display units for system visualization. The ergonomic aspects associated with physical layout, seating arrangement, acoustics, lighting, space cooling, size & type of desktop consoles, desk-height, chair design etc. must be as per the standards to enhance operator performance and minimize the physiological stress. The human factors (font type, font size, language, colour combination etc.) need to be suitably considered in designing of mimic displays for the operators. The mission critical nature of LDC operations calls for robust infrastructure security, access control, cyber security systems, fire-fighting systems, disaster resilience and redundancy of auxiliary power supply in the form of dual independent sources of AC supply, UPS and back up diesel generator sets.

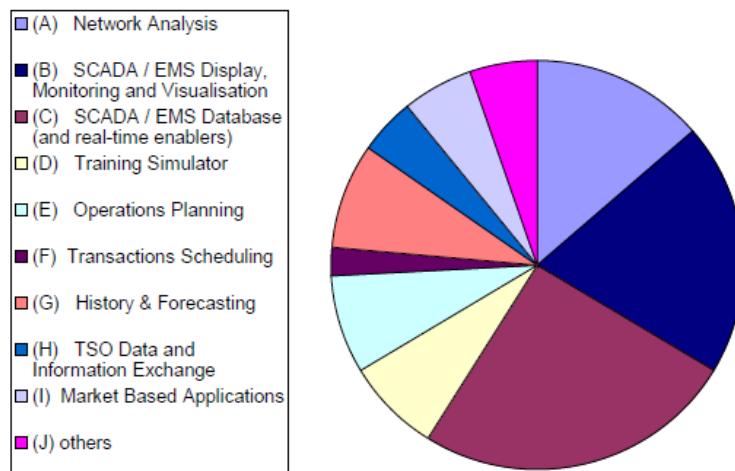
### **Decision support system and operating aids**

Load Despatch Centres require state-of-the art decision support system in the form of Supervisory Control and Data Acquisition System (SCADA), Energy Management System (EMS), Wide Area Measurement Systems (WAMS), video displays, application software for network simulation, grid event analysis, market simulation, real-time optimization and controls, dispatcher training simulator and visualization. They need customized applications for development of displays for operators (Single line diagrams, GIS based power maps populated with different layers of data etc.), Network modelling, Market modelling and simulation. These decision support systems are highly technology intensive and need to be upgraded periodically. This calls for continuous learning, unlearning and re-learning. LDC personnel need to be adequately trained in utilization of the available operating aids for taking appropriate decisions in real-time and providing evidence based inputs to stakeholders.

### **Information and communication technology infrastructure**

In addition to the decision support system, the LDCs need to be equipped with data repository, knowledge management, big data analytics and information dissemination. They require web-enabled customized application software for activities such as user registration, open access, energy scheduling, accounting, metering, settlement, reporting, outage coordination, and availability verification. This aspect was highlighted in the SAMAST report also.

The emphasis should be on developing robust, agile, flexible, modular, scalable, interoperable and compatible Information Technology & communication infrastructure that is periodically upgraded to take care of high obsolescence. All protocols related to cyber security threats should be complied with to ensure information security. While considering development of software solutions from third-party vendors, adequate emphasis should be on in-house capability development in this area to avoid excessive reliance on vendors and service providers. Appropriate initiatives for vendor development in the niche areas may be taken to increase competition and avoid monopoly of single vendor.



*Figure 2: Expenditure on decision support and IT [Source: TSO comparison group, 2010]*

## **Data management**

The LDCs have access to huge amount of time series and offline data related to power system and electricity market which could be gainfully utilized for the benefit of the sector. Data archival, sharing and analysis is crucial. Relevant data as mandated by appropriate regulations could be shared in public domain.

## **Real time operation team**

A large proportion of the staff in LDCs work in rotating eight hour shifts (Morning, Evening and Night). The emerging challenges and complexity call for having a real-time ‘forecasting desk’, ‘scheduling desk’, ‘balancing desk’, ‘renewable desk’ and ‘reliability desk’ under the oversight of a Shift Incharge supported by personnel to maintain decision support system and Information and Communication Technology systems. In the emerging LDCs one or more desks could be merged.

The HR budget must factor training, business travel, official nominations, special assignments, leave entitlements, contingency reserves, leaves on extended weekends/festivals. Thus the real-time operations require five teams comprising of minimum three to eight persons per team.

### **Human resource adequacy**

The functioning of LDCs is executive oriented with a typical Executive to Non-Executive ratio of 95:5. The number of executives (including supervisors but excluding non-executives) for an emerging LDC would be in the range of 30 to 50; for a medium LDC it would be in the range of 70 to 100; while in a large LDC it would be in the range of 100 to 150. The States/Regions where Renewable Energy Management Centres are being set up would require additional 25-30 personnel. The larger states like Uttar Pradesh, Maharashtra, Tamil Nadu and Gujarat have one or more sub-LDCs to assist the SLDC. The regular staff for Sub-LDCs would be in the range of 15-25 per Sub-LDC. It is desirable that one of the sub-LDCs act as the Main-II (or back up) control centre and be capable to taking up the functions of the Main-I control centre in the event of a disaster. The numbers of personnel excludes the staff deployed for security of the physical infrastructure of the LDC. It also excludes the outsourced staff for activities such as house-keeping, horticulture, civil maintenance, electrical maintenance etc.

Considering their overarching role in the power sector, the LDCs, need to be nurtured as centres of excellence. In addition to the personnel from Power system / Electrical / Electronics disciplines, recruitment / posting of few persons qualified in renewable technology, communication system, computer science, law, meteorology, public policy, economics, statistics, data science, finance and commerce is desirable. Specialization needs to be encouraged.

### **Selecting, retaining and nurturing talent**

The recruitment, compensation and benefits of the personnel working in different Load Despatch Centres would be governed by the respective parent organizations. However, in order to encourage long-term commitment and motivation of the staff, the head of LDC should be suitably empowered in matters related to transfer, posting, training, certification, professional engagement and career progression of the staff working in the LDC. Comfortable working environment, night shift reimbursement, pick-up/drop facility for shift duties, rest-room, adequate healthcare facilities, compensatory off, residential facilities and other benefits are essential to motivate and retain qualified personnel at LDCs. Apart from induction level training, the LDC personnel should be given domain-specific training as well as training on written/oral communication skills, behaviour, physical health, financial planning, social health, hard skills (forecasting, network simulation, market simulation, software development, optimization, research etc.), soft skills (public speaking, interpersonal skills, cognitive skills, emotional intelligence, aesthetics, public relations etc.).

Minimum 7 man-days of training per person per year shall be ensured. Policies that encourage acquisition of higher qualification by personnel and taking up applied research are desirable. HRD expenses shall be booked under HR expenses instead of A&G expenses with a target to spend at least Capacity Building of Indian Load Despatch Centres

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5 % of total HR expenses in HRD in line with the National Training Policy. Certification of Operators should come as a culture rather than a mandate. It is desirable that at least 75 % of the executives in a Load Despatch Centre are certified for basic level and at least 10-15 % are certified specialist level. Provision of Operator certificate retainer ship would encourage LDC personnel to acquire and maintain valid certificate.

### **Forum of Load Despatchers**

The Forum of Load Despatchers (FOLD) needs to be strengthened to take up larger role in institutional capacity building of the LDCs in India through certification training, expert lectures, seminars, conferences, working groups, physical visits, national/international exposure. The expenditure of FOLD may be recovered through the NLDC fees and charges.

There are several States/ Union territories where a LDC is yet to be established. In a few States/UTs, despite installation of decision support equipment, the control centre is yet to be fully functional for want of adequate and skilled staff. The sub-group recommends that adequate and capable staff should be posted to ensure maximum utilization of the decision support system in improving the power management in the area under its jurisdiction. The LDC personnel should be associated with the decision projects from concept to commissioning stage to dovetail them as per the local requirements and ensure maximum utilization of the technology in grid operation. Established LDCs could hand hold the emerging LDCs. A roadmap for establishing a new control centre has been developed.

### **Business model**

The LDCs are considered to be CAPEX-lite and profit-neutral. The HR expense comprise 70-80 % of the Annual Revenue Requirement while the CAPEX would be in the range of 20-30 % of the total ARR. Thus the revenue model for the LDCs would be distinct from other capital intensive utilities. The report suggests common principles that could be considered while evolving a business model for the LDCs. The methodology for computation, approval, collection, reconciliation and truing up of fees and charges of LDCs should be simple. The formulation should be such that the Users have a rough idea of their liability ex-ante without having to wait for the monthly bills.

The expenditure incurred by the LDCs are computed/approved under the distinct heads – Return on Equity; Interest on Loan Capital; Depreciation; Operation & Maintenance (excluding Human Resources but including communication expenses) expenses; Human resource (including HRD) expenses; Administrative and General office expenses (excluding HRD and communication expenses); and Interest on working capital. The Regulatory pool funds administered by the LDCs should be kept separate from the LDC balance sheet. The corpus for payment of incentives to LDCs upon achievement of targets for Key Performance Indicators (KPIs) should be separately approved.

User registration fee should be explicitly charged every month all the users of LDCs. The approved ARR could be apportioned equally between three major category of users viz. generating companies/sellers, distribution licensees/buyers and transmission licensees. Within a particular category of Users, the charges may be apportioned in proportion of aggregate allocated capacity/contracted (in case of generating company/ Seller or Distribution licensee/ Buyer) or circuit kilometers of transmission lines (in case of transmission licensee). All other category of Users existing or envisaged in future (such as EV, BESS/ QCA/NHPTL/Demand Response etc.) could be considered as a distribution licensee with an adhoc contracted capacity for the purpose of billing.

In addition to the charges for recovery of approved expenditure, the LDCs collect one-time registration fee, STOA application fee / operating charges, interest income, etc. Learning from the experience at the State and regional level, creation of a reserve is strongly recommended for empowering the LDCs. The reserve could be under the oversight of the respective ERCs. However utilization of funds from this reserve could be permitted for institutional capacity building and empowerment of LDCs. It could be utilized for equity portion of CAPEX/REPEX and for meeting unforeseen expenses on pilot projects, customized software development, consultancy services for deployment of new technology etc. Instead of treating the drawal from this fund as grant for creation of assets, suitable provision for Return on Equity and Depreciation would avoid depletion of this reserve / net worth. The reserves could also provide a buffer for tiding over cash flow constraints arising from contingency expenses, payment defaults or major revenue expenses with a provision to recoup the reserve.

### **Key Performance Indicators**

The LDCs contribute significantly in reliable, secure, economic and sustainable operation of the interconnected grid formed by assets owned by diverse utilities. The evidence based inputs from LDCs to policy makers, regulators and planners are critical for strategic decision making at the highest level. The success of reform initiatives in the power sector largely depends on the efficiency of the internal processes of LDC. Thus the services of the LDC are mostly intangible and the economic value of the interventions of LDCs in the system are widely shared among the stakeholders at large. The LDCs are expected to be non-discriminatory, fair, transparent and profit-neutral entities. To ensure the altruistic, ethical and frugal character of LDCs, it is strongly recommended that the performance of the LDCs should be de-coupled from commercial profits of any kind.

In view of the above the sub-group recommends that the performance of the LDC could be evaluated in four dimensions- '**stakeholder satisfaction**' (Area Control Error, Voltage profile, Declaration of Transfer capability, information dissemination etc.); '**financial prudence**' (utilization of CAPEX, recovery of fees and charges, HRD expenses etc.); '**internal processes**' (availability of decision Capacity Building of Indian Load Despatch Centres

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support system, availability of mandated documents, availability of website etc.); ‘learning & growth’ (no. certified operators, achieving training norms etc.). Possible Key Performance Indicators has been prepared. It is recommended that the incentives for LDC shall be linked to achieving the KPI targets set by the respective ERC. The performance related pay to the individuals should also be linked to achieving the individual KPIs derived from the LDC KPIs.

### **Benchmarking**

The LDCs perform similar functions. Despite the diversity there is value in benchmarking them. The performing LDCs could be rewarded and encouraged while the emerging (small) LDCs need to be supported to raise their performance. There is a need for benchmarking LDCs based on factors viz. frugal approach, high performance to resource ratios etc.

### **Summary**

The aggregate strength of personnel (executives + supervisors) working in LDCs (including Sub-LDC and REMC) would be in the range of 3500 – 4000 which would be less than 1% of the total number of personnel engaged in the power sector. The aggregate ARR at pan-India would roughly be in the range of Rs. 900 – 1400 Crore which would be below 1% of the aggregate business volume in the Electricity Supply Industry. Small interventions by the LDCs in real-time would have significant impact on the operating charges. Evidence based inputs from LDCs would help in optimizing future capital expenditure in the sector. Thus, the consequential saving to the state/national economy caused by an empowered and capable LDC would far exceed the annual aggregate revenue expenses of the LDCs which would be in the range of less than 1 paise per unit (assuming annual energy consumption of 1200 Billion Units). Thus small investment in the institutional capacity building of the LDCs would leverage significant savings for the sector and ensure grid security. In order to facilitate implementation of the recommendations, the report includes a model regulation on LDC fees and charges along with a suggested roadmap for execution.

### **Deliberations in the 65<sup>th</sup> FOR meeting**

The Report on Capacity building of LDCs (CABIL) was formally released by Chairperson, CERC/FOR, Chairperson, GERC, Chairperson, OERC and Secretary, CERC in the 65<sup>th</sup> FOR meeting held on 13<sup>th</sup> November, 2018 at Bhubaneswar. Thereafter, Advisor POSOCO and Chairman of the Sub-Group of the FOR Standing Technical Committee presented the report (Annexure 20) and highlighted the following points:

- a. Institutional capacity building of LDCs is essential for implementation of various regulatory initiatives such as framework for forecasting, scheduling and deviation settlement of RES through SAMAST, National Open Access Registry (NOAR), Ancillary services, valuing flexibility services etc.
- b. The report is an outcome of extensive consultation and collaboration with the various stakeholders. It provides a 365 days road map for implementation of recommendations on financial and functional autonomy of LDCs through adequate man-power with appropriate skillset, strengthening real time operation desks, robust infrastructure, information and communication systems, automation and decision support tools, appropriate working environment, HR capacity building, collaborative learning through FOLD, provision for LDC empowerment reserve, certification retainer-ship, KPI linked incentives, benchmarking and reward programs etc.
- c. The resources required would vary for emerging, medium and large sized LDCs. At All India level, it would be in the range of 3500-4000 persons and Rs. 900-1400 crores per annum which would be less than 1% of the resources deployed in the electricity sector.
- d. A model regulation on LDC fees and charges evolved by deriving the best practices of existing Fees and Charges regulations of the CERC/ SERCs could be suitably adopted by the Appropriate Commissions.

The Forum appreciated the efforts of the sub-group and acknowledged the role of load dispatch centres in the sector.

The Forum while adopting the report of the sub-group (as endorsed by the FOR Technical Committee) also advised as under:

- a. The Report may be disseminated to the SERCs/ JERCs
- b. The FOR Standing Technical Committee to monitor the implementation of the Report at regular intervals in its meetings

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## 1. Introduction

*'The challenge is to design a governance system that lubricates day to day operation, facilitates constructive capital investment and channels political energy in a constructive way.'*

### 1.1. Background

Load Despatch Centres perform a critical role in the power system. They are apex bodies within their area of jurisdiction to ensure integrated, secure, reliable, economic and efficient operation of power system. The Load Despatch Centres are a natural monopoly, asset-lite, profit neutral entities that primarily provide coordination services to the competitive Users of the electricity grid viz. generating companies, distribution licensees, transmission licensees and market intermediaries. They disseminate information with stakeholders through their website and provide feedback (knowledge services) to the planners, regulators, policy makers and other stakeholders for evolution of a robust, resilient and responsive power system. The Electricity Act mandates the Load Despatch Centres to be independent, non-discriminatory and transparent while discharging their statutory functions. There have been several initiatives by the government and the regulators for strengthening the Load Despatch Centres at the State and Central level. Major milestones and achievements in this direction are listed below in chronological order.

- 5<sup>th</sup> Nov 2007: Interactive session convened by Ministry of Power with Forum of Regulators and State Government. Pradhan Committee on Ring fencing of LDCs constituted in Feb 2008 after this meeting.
- 4<sup>th</sup> July 2008: Ministry of Power directed POWERGRID for formation of POSOCO
- 11<sup>th</sup> August 2008: Gireesh B. Pradhan Committee Report on "Manpower, Certification and Incentives for System Operation and Ring fencing Load Despatch Centres" submitted. Report accepted and a meeting called on 7<sup>th</sup> Oct 2008 by Secretary Power.
- 15<sup>th</sup> Nov 2008: Forum of Regulators (FOR) approves formation of 'Forum of Load Despatchers (FOLD) and approves FOLD charter in Jan 2009
- Nov 2008 : Report of "Open Access-Theory and Practice", endorsed by Forum of Regulators 20<sup>th</sup> March 2009: Power System Operation Corporation Ltd. incorporated as a 100% subsidiary of POWERGRID with authorized share capital of Rs.200 crores.
- March 2009: Satnam Singh Task force report on "Capital Expenditure and Issues Related to Emoluments for Personnel in Load Despatch Centres" submitted.
- June 2009: Rakesh Nath Committee Report on "Manpower Selection, Recruitment Procedure and Tenures for Personnel in SLDCs"
- 18<sup>th</sup> Sept' 2009: CERC notifies Regulation on Fees and Charges of Regional Load Despatch Centres for the control period 2009-2014.
- 19<sup>th</sup> March 2010: Dhiman Committee Report on "Training and Certification of System Operators" submitted.

- 9<sup>th</sup> June 2010: Ministry of Power designated National Power Training Institute (NPTI) as the Certification Authority for executives of SLDCs, RLDCs and NLDC for an initial period of 3 yrs. i.e. up to 31<sup>st</sup> March 2013
- 26<sup>th</sup> Sept 2010: Gazette notification by Central Govt. of India that the POSOCO a wholly owned subsidiary of POWERGRID shall operate RLDCs/NLDC w.e.f. 1<sup>st</sup> Oct 2010.
- April 2011-Sep 2011: 6 batches basic certification training at PSTI Bengaluru
- Nov 2011: First online certification test completed leading to 266 certified operators.
- July 2016: Report on Scheduling, Accounting, Metering and Settlement of Transactions in Electricity (SAMAST) endorsed by the Forum of Regulators on 22 July 2016

### **1.2. Formation of the Sub-group**

In the 18<sup>th</sup> meeting of the Technical Committee of the Forum of Regulators for implementation of Framework on Renewables at the State level held at New Delhi on 23<sup>rd</sup> February 2018 it was deliberated that institutional building of LDCs in India needs fresh impetus in view of the fast changing energy landscape due to introduction of electricity markets, large scale integration of Renewables, Battery Energy Storage Systems, Electric Vehicles, Prosumers, envisaged segregation of carriage and content. Consequently, the Forum of Regulators constituted a sub-group to survey and identify the best practices in all LDCs in India and recommend suitable measures and roadmap for institution building and strengthening of the LDCs.

### **1.3. Terms of reference**

The terms of reference (ToR) of the sub-group were as under:

- a) To survey various practices in all LDCs in India and international system operators, evolve and recommend Key Performance Indicators (KPIs) to be defined by the Regulatory Commissions
- b) To review functions of LDCs and suggest the future requirements in view of megatrends like Large Scale Integration of Renewables, Storage, Electric Vehicles, Prosumers and Introduction of markets
- c) To evolve the suitable Business Model of LDCs for Financial Autonomy and Funding Mechanism for both the Capital Costs & Recurring Costs to be future-ready
- d) To Identify the Infrastructure, System Logistics, Cyber Secure Information and Communication Requirements for LDCs Functioning in terms of Hardware, Software and Ergonomic Spatial Upgradation
- e) To assess the human resource requirement along with skill-set required for the future Power System Operation and other Support Functions

- f) To evolve Framework for Attracting, Development and Retaining Talent at LDCs in Terms of emoluments, selection/recruitment procedures along with training and certification of System Operators
- g) Any other suggestions related to above

The FOR letter regarding constitution of the sub-group and the terms of reference of the sub-group is enclosed as Annexure-1.

#### **1.4. Members of the Sub-Group**

Members of the Subgroup are given under.

*Table 1: Members of the Subgroup*

|   |                          |                             |                        |
|---|--------------------------|-----------------------------|------------------------|
| 1 | Chairperson              | Sh S. K. Soonee             | Advisor, POSOCO        |
| 2 | Head-SLDC, Gujarat       | Sh. B. B. Mehta             | Chief Engineer (LD)    |
| 3 | Head-SLDC, Maharashtra   | Sh. Anil Kolap              | Chief Engineer (LD)    |
| 4 | Head-SLDC, Tamil Nadu    | Sh. S. Ravichandran         | Chief Engineer (Ops.)  |
| 5 | Head-SLDC, Rajasthan     | Sh R. P. Sharma             | Chief Engineer(LD)     |
| 6 | Head-SLDC, Telangana     | Sh. N. Bhaskar              | Chief Engineer         |
| 7 | Head-SLDC, West Bengal   | Sh. Dibyuendu Bhattacharyya | Addl. Chief Engineer   |
| 8 | Representative of POSOCO | Sh. Vivek Pandey            | Ch. Manager WRLDC      |
| 9 | Member Convenor          | Ms Shilpa Agrawal           | Joint Chief Engg, CERC |

In addition to above the following members were coopted during the first meeting.

|   |                |                          |                              |
|---|----------------|--------------------------|------------------------------|
| 1 | Academia       | Dr. Anoop Singh          | Assoc. Professor, IIT-Kanpur |
| 2 | SLDC-Meghalaya | Mr. Frederick Kharshiing | SE,SLDC                      |
| 3 | NLDC           | Sh. S.R. Narasimhan      | ED, NLDC                     |

#### **1.5. Methodology**

The methodology adopted by the sub-group involved the following key steps:

1. Literature survey
2. Visit to Load Despatch Centres
3. Interaction with LDC personnel, ERCs and other stakeholders (generating companies, licensees)
4. Interaction with international experts
5. Framing questionnaire related to institution building of LDCs
6. Survey of manpower, facilities, technology, international practice, revenue model
7. Analysis of business model
8. Usage of google group/whats-app group for information dissemination and collaboration

Total **11** meetings of the sub-group were conducted to deliberate on various issues as per the terms of reference. The chronology of meetings is tabulated below at table-2.

*Table 2: List of Meetings of the sub-group*

| Meeting No. | Date                      | Venue                        |
|-------------|---------------------------|------------------------------|
| 1           | 20-July-2018              | Through Video Conference     |
| 2           | 28-July-2018              | SLDC Rajasthan (Jaipur)      |
| 3           | 6-Aug-2018                | SLDC Gujarat (Vadodara)      |
| 4           | 14-Aug-2018               | SLDC Maharashtra (Mumbai)    |
| 5           | 31 <sup>st</sup> Aug-2018 | SLDC Telangana (Hyderabad)   |
| 6           | 11 <sup>th</sup> Sep-2018 | SLDC Uttar Pradesh (Lucknow) |
| 7           | 21 <sup>st</sup> Sep-2018 | SLDC Meghalaya (Shillong)    |
| 8           | 21 <sup>st</sup> Sep-2018 | NERLDC Shillong              |
| 9           | 22 <sup>nd</sup> Sep-2018 | SLDC Assam (Guwahati)        |
| 10          | 30 <sup>th</sup> Sep-2018 | Through Video Conference     |
| 11          | 06 <sup>th</sup> Oct-2018 | Through Video Conference     |

The sub-group visited SLDCs of Rajasthan, Gujarat, Maharashtra, Telangana, Uttar Pradesh, Meghalaya and Assam. Interaction with SLDC West Bengal was held through Video Conference. Few members of the sub-group separately visited SLDC Ranchi and SLDC Shimla. The physical visits provided deeper insights into the best practices in each State and the challenges being faced by them. Several suggestions were received while interacting with the personnel and also got their inputs on various terms of reference of the sub-group. Thus sub-group had the privilege of interacting with sixteen SLDCs.

The sub-group also interacted with the representatives of few intra State entities (generators, transmission utilities, open access customers, distribution licensees) to take their feedback and understand their expectations from the LDCs. SERC staff at many locations also provided useful insights during the above meetings. Chairperson AERC, Member AERC and Member GERC provided lot of guidance during the above interaction at the respective SLDCs.

The minutes of all the meetings are collectively enclosed as Annexure-15.

The Sub-Group organized three online surveys. The first survey tried to assess the profile of personnel working in LDCs. The second survey was conducted to see the civil infrastructure of the LDCs and the third survey was conducted to assess the existing IT infrastructure of the LDCs. The Survey questionnaire is enclosed as Annexure-5.

The Sub-group conducted survey of the international ISOs and TSOs to study their infrastructure facilities, organization structure, revenue streams, functional activities and HR practices. A brief report is enclosed as Annexure-6.

While due precaution has been taken to ensure accuracy of data and information received from the respondents of various surveys, the sub-group disclaims any liability for any profit/loss, direct and/or indirect, special or consequential, incidental or possible punitive damage likely to be caused to any third party on account of any errors or omissions in survey data.

Literature survey was conducted to derive learning from other sectors. The list of references is included. The Regulations and orders on LDC Fees and Charges were studied in depth to understand prevailing business and revenue model in various State. The CERC Regulations/Orders for RLDC fees and charges were also studied.

The Sub-group also sought inputs / feedback from the Forum of Load Despatchers during its 26<sup>th</sup> meeting held on 01<sup>st</sup> October 2018.

The draft report of the sub-group was discussed in the 11<sup>th</sup> meeting (through VC) on 06.10.2018.

All the decisions of the sub-group were taken through consensus.

### **1.6. Framing of questions**

The deliberations of the sub-group were held on the following key aspects:

1. What is capacity?
2. What are the dimensions of capacity at the system level?
3. What are the dimensions of capacity at the entity level?
4. What are the dimensions of capacity at the individual level?
5. What is institutional capacity building?
6. What is capacity development?
7. What are the objectives of capacity development?
8. What is the conceptual framework of capacity development?
9. How to identify the stakeholders in the capacity development programme?
10. Factors that make a capacity initiative successful?
11. What is governance and how is it related with capacity development?
12. What are capacity development indicators?
13. What is the role of the grid operator in an environment with high penetration of DER?

14. What might be the regulatory and market needs for LDC strengthening?
15. Are there gaps in current regulatory framework?
16. How to deliver value for customers in future?
17. What might be potential new economic opportunities for the grid operator?
18. How can existing systems be leveraged to support future directions & opportunities?
19. What kind of data, information or clearing houses are needed?
20. Whether independent campus or within commercial building?
21. What is the size and ergonomic requirement?
22. What should the Information Technology roadmap for LDCs?
23. What shall be the philosophy for Main and back-up control centre?
24. What are the existing challenges in IT infrastructure?
25. Should IT development be outsourced or done in-house?
26. How to strengthen seamless flow of information between control centres?
27. How to strengthen data archival and data analytics at LDCs?
28. How to ensure information security?
29. What is the desired architecture for IT?
30. Should the IT architecture be ‘monolith and centralized’ or ‘modular and decentralized’?
31. How to facilitate sharing of best practices in IT infrastructure to avoid re-invention of wheel?
32. How to encourage vendors for niche software applications?
33. How to make an LDC resilient to disasters?
34. How to address governance issues related to data sharing?
35. What would be the normative HR strength in an LDC?
36. Is there a need to strengthen personnel in shift duty?
37. How to encourage capacity building of personnel working in shifts?
38. What would be the desired organogram for LDC?
39. Does the HR requirement increase linearly with system size?
40. What is the preferred Executive to Non-executive ratio?
41. How to attract, retain, nurture talent in Load Despatch Centres?
42. How to ensure career growth and succession planning?
43. What are the required skill sets?
44. How to motivate HR in a profit-neutral set up?
45. How to encourage, facilitate HR capacity building?
46. How to achieve targets for certification of operators?
47. In-house capability or reliance on consultants?
48. How to encourage further inter-LDC engagement?
49. How to enhance international exposure of LDCs?
50. How to encourage participation of LDCs in collaborative activities at international level?

51. How to encourage participation of LDCs in ICPS/NPSC/other national conferences?
52. How to inculcate the culture of peer review?
53. How to encourage interaction between ERCs and LDCs?
54. How to encourage engagement of LDCs with stakeholders?
55. Who should be defined as “Users” of LDCs?
56. How can the revenue recovery model be further simplified?
57. Is it essential to segregate ARR into SOC and MOC?
58. Can SOC and MOC be merged into one?
59. What should be proportion for apportioning SOC / MOC between Users?
60. Should transmission licensees share MOC?
61. How to ensure financial prudence of LDCs?
62. What should be the frequency of truing up?
63. How to encourage realistic and practical CAPEX plan?
64. What should be the framework to monitor CAPEX utilization?
65. Whether the LDC ARR shall be offset with surplus income or considered as Reserves?
66. What should be the heads for which LDCDF could be utilized by LDC?
67. How could LDCDF be utilized for LDC institution building and strengthening?
68. Should LDCs take loan for CAPEX or should they use LDCDF?
69. Whether the funds released from LDCDF should be treated as grant?
70. Should RoE be allowed on CAPEX from LDCDF or not? What would be the rationale?
71. Should depreciation be allowed on CAPEX from LDCDF? What is the rationale?

### **1.7. Scope of the report**

This sub-group has prepared this report in line with the Terms of Reference which has primarily focused on strengthening the Load Despatch Centres in India so as to establish them as sustainable institutions of power system operation & facilitators of an efficient & robust electricity markets. This report has intentionally kept aside the technical issues specific to grid operation & electricity market design so as to bring focus on institution building part rather than digging into the nitty gritty of day-to-day operational issues of the electricity grid & the power market operation. The objective of this subgroup has been more oriented towards developing a meta-tool (the institution) that will take care of development of tools for system operation & market operation.

The points that are not covered intentionally in this report includes (but not limited to) the following:

1. Power System Operation & Control - Stability & Reliability Issues
2. Market Design Issues – Scheduling, Deviation Settlement, Open Access, Reconciliation
3. Other issues on day-to-day operation of power system & electricity markets

\*\*\*

## 2. Interface of LDCs with other stakeholders

कबीरा खड़ा बाजार में, मांगे सबकी खैर / ना काहू से दोस्ती – ना काहू से बैर // – कबीर

Power System Operation is a distinct, overarching and multi-dimensional activity. The Load Despatch function performed by power system operators has been recognized by the MoP Committee (*on Manpower certification and incentive for system operation and ring-fencing load Despatch Centres*) [2][5] as a ‘mission critical activity’ for uninterrupted and reliable power supply; a facilitator for an efficient electricity market; an “optimizer” of precious power generating resources; an ‘instrument’ for equitable and fair use of transmission infrastructure and an ‘indispensable link’ between the managers, administrators, planners and regulators on one end and the physical system on the other end. Accordingly, the Load Despatch Centres (LDCs) interact with multiple entities & stake holders including market players, planners, regulators & policy makers. The existing and envisaged interactions of Load Despatch Centres with different stakeholders are summarized in the subsequent sections.

### 2.1. Generating companies

The Load Despatch Centres in India interact either directly with Generating Stations or through their centralized control centre (s) or head-quarters in different time horizons (day-ahead, real time and post-facto). The various interactions taking place at present conditions as well as the interactions envisaged for future are summarized at table-3 below:

Table 3: Interactions of LDCs with Generators/Suppliers

| Present Interactions with Generators   | Envisaged interactions in future   |
|--|--|
| <ul style="list-style-type: none"><li>User Registration (with LDCs)</li><li>Grid Integration: Connectivity, Metering, Protection, SCADA &amp; Communication, Statutory Compliance</li><li>Commencement of Grid Access – for start-up</li><li>Trial Run &amp; Commercial Operation</li><li>Commencement of scheduling &amp; dispatch</li><li>Compliance Monitoring (grid standards, LVRT etc.)</li><li>Compliance monitoring for grid code (gaming etc.)</li><li>Imbalance, Congestion Management, voltage Regulation, primary response, switching, part load operation &amp; reserve shut down</li></ul> | <ul style="list-style-type: none"><li>Automatic Generation Control (AGC)</li><li>Hydro-Thermal-RE coordination</li><li>Supply side adequacy - Fuel Adequacy, Associated constraints</li><li>Renewable forecasting,</li><li>Net load assessment</li><li>Hydrological constraints</li><li>Optimization,</li><li>Assessment of Flexibility need</li><li>Coordination with flexibility resources - Energy Storage, PSP, demand response, EV charging stations etc.</li><li>Tests for Primary Responses, reactive capability</li><li>Market based procurement of Ancillary services –</li></ul> |

| <b>Present Interactions with Generators</b>   | <b>Envisaged interactions in future</b>   |
|---|---|
| <ul style="list-style-type: none"> <li>• Tripping analysis, protection coordination, SPS design</li> <li>• Restoration, black start exercise</li> <li>• Stability assessment, PSS tuning, oscillation monitoring</li> <li>• Capacity building Work-shops of various aspects on system operation, market operation, regulatory affairs etc.</li> <li>• Data analysis &amp; Information dissemination – Feedback on system operation &amp; market operation.</li> </ul> | <ul style="list-style-type: none"> <li>with Markets for secondary &amp; tertiary reserves, AGC, voltage control ancillary services, fast regulation services (FRAS), black start services</li> <li>• New market products, Faster (5- min) scheduling, dispatch &amp; settlement, short &amp; long term reserves, flexibility service</li> <li>• Micro-grids, Distributed generation, Prosumers, Aggregators</li> <li>• Enhanced data analytics &amp; information sharing, input to policy makers/regulators.</li> </ul> |

## **2.2. Transmission licensees**

Transmission licensees are responsible for developing a robust & secure EHV grid for facilitating transfer of power with reliability & economy. In India, the state transmission utilities (STUs) are entrusted with the responsibility of operating the SLDCs where-as the RLDCs are being operated by an independent central govt. corporation (POSOCO). Thus the LDCs in India perform the role similar to that of a non-switching ISO (independent system operators) at the inter-state level and TSOs (transmission system operators) at the intra-state level. The associated complexity of managing the grid has increased manifold with the ever expanding EHV transmission network comprising of multiple voltage levels & carrying capacities (viz. 765 kV to 33 kV AC lines, 800 kV to 500 kV DC lines, 1500 MVA to 100 MVA ICTs, shunt reactors, FACT devices and more) owned by multiple public and private licensees. This has exponentially increased the coordination efforts on many fronts viz. facilitating of first time charging of elements, trial operation verification & certification, coordination of planned & forced shut-downs, transfer capability assessment, reactive power management & voltage control, congestion management, event analysis etc. The following table-4 summarizes the level of current interactions with list of envisaged future activities.

*Table 4: Interactions of LDCs with Transmission Licensees*

| <b>Present Interactions</b>   | <b>Envisaged interactions in future</b>  |
|---|--|
| <ul style="list-style-type: none"> <li>• User Registration (with LDCs)</li> <li>• First time charging coordination for grid connectivity, Metering, Protection, SCADA &amp; Communication, Statutory Compliance</li> <li>• Review of Telemetry status for real time data transfer</li> <li>• Trial Run &amp; Commercial Operation</li> <li>• Compliance Monitoring for grid standards &amp; regulations</li> <li>• Switching Coordination for facilitating planned &amp; forced shut-down, voltage control, power flow control, congestion management etc.</li> <li>• Transfer capability assessment</li> <li>• Transmission system Availability Verification</li> <li>• Tripping analysis, Protection coordination</li> <li>• SPS design &amp; implementation</li> <li>• Network Restoration coordination</li> <li>• Dynamic stability assessment - oscillation monitoring using WAMS &amp; other analytical tools</li> <li>• Capacity building Work-shops of various aspects on system operation, market operation, regulatory affairs etc.</li> <li>• Computation of Point of Connection Transmission charges &amp; transmission loss</li> <li>• Data analysis &amp; Information dissemination – Feedback for coordinated network planning, protection audit etc.</li> </ul> | <ul style="list-style-type: none"> <li>• Coordinated network planning, network reconfiguration for congestion management</li> <li>• Connectivity Studies for RE Integration</li> <li>• General Network Access</li> <li>• Loss Optimization</li> <li>• Optimization of FACTS device settings</li> <li>• Network Operation statistics - Performance assessment of transmission utilities against the standards of performance, Availability verification, assessment of communication system availability, Performance of Interface meters,</li> <li>• Voltage regulation Services through - STATCOMs</li> <li>• Emergency Restoration Services during crisis.</li> <li>• Web based tools for first time charging coordination, shutdown coordination</li> <li>• Wide Area Monitoring for better protection coordination</li> <li>• Improving situational awareness with advanced analytics on Wide area monitoring systems (WAMS)</li> <li>• High bandwidth communication network for implementation of new regulations (AGC etc.) &amp; other smart grid concepts</li> <li>• Evolution of Transmission Pricing - Locational Marginal Pricing / Nodal Pricing etc.</li> <li>• Carriage-Content separation</li> <li>• Enhanced statistical analysis &amp; information sharing, input to policy makers/regulators.</li> </ul> |

### 2.3. Distribution licensees

The Load Despatch Centres interact with Distribution Licensees for integrated grid operation, optimum scheduling & dispatch of power within their control areas. Presently, there are some states in India, with multiple discom-level control centres e.g. in New Delhi (BSES, TPDDL, NDMC & MES) and in Mumbai (TPC, Chembur & RInfra, Aarey Colony) etc. which perform the roles similar to that of a Distribution System Operator (DSO). The following table gives a brief account of the current areas of interaction with Distribution Companies and the future scope in view of the emerging trends.

*Table 5: Interactions of LDCs with Distribution Companies*

| Present LDC-DISCOM Interactions   | Envisaged interactions in future   |
|---|--|
| <ul style="list-style-type: none"> <li>• User Registration (with LDCs)</li> <li>• LDC Fees &amp; Charges payment</li> <li>• Demand side management, Safety-net in the form of AULFS, AUFLS, ROCOF load shedding etc., Islanding scheme etc.</li> <li>• Load Forecasting</li> <li>• Auxiliary power supply for FACT devices, HVDC s/s etc.</li> <li>• Scheduling/Rescheduling of Power</li> <li>• Energy Accounting &amp; Settlement</li> <li>• Deviation Settlement Mechanism</li> <li>• Transaction with Intra-state &amp; inter-state pools<br/>For DSM, Reactive &amp; Congestion charges</li> <li>• Facilitating participation in short term market (Bilateral, PX) – NOC grant, scheduling etc.</li> <li>• REC Mechanism, RPO Compliance</li> <li>• Transmission Charge &amp; loss sharing</li> <li>• Information dissemination</li> </ul> | <ul style="list-style-type: none"> <li>• Distribution System Operator (DSO) functions like operating the distribution grid, managing Distributed Energy Resources (DERs) etc., coordinated operation between distribution &amp; transmission grids for switching, managing bi-directional power flow, optimized shutdown processing etc.</li> <li>• Coordination with deemed licensees (Indian Railways)</li> <li>• Coordinated system planning, GNA</li> <li>• Coordinated planning of Communication Infrastructure</li> <li>• RE forecasting, scheduling and deviation settlement,</li> <li>• Congestion management in distribution network</li> <li>• Managing DERs by DSO- TSO, DSO-ISO interactions</li> <li>• Planning studies to facilitate the "multiple use" of DERs</li> <li>• Coordinated load forecasting, demand side management</li> <li>• Feedback &amp; information dissemination for the better planning &amp; optimisation, Common Information Registry for better interaction</li> <li>• Providing appropriate signals to the LDCs on the technical needs of the distribution system.</li> <li>• Separation of Wire business &amp; supply business</li> <li>• Creating platform for existing &amp; new players, Prosumers, iDSOs (independent DSOs), Data Management Operators (DMOs), Distribution Network Operators (DNO) etc., Aggregators, Demand Response service providers, EV charging units etc.</li> </ul> |

## 2.4. Market intermediaries and aggregators

Apart from the generating stations, transmission & distribution licensees, the LDCs do interact with several market players viz. the traders, aggregators (viz. energy exchanges) etc. for operation of a fair, transparent & vibrant electricity market. Presently, there are multiple intra-state trading licensees and 2 power exchanges in India. Similarly, recent intra-state regulations on Renewable forecasting, scheduling & imbalance handling notified by several SERCs have defined the term aggregator (or qualified coordinating agencies - QCA) as one who would coordinate on behalf of a group of generators for interacting with SLDCs/RLDCs/RPCs for scheduling, metering & commercial settlement for transactions in electricity. The following table summarizes the current areas of interaction with such entities and the future scope in view of the emerging trends.

*Table 6: Interaction of LDCs with Market Intermediaries*

| Present Interactions   | Envisaged interactions in future   |
|--|--|
| <ul style="list-style-type: none"> <li>• Registration (with LDCs)</li> <li>• Short Term Open Access</li> <li>• Sale of URS power</li> <li>• Scheduling &amp; rescheduling</li> <li>• Payment of STOA charges</li> <li>• Commercial settlement</li> <li>• TDS reconciliation</li> <li>• Pooling &amp; De-pooling</li> <li>• Regulatory Compliance – Regulation of power</li> <li>• Reporting &amp; Information dissemination</li> </ul> | <ul style="list-style-type: none"> <li>• Aggregators being recognized as distinct entities</li> <li>• Aggregators at retail level (carriage-content separation)</li> <li>• Community Choice Aggregators (CCAs)</li> <li>• Capacity market</li> <li>• Flexibility services</li> <li>• DERs, EVs, Storage services, demand response</li> </ul> |

## 2.5. Other control centres

The system operator working at the LDCs in India (SLDCs, RLDCs) do interact with several other control centres on a wide spectrum of issues. The SLDCs interact directly with RLDCs for coordinated system operation, optimal scheduling and dispatch in a decentralized fashion, information dissemination for feedback & improvement etc. Similarly, the SLDCs do interact with sub-LDCs or area load dispatch centres which act as an extended branch of the SLDC for managing grid operation issues at their area of jurisdiction. Detailed function of existing sub-LDCs are given at Annexure-12. The SLDCs do also interact as state nodal agencies with the NLDC for facilitation of REC mechanism, activities of FOLD working groups etc. Similarly, there is regular interaction between RLDCs & NLDC on real time grid operation, coordinated scheduling & dispatch of power over trans-regional & trans-national corridors, PX scheduling, transfer capability assessment, network model updating, coordinated event analysis and more. Similarly, all RLDCs interact with control centres of

Transmission Asset Owners viz. RTAMC in real time grid operation viz. switching & shutdown coordination etc. The following table gives a summary of existing areas of inter-control centre interactions as well as the interactions envisaged in a more evolved power system.

*Table 7: Interactions of LDCs with other control centres*

| Present Interactions  | Envisaged interactions in future  |
|---|---|
| <b>SLDC - RLDC</b>  |   |
| <ul style="list-style-type: none"> <li>• Coordinated grid operation, transfer capability assessment, frequency response monitoring etc.</li> <li>• New element integration, renewable integration</li> <li>• Shut down coordination</li> <li>• Event Reporting &amp; analysis</li> <li>• Optimum scheduling &amp; despatch</li> <li>• Pool account management, Settlement &amp; reconciliation</li> <li>• Deviation settlement</li> <li>• Operational, Commercial, Protection &amp; system planning.</li> <li>• FOLD</li> <li>• Operational feedback</li> <li>• Implementation of regulatory amendments</li> <li>• Reporting &amp; information dissemination</li> </ul> | <ul style="list-style-type: none"> <li>• Interaction with Transmission control centres</li> <li>• Distribution control centres</li> <li>• Micro grid control centres</li> <li>• Energy Storage control centres</li> <li>• EV Charging control centres</li> <li>• Demand Response control centres</li> <li>• Communication control centres</li> <li>• Meter data management Control Centre (e.g. smart meter data management)</li> </ul> |
| <b>SLDC – NLDC</b>  |   |
| <ul style="list-style-type: none"> <li>• REC Mechanism,</li> </ul>  |   |
| <b>RLDC – NLDC</b>  |   |
| <ul style="list-style-type: none"> <li>• Real time grid operation</li> <li>• Transfer capability assessment</li> <li>• Coordinated tripping analysis, event reporting</li> <li>• Scheduling &amp; despatch on trans-regional / trans-national links</li> <li>• Scheduling of Collective transactions</li> <li>• Despatch of Ancillary Services</li> <li>• Operational Feedback, information sharing, FOLD interaction</li> <li>• Collaborative research &amp; paper publication</li> </ul>  | <ul style="list-style-type: none"> <li>• Smart distribution substation control centres (MV/LV substation)</li> <li>• Network customer control centres (e.g. for auto registration of customers and changes in customer installations)</li> <li>• Renewable Energy Management Centres (REMCs)</li> </ul>   |
| <b>SLDC- Sub-LDC</b>  |   |
| <ul style="list-style-type: none"> <li>- Shut down coordination at lower voltage level</li> <li>- System Restoration, tripping analysis etc.</li> <li>- SCADA/Communication availability for RES</li> </ul>   | <ul style="list-style-type: none"> <li>• IMD, Weather service providers</li> <li>• Railways, SEZ</li> <li>• SAARC Grid Operators</li> <li>• Gas Grid Operators</li> </ul>   |

## **2.6. Coordination forums**

Section 166 of the Electricity Act, 2003 provides for a coordination forum, at both central and state level, for smooth and coordinated development of the power system in the country. Similarly, Section 80/87 provides for constitution of the Central/State Advisory Committee to represent the interests of commerce, industry, transport, agriculture, labour, consumers, non-governmental organizations and academic and research bodies in the electricity sector at both central and state levels. The LDCs interact with following coordination forums.

- Operation Coordination Committee (OCC), Protection Coordination Committee (PCC), Commercial Coordination Committee (CCC), Transmission Coordination Committee (TCC) etc. formed by the regional power committees and
- Intra-state Grid Coordination Committees, Commercial Committees
- Regional Standing Committee on Power System Planning constituted by the Ministry of Power,
- National Power Committee (by CEA, MoP)
- Forum of Regulators (FOR) constituted by ERCs under section 166(2) of the Act
- Technical Sub-Committee of the FOR
- Different Ministry of Power Committees from time to time in emerging areas such as Hydro Generation as a source of peaking, MoP Committee on silt management, MoP Committee on Integrated reservoir operation etc.
- MOP Committees for RE Integration etc.

LDCs would play a crucial role in flagging the ground level issues at the different state/regional/national fora.

## **2.7. Planners**

In July, 2018, the CERC notified (Planning, Coordination and Development of Economic and Efficient Inter-State Transmission System by Central Transmission Utility and other related matters) Regulations. The regulations lay down the broad principles, procedures and processes to be followed for planning and development of an efficient, co-ordinated, reliable and economical system of inter-State transmission system (ISTS) for smooth flow of electricity from generating stations to the load centres. LDCs have been mandated to provide periodic operational statistics and feedback to the CTU/STU so as to maintain transparency at all stages of planning of augmentation or strengthening of ISTS. Further, there could be synergy by close coordination between operators and planners for integrated design, delivery and operation.

## **2.8. Policy makers**

With increasing focus on power sector in general & on fast switching over to clean energy in particular, the policy makers (viz. MOP, MNRE) and power system planners (CEA, CTU) have been interacting with the system operators at all levels to arrive at the right decisions in the interest of the

Indian Power Sector. The relationship of the LDCs with the Ministry of Energy/Power in State / Central Government, NITI Aayog, Parliamentary Committees, Legislative Committees, Performance Auditors etc. is crucial in the sectoral reform process. The LDCs interact with the stakeholders on a day-to-day basis. Hence they can provide valuable insights and information for policy making.

### **2.9. Regulatory commissions**

As change agents, the LDCs need to implement regulations and standards in impartial & transparent manner. The central & state electricity regulatory commissions closely interact with LDCs during floating of discussion papers, staff papers, public hearings on draft regulations, implementation of new regulations & orders etc. Further, the LDCs are impleaded as default respondents while dealing with petitions and the regulators seek opinion of system operators on various matters. Feedback by LDCs serves as a critical input for the ever evolving regulatory regime in the country.

Presently, there is increased thrust over compliance oversight and Non-compliance reporting due to overarching regulatory framework provided by the different regulatory institutions. The interaction between the LDCs & ERCs is likely to increase manifold in several emerging areas viz. RE integration, Hybrid RES & Storage system integration, EVs, DERs, Flexibility Services, ancillary services, designing business model for the evolving energy market etc.

### **2.10. Judicial bodies**

LDCs being distinct statutory organisations entrusted to play the role of a transparent & neutral body are often considered as friends of the Court & thus impleaded to assist the judiciary bodies in the court proceedings in matters related to electricity industry. The Central/State Governments at times issues letters directing the appropriate LDCs to defend in courts on behalf of the government in cases where both the Government and LDC are respondents. There are several levels of interactions of LDCs with the Tribunals/ Judicial bodies viz. the APTEL, High Court Supreme Court etc. With increasing interactions with different market players, entities in the sector, the system operators in future would be required to engage legal counsels, be present in court proceedings and public hearings in multiple legal cases & litigations.

### **2.11. Auditors**

The LDCs being statutory organisations & distinct business entities are subject to several audit procedures. Accordingly, they periodically interact with Statutory Auditors, CAG, Energy Auditors, Quality Management (IMS) & Information Security (ISMS) auditors etc. Further, the CAG Performance Auditors and Financial Auditors perform periodic audits to promote accountability, transparency and good governance through high quality auditing and accounting and provide independent assurance. The Security Auditors, IMS /OHSAS Auditors, Fire Safety Audits, Energy Efficiency, Energy Conservation Audits and Structural Audits are crucial for LDCs as benchmark to the world-class specifications for products, services and systems, to ensure quality, safety and

efficiency. With the fast changing statutory regimes and business environment where-in the role of LDCs are expanding across several functional & cross functional areas, such interactions with different auditors are likely to multiply in foreseeable future.

## **2.12. Academia and research agencies**

Industry academia interaction is essential to bring together the research professionals and practicing engineers in identifying problems and evolving possible solutions. The present & future scope for interaction with Academia is summarized under.

*Table 8: Interaction of LDCs with Academia and research*

| <b>Present Interactions</b>  | <b>Envisaged interactions in future</b>   |
|--|---|
| <ul style="list-style-type: none"> <li>• Collaborative Research &amp; Development projects with NITs/ IITs etc. on new technology &amp; processes, data analysis etc.</li> <li>• Implementation of regulatory reform (POC-Mechanism)</li> <li>• Encouraging R&amp;D through Award Programs (e.g., PPSA)</li> <li>• Participation of LDC personnel in National &amp; International conferences organized by Academic Institutions by paper presentation,</li> <li>• Guest lectures on domain specific area</li> <li>• Training &amp; Capacity building</li> </ul> | <ul style="list-style-type: none"> <li>• Collaborative research on common power system issues/challenges with data based statistical analysis</li> <li>• Pilot Projects on new areas such as visualization, grid expert system, Artificial Intelligence, Augmented Reality, Block chain framework etc.</li> <li>• Revision of syllabus in line with emerging industry need.</li> <li>• Skill upgradation/continuing education program</li> <li>• Certification in specialized areas such as Law, Public Policy, Economics, IT, Statistics, behavioural science etc.</li> <li>• Model Validation,</li> <li>• Enhanced participation in IEEE/CIGRE working groups</li> <li>• Participation in Web-Sessions (webinars etc.)</li> </ul> |

## **2.13. Interns**

Human resource is the key asset of load despatch centres. Many LDCs across the country conduct internship programs as a part of industry – academia outreach initiative. Such internship programs aim to enlarge the pool of talented individuals & potential system operators. The feedback given by the interns to their institutes would help in customizing & upgrading their curriculum. Similarly, the internship projects /assignments done by the interns can be gainfully utilized by the LDC professionals. Considering the fact that LDCs have to compete with other industries to attract talent, internships offer a unique opportunity for LDCs to brand themselves uniquely and ‘catching them young’.

## **2.14. Multilateral agencies, technical bodies**

LDC personnel engage to an extent with the multilateral agencies and technical bodies such as CBIP, TERI, GIZ, USAID, IEA, GO15, CIGRE, IEEE, IEC, Institution of Engineers, NASPI, International

Confederation of Energy Regulators (ICER), World Energy Council (WEC), IRENA, etc. for peer learning, evolving consensus on strategic issues, developing common vision, benchmarking, surveys.

### **2.15. Consultants and vendors**

LDCs rely on information technology with components having high obsolescence rate. A few of the applications (such as SCADA/EMS/WAMS) are offered by a limited number of vendors and costs are high. Thus, they need to collaborate with national and international consultancy firms for upgradation & deployment of new technology, developing specifications, execution, compliance testing.

### **2.16. Associations, consumer groups, NGO**

The LDCs also interact with several Non-Government organizations (NGOs) & associations, consumer groups for undertaking CSR activities mandated by the Companies act, promoting the GOI initiatives on several areas such as energy efficiency, vigilance and sanitation as directed by the concerned ministry / authority from time to time. Market domination, thwarting competition etc. are also issues which would lead to engagement at the Competition Commission level.

### **2.17. Peers**

LDCs with their hands-on experience in managing a large (176 GW) synchronous grid, could take up consultancy assignments within the country and abroad in the following area.

- Management and engineering in the context of the study
- Training aimed at gaining new skills
- Tailor-made seminars to provide updates on the latest developments in the field
- Expert advice and consulting on specific issues
- Technical assistance with short or long-term projects
- Specialized Software for the management of the electricity grid systems and data analytic tools.

### **2.18. Summary**

The load despatch centres play a crucial role in the entire electricity value chain comprising the generators, licensees, consumers, market intermediaries etc. With the evolving energy landscape, the role of LDCs would be more critical and the level of interaction of system operators with existing & evolving players in the sector is likely to grow manifold. The following extracts of the November 2005 report titled "*The Value of Independent Regional Grid Operators*" published by the ISO/RTO Council are highly relevant in this matter.

*"Today's power industry is far more than a collection of power plants and transmission lines. Maintaining an effective grid requires management of three different but related sets of flows – the flow of energy across the grid; the exchange of information about power flows and the equipment it moves across; and the flow of money between producers, marketers, transmission owners, buyers, and others. ISO/RTOs play essential roles in managing and improving all three of these flows."*

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### **3. Functional Activities of LDCs**

चन्दनं शीतलं लोके, चन्दनादपि चन्द्रमा: | चन्द्रचन्दनयोर्मध्ये शीतला साधुसंगतिः ||

The functions of Power System Operators in the Electricity Supply Industry in India has been evolving with the integration of power systems, increase in electrical energy demand, growth in the economy and changes in technology, regulations, market design, administration and management of the power system. The Load Despatch Centres have to function round-the-clock with suitably skilled manpower for System Operation, Market Operation, research, analysis, regulatory affairs, logistics (system data acquisition, Energy Management, Communication, IT systems) and other establishment services to carry out the various functions.

The Committee on ‘Manpower, Certification, and Incentives for System Operation and Ring-fencing Load Despatch Centres’ (Pradhan Committee) had estimated a total requirement of 60-70 persons for each State Load Despatch Centre in Aug 2008. The committee had grouped all the activities of SLDCs under four major divisions namely - System Operation, Market Operation, System Logistics (system data acquisition, Energy Management, communication, IT systems) and Establishment Services.

However, in the past decade, the grid management has transitioned from supervisory role to sophisticated controls in terms of Automatic Generation Control, Automatic Demand Management Systems, System Integrity Protection Systems, Demand Side Response, Smart Grid, Transactive Energy, Advance metering Architecture/Smart Grid. There is now an increased thrust on optimization – Economic Dispatch, Energy Optimization, Asset Optimization and Demand Optimization. Based on the envisaged interactions with other stakeholders, the functions have been further detailed.

#### **3.1. System Operation**

##### **i. Operational Planning**

The aim of a power system is to supply electric energy with reliability, economy and sustainability. Operation planning activities in India cover three months in advance to a day ahead timeframe. All planned outages for the day of operation are evaluated during this period and curtailment of transactions required, if any, are informed to all stakeholders including the real time operators. The pre-conditions for availing the outage are clearly defined. Operation planning is done based on specified security criteria. Until the last decade, the operational planning was primarily focussed on reliability of supply. With unbundling and liberalization of energy markets, growing penetration of renewable sources of energy, changing regulatory regimes, the system operators are required to be oriented towards new and advanced reliability assessment tools, preventive and corrective measures, self-healing techniques and resilience aspects of operation. Some of the new

work domains include Load Forecasting, RE forecasting, Fuel security assessment, Production cost optimization studies, Generation outage planning, Transmission outage planning, Assessment of Transfer Capability, Reactive Power studies, Short circuit and transient stability studies, Small signal stability studies, Electromagnetic transient studies, Mock black start drills, Activation of back up control centre, Preparations for special events like festivals, natural calamities like cyclone, floods etc. and Documentation of procedures (operating, restoration).

## **ii. Scheduling**

A multi-lateral coordinated model has been implemented in India for scheduling. At the regional level, the RLDCs are responsible for scheduling generation from Inter State Generating Stations (ISGS), drawal schedules of states and any market related trades/transactions. The power system under each SLDC constitutes a notional control area in which the states have full operational autonomy and their SLDCs shall have the total responsibility for scheduling and despatch of their own generation (including generation of their captive licensees), regulating the demand of their customers, scheduling of their drawal from ISGS, arranging any bilateral exchanges & Power Exchange Transactions scheduling and regulating their net drawal from the regional grid. With increasing number of distribution resources, there are increased domains for scheduling coordinators such as Day ahead security studies factoring all outages, Day ahead unit commitment, Day ahead optimization and scheduling, Crew Resource Management, Anticipating and mitigating congestion, Preparation for special events and handling requests for emergency/urgent outages unforeseen in operational planning horizon.

## **iii. Real Time Operation**

The real time operation includes close monitoring of the system parameters, such as frequency, voltages, line loadings, while facilitating inter-state / inter-regional power exchanges in accordance with Indian Electricity Grid Code (IEGC). Energy Management system (EMS) modules implemented in the different control centers (NLDC/RLDCs/ SLDCs) consists of various applications covering wide spectrum of functions like Pre-dispatch, Real time dispatch and Post-dispatch functions. The Energy Management System (EMS) tools such as state estimation, contingent analysis, optimum power flow, load forecasting, resources scheduling has provided system operators greater flexibility in taking appropriate and judicious decisions during the course of operation. The control room operator has to be equipped with latest technological tools to manage the grid for Frequency Control, Voltage control, Tie line loading or congestion management, Ensuring N-1 security at all times, Real Time Contingency Analysis, Dynamic Security Assessment, Monitoring weather updates, Handling emergency outage requests, Restoration of network after tripping, Rescheduling of generation, Information dissemination to authorities in case of a grid disturbance/grid event, Periodic

communication with relevant stakeholders and sensitizing in case of emergencies and de-briefing after an extreme event.

#### iv. Post-despatch analysis

The need for post event analysis in large power grids is very important as far as power system operations are concerned. Many incipient problems can be diagnosed in the root itself. The probable result of not doing the post-despatch analysis will have catastrophic effects on the power system. The availability of synchro phasors has considerably enhanced the wide area visualization and situational awareness of power system behaviour under steady state as well in transient/dynamic conditions. The availability of synchro phasor data at control centre has become first-hand information for grid operator to view and analyze any transient phenomenon occurring in the grid. Various events that went unnoticed with Supervisory Control and Data Acquisition (SCADA) system are now being detected and analyzed, opening up a completely new era in power system monitoring and control.

There is a paradigm shift in monitoring the grid after the commissioning of synchro phasor projects. Now-a-days control centre operator first observes the signature of events through PMUs data and then refers to SCADA system for the details of the events. Since the commissioning of synchro phasor pilot projects in India, the synchro phasor data available at the LDCs has been utilized for real time visualization and also for post-dispatch analysis in offline mode. There are more avenues for the post-despatch analysis in the areas such as analysis of frequency and voltage, analysis of Grid Code violations and follow up with agencies, analysis of tripping in the transmission system, evaluating primary response through Frequency Response Characteristics (FRC), Low Frequency Oscillations (LFO) monitoring and analysis, detailed reports of Grid Disturbances/Grid Events, simulation of events and learnings thereof, event replay, lessons learnt and dissemination of same, Taking up shortcomings with stakeholders and operational feedback to CEA and CTU/STU.

### 3.2. Market Operation

Promotion of competition in the electricity industry in India is one of the key objectives of the Electricity Act, 2003 (the Act). In line with the mandate of the Electricity Act and the National Electricity Policy, competitive procurement of generation and transmission has been implemented in the country. Section 62 & 63 of the Electricity Act, 2003 provide for tariff regulation and determination of tariff of generation, transmission, wheeling and retail sale of electricity by the appropriate commission. In order to facilitate competitive procurement of power by the distribution licensees, the Ministry of Power has provided *Standard Bidding Guidelines and Standard Bidding Documents*. As per section 66 of the Electricity Act 2003, appropriate commission is envisaged to promote development of a market (including trading) in power sector in such manner as may be specified and shall be guided by the National Electricity Policy. The Electricity Act, 2003 recognizes trading as a distinct licensed activity. CERC issues license for inter-state trading under CERC

(Procedure, Terms and Conditions for grant of trading license and other related matters) Regulations, 2009.

The trading licensees undertake electricity transactions through bilateral mode and by bidding in power exchanges. Since inception, both short term bilateral and collective trade have been increasing persistently both in terms of number and volume transacted. Private sector participation has been encouraged for bringing forth competition, economy & efficiency. With the advent of open access and de-licensing of generation, many private sector players established generation and participate in the open electricity market through bilateral contracts and power exchanges. With the advent of new actors such as distributed generation, storage, electric vehicles, aggregators etc., there is a need for renewed thrust in the areas such as Market Design, Open Access Administration, Day Ahead Market, Real Time Market, Ancillary Services Market, Metering, Accounting, Settlement & Pool Accounts, Tax reconciliation & LDC fees and charges etc. With introduction of ancillary services, forecasting scheduling & deviation settlement regulations for RES, demand for market based instruments (balancing & flexibility services viz. AGC, fast response tertiary regulation, ramping, load following etc.) is likely to arise on a significant scale. Suitable framework for scheduling, metering & settlement would be required. Accordingly, the LDC personnel need to be equipped with the necessary expertise & skillset to facilitate emerging needs of a vibrant electricity market.

### **3.3. Decision support systems**

Wherever feasible the LDCs should have a separate office campus with infrastructure security and modern amenities. In case of real estate constraints, the LDC may be housed within a secure commercial complex. Most of the LDCs are located in cities where getting accommodation is a challenge. Therefore, provision of residential accommodation for the LDC employees is desirable. Alternately the company could accommodate their employees in residential premises taken on lease by the company. Transit Camps / Field hostel / Guestroom facilities needs to be created for transit accommodation for visitors to LDC. There shall be adequate redundancy of communication system for LDCs so as to ensure high availability of real-time data, other web-based facilities (scheduling, open access etc.), video conference facility etc. LDCs shall have communication system experts to coordinate with the Communication Service Providers.

LDCs need to build in-house capabilities for modelling (network & market), simulation studies and optimization. Over-reliance on external consultants may not be desirable. The States rich in hydro resources would have to coordinate with water resource and irrigation department. Pumping load of Lift irrigation projects and Pumped Storage hydro stations could be used in a versatile manner. The LDCs require people with capabilities who could design mechanisms to exploit the inherent potential of hydro resources. After unbundling the LDC need to coordinate between different entities in a non-discriminatory manner. For fail-safe operation of LDCs even in case of a disaster, the back-up LDC should be planned and maintained as Main-I / Main-II rather than Main and Back-up. The LDC

functions shall be carried out from Main I and Main II at periodic intervals. CERC Communication systems Regulations be complied with and each State may come out with similar Regulations for State. Thus, the focus areas essential for building and strengthening of infrastructure in LDCs are Engineering of new SCADA/EMS upgrades, Synchro-phasor technologies, Real time Applications, Off-line applications, Big Data Analytics tools, Website development, upgrading and maintaining, Cyber security, Access control, Conference call facilities (multiple), conference rooms, work Area for statutory auditors, Workstations for guests/interns, Guest Wi-Fi, Power supply system, fire-fighting, ergonomics, public address system and operational philosophy (in house development/technology partner/outsourcing).

### **3.4. Human resource management**

HR functions include manpower projections, recruitment/attract talent, induction level training, continuing education/learning and certification, publication of papers and reports, annual appraisals vs continuous performance management, Key Performance Indicators (KPIs - for LDC departments, individuals), motivational tools, sabbaticals, job rotation, succession planning, physical, mental, social and emotional wellbeing, policy for outsourcing, summer/winter internships, employee welfare benefits such as gymnasium, crèche, rest areas for shift personnel, gender inclusiveness, special health programs for shift personnel, professional engagement (PE) through conferences/workshops within India and abroad, knowledge management(KM) and work life integration.

### **3.5. Finance and accounts**

The commercial, finance and accounts functionalities in a LDC have a critical role to play in the administration of system operation, market operation and system infrastructure development. The major focus areas include separate balance sheet and Profit & Loss Account for LDC, audit of balance sheet periodically, separate bank account for LDCs and Pool Accounts, financial powers at LDC level, settlement of employee claims, settlement of third party claims, timely filing of tax returns and other statutory compliances and follow up in respect of tax refunds.

### **3.6. Contracts & Materials**

With increasing technological advancements year on year, the hardware & software have to be upgraded in a periodic manner without any disruption to the grid management and electricity market functionalities. There is a need for trained manpower specifically for contracts and materials to support in establishment services such as E-procurement & reverse auctions, no of orders placed every year (supply/service), monitoring of single tender cases, monitoring of contract extension, re-tendering etc., timely refund of EMDs, timely return of Bank Guarantees and periodic disposal of scrap and buyback provisions etc.

### **3.7. Legal & regulatory affairs**

The system operators have the onerous responsibility to act as vital link between the physical system and administrators & regulators. Therefore, there is enhanced role for system operators in Policy Capacity Building of Indian Load Despatch Centres

Forum of Regulators

advocacy, Participation in regulatory process at CEA/CERC/SERC levels, handling of RTI cases, timely filing of responses in petitions, engagement of lawyers/counsel for cases, analysis of regulatory orders and using it as a feedback for improving internal processes, handling Parliament/Vidhan Sabha questions and handling issues like Sexual Harassment of Women at workplace.

### 3.8. Summary

Considering the different key functional areas, current & envisaged activities for the load despatch centres, the sub-group developed a typical organogram for a Load Despatch Centre as under:

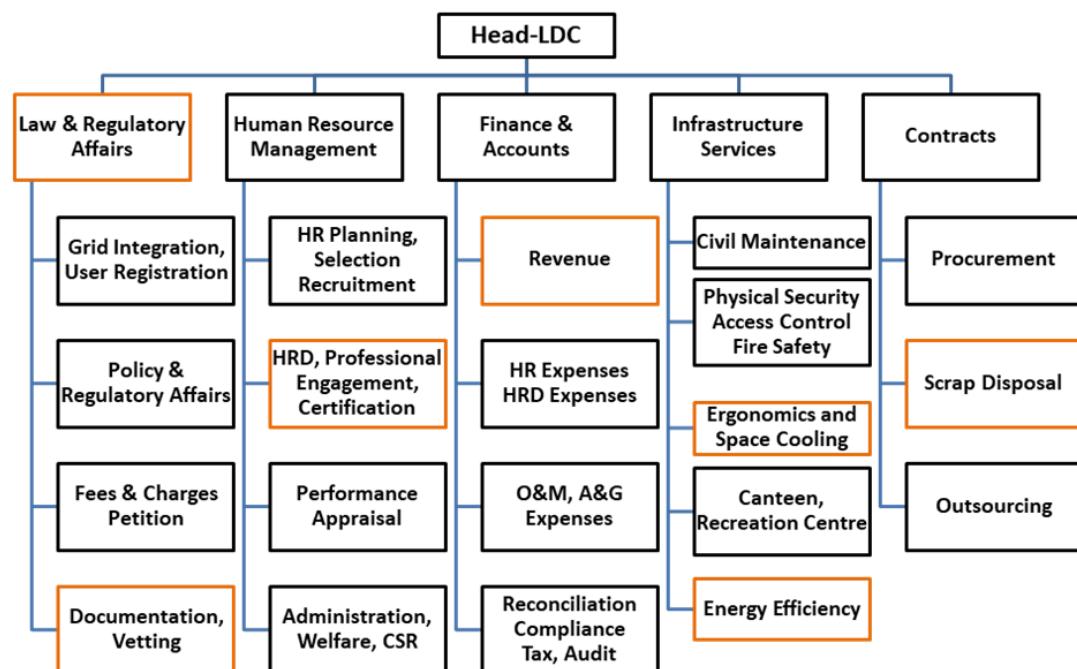
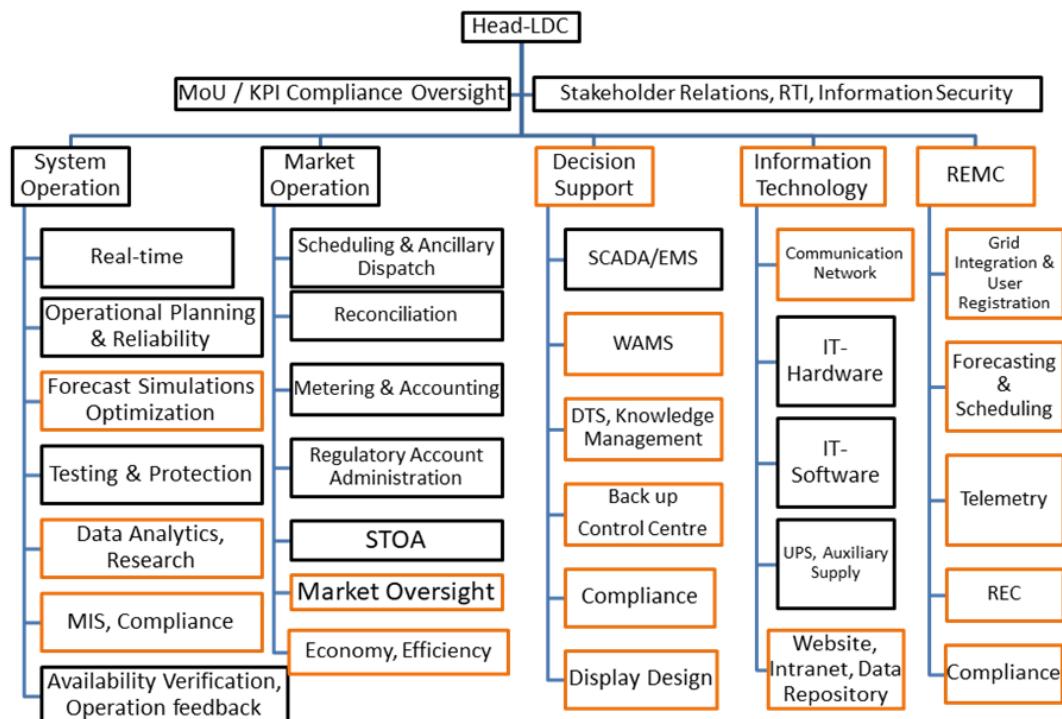


Figure 3: Typical organogram for a Load Despatch Centre

## 4. Human Resource

આરોપ્યતે શિલા શૈલે યત્નેન મહત્વા યથા | નિપાત્યતે તુ ક્ષણેનાધસ્તથાત્મા ગુણદોષયો: ||

Human resource plays the key role in the functioning of load despatch centres. Adequacy of human resource (HR) was recommended in the earlier committees and task forces of GoI. The selection & training of human resource for LDC functions requires careful assessment of their orientation for the job & motivation level along with multi-disciplinary skill sets. The following extracts from “*Control Area Concepts and Obligations*” issued by the North American Electricity Reliability Council (NERC) in July 1992 (as endorsed by the CERC in its order of 07.03.2008 in sou moto petition no 58/2008 in the matter of ‘Clarity regarding control areas and demarcation of scheduling responsibility between RLDCs and SLDCs’) are highly relevant in this matter.

“A control area is obligated to:

- (a) carefully select and train its system operating personnel. The operation of increasingly sophisticated control centers, which is supported by control equipment, instrumentation, and data presentation systems, and the closer integration of power systems through stronger interconnections, require highly-skilled and extensively-trained personnel. Proper action during a system emergency as well as minute-to-minute operation depends upon prompt, correct human performance. ....
- (c) select system operators with skills that include directing other personnel and contributing to a positive working environment. Ability to perform under pressure in high-stress situations is of utmost importance. In addition, system operators should possess aptitude for logical problem solving, strong reasoning, and mechanical, electrical, mathematical analysis, communication, supervisory, and decision-making skills. Successful performance in lower-level positions is desirable. ....
- (e) implement a training program for its operating personnel. This should include both classroom and on-the-job training. Emergencies should periodically be simulated using a simulation training program when possible.”

The survey result of current HR in different LDCs across the country (fig. 4) and the deliberations reveal that the HR strength is disproportionately inadequate in most of the LDCs.

### 4.1. Human resource adequacy

The adequacy of ‘Human ware’ at LDCs has to be ensured. After carrying out detailed analysis of the surveys carried out by the sub-group, it is felt that total number of executives (including Supervisors, excluding staff for Sub-LDCs & Physical Security) in Group-A (Large LDCs) is in the range of 100 – 150 nos. , in Group-B (Medium LDCs) is in the range of 70 – 100 Nos. and Group-C (emerging/small LDCs) is in the range of 30 – 50 nos. The sub-LDCs may be staffed with 4-10 nos. of additional personnel for support activities in back-up SLDC functionalities. The proportion of executive Staff in Capacity Building of Indian Load Despatch Centres

System Operation : Market Operation : System Logistics : Others may be in the range of (35 – 45) % : (20 – 30) % : (15 – 20) % : (10 – 15) %. Further, the support staff (HR, F&A, and Contracts etc.) may constitute about 10 - 15 % of the total HR of an LDC.

Infrastructure and HR requirement in a Load Despatch Centre have a non-linear relation with the peak demand met and energy consumption. Coordination effort by LDCs increases with the number of generating stations, transmission lines, substations and other users. Management of bigger systems requires automation and special tools at LDCs. Complex systems require advanced technologies and mechanisms for congestion management, decision support and analytics. LDCs shall be executive oriented centres with limited support staff. The ratio of (Executive + Supervisors) to Non-executive may be maintained at around 95%:5% levels. The manual work associated with data collection needs to be automated and certain mundane work may be outsourced. Computer literacy is essential for an LDC personnel. There is a need for clear definition of executive, non-executive and workman in the context of LDC functions.

#### **4.2. New skills and competency**

In addition to the engineering knowledge, the following new skill-sets are required

- **Hard skills:** MS Office applications, Forecasting, Network Simulation, Market Simulation, Software Development, Optimization, Economics, Law, Meteorology, Communication, Research Methodology, Statistics, Data Science, Analytics
- **Soft skills :** Cognitive, verbal and written communication, interpersonal communication, public speaking, emotional intelligence, report writing, analytical, aesthetics, public relations

Study of international ISOs/TSOs indicates the need to strengthen the Information Technology and compliance oversight in LDCs in India. From International literature it was learned that the grid operator has to be prepared for Area Control Error, Security Constrained Economic Despatch and Optimization. It would require modelling capabilities, data archiving and analytics. Decisions taken by Operators must be mathematically proven. The faculties required in System Operation are expanding. Besides System Operation, Market Operation, Logistics, the System Operators require knowledge of regulations, laws economics as well as art of report writing.

## Existing Manpower in different LDCs

Total Employees= 2225

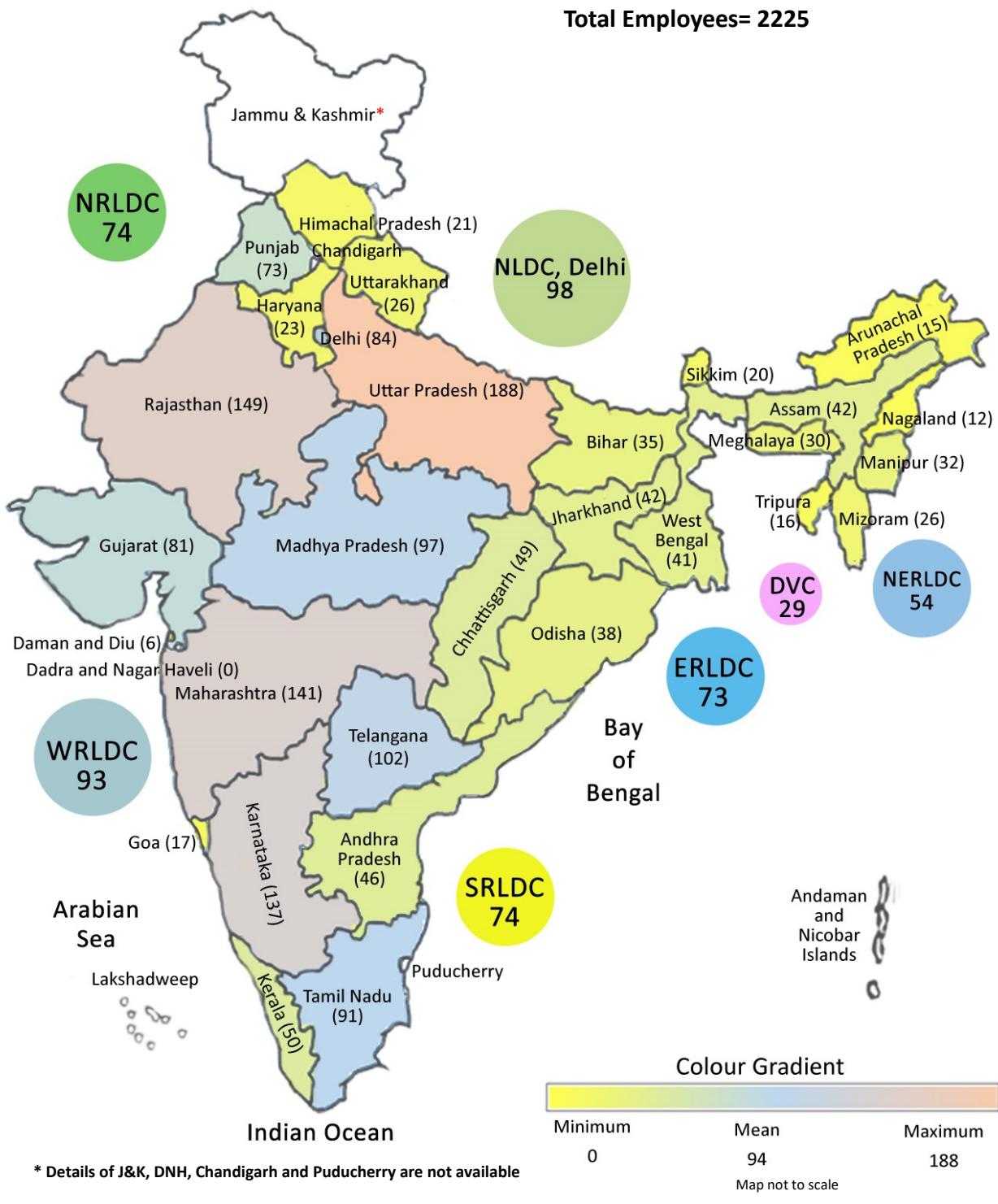
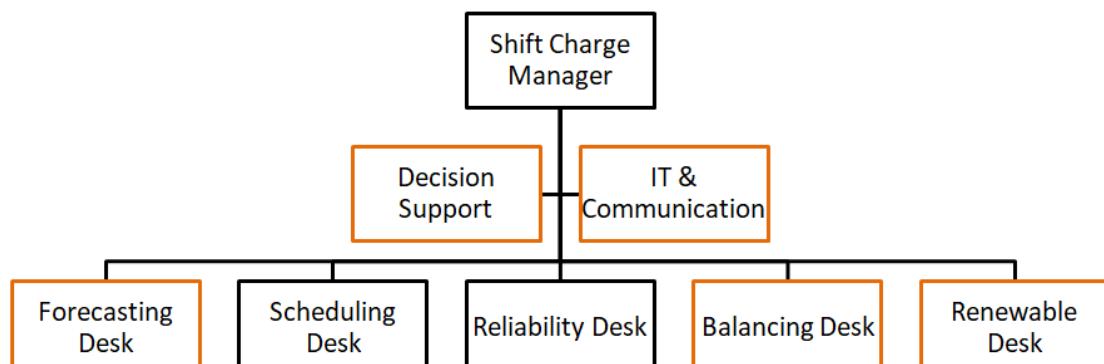


Figure 4: Survey Results - HR strength of LDCs across India

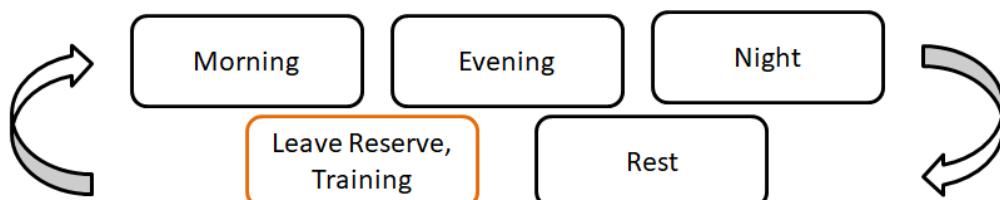
### 4.3. Real time shift operations

The number of personnel in real-time needs to be enhanced to ensure adequate strength in the control room, round-the-clock after taking into account entitled leaves, public holidays, festivals, business travel, training, special assignments. There is a need for five groups to factor leave reserves and training of real-time operations personnel. A typical LDC can have rotating shift for control room operation with 3-8 nos. per shift with total 15 – 40 nos. so that at least 30 % of the total HR is allocated for Real-time operation. It is also essential that staff in general shift have to be adequately trained to support the real time shift personnel. Self-driving and commuting during odd hours is a risky proposition in the absence of official transport facility or public transport. Therefore, adequate transportation arrangement is desirable for the night shift personnel. The survey results showing the manpower deployed in shift operations across the LDCs in India is given at fig.6. Based on the deliberations, the sub-group suggests the following typical framework for running of real time shift operations (ref. fig. 5).

Typical Organization of the real-time team



Typical Rotation of Groups



HR budgeting must factor training, business travel, official nominations, special assignments, leave entitlements, contingency leaves, leaves on extended weekends/Festivals

*Figure 5: Typical organisation of real time team for LDC*

## Total Manpower in Shift Duty in LDCs

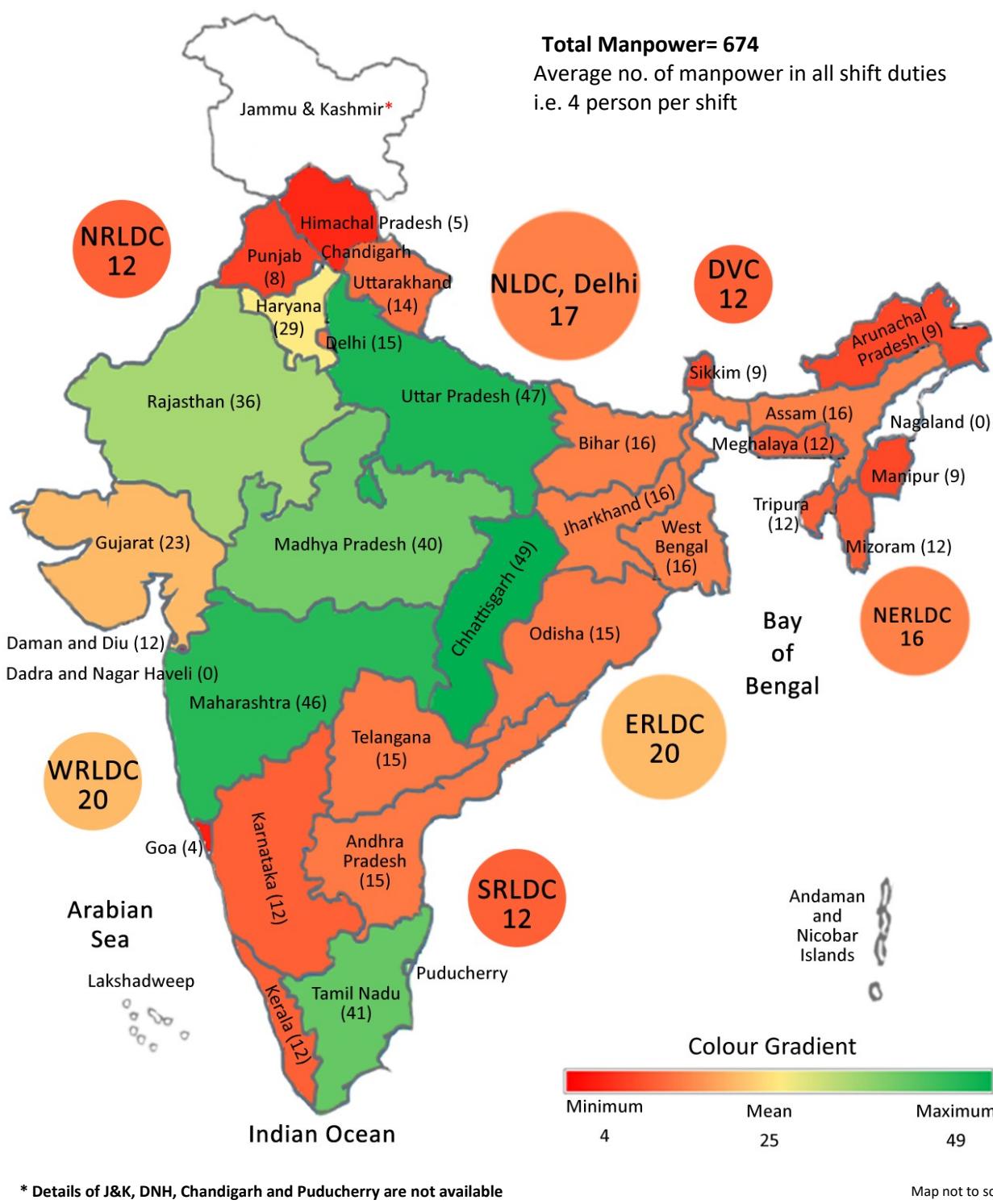


Figure 6: Survey Results - Man power in shift duty across LDCs in India

#### 4.4. Talent management

The recruitment and emoluments would mainly be governed by the terms of service conditions of the respective organizations and hence not been dealt with in this report. The various value streams for talent attraction, selection, and retention identified for LDCs are in given in table 9 while the survey results showing current qualification of LDC personnel is given in figure 7.

*Table 9: Scheme for Talent Attraction, Selection, Recruitment & Retention by LDCs*

| <b>Talent Attraction, Selection, Recruitment, Retention</b> |                                    |                  |                         |
|---|------------------------------------|------------------|-------------------------|
| <b>Discipline</b>   | <b>Qualifications</b>              | <b>Selection</b> | <b>Training</b>         |
| Power System  | Diploma                            | Written Exam     | Induction level         |
| Electrical  | Graduate                           | Campus           | Certification           |
| Renewable   | Post Graduate                      | GATE             | Continuing Education    |
| Communication   | Doctorate                          | CAT/MAT/GMAT     | Domain Specific         |
| Computer Science  | <b>Branding, Attracting Talent</b> | Group Discussion | Lateral Exposure        |
| Public Policy   | Power System Awards, LDC Awards    | Interview        | Professional Engagement |
| Economics   | Student Scholarship, Internship    |                  | Tax Planning            |
| Commerce  | Research Problems, Swiss Challenge |                  | Mentoring. Behavioural  |
| Statistics  | Academia Collaboration             |                  | Physical health         |
| Law   | Visibility in conferences          |                  | Physiological health    |
| Human Resource  | Cyber presence, Social media       |                  | Mental health           |
| Finance   | Word of mouth                      |                  | Social health           |

## % of Post Graduate Employees to Graduate Employees at LDCs

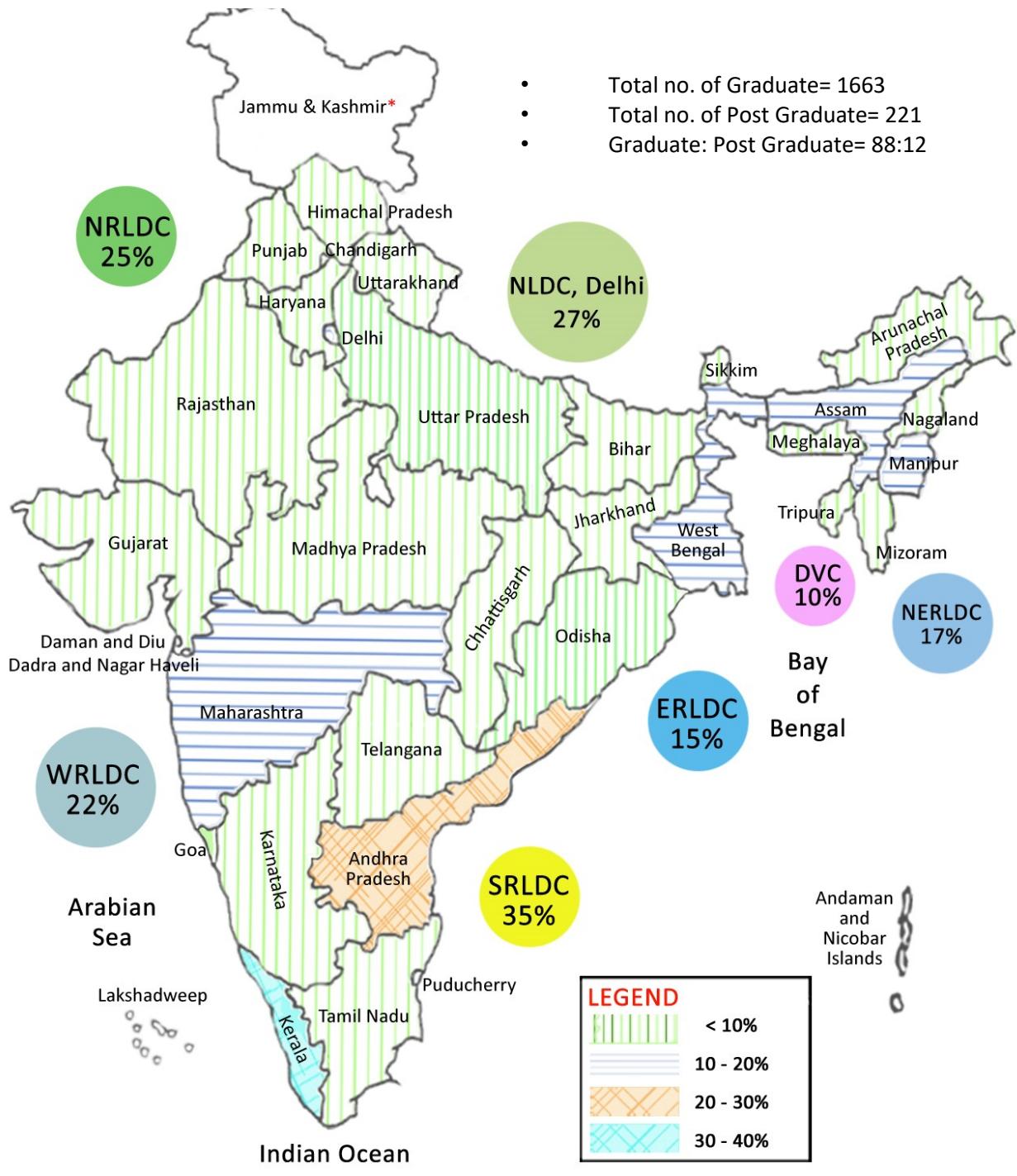


Figure 7: FOLD Survey - Qualification of LDC employees

#### **4.5. Compensation & recognition**

The sub-group suggests that the compensation incentives, sabbatical, recognition and reimbursements admissible to the different categories of executives may follow ‘cafeteria approach’ allowing the executives to choose from a set of incentives and allowances (listed below) instead of having a fixed set of allowances.

*Table 10: Proposed Incentives & Allowances in Cafeteria Approach*

| <b>Compensation/Incentives</b> | <b>Leaves</b>             | <b>Recognition</b>      | <b>Reimbursements</b> |
|--------------------------------|---------------------------|-------------------------|-----------------------|
| Incentives                     | Public holidays           | Service rewards         | Communication         |
| Emoluments                     | Paid Leave (CL,EL)        | Formal recognition      | Broadband             |
| PRP linked to KPI              | Compensatory off          | Job enrichment          | Meal vouchers         |
| Certification linked incentive | Maternity/Paternity leave | Professional engagement | Conveyance            |
| Night shift reimbursement      | Child Care leave          |                         | Tuition fees (Child)  |
| Night shift pick up/drop       | Work-on-holiday incentive |                         | Scholarship           |
| Retirement benefits            | Flexi-time, Part-time     |                         |                       |
| Group insurance                | Study leave               |                         |                       |
| Company accommodation          |                           |                         |                       |
| Company loan/advances          |                           |                         |                       |

#### **4.6. HR capacity building**

HR capability building is vital for sustainability. The existing and envisaged roles/responsibilities of LDCs in the emerging scenario at the intra-state, interstate and international level call for HR capacity building in the following areas:

- IT services and administration
- Monitoring fuel adequacy
- Renewable Energy Management Centre
- Coordination with Distribution System Operators (DSO), Electrical vehicle charging
- Electricity Market Economics,
- Market coordination with emerging financial markets in electricity
- Big Data Analytics, Pattern Recognition
- Applied Research
- Policy and regulatory advocacy
- Team Building
- Language Skills – Familiarity with local dialects

The adequacy of HR from multi-disciplines has to be ensured. The certification could serve as a deterrent against opportunity postings in LDCs and hence, certification linked incentives would encourage participation in certification program. There should be emphasis on In-house capability building to guard against excessive reliance on external consultants. Human Resource Development (HRD) is akin to capital expenditure and hence, HRD expenses may be a separate head in HR

expenses instead of Administrative and General Expenses. Further, minimum 5 % of total HR expenses has to be allocated towards HRD expenditure.

There is a need for ensuring functional activities of LDCs to be amenable to outsourcing without compromising on cyber and infrastructural security. The best HR practices in respect of recruitment, training, development, motivation, team building, retention, social security, emoluments, monetary/non-monetary incentives to retain talent and encourage excellence in LDC functioning have been surveyed. There is a need for development of exchange programme of personnel between inter-control centres for learning/exposure at mutual convenience of the respective utilities.

Applied research on the practical problems faced in Indian power system/electricity market needs to be encouraged. The LDC staff needs to be facilitated to take up higher studies. Collaboration with local colleges/NIT/IIT needs to be encouraged. The institutions of excellence and training Centre viz. IITs, IIMs, National Power Training Institute, ESCI, Power Management Institute, ASCI may be approached for Continuing Education Programs, Short term projects and commencing a Post Graduate diploma course on the functional areas of Load Despatch Centre. This is required for creating a pool of skilled personnel for recruitment at LDCs.

FOLD has been taking a lead role in institutional capacity building and harmonization of practices at different LDCs. The collaborative activities among LDCs could be enhanced through FOLD. Twining, Peer Reviews, Joint Working Groups, Short deputation could also be explored Incentive for the LDC personnel shall be drawn from the incentive approved by the respective ERC and shall be linked to achieving individual KPI targets derived from the LDC KPIs. LDC personnel shall also be given a certain amount as ‘certificate retainer-ship’ for qualifying operator certification exams and maintaining the validity of the certificate.

#### **4.7. Certification**

NPTI should maintain database of all certified Operators and Validity of Certificates. LDCs also should maintain database of certified employees and keep track of number of employees with valid certificates after retirement and transfers. Certification should be voluntary. It should come as a culture rather than a mandate.

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## **5. Infrastructure and ergonomics**

*'A mechanic is known by the tools he carries.'*

Each Load Despatch Centre, which has been in operation have evolved their own process, procedures, logistics & related equipment system, security system etc. as per their local requirements and availability of infrastructure. However, since the administrative setup & core functions of all Load Despatch Centres, are mostly similar in nature, the concerned logistics, security arrangement, their operations & management, etc. also are generally having significant similarity. However, some control centres have moved forward and adopted new technology in early stages whereas some are lacking behind due to various technical and administrative reasons.

One of the key recommendations of the Pradhan Committee was to have adequate logistics / infrastructure by LDCs to cater the ever increasing need of advanced tools to manage the complex grid operations in an indiscriminate manner confirming regulatory compliance. Based on various type of requirements of infrastructure, it can be categorized as: (i) space requirements, (ii) physical security, (iii) power supply, (iv) logistics supports, (v) ergonomic requirement.

### **Present Status of facilities:**

In order to get the present status of availability of facilities in different control centre, survey on some of the mentioned parameters was done. Survey results are indicated at fig.9. It is evident from the survey results that (i) video conference facility is available at most of the LDCs; (ii) Significant number (42%) of LDCs are yet to have a back-up control centre; (iii) Facilities like rest room, shower, resource centre(library etc.) are yet to be developed in many of the LDCs; (iv) Gymnasium, training centre, crèche etc. are available only at a few LDCs.

### **5.1.Space requirements**

The civil infrastructure of LDCs plays an important role in accommodating all the required set-up related to Control Room, Server space for equipment and documents, space for Training / DTS, Auxiliary Power Supply (APS) System, Seating space, Conference/Meeting hall, Viewing Gallery, Storage Space, Air-conditioning systems, LT Panels, Parking area, security rooms, green area, Fire Extinguisher, Pump Room and to provide facilities like library, R&D centre recreation centre, Doctor's room, Gym, Pantry, Dining hall etc.

The control centre should have staff quarters within its premises to support the 24 X 7 control room operation, which is of emergency nature. All the control centres should preferably have independent buildings / infrastructure so that unauthorized/public entry is restricted and to ensure physical security. Sufficient space should be made available so that facilities could be designed considering the ergonomics requirement. All the control centres should preferably have independent buildings / infrastructure so that unauthorized/public entry is restricted and to ensure physical security.

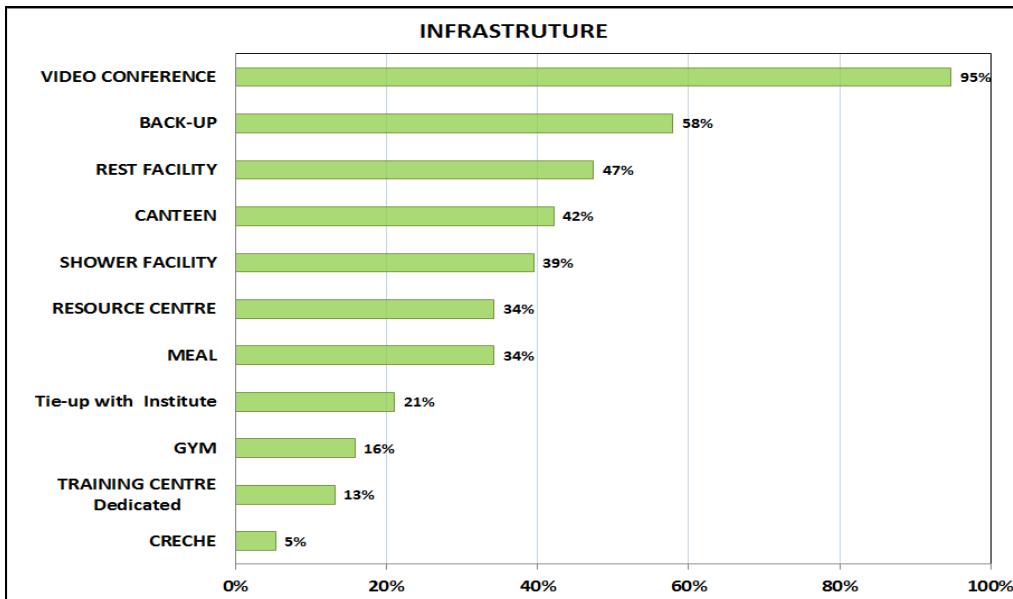


Figure 8: Survey result on status of facilities at LDCs

Incidentally, this is also one of the issues under discussion in the UK where the regulator Ofgem had in 2017 directed the transmission system operator, the National Grid plc to set up a distinct subsidiary for the System Operation functions with effect from 1<sup>st</sup> April 2019. Among other issues, a separate building for the System Operations has been suggested from the viewpoint of avoiding conflict of interest as well as ‘information ring fencing’. Details are available at the following web-link.

[https://www.ofgem.gov.uk/system/files/docs/2017/08/future\\_arrangements\\_for\\_the\\_electricity\\_system\\_operator - response\\_to\\_consultation\\_on\\_so\\_separation.pdf](https://www.ofgem.gov.uk/system/files/docs/2017/08/future_arrangements_for_the_electricity_system_operator - response_to_consultation_on_so_separation.pdf)

## 5.2. Control Room

Control room acts as an “eyes and ears” of the real-time grid Operators, hence, designing of it is extremely important. For any Load Despatch Centre, well designed Control Room and associated facilities are the foremost requirements. While designing a control room, it’s important to consider all factors i.e. equipment selection, lay-out of equipment, design of a workstation, operating practices, working environments and furniture choices etc.

Control room planning shall incorporate every aspect of human, machine and environment interaction, from monitor tilt and indirect lighting to air temperature and movement, to create the optimal working conditions and comfort level. While the equipment in the control room is essential to operation, to be effective, it has to support the requirements of the operator as well. While designing the control room, standard for control centre ergonomics i.e. ISO 11064 shall be considered which elaborate all the aspect of it.

Following aspects have to be considered while designing the control room:

- a. Size and Lay-out** - While designing, control room objectives shall be considered along-with pre-assessment on equipment and people to be accommodated considering the future requirement as well. The size of the room should accommodate all necessary equipment, while allowing for people to comfortably move about. Layout should also support additional display devices to support non-SCADA displays like weather, MIS, News etc. Physical layouts shall also accommodate the use of non-electronic equipment and documents, such as operations manuals, log books, maps and clipboards. Space should also be allowed for positioning items such as Desktops, telephones, keyboards, pointing devices, controllers, Printers/Scanner/ Multi-Function Devices, Telephone handsets and writing area.
- b. Shape** – A rectangular room provides the most options for equipment, display and console positioning. In general, rooms with sharply angled walls or with support columns should be avoided. Designing a control room of the right size and shape can go a long way toward achieving an efficient, comfortable operating environment.
- c. Material** – Ceiling materials should offer moderate to high reflectance to improve light distribution throughout the room and reduce energy cost. The wall material (anti-acoustic) should be selected in such a way so that internal refection of sound wave is restricted to achieve less noisy atmosphere in the control room to facilitate concentration of the shift operators.
- d. Windows** – Unless prescribed for operational or security reasons, it is strongly recommended that some windows are to be included in a control room, primarily for psychological reasons. However, such light sources also present potential security challenges and can contribute to reflections and glare. Video projection system should preferably be placed with 90 degrees angle with the windows and doors to avoid glare and reflections. Windows and doors shall be out of the primary field of view but visible from a seated position.
- e. Illumination level** - Lighting within control rooms shall be suitable for all visual tasks. Selection of LED light and location shall be such that it shall not create reflection in any of the displays particularly VPS system. Provision for emergency lights shall also be kept.
- f. Furniture/Consoles** - When determining console placement in the control room, it is important to consider the room's dimensions, number of stations, measurements of each station, video wall sizes and aisle width. For the ideal viewing angles, there shall be little head movement and minimal eye movement. The height of the console should be calculated so the smallest operator can see over the top of any mounted electronics, walls or displays, and the clearance beneath the work surface should allow for the tallest operator to sit comfortably. For this motorized workstation shall be preferred.

**g. Environment** - Environmental factors, including a requirement for auditory or visual tasks, air quality and temperature, equipment housing, lighting, structure materials, windows and room shape shall also be considered. Air quality and air temperature play an important role in keeping operators awake and alert. One of the most challenge in control room design is to keep consistent ambient temperature and maintain the balance between machine and people.

**h. Rest space** – Space for proper rest room (along-with attached bathroom) shall be identified.

**i. Aesthetics & other aspects such as storage space, emergency exit etc.** shall be considered.

### **5.3.Server space**

Separate equipment's room shall be identified to house servers and other rack-mount equipment. As the temperature of the servers is critical for its performance, sufficient space between the racks should be provided to aid the cooling of the equipment mounted on the racks. The layout of the racks should be such that the hot air flow and cold air flow should not be mixed to aid proper cooling. Size of the room shall be such that it can accommodate all the present system with a sufficient spare space to accommodate all the future requirements. Main and back-up servers should be placed in separate server rooms to prevent failure of both the main and back-up server in case of fire hazards. Server room shall be separate and accessible only when required. All the necessary measures i.e. firefighting as recommended for data centre, access control, CCTV (it shall cover all the angle of server room with redundancy) etc. shall be taken from security point of view.

Server room comprises a number of panels. Hence, necessary precaution shall be taken for proper cooling. AC shall be designed in such a way so that it can cater the future requirement also. While designing maximum loading and atmospheric temperature shall be considered. Provision of failure of one or two unit shall also be considered. In general Precision AC are highly recommended for Server Rooms considering their effectiveness.

Apart from server room, there should be separate communication room. There should be adequate space for future expansion and for break-out rooms. Separate room for database and development shall be kept considering the specialize nature of work.

### **5.4.Conference and meeting**

Most of the work done by LDCs are collaborative in nature. Stakeholders like to visit the LDCs for deliberations on issues of concern. LDCs have to frequently interact with researchers, international experts, consultants, vendors, product/software developers etc. for emerging technologies and solutions. Most of these discussions involve presentations or demonstration of prototype. The number of participants may vary. Workshops and capacity building programs are frequently organized. The setting for one-to-one discussion, deliberation with a small group, video conference with remote stations, seminar and workshop would significantly differ. Seating space for auditors and interns is Capacity Building of Indian Load Despatch Centres

also important. Hence adequate space with modular set-up and required accessories are needed in an LDC. The location of the conference rooms shall be suitable to enable controlled accessibility. Provision should be made for separate visitors interaction room(s), regulating visitors access to sensitive area viz. server room, SCADA & communication room, PMU/PDC room, control room etc.

### **5.5. Office space**

Adequate space i.e. required in the LDC for seating - head of LDCs, department/section heads, employees (group/department-wise), control room personnel and support staff, contractual personnel and visitors. There shall be adequate space for storage, collaborative activities, appraisal, audit, record keeping, and spares, basic amenities (recreation, gymnasium, library, crèche, and cafeteria). Separate space needs to be provided for incoming transformer (dedicated supply with two separate sources), LT panel, input / output ac distribution board, UPS, DC Power Supply, battery DG sets, dual input, DC distribution system Server supply should be through PDUs equipped with redundant power supply to ensure reliable power supply to the servers. Separate space for A C plants in case of centralized AC will be required along-with multiple AHU room. Space for AC can be provisioned as per the design of AC System.

### **5.6. Video conferencing system**

Meetings through video conferencing (VC) amongst the LDCs are taking place very frequently for operation related issues. Most of the LDCs are equipped with VC system. In some places it is recordable, whereas at most of the locations only end points are installed. In-spite of availability of VC facility at each control centre, it is missing from control room i.e. operators cannot interact with their counter parts through visual conversation. This functionality can be achieved using Cloud based solution or centralized localized solution at one of the control centre and operators at other location can use the functionalities through internet.

### **5.7. Internet facility**

At all LDCs, internet facilities are available as per their requirements and usages. In order to minimize the interruptions in services, it is recommended to avail services from the different service providers. Separate dongle for internet connection shall also be provided at Control Room as an alternative arrangement during emergency conditions.

### **5.8. Voice communication and recording system**

Redundant data & speech communication with adequate redundancy for communication path and terminal server equipment at LDCs is necessary for ensuring uninterrupted flow of telemetered data for real time grid operation at LDCs. Similarly, voice communication from different network service providers is desirable for ensuring redundancy. Adequate number of mobile phone shall also be provided at control room. Control room landline & mobile connection should have recording facility and such recordings should be auto-archived & reviewed periodically.

## **5.9.Physical security**

The physical security and safety of the premises, each & every equipment, concerned manpower working within the control centres are of paramount importance, and is one of the most vital aspect for satisfactory performance delivery by both - the man and the machine. In present day security scenario, where perception of wilful sabotage is real and persistent, appropriate arrangement for physical & cyber security of our premises and assets (manpower & equipment) should be unceasing, always alert, and must be backed by continuous evolution & upgradation in keeping with changes in threat perceptions and roving focus of security concerns.

At the same time, it is also of paramount importance to take care that the security arrangements should not be too cumbersome, as to impede the very purpose of its existence. The bona fide and appropriately authorized manpower should not face unwarranted hurdles in their endeavour of timely discharge of duties and obligations, on each and every occasion. Therefore, the security arrangements on one hand should be highly penetrative, thorough & comprehensive, while on the other hand, should also be unobtrusive and discreet, without compromising on real time alarm raising capabilities. Considering the sensitivity of the control centre, processes for suitable verification of all outsourced personnel at LDCs must be in place.

### **Systems for physical security**

Hand held metal detector, door frame metal detector and under vehicle search machine are prime requirements for security of LDCs. These devices act as first level of security for any unauthorized access. Under prevailing security threat perception, it is essential that all above equipment are put in place at all LDCs. These devices shall be kept health and a periodic check may be conducted with proper recording in relevant register.

### **Access control system**

Electronic access control system is the second level of security protection and a vital security measure to control access of unauthorized visitors to inside the building, as well as to permit access to sensitive areas of LDCs only to the bona fide & authorized personnel. Role based access control system shall be designed and only authorized and concerned person shall be allowed to sensitive area. In case of repeated attempts of unauthorized access, audio alarm shall be generated. Each entry shall be recorded in database for analysis purposes.

### **Visitor Management system**

Visitor entry management system is a handy tool with security staff to keep track of outside personnel coming into and leaving the premises, and gives real time information of visitors inside the premises at any point of time. Software based visitor management system is handy tool to maintain details of each visitor including the photograph, which can be retrieved easily from database archive in case of necessity. In LDCs context, an automatized visitor management system is essential for security reasons, since sensitive equipment and information are spread out across the control centre building.

## **Surveillance System**

Closed circuit TV (CCTV) systems provide surveillance capabilities used in the protection of people, assets, and systems. A CCTV system serves mainly as a security force multiplier, providing surveillance for a larger area, more of the time, than would be feasible with security personnel alone. CCTV system is a handy tool with security staff to keep visual vigil of the outdoor compound and indoor movement from a central monitoring centre. The tool is also used to post mortem analysis of any incident/event. In LDCs context, CCTV also provides the Load despatchers to remotely identify/verify the visitor at the entrance gate and authorize their entry into premise at odd hours.

CCTV systems have many components with a variety of functions, features, and specifications. Key components include cameras, lenses, data distribution, power, and lighting, among others. Some of the aspects to be considered are: 24 x 7 surveillance basis, night vision, remotely accessible i.e. IP based, video recording and playback facility (for at least 90 days), movement based recording, restricted and authorized access, future expansion. Coordination with local administration, fire department, hospital and disaster management agencies is also essential.

## **5.10. Power supply**

Control room requires uninterrupted redundant, independent external source for reliable power supply.

| Sr.no. | Description                   | Load (KW)      |
|--------|-------------------------------|----------------|
| 1      | Control room                  | 18             |
| 2      | Server room                   | 11             |
| 3      | Training and development room | 7.5            |
| 4      | Conference room               | 4              |
| 5      | Miscellaneous rooms           | 2              |
| 6      | Auxiliary lighting            | 5              |
|        | <b>TOTAL LOAD</b>             | <b>47.5 KW</b> |

*Figure 9: Typical Electrical load in an LDC [65]*

## **High/Low Tension Panel & Transformers**

The HT/LT switchgear system, including step-down transformer in control centre premises, plays a vital role in satisfactory functioning of the control centres. HT/LT panel shall be sectionalized, in order to provide interruption free services to critical infrastructure during emergency/maintenance period. It is preferred to extend redundant power supply from the distribution station of power utilities in order to avoid any long-term outages.

## **Earthing system**

Effective electrical earthing system in control centre is of paramount importance, especially since the electronic equipment are extremely sensitive to the system earthing quality.

## **Lightning protection**

It is recommended that lightning protection system with adequate lightning arrestors along with grounding arrangement (wherever necessary) may be installed on priority. There have been considerable technological developments in lightning protection sphere and Early Streamer Emission (ESE) Lightning Protection System which may be consideration.

In addition to the lightning protection, it is advisable to have Lightning Surge Suppressors on each power distribution lines outgoing from output ACDBs, for providing power to servers and display panels. These special protection devices protects all indoor electrical/electronic equipment from direct lightning and switching activity with Class B and class C Lighting Cum Switching Surge Protection. Since such combi-controllers are available in the market these days, these should be installed for safety of the mission critical & expensive electronic equipment in control centres.

### **Auxiliary Power Supply System**

SCADA/EMS, URTDMS & IT system gets power from the UPS and associated battery banks. Due to criticality of services, generally two UPS runs in parallel with two attached battery banks (one with each UPS) and shares connected load. In case of failure of any one UPS and battery bank, other can take care of full load. It should be designed in such a way to cater the existing as-well-as future loads as well. Healthiness of battery banks are more important as failure of single cell may fail the entire battery bank.

Since the battery cells generally weakens progressive before internal raptures, it can usually be detected well in time, if a periodic inspection/maintenance testing is conducted on each cell. It is therefore imperative that fortnightly/monthly preventive maintenance testing should be undertaken to identify the weakening cells and replace them well before they reach the brink of failure. Further, redundancy in cabling, distribution switch shall be maintained from UPS to the equipment's with a provisioning of maintenance.

### **Maintenance staff**

Although technological advancement has empowered LDCs to adopt intelligent and fail proof equipment & systems to provide services with reliability, security and redundancy, the importance of proper manpower support to take care of these equipment and processes cannot be undermined. Ensuring a stable and uninterrupted power supply to the control centre on round the clock basis is most critical part of the logistics system. Although various fall back arrangements are planned & put in place, their satisfactory performance is dependent on the effective operation & timely maintenance. This activity could be preferably outsourced.

### **DG Set**

DG sets provide backup power during short as well as long duration power cuts/ outages of power utilities. Proper periodic maintenance and storage of sufficient fuel are the factors to be taken care.

### **5.11. Space cooling**

The central AC plant in all control centres is critical for optimum operation of several equipment and systems in the control centre. Non-availability of cooling arrangement even for a fraction of hour in server room/ control room/communication room/UPS rooms shall lead to overheating of the rooms, as substantial heat is generated by all servers, VPS system and other IT equipment. It is therefore imperative that redundancy in cooling system must be kept in view during planning.

Cooling requirement in normal seating area and server room are different, hence, both shall be segregated and shall be controllable independently. Server room air conditioning system requires different type of set-up and it shall be as per industry standard for data centres i.e. precision AC, as normal AC system may not provide sufficient cooling in extreme weather conditions. Proper cooling shall be provisioned in UPS and battery rooms.

### **5.12. Fire detection and fire fighting system**

Proper firefighting arrangement in the premise is of equally importance to cater any emergency due to fire. Also LDCs buildings have substantial electronic equipment, choosing firefighting is also equally important. The class and the size of fire likely to occur in a particular area are key factors in determining the appropriate type and size of extinguisher to be used. Together, the class and size of a potential fire define the hazard for which your extinguisher installations must be designed.

For the rooms where IT equipment are installed (Server Room), are generally equipped with fire detection and clean agent based fire suppression system and intelligent very early warning Aspirating Smoke Detection (VESDA System).

In other part of buildings, generally fire detection and fire-fighting system are integrated with Building Management System (BMS) for centralized monitoring.

### **5.13. Public address system**

A public address system (PA system) is an electronic sound amplification and distribution system with a microphone, amplifier and loudspeakers, used to allow a person to address a large public. The term is also used for systems which may additionally have a mixing console, and amplifiers and loudspeakers suitable for music as well as speech, used to reinforce a sound source, such as recorded music or a person giving a speech or distributing the sound throughout a venue or building.

### **5.14. Building management system**

A building management system (BMS), otherwise known as a building automation system (BAS), is a computer-based control system installed in buildings that controls and monitors the building's mechanical and electrical equipment such as ventilation, lighting, power systems, fire systems, and security systems. Depending upon the usages and design following systems can be monitored or controlled by a BMS - illumination (lighting) control, electric power control, heating, ventilation and

air-conditioning (HVAC), security and observation, access control, fire alarm system, lifts, elevators etc., plumbing, closed-circuit television (CCTV), control panel, public address system, alarm Monitor, security automation.

#### **Efficient lighting**

LED based lighting shall be used considering the energy efficiency. Sensor based lighting control system can also be planned, if possible.

#### **Temperature sensors**

Temperature sensors shall be installed in critical areas i.e. Server Room, UPS Room, IT equipment's etc. This shall be integrated with existing system so that real-time grid operator can also monitor. SMS system can also be integrated to get auto generated SMS in case of violation be limits.

### **5.15. Ergonomics**

Civil infrastructure and setting-up of basic amenities are required to facilitate the interruption free services to the operators/users in a healthy environment. One of the basic and internationally recommendation is ergonomically designed control centres and other areas of office. Ergonomic design of Control Centre helps in Speed & accuracy in identification and resolution of problems, collaboration, alertness of operator, accessibility of desired information in least possible time, motivate a two-way interactive approach, etc. A broad standard for control centre ergonomics i.e. ISO 11064 is available and widely used by several control centres world-wide.

The control centre in a SCADA set up is the place from where the operator / system engineer monitors the health of the power system and issues necessary control instructions. The operator / system engineer at the control centre undergoes a variety of muscular stresses while working for long durations, which degrades the quality of work. The proper design of the control centre will ensure ease of functioning for the operator without experiencing stress in vital body parts. Proper care should be taken to install the different equipment for monitoring and controlling the Power System in suitable atmosphere and housing. Broadly, the classification can be done for the systems and different equipment in a SCADA Control Centre as listed in table-11.

*Table 11: Classification of major requirements for a control room*

| Description  | Details   |
|--|---|
| <b>Control room / operator console</b>   | The layout of the control room shall be such that the various personnel sitting in the room can work on the consoles and interact with each other effectively and efficiently. The design must ensure the minimum space for the VDU and different consoles installed to carry out the functional requirement, attached washroom, printer, water and the tea facility inside the room itself, writing board, etc.  |
| <b>Server room / computer hardware</b>   | The server room includes server panels, racks, trenches, heavy cabling, consoles includes the necessary software and the SCADA software as installed in the control room.   |
| <b>Telemetry and communication room</b>  | The communication room includes communication equipment panels, racks, trenches, heavy cabling, etc.  |
| <b>Training and development room</b>   | The training and development room hosts the training consoles, necessary software and the SCADA software as installed in the control room, printer, LCD display system, Personal Computer, writing board, water and tea facility inside the room itself, PA system and a wash room. There should be separate room for simulator (DTS) training  |
| <b>Conference hall</b>   | The dimension of the conference room shall include the conference table, chairs, PA system, Fax, machine, Xerox machine, LCD display system, Personal Computer, printer and wash room.  |
| <b>Auxiliary facility room viz. entertainment room, exercise room, refreshment room, rest room and changing room</b> | Rooms in the control centre premises such as entertainment room, exercise room, refreshment room, rest room, changing room, UPS and battery room.<br>The entertainment room includes a TV system, an audio system, PA system, tea / coffee arrangement, half bed, playing equipment viz. carom board, chess etc.<br>The exercise room includes yoga and meditation training, indoor sports, light music and necessary equipment for keeping the operators mentally fresh and healthy for relief of temporary stress in the different parts of the body.<br>The refreshment room includes the arrangement for tea/ coffee, a light refreshment, a TV set to reduce the temporary stress. |
| <b>UPS and battery room</b>  | The UPS and the battery room is the backbone of the control centre, which supports all the necessary equipment. It provides the required illumination in the control room and the server room.  |
| <b>Miscellaneous rooms</b>   | For other facilities such as Store, generators, Cooling system, LT Panels, Fire-fighting equipment, etc.  |

Detailed requirement as per ergonomics standard is given in Annexure-7.

## **5.16. Learning from survey of international ISOs/TSOs**

While considering the various factors pertaining to Control Centre infrastructure design particularly related to power sector, publically available information from ISOs/TSOs has been gathered. It has been found that only limited information was available regarding the state-of-the-art control room of ISOs/TSOs. Based on the available information, a comparison of the spatial infrastructure available with ISOs/TSOs are given at Annexure-6. The space used for typical spatial infrastructure by ISOs in North America is summarised under at table-12.

*Table 12:Typical space used for spatial infrastructure by ISOs in NA*

| Description           | ERCOT (US) | MISO (US) | ISO-NE (US) | NYISO (US) | CAISO (US) |
|-----------------------|------------|-----------|-------------|------------|------------|
| Campus Area (sq. ft.) | 6,000      | 50,000    | 90,000      | 64,000     | 277,000    |

## **5.17. Recommendations**

Requirement of various facilities/amenities for the Control Centre are described in details in previous sections. Some of the basic facilities are already in-use at many locations, however, other facilities may or may not be available at many LDCs. In order to build a proper infrastructure for the Control Centre, it is necessary to accommodate all the facilities, may be in a phased manner. Apart from the described requirements following shall also be considered:

- 1) Wherever feasible the LDCs should have a separate office campus. Alternatively, LDCs could be established within a secure premises.
- 2) Provisioning of separate control room for REMC, wherever applicable;
- 3) Installation of physical security systems;
- 4) Provisioning of separate desks for critical functionalities;
- 5) Provisioning of residential accommodation for the LDC employees;
- 6) Transit Camps / field hostel / Guest room;
- 7) Creating amenities for LDC personnel.
- 8) Monitoring of drinking water and air quality.
- 9) Safety audit and energy audit at regular interval;
- 10) Installation of rooftop solar system;
- 11) Sewage treatment plant for generating reusable water (for gardening/ miscellaneous use);

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## **6. Decision Support System**

*“The more you learn, the more acutely aware you become of your ignorance” - Peter M. Senge.*

The load despatch control centres make mission critical decisions in real time for reliable operation of the electricity grid. The IEEE proceedings Volume 93 (2005) titled “Power System Control Centres Past Present and Future” by Felix F Wu et.al. have noted that *“The control centre is the nerve system of the power system. It senses the pulse of the power system, adjusts its conditions, coordinates its movements and provides defense against exogenous events.*

Thus, for reliable operation of the power system, the Load Despatch Centres are required to be equipped with the necessary decision support systems. The ensuing sections would describe in detail, the necessity of robust decision support infrastructure for the Load Despatch Centres viz. SCADA, EMS, WAMS, visualization tools, thematic mapping & cartography. Artificial intelligence etc.

### **6.1.Existing systems deployed at LDCs**

The Supervisory Data Acquisition system which was implemented pan India during the 2002 – 2005 has been renovated during 2014-16 by all the LDCs PAN India to deal with obsolescence of the equipment and to implement the latest technology. Wide Area Measurement Systems which includes around 1400 PMU are also under implementations at different LDCs which will provide the LDC operator visualize dynamic behaviour of the power systems. These systems are under comprehensive Maintenance Contract for 6 years and are expected to cater the future requirements in this domain. However, being the multi-vendor implementation, the systems have some inherent incompatibilities across seams. Visualization tools are available for the real time data as implemented in SCADA/WAM system. However, there is very limited visualization tool available for the off-line data. Further, there is limited processing available for these data to extract information for decision making. It is also felt that some visualizations tool should be made available in the real time system to facilitate real time grid operations.

#### **6.1.1.SCADA/EMS system**

The following facilities have been implemented during the present up-gradation of the SCADA/EMS system of SLDCs / RLDCs.

- Backup SCADA/EMS systems has been established for the first time across SLDCs /RLDCs. Main and backup data flow philosophy followed across all RLDCs has been implemented mainly through multisite implementation between Main and back-up CC. The new ICCP connections have been established to make the data available at Back-up CC directly from stations and Sub-LDCs/SLDCs.

- Data Historian has been established first time for archiving the real time (time series) data at SLDCs/RLDCs. This application also supports visualization as per user's requirement and supports quick retrieval of data. The historian is also available in Back-up control centre.
- The new system is CIM (Common Information Model) compliant and the data exchanges are on CIM model through .xml files has also been implemented partly. However, issues are being faced due to non-uniform implementations across regions.
- Implementation data communication between Control Centres are done on Secure ICCP to ensure cyber security.
- Implementation of front end system has been done to accept both IEC – 101 and IEC – 104 protocol in a view to have smooth transition from IEC-101 system to IEC – 104 systems.
- Implementation of hybrid State Estimation application is in progress to improve the state estimator output. The SCADA system has been interfaced with WAM system to feed the measured state (voltage & angle) available from the PMUs installed at substations.
- Additional power system model for HVDC system, TCSC / FSCs, SVCs has been implemented in State Estimator to improve the estimation.
- Segmentation of SCADA/EMS network to comply with the cyber security. Separate VLANs have been implemented with internal and external firewalls to separate SCADA core network, data acquisition network, connectivity to corporate network. DMZ has been implemented to isolate the webserver which are having public network connectivity.
- A separate SCADA system has been implemented at National control centre to support AGC functionalities as a pilot and real time AGC operation has also been started with one Station in Northern Region and implementation in other plants (one in each region) in also under progress.

#### **6.1.2. Wide Area Measurement System**

The PMU based wide area measurement system is under advance stage of implementation in many LDCs. This includes installation of PMUs at all major substations and generating stations for running linear State Estimator, improving visualisation at control centres, better grid event analysis etc. The Phasor Data Concentrators (PDCs) are being installed at SLDCs as well as RLDCs/NLDC for developing data visualization tools & other analytical tools.

Apart from implementing good visualization tools which provide real time data trends, other features viz. selective alarms, contour maps on selected parameters, modal analysis etc. are also being deployed. Suitable application software for further utilisation of WAMS technology in real time /post-despatch is required. Applications such as oscillation monitoring system, PMU based remote synchro scope, eigen value analysis and identifying potential inter-area modes, detection of sub-synchronous resonance, identifying generators for PSS tuning, signature analysis of tripping etc. are required.

WAMS requires high speed, redundant communication system with route diversity. Archival of high resolution PMU data is a challenge. This high precision PMU data & WAMS applications further, complements the SCADA system. Capacity building in this area is also vital.

## **6.2. Constraints and emerging challenges**

### **6.2.1. Uniform data model**

While implementing the SCADA up-gradation project through multi-vendor implementation, it is observed that the transfers of models are not possible due to non-standardization of the database structure and its conventions which is leading to serious operation and maintenance issues.

It is desired that while designing the next phase of implementation, the design document should include the basic database structure along with standard conventions to be followed for naming the electrical equipment and its model which should be followed by all implementation agencies to have a standard implementation across load despatch centres. Common Information Model (CIM) may be used as a standard for data model exchange and standardization should be made with a target to implement transfer through CIM.

### **6.2.2. Common network model**

A strong all India transmission network is in place for transfer of power across the country. It is desirable that the system operators operate the national grid with reliability and economy. This could be achieved if the real time and off-line network study models are made uniform so that online studies could be performed on the full network available in the real time environment to avoid any network model mismatch and to ensure optimum usage without any model error.

Presently, this is not being feasible, as the telemetry is not available on reliable basis from the low voltage network (132 kV) and hence the real time models are sometimes limited to 220 kV network only. Due to these constraints, the off-line network which is being maintained up to 132 kV level is different from the real time environment.

Effort should be made to enforce real time telemetry at least up to 132 kV level by all Load Despatch Centres along with digital status implementation so that the data model at real time environment is possible up to 132 kV level. This would not only improve the short term planning study but also improve the real time visualization.

Further, the network model should be developed uniformly to take care of requirements of steady state & dynamic studies for reliability assessment.

### **6.2.3. Advanced data visualization tool**

Several Visualization tools have already been provided in the existing SCADA and Wide Area Measurement systems (WAMS) implemented at several LDCs. However, to deal with the increasing complexities in the Indian Grid and to cater the increasing challenges for accommodating the renewables, the requirement of advanced data visualization tool is being felt. Separate initiative needs to be taken for implementation of such tool for phasor data and real-time data with advanced graphics,

GIS interfacing to equip system operators with advanced situational awareness tool. An analysis on situational awareness with visualisation tools & displays was done and the corresponding details are attached as Annexure-10.

#### **6.2.4. Thematic mapping & cartography**

It is an essential requirement for the practicing system operators to have a fairly reasonable familiarity with the geographical area of the system being monitored by their LDC. Such familiarity helps in better assessment of the grid conditions & fast decision making during real time operations. Accordingly, it is desirable to have power atlas with electricity grid mapped on the geographical boundary map with latitude & longitude information given with a certain level of accuracy. The SCADA/EMS network diagrams developed over geographical maps have proven very useful to real time operators during normal operation as well as during grid restoration & crisis management where speed & accuracy of decision is very crucial. Thus it is desirable that the network visualisation diagrams developed in SCADA/EMS system for the LDCs be developed showing the geographical location of critical resources such as shunt reactors, synchronous condensers, hydro generators, RES, flexibility resources, black start capable generators, PMUs etc. In fact for the regional/national LDCs periodic updating of power maps is defined as a major performance index (KPI).

Thus, the faculty of cartography & thematic map making must be developed & nurtured by the LDCs in association with professional map making organisations viz. the NATMO. (National Atlas Thematic Mapping Organisation, Kolkata).

#### **6.2.5. Weather information**

Weather data plays a crucial role in power system operation. The real time grid operator needs regular update on weather data such as temperature, pressure, humidity, rain fall etc. at key load centres to assess the expected demand trend. Demand forecasting is a key input for preparation of day ahead schedules which in turn requires accurate weather information from large geographical areas. With increase in renewable energy penetration in the grid, there is added emphasis on providing accurate weather data such as wind speed, solar insolation etc. to the LDC control rooms. Further, for managing the grid during inclement weather conditions such as storms, cyclones (Hud-hud, Phailin, Titli etc.) & earth quakes that adversely impact the power system, the LDCs need to prepare in advance. Hence to improve crisis-preparedness they require advance information from weather service providers.

Accordingly the LDCs would require services from weather information service providers viz. Indian meteorological department etc. which provide standard and customised information on weather over different time horizons viz. nowcast, weekly forecast, day-ahead forecast etc. Thus, the sub-group feels that there must be close collaboration among the LDCs and weather forecasting agencies, weather service providers so as to develop appropriate decision support tools based on weather forecast information.

#### **6.2.6.Big data analytics tool**

Big data burst upon the scene in the first decade of the 21st century, and the first organizations to embrace it were online and start-up firms. They didn't have to reconcile or integrate big data with more traditional sources of data and the analytics performed upon them, because they didn't have those traditional forms. They didn't have to merge big data technologies with their IT infrastructures because those infrastructures didn't exist.

The Load Despatch Centres have volumes of data considering the real-time data in SCADA updating every 10 seconds, phasor data updating every 40 milli seconds, offline data being collected from the Utilities and its archival available for past more than 07 years. These large volume of data which is being captured by the State of the Art systems available at Load Despatch Centres have wealth of information which needs to be harnessed through proper tools and the information thus captured should be made available to the system operators for decision making and may be a valuable input to the planner also. Apart from the history data, effort should be made to have data analytics in near real time environment (e.g., persistent forecast) to aid the system operational planning far more near accurate.

Big data implementation with analytics is felt as a solution to cater the requirement for data crunching an analysing the huge volume of power system data available at Load Despatch Centres. The big-data analytics tool needs to be implemented in Load Despatch Centres considering the amount of critical and important data handled by the control centres.

#### **6.2.7.Interface with business applications**

A Business Intelligence (BI) tool seamlessly integrated with ERP/e-KPI/Historian is required with following functional requirements –

- a. Creation of ranking-reports with variable rankings, across multiple dimensions, while specifying various selection criteria at run-time.
- b. Creation of executive dashboards to get a real-time view of the data using multiple, easy-to-read graphs.
- c. Interactive reporting which offers instant access to a wide range of the data in one place starting with a high level view of the data and lets users drill down to the smallest details wherever possible.
- d. Use of Pivot tables to automatically extract, organize, and summarize data.
- e. What-if analysis feature shall be provided which lets user to assess potential changes before it is to be done.

#### **6.2.8.Expert systems based on artificial intelligence**

SCADA systems provide the basic means for an operator to monitor and control the power system operation. These systems have inadvertently created a situation of information overload. Exacerbating this problem is the fact the power system operation is complex and difficult to control, while, at the

same time, there is a general scarcity of knowledge and skills to absorb, analyse and use all available data/information.

To help ease the operator's load and ensure reliable and better supervisory control, it is becoming common to use artificial intelligence tools such as expert systems. These are being used as an intelligent SCADA or a "super operator" which does not fall asleep or miss any abnormal conditions. Such systems are either embedded in a SCADA or used as the actual SCADA itself and provide a reliable mechanism of continuous surveillance. This intelligent SCADA is loaded with domain and process knowledge such as scanning thousands of process variables in a systematic way, in real-time inferring problems or potential problems. This system then focuses the operator's attention on the problem or enforces standard operating procedures, ensuring the abnormal conditions are easily identified in time. This ensures that the power system operation run more reliably and consistently, resulting in numerous benefits.

### **6.3. Recommendations and future roadmap**

In view of the need of advanced data visualization, business applications, expert systems based on artificial intelligence and big data analytics; the recommendations are listed in table-13 below:

*Table 13: Road map for developing visualisation aids for LDCs*

| S. No. | Recommendations  | Remarks   |
|--------|--|---|
| 1      | Implementation of Advanced Data Visualization Tools based on advanced graphics and GIS | To bring Situational Awareness concept into practice  |
| 2      | Implementation of Big-data analytics tool  | To help in analysis of the power system data (real-time, archived and offline) available in LDCs and publishing of reports for the benefit of the energy sector |
| 3      | Implementation of Business Applications  | To help in fast dissemination of information and decision making in the organization  |
| 4      | Implementation of expert systems based on Artificial Intelligence                      | To help ease the operator's load and ensure reliable and better supervisory management of power system  |
| 5      | Uniform Naming Convention  | Common Information Model ( CIM ) may be used as a standard for data model exchange  |
| 6      | Power Maps   | Good cartography, display in local language   |

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## **7. Information and Communication Technology**

पुराणमित्रेव न साधु सर्वं चापि काव्यं नवमित्यवद्यम्। सन्तः परीक्ष्यान्यतरद्वजत्ते मूढः परप्रत्ययनेयबुद्धिः ॥

In addition to the decision support system, the LDCs need to be equipped with data repository, knowledge management, big data analytics and information dissemination. They require web-enabled customized application software for activities such as user registration, open access, energy scheduling, accounting, metering, settlement, reporting, outage coordination, and availability verification etc. Thus, due emphasis should be given on developing robust, agile, flexible, modular, scalable, interoperable and compatible Information Technology & communication (IT&C) infrastructure that is periodically upgraded to take care of high rate of obsolescence. All protocols related to cyber security threats should be complied with to ensure information security. Considering the statutory roles & responsibilities of LDCs, various applications/ processes in place or envisaged for smooth operation of control centre. The activities could be classified mainly into following main categories:

- i. System Operation – Real time & Off-line
- ii. Market Operation
- iii. Office Applications

There are other applications which are not directly related to the grid operations are as follows:

- i. Office Administration & HR
- ii. Finance Applications

### **7.1. Need for technology roadmap for LDCs**

One of the key recommendations of the Pradhan Committee was to have adequate logistics / infrastructure by LDCs to cater the ever increasing need of advanced tools to manage the complex grid operations in an indiscriminate manner confirming regulatory compliance. Technologies in IT industry are fast changing. Thus the existing technology needs to be periodically upgraded at LDCs to equip the LDCs with necessary information at right time for helping desired decision making. The tools deployed needs to be user friendly for quick adaptation. LDCs in India are at different stages of adoption and implementation of latest technologies especially in IT. While some of the LDCs have gone ahead with automation of most activities with IT technology implementations, others are in the process of automating some critical activities only. It is desirable that a ‘technology roadmap’ is framed as strategic plan for the LDCs for new technology implementation in line with long-term objectives, operational priorities, and financial discipline towards creation of sustainable technology infrastructure.

## **7.2. Hardware**

Information & communication systems constitute one of the major infrastructures for LDCs required for running the day to day operation. The hardware infrastructure for information & communication system for load dispatch centres include the computer systems, data base servers, application servers, communication servers, data cables etc.

## **7.3. Software deployed**

Apart from SCADA/EMS/WAMS implementation, considering the best practices of implementations across LDCs pan India, IT technologies are being deployed in automating the activities viz. simulation software, energy scheduling, automated meter reading, meter data validation, processing and accounting, automatic demand management, outage management, reporting, MIS, open access, deviation settlement mechanism, demand forecasting, renewable energy forecasting, LDC fees and charges, mobile app etc. IT infrastructure across LDCs has grown in a varied way depending on the legacy of each location, time to time procurement processes and individual assessment, likings and initiatives. Due to absence of any suitable guideline or standardization of practice(s), each location has continued development of various automation techniques either in-house or by engaging external agencies in heterogeneous environment. At present, the IT setup at each LDC varies widely and it is felt that some standardization needs to be done for implementation of IT infrastructure to reap the full benefit of IT technology in LDC operation.

### **Applications software**

Local Area Network (LAN) has been implemented in all the LDCs for day to day office activities and office works are done on MS Windows platform. MS Office tools are mostly used for day-to-day works. Other office tools like AutoCAD, Adobe Acrobat Pro etc. are used for specific purposes. However, in most of the LDCs some of freeware software are also used as per prevailing practice for minor office automations and/or maintenance support such as Akshar (for Hindi typing), Team-Viewer /Real-VNC ( for remote log-in and maintenance), WinRAR (for Zip), Skype (for video conferencing), Spice Works /similar (for maintenance support) etc. Discrete functional automations have been developed at local level in-house using various tools mostly on MS Windows platform such as MS Excel, VB Scripts, MS Access DB using Visual Studio tools as frontend, ASP .Net & Java Scripts. Customized development of web based applications for specific functional area/ requirements have been done either in-house or by external agency. Apart from the core activities as mentioned above, plenty of in-house automations for day to day activities are in use at each LDC depending on the requirement vis-à-vis available technical knowhow of the concerned manpower / department. Implementation of E-Log Book will also help the grid operators to manage many routine works in real-time in coordinated way.

#### **7.4. Emerging challenges**

The key challenges in present infrastructure at LDCs may be summarized as under:

- a. Non-uniformity in IT infrastructure & prevailing practice, different business logic due to decentralized legacy developments.
- b. Inadequate scalability planning
- c. Partial deployment of existing tools
- d. Inadequate human resource
- e. Absence of suitable data/information modelling tool for various parameters especially pertaining to Power System information. This also includes lack of synergy in identification of correlation between same power system attribute collected from various sources. The identification of information/data collected from SCADA source, PMU Source, SEM source, Outage Management System for single element is different and is being maintained differently. There is a need to create information/ data with uniform field classification (having a separate attribute called “source”) to have a single window access by the user.
- f. De-centralised and unstructured approach, thereby creating multiplicity of available information in different locations as well as in application tending to large possibility of mismatch between various information having same attributes. There is a need to implement a uniform database structure / identification / naming across applications to avoid mismatch/error in the extracted data by user.
- g. Lack in implementation of security infrastructure and suitable enforcement of security measures, policies and practices.
- h. Disaster recovery system for the IT infrastructure is absent in all the LDCs and the applications are being managed through a local Hot - Standby server configuration. There is an urgent need for implementation for DR (Disaster recovery) Centre for IT infrastructure also as in the case for SCADA implementations.
- i. Though some of the LDCs have gone ahead with Tier – III / Tier-IV concepts for Data Centre implementations for their IT infrastructure for space allocation, power supply, physical security, availability of internet/communication, fire-fighting, there is a need to have a firm guideline for implementation to facilitate implementation by all LDCs uniformly.
- j. Visualization is available for the real time data as implemented in SCADA/WAM system. However, there is very limited visualization tool available for the off-line data. Further, there is limited processing available for these data to extract information for decision making. It is also felt that some visualization tool should be made available in the real time system to facilitate real time grid operations.

- k. The absence of policies / process of data security / data sharing / data retention is sometimes posing difficulties in decision making and consuming valuable resources.
- a. Deficiency arising due to absence of strategic technology roadmap has created large gap in scalability planning and in adoption & implementation of latest technological advancement in enterprise wide IT setup & developments.

### **7.5. Infrastructure**

Most of the office work at LDCs are catered through desktop-class computers connected in local network. Further, in-house automation works for catering various functional needs from time to time are also done on desktop computers or workstation-class machines. The configuration & specification of desktops are not uniformly standardized.

- a. Individual LDC websites, intranet sites and few functional automations like scheduling & accounting system, outage management system, Short Term Open Access (STOA) registration & approval system, ancillary service despatch etc. are deployed and are hosted on server class machine of various make, model & specification
- b. Separate storage capacity for backup and disaster recovery mechanism is yet to be implemented at most of the LDCs. Hardware system for centralized file repository, data sharing system etc. is mostly in primitive stage and need to be upgraded.

Thus, IT infrastructure expansion at various LDCs may be planned considering the following:

- i. Infrastructure may be planned considering the workload and growth for next 5 years after commissioning.
- ii. One of the Central locations may be developed as the LDCs IT Central location with another one location as Disaster Recovery location.
- iii. Each LDC location infrastructure shall also be used for back-up of any one application and for local image backups of the central deployment keeping in mind the disaster recovery of the local site. Availability of Centralised storage with Storage Area Network (SAN) and Network Attached Storage (NAS) and Direct Attached Storage (DAS) may be planned based on application requirement. DR site shall have similar implementations to that of Main site.
- iv. Suitable NMS (Network Management Tool) & Asset management tool to be implemented for Network & IT Asset Monitoring.
- v. Active Directory Service (ADS) to be implemented at centralised location. All policy implementation, security systems and authentication may be enforced using AD services
- vi. Similar Setup may be adopted for LDC wide Mail Server solution with one Central Mail Server with local mail server at Back-up Site/Sub-LDC/corporate office location if any.
- vii. The applications at LDCs may be hosted using virtual server environment with 3 or 4 host servers for maintaining High Availability.

- viii. While designing the implementation of the application packages, it is desired that the plan for business continuity is considered to have an un-interrupted service to the users. The applications which are required to be deployed as centralised implementation and the applications to be implemented in a de-centralised manner needs to be finalised before going ahead with final implementation plan. All critical applications may be implemented using the requisite architecture with local Database backup for reporting needs. Database may be designed to have necessary synchronisation between main-backup implementation.
- ix. Dual redundant internet connectivity from different service provider needs to be implemented for Web Servers of LDCs and Share Portals to be implemented to ensure higher availability.

Seamless horizontal integration of information across application is the key challenge. Though as per prevailing practice separate applications & DB for each process and location are being maintained or has been suggested, seamless integration of all such applications in a single platform is very much necessary to avoid data mismatch and multiplication errors.

A uniform database architecture with sufficient redundancy for all critical functions of LDCs needs to be maintained to avoid voluminous data transfer across applications. A typical flow chart may be used while designing the future applications.

The availability of the Information Technology (IT) and Operation Technology (OT) applications are mandated for 99.9% availability and accordingly associated infrastructure are to be designed. It is recommended that the facilities to be implemented meeting the requirements for tier-IV implementations of a data centre. It should comply the following:

- i. Redundant communication links / distribution path for IT / OT equipment
- ii. Redundant site infrastructure – DR
- iii. Multiple independent distribution path serving the equipment
- iv. Must be dual powered and fully compatible with the site topology
- v. Concurrently maintainable site infrastructure
- vi. Cooling equipment dual powered including air-conditioning system
- vii. Fault tolerant site infrastructure with electrical power storage, standby power supply, distribution facility with expected availability of 99.995%.

The following activities are to be carried out to ensure security and availability of the IT – OT infrastructure by all the LDCs:

- i. Mock drill for switchover to DR site at least once in a year
- ii. Mock Drill for physical security implementations at least once in a year.
- iii. Changeover to local redundant system at lease on quarterly basis
- iv. Cyber Security Audit by CERT-In authorised representative and its Compliance by third Party at least on yearly basis.

Additional Infrastructure which is required for smooth functioning of LDCs:

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**Digital Signature:** All the documents that are made available on public domain may be digitally signed. It can provide the added assurances of evidence to origin, identity and status of an electronic document.

**Instant Messaging for Business:** Considering the real time operation in the LDC, a business messaging app can be used for a quick communication/exchange of information among employees. (Similar to WhatsApp but much more secure and designed for business). These messaging apps can put instant messaging, text messaging, private forums, video calls, and screen-sharing, into one specialized collaboration app.

**Centralized Patch Management and Antivirus server:** Considering the compliance and security requirements LDCs have to keep IT infrastructure patched and up to date. Hence a patch management server such as WSUS is required. Similarly, a centralized Antivirus server will help in managing the entire LDC end point security from a single source. (This may be part of the SIEM or standalone application)

**Syslog Server:** Considering the large number of devices in a typical LDC set up, a syslog server will collect error and system logs in one location. It can be used to decode and coordinate system events across multiple systems during forensic investigations.

**Enterprise class Backup and replication software:** Backup software for the critical applications and database is essential to safeguard against errors, cyber-attacks, negligent workers and countless other IT mishaps. The backed up data may also be replicated at the DR site.

**Data Archiving:** Data archiving is the process of moving data that is no longer actively used to a separate storage device for long-term retention. Archived data consists of older data that is still important to the organization and may be needed for future reference, as well as data that must be retained for regulatory compliance.

## 7.6. Interfaces

Data exchange interfaces may be designed so that the applications deployed can exchange data as per requirement of the various applications and for implementation of centralised reporting/MIS infrastructure.

## 7.7. Cyber security

The LDCs in India handle significant amount of data & information related to power system operation as well as electricity markets. Further, they communicate with multiple entities including other LDCs, control centres, generating stations, transmission licensees, market players, regulators, policy makers, statutory auditors, academia, several public & private firms, consultants, etc. over the internet. Accordingly, the LDCs are exposed to considerable risk as far as cyber security is concerned. Thus Capacity Building of Indian Load Despatch Centres

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there must be robust cyber security infrastructure in place in line with the international standards (ISMS & CERT-In guidelines).

### **7.8. Future technology**

LDCs may develop emerging technologies such as cloud computing (viz. PaaS - Platform as a Service, DaaS - Desktop as a Service, SaaS - Software as a service, public cloud, private cloud etc.), Big data computing (viz. data filtering, optimization, artificial intelligence, super-computing), Advance visualization (viz. PMU based tools, geographical information system-GIS based tools etc.).

### **7.9. Knowledge management systems**

Knowledge Management (KM) is one of the key driving vehicles for the digital transformation, especially in the context of LDCs. Digital data needs to be appropriately used considering the LDC's critical knowledge assets: its core competencies, intellectual property rights, market and industry comprehension, and customer understanding and expectations. KM is the art of transforming information & intellectual assets into enduring value for LDCs and stakeholders of the power sector. The core objective of KM is to provide the right information to the right people at the right times to help people share experiences and insights, and to improve the productivity of teams. Various data science techniques are being used to accomplish KM objectives. LDCs need to map the strategic and critical knowledge for complete digital transformation. This helps in identifying those knowledge assets that digital transformation can leverage, as well as highlights gaps in an LDC's knowledge network. KM prevents LDC personnel from constantly reinventing the wheel, provides a baseline for progress measurement, reduces the burden on expert attrition, makes visual thinking tangible, and manages effectively large volumes of information to help employees serve their clients better and faster. KM, in the current scenario, is a necessary game changer. Considering the diversity of expertise required a control center, expecting a single individual to have proficiency in every area would be unrealistic. Therefore, pooling of expertise and effective knowledge management appear to be the most practical alternative to achieve the desired objective. Accordingly, there needs to be commensurate infrastructure for effective knowledge management at the LDCs.

### **7.10. Recommended road map**

- a. **IT infrastructure** – Corporate LAN, Office LAN, Redundant servers, Data Repository, Cyber Security Systems, Secure transfer data (other than SCADA) between LDCs, Multiple Video conferencing facilities, Voice logging, access to supercomputing facilities
- b. **Supporting Applications** – Website, ERP, Application software for Outage management and Application software recommended in SAMAST, e-payment mechanism
- c. Role based IT Policy, Annual Cyber Security Audits, ISO certification, CCTV, separate dongle for web surfing, Solutions for Anti- Advanced Persistent Threat

- d. Redundant Communication infrastructure – Satellite communication in addition to conventional, Generate SMS for information dissemination
- e. There shall be adequate redundancy of communication system for LDCs so as to ensure high availability of real-time data, other web-based facilities (scheduling, open access etc.), video conference facility etc. LDCs shall have communication system experts to coordinate with the Communication Service Providers
- f. Modular approach better than Integrated monolith IT solution for diversity and risk mitigation
- g. Vendor development, diversity of vendors to be encouraged
- h. Pros and cons of Public cloud or Private cloud to be considered before deployment
- i. Streaming of Commercial Meter Data in Control Centre not desirable
  - Automation of Bad data detection in Energy Meter yet to mature unlike SCADA
  - Operator stress due to information overload and incorrect data
  - Operators to be protected from being vulnerable to legal-commercial disputes
- j. Implementation aspects to be left to LDCs. The choice of in-house development vs Outsourcing; Capex model or Opex model shall be left to the respective LDCs
- k. Implementation of E-Log Book will also help the grid operators to manage many routine works in real-time in a coordinated way.
- l. The infrastructure, interfaces and security implementations needs to be planned in advanced for coherent implementations.
- m. A uniform hardware & software architecture for general functioning of LDCs may be evolved enabling integrated enterprise level security & management features.
- n. **Vendor development:** While considering development of software solutions from third-party vendors, adequate emphasis should be on in-house capability development in this area to avoid excessive reliance on vendors and service providers. Appropriate initiatives for vendor development in the niche areas may be taken to increase competition and avoid monopoly of single vendor. The following extracts of report (November, 2005) of the ISO/RTO council titled "*The Value of Independent Regional Grid Operators*" are very relevant in the context of vendor development programs "*ISO/RTO IT applications are highly specialized and many are unique to the power industry. These applications are offered by a limited number of vendors and development costs cannot be spread across a large user base. Furthermore, because there are few vendors, there is less inter-vendor competition to drive down software costs.*"

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## 8. Governance Aspects of Data

*“In God we trust, all others must bring data” – W. Edwards Deming*

Load Despatch Centres are a repository of huge volume of real-time as well as offline data. A lot of information of knowledge and wisdom is hidden in the data which is required to be processed to derive meaningful information. Data accessibility is desirable from the perspective of transparency as well as for research, product development and policy making.

Section 4(2) of the Right to Information Act, 2005 also mandates the same. Relevant para is quoted below:

*“It shall be a constant endeavour of every public authority to take steps in accordance with the requirements of clause (b) of subsection (1) to provide as much information suo moto to the public at regular intervals through various means of communication, including internet, so that the public have minimum resort to the use of this Act to obtain information”*

Along with the Right to Information, data protection is equally important. Government of India constituted a committee of experts in July 2017 under the Chairmanship of former Supreme Court Justice Shri B N Srikrishna to study various issues relating to data protection in India and make specific suggestions on principles to be considered for data protection in India and suggest a draft Data Protection Bill. The objective is to “ensure growth of the digital economy while keeping personal data of citizens secure and protected.”

The Committee came out with a White Paper which recognized that instrumentally, a firm legal framework for data protection is the foundation on which data-driven innovation and entrepreneurship can flourish in India. Fostering such innovation and entrepreneurship is essential if India is to lead its citizens and the world into a digital future committed to empowerment, experiment and equal access.

Based on the Committee report, a draft Personal Data protection bill has been shared in the public domain by Government of India. The above details are available at <http://meity.gov.in/data-protection-framework>.

Though the issue is mainly related to personal data, the principles elucidated in the above documents become important when the issue of data sharing is discussed. At present, the data made available on public domain by LDC is primarily to fulfil the regulatory requirements. A lot of data which is non sensitive is available with LDC but shared with other agencies/ institutes only on request and on case to case basis.

### 8.1. Legal and regulatory framework

Power Sector in India is primarily governed by Electricity Act 2003 and amendments thereafter which provides for regular dissemination of information on public domain. As per section 177 & 178 of Electricity Act 2003, Central Electricity Authority (CEA) and Central Electricity Regulatory Commission (CERC) has been entrusted with the responsibility to make regulations consistent with Capacity Building of Indian Load Despatch Centres

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the Act. Accordingly, several regulations have been made by CEA and CERC which also have provisions for data sharing.

The relevant extracts are quoted below:

### **Electricity Act 2003**

#### **Section 73. (Functions and duties of Authority):**

“The Authority shall perform such functions and duties as the Central Government may prescribe or direct, and in particular to -

- (i) collect and record the data concerning the generation, transmission, trading, distribution and utilisation of electricity and carry out studies relating to cost, efficiency, competitiveness and such like matters;
- (j) make public from time to time the information secured under this Act, and provide for the publication of reports and investigations;
- (k) promote research in matters affecting the generation, transmission, distribution and trading of electricity;”

#### **1. Central Electricity Authority (Furnishing of Statistics, Returns and Information) Regulations, 2007**

Central Electricity Authority has notified the Central Electricity Authority (Furnishing of Statistics, Returns and Information) Regulations, 2007 on 10th April 2007 under which all licensees, generating companies, person(s), load despatch centres shall furnish to the Authority such statistics, returns or other information relating to generation, transmission, distribution, trading and utilization of electricity at such times and in such form and manner as specified under these regulations.

#### **2. National Load Despatch Centre Rules, 2004 dated 2nd March 2005**

##### **Clause 4(l)**

*“Dissemination of information relating to operations of transmission system in accordance with directions or regulations issued by Central Government from time to time.”*

#### **3. Indian Electricity Grid Code**

##### **Regulation 5.7.4 (c)**

*“RPC Secretariat shall then come out with a draft outage programme for the next financial year by 31st December of each year for the Regional grid taking into account the available resources in an optimal manner and to maintain security standards. This will be done after carrying out necessary system studies and, if necessary, the outage programmes shall be rescheduled. Adequate balance between generation and load requirement shall be ensured while finalising outage programmes. The same shall be uploaded by the RPCs on their website.”*

##### **Regulation 5.7.4 (j)**

*“RPCs shall submit quarterly , half-yearly reports to the Commission indicating deviation in outages from the plan along with reasons .These reports shall also be put up on the RPC website”*

*Regulation 5.2 (c)*

*“The list of such important grid elements on which the above stipulations apply shall be prepared by the RLDC in consultation with the concerned Users, CTU and STUs, and be available at the websites of NLDC/RLDC/SLDCs.”*

*Regulation 5.5.1 (a)*

*“A weekly report covering performance of the national/integrated grid in previous week shall be prepared by NLDC . Such weekly report shall be available on the website of the NLDC for at least 12 weeks. A monthly report covering performance of the national/integrated grid shall be prepared by NLDC and shall be sent to CERC, CEA , RLDCs and RPCs and made available on its web site.”*

*Regulation 5.5.1 (b)*

*“A daily report covering the performance of the regional grid shall be prepared by each RLDC based on the inputs received from SLDCs/Users and shall be put on its website. This report shall also cover the wind power generation and injection in to grid.”*

*Regulation 5.5.1 (c)*

*“A weekly report shall be put on its website by RLDC and shall cover the performance of the Regional grid for the previous week. Such weekly report shall also be available on the website of the RLDC concerned for at least 12 weeks.*

*The weekly reports shall contain the following:-*

- (a) Frequency profile
- (b) Voltage profile of important substations and sub-stations normally having low /high voltages
- (c) Major Generation and Transmission Outages
- (d) Transmission Constraints
- (e) Instances of persistent/significant non-compliance of IEGC.
- (f) Instances of congestion in transmission system
- (g) Instances of inordinate delays in restoration of transmission elements and generating units
- (h) Non-compliance of instructions of SLDC by SEB/distribution”

#### **4. CERC (Open Access in Interstate Transmission System), Regulations**

**Regulation 27**

*National Load Despatch Centre and each Regional Load Despatch Centre shall post the following information on their websites in a separate web-page titled “Open access information”:*

- a) These regulations;
- b) The detailed procedure;
- c) A list of bilateral transactions accepted by the nodal agency, to be displayed till the end of the month in which transactions are scheduled, indicating:
  - (i) Name of customers;
  - (ii) Period of the 56[short-term open access] granted (start date and end date);
  - (iii) Point or points of injection;

- (iv) Point or points of drawal;
- (v) Transmission systems used (in terms of regions and States);
- (vi) Accepted schedule (MW) with start time and end time;
- d) Information regarding usage of the inter-regional links.
- e) The information regarding average regional energy losses for the previous 52 weeks.
- f) Transmission charges and applicable transmission losses for various State networks as informed by the State Transmission Utility concerned.

**Regulation 27 (A)**

*Each State Load Despatch Centre, shall within 60 days of coming into force of these regulations, develop its website and post the following information on separate web-page titled “information on Inter-State Open Access”:*

*(a) List of bilateral transactions for which concurrence has been granted and list of entities to whom concurrence or “no objection” or prior standing clearance, as the case may be, has been granted till the end of the month in which such concurrence or no objection or prior standing clearance has been granted, indicating:*

- (i) Name of customer;
- (ii) Period of concurrence or “no objection” or standing clearance, as the case may be, (start date and end date);
- (iii) Point or points of injection and drawal, and
- (iv) Accepted schedule (MW).

*g) The list of short-term open access applications for advance scheduling received as the nodal agency which has not been accepted, along with reasons for denial, to be displayed till one month after the scheduling period.*

## **5. CERC (Measures to relieve congestion in real time grid operation), 2009 Regulations**

**Regulation 3(2)**

*“TTC, ATC, and TRM along with the details of basis of calculations, including assumptions if any, shall be put up on the website of NLDC and RLDC at least three months in advance. The specific constraints indicated by the study would also be put on the website.”*

**Regulation 3(3)**

*“Regional Load Despatch Centres shall assess Total Transfer Capability (TTC) , Available Transfer Capability (ATC) and Transmission Reliability Margin (TRM) of individual control areas within the Region, if required, and the same would be put on the website of respective RLDC, along with the details of basis of calculations, including assumptions if any, three months in advance. The specific constraints indicated by the study would also be put on the website.”*

**Regulation 6**

*“Notice for application of congestion charge. When, in the opinion of the National/Regional Load Despatch Centre, flow of electricity on an inter-regional /intra- regional corridor/ link used for transfer of electricity has crossed the ATC of such corridor/link, the NLDC/RLDC shall issue a warning notice to the defaulting entities. If the flow of electricity on the inter-regional /intra-regional corridor/ link exceeds the TTC, the NLDC/RLDC may, after notice through fax/voice message and through posting on its website and the common screen available on the Energy Management System, which is common to NLDC, RLDC and SLDCs, decide to apply congestion charge on the defaulting entities from a particular time-block in accordance with regulation 4:”*

### **Regulation 7**

*“Notice for withdrawal of congestion charge. When in the opinion of the National/ Regional Load Despatch Centre, flow of electricity on the affected transmission link/corridor has come down to the ATC, it may, after notice through fax/voice message and through posting on its website and the common screen available on the Energy Management System, withdraw congestion charge from a particular time-block:”*

## **6. CERC (Sharing of Inter State Transmission Charges and Losses), Regulations 2010**

### Regulation 7(1)(i)

*“The approved Basic Network, nodal generation, nodal demand along with the load flow results shall be made available on the websites of the Commission and the Implementing Agency immediately after its approval by the Validation Committee.”*

### Regulation 10(1)(d)

*“.....RPCs shall, based on Regulation 10 (1) (d), issue Regional Transmission Deviation Accounts by 15th of every month for the previous month to all Designated ISTS Customers, CTU and other ISTS Transmission Licensees and display the same on the website of the respective RPCs.”*

(1) The information to be provided by the Implementing Agency consequent to the computations undertaken shall include:

- (a) Approved Basic Network Data and Assumptions, if any;
- (b) Zonal and nodal transmission charges for the ensuing Application Period;
- (c) Zonal and nodal transmission losses data for the ensuing Application Period;
- (d) Schedule of charges payable by each constituent for the ensuing ApplicationPeriod;
- (e) YTC detail (Information submitted by the transmission licensees covered under these Regulation and computation by Implementing Agency);
- (f) Zone wise details of PoC Charges to enable each DIC to see details of transmission lines it is using and whose transmission charges it is sharing;
- (g) LTA /MTOA and their commencement schedule.

(2) Such information shall be made public by Implementing Agency after undertaking the computations for the Application Period, and upon being approved by the Commission.

## **7. CERC Deviation Settlement Mechanism and Related Matters) Regulations, 2014:**

*"The Regional Load Despatch Centre shall, on monthly basis, prepare and publish on its website the records of the Deviation Accounts, specifying the quantum of over-drawal/ under-injection and corresponding amount of Charges for Deviation payable/receivable for each buyer and seller for all the time-blocks when grid frequency was "49.90Hz and above" and "below 49.90" Hz separately."*

### **8.2. Data classification**

The National Data Sharing and Accessibility Policy, 2012 of Government of India classifies the data under following broad categories:

**Open Access Data:** The data under this category shall be available on public domain on the website of respective agencies and shall be available for download without any restriction.

**Registered Access Data:** The data under this category shall be made available to the requesting agency / person only after receiving written request after giving data usage undertaking.

**Restricted Access Data:** The data under this category shall be made available to any person/agency only after approval and signing Non-Disclosure Agreement (NDA).

CERC vide Office Memorandum of No. 2/7(24)/2010-Policy/CERC dated 14th January, 2010 had constituted a Committee under chairmanship of Member, CERC, with representation from Engineering Wing of the Commission, CEA, POSOCO, CTU and CPRI for identifying operation data of Indian power system to be made available in the public domain for research and analysis, so that academia and research institutes can contribute significantly to decision making in power system operation of the country.

Pradhan Committee Report on Manpower, Certification and Incentives for System Operation and Ring fencing Load Despatch Centres talks about value added services such as access to data archives for a fee etc. which could be provided by Load Despatch Centres. Relevant extracts from the report are given below:

*"In addition LDCs could provide value added services (requested studies, manpower development, detailed reports, access to data archives for a fee etc) on chargeable basis."*

### **8.3. International practice**

Internationally, the Independent System Operators or ISOs have their own guidelines for public data sharing. In respect of PJM, the details are available at <https://www.pjm.com/markets-and-operations/etools/data-miner-2/data-availability.aspx>. It is interesting to note that quantities like individual generator output, individual generator outages, nodal load, generator offers into the market, location data of various generation and transmission facilities etc. are not distributed publicly.

## **8.4. Recommendations**

1. The data which falls under open access category shall be uploaded on LDC website as per approved format.
2. Any entity/person who wishes to access the registered access data must get registered first. Only after successful registration, the entity/person shall be able to access the data sharing portal on website.
3. Requesting agency/person shall give a request for accessing restricted access data as per attached format. The data shall be shared only after the approval of management and signing of Non-Disclosure Agreement.
4. A state of the art data warehouse and data archive with online analytical processing capabilities shall be created by LDC for sharing of data.
5. Data furnishing to Govt. authority, (Ministries of Govt. of India, Government agencies such as Central Electricity Authority, Regional Power Committee etc. and Electricity Regulatory Commission etc.) may require non-disclosure approval.
6. The data shall be shared on “as is where is” basis. No processing of data shall be done by LDC.
7. Any data which is not generated/recorded at LDC shall not be compiled or shared with any agency or person.
8. All efforts shall be made to provide error free data. However, LDC shall not be liable for any error in the data provided to any agency. Suitable disclaimers shall be put in the undertakings and NDA.

### **8.4.1. Future work - Regulation on Data**

In view of the evolving demand from multiple agencies including academia, industry, public authorities etc. for the various data generated & managed by LDCs, the sub group felt the need for promulgation of a suitable regulation for management & administration of operational data by LDCs. It is desirable that the regulation takes care of the issues & challenges associated with managing & sharing of various type & nature of data by the LDCs. Some of the key aspects are RTI Provisions, all India Network Model – steady state & dynamic model data, information uniformity & symmetry, market operation data, data granularity, duration of archival, responsibility & accountability on data sharing.

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## **9. Capacity development through FOLD**

समानी व आकृति: समाना हृदयानि वः / समानमर्तु वो मनो यथा वः सुसहासति॥

Pursuant to the recommendations of the committee on “Manpower, Certification and Incentives for System Operation and Ring-fencing of Load Despatch Centres”, the FOR in its 9<sup>th</sup> meeting held at Bhubaneshwar on 14-15 Nov, 2008 approved the formation of Forum of Load Despatchers (FOLD) with the vision of “being a catalyst in reliable, efficient and economic operation of the Indian bulk electric power supply system.” FOLD was mandated by FOR, to achieve its vision through technical cooperation, knowledge sharing, regular interaction, active collaboration, mutual respect, cooperation, consensus building, international benchmarking and promoting ethical, non-discriminatory and fair practices.” The broad contours of the functions of FOLD are listed below:

1. Promoting technological excellence
2. Promoting harmonization of practices
3. Promoting compliance to reliability standards
4. Facilitating development of Ancillary Services
5. Promoting capacity building
6. Facilitating information sharing with stakeholders
7. Development of code of ethics
8. Developing performance indicators and deliberating issues referred by FOR

The code of ethics and charter of FOLD as adopted by its members is given as Annexure-17.

### **9.1. Membership**

All the State Load Despatch Centres, Regional Load Despatch Centres and National Load Despatch Centre in India are members of this forum. FOLD could be invited members from industry and academic institutions. All the executives working in SLDCs, RLDCs, NLDC would be members of the General Body of Forum of Load Despatchers (FOLD). A Steering Committee comprises of the Head of State/Regional/National Load Despatch Centres or their authorized representative. The steering Committee can constitute Working Groups to advise the Steering Committee on matters related to power system and electricity market operation. The Working Groups can have volunteers/nominated members from the General Body and invited experts.

### **9.2. Activities**

The NLDC provides secretarial assistance to the FOLD. 26 meetings of the FOLD have been held. Most of the meetings were held through video conference to facilitate greater participation and enable saving of time and expenditure. Diverse issues have been deliberated in the FOLD meetings. The major ones are listed in Table 14. FOLD members have collaborated in conducting research on

specific practical issues and published reports. Few of these reports that have been recently deliberated in the meetings of FOLD are as under:

- Report on Scheduling, Accounting, Metering and Settlement of Transactions in Electricity
- Report on Operational Analysis & Optimization of Hydro resources
- Report on Bringing Power System Operation closer to 50Hz
- Report on Implementation of 5-Minute Scheduling, Despatch and Settlement - Introduction of Fast Markets at Inter-State Level in India.

These reports are generally shared with all the members and feedback is suitably incorporated. The reports have been valued by policy makers, regulators and stakeholders at large.

*Table 14: Topics that were deliberated in FOLD*

| <b>System Operation / Market Operation / Decision Support / Infrastructure</b> |  |
|--|--|
| Preparation of State Grid Code   | National Power Atlas compilation       |
| Tightening of frequency band   | Harmonization of colour convention     |
| Ancillary Services and AGC implementation                                      | Grid Security Expert System            |
| Transfer Capability assessment   | Common Information Model               |
| Grid Security protocol adherence   | State Estimation                       |
| Frequency Response Characteristics   | Uniform Coding of Status Data in SCADA |
| NEW-SR Grid synchronization  | Data flow philosophy - URTDSM project  |
| Area Control Error supervision   | Transmission Pricing                   |
| Real Time Security Desk in Control Rooms                                       | Open Access Registry                   |
| Reliability coordinators nomination in LDCs                                    | Ancillary Services                     |
| Web pages for Merit Order Dispatch Portal                                      | Coal Flexing, grid balancing           |
| Implementation of SAMAST   | Need for Balancing                     |
| Forecasting- Weather, Demand, RE   | Deviation Settlement                   |
| IMS certification  | SLDC website – Desirable features      |

### 9.3. Capacity building

Several initiatives have been taken up in FOLD for institutional capacity building of the Load Despatch Centres. Benchmarking of infrastructure and human resources at various LDCs in India through surveys conducted by FOLD have been extremely useful for identifying best practices and gaps. Apart from the surveys, twelve SLDCs have voluntarily given detailed presentations in FOLD to share their best practices and challenges. FOLD conducts HR capacity building workshops in variety of emerging issues. It collaborated with Indian Meteorological Department in development of weather portal for the FOLD members. Several boot camps were organized under the Greening the grid project. FOLD has also been organizing expert talks and seminars on new technology and

international best practices through VC. FOLD has been providing a platform for sharing of best practices by SLDCs.

#### **9.4. Certification**

Promoting capacity building in Power System/Markets has been one of the major thrust areas of FOLD. The CEA has designated the National Power Training Institute (NPTI) as the certification agency for load despatchers. In association with FOLD, NPTI is conducting certification courses and examinations for basic level, regulatory specialists, power system reliability specialists, electricity market specialist, logistics specialists and renewable energy specialist. NLDC has been supporting National Power Training Institute (NPTI) in organizing training programs and sponsoring operators from all LDCs to attend the sessions.

#### **9.5. Information dissemination**

FOLD has a website for information dissemination (<https://forumofld.in/>). The website contains the FOLD Charter, Code of Ethics, relevant documents, technical papers, reports, capacity building programmes, message flasher and gallery of photographs.

#### **9.6. Funding of FOLD activities**

Presently the FOLD activities are being sponsored by NLDC. FOLD will strengthen the inter-State coordination and strengthen bonding and technical solidarity. The FOLD shall be driven by shared vision, strong focus on peer learning, transparency, promotion of highest ethical standards among operators. This would pave way for creation of an institution for perpetuity.

#### **9.7. Recommendations**

FOLD has been playing a pivotal role in the institutional capacity building of the LDCs in India. It is recommended that the FOLD should be further strengthened to take up larger role in hand holding emerging SLDCs and to take up activities for long-term sustainability of the load dispatching faculty. The survey reveals that the LDC personnel have very limited opportunities to participate in national/international conferences/symposiums/seminars, sponsored physical visits due to fund constraints. FOLD could sponsor LDC personnel to national/international conferences such as National Power System Conference (NPSC), International Conference of Power System (ICPS) and other events organized under CBIP / CIGRE / IEEE-PES etc. FOLD could organize national / international conference for exchange of knowledge and peer learning. It could organize workshops for stakeholders. FOLD could engage with the peers in other countries and multilateral agencies (such as World Bank, EPRI etc.) for collaboration/learning from international experience and best practices. For instance, in the past Dr. N.D.R. Sarma from ERCOT was engaged by FOLD to mentor the engineers in SLDCs/RLDCs/NLDC in maintaining and utilizing the State Estimator / Energy Management System. A similar exercise was taken up under the Regulatory Assistance Project to Capacity Building of Indian Load Despatch Centres

Forum of Regulators

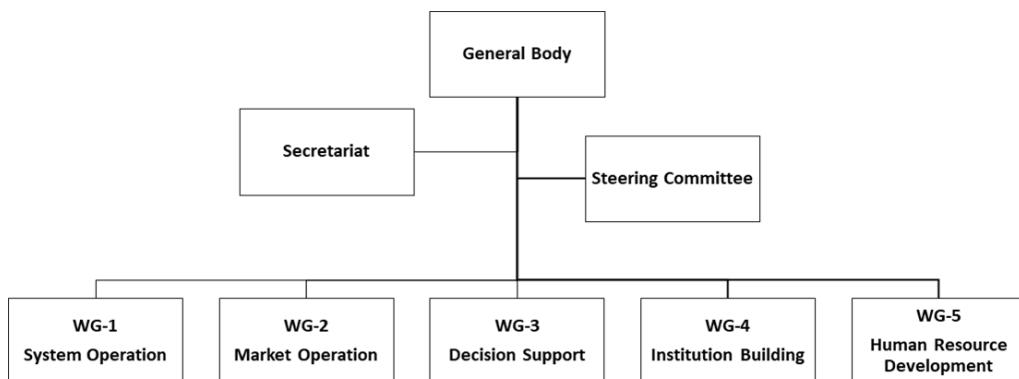
provide exposure to LDCs personnel on Energy Market economics and optimization. Such initiatives could be taken up in other areas such as dynamic simulation, optimization etc.

Through their association in FOLD, the LDCs could also collectively negotiate with vendors and service providers for customized solutions / niche products. For instance, multiple licenses of Power System Simulation Software were procured by POSOCO on behalf of SLDCs/RLDCs/NLDC/SERCs, for harmonization across LDCs. Subsequent training sessions were also conducted. This established capability in steady state simulation in LDCs in India. Such off-the-shelf application software or products could be procured at an economic rate.

On behalf of LDCs, FOLD could avail consultancy services in emerging technologies or market products on better terms and conditions. It could take up pilot projects, develop common specifications and commission studies on areas of common interest. The emerging LDCs could seek guidance or value added services from other LDCs in FOLD on mutually convenient terms and conditions.

FOLD could facilitate inter-LDC visits, peer-review in the spirit of learning and sharing of expertise. FOLD could constitute awards to recognize outstanding contribution and excellence in various functional areas of the LDCs. It could organize individual level and LDC level contests to inculcate a spirit of healthy competition.

It could constitute working groups in the lines of CIGRE and IEEE on specific areas.



*Figure 10: FOLD working groups*

These Working Groups (WG) would identify emerging challenges and possible solutions in various functional areas. It could study the prevailing practices in different LDCs and provide recommendations for harmonization, suggest possible tools, technologies and techniques to address the challenge. WGs could meet at least once in a year and give recommendations. In addition to VC, FOLD meetings may be hosted by different LDCs on rotation basis. The expenditure incurred by LDCs for FOLD activities shall be booked under a separate head and recovered through the LDC fees and charges.

- संघे शक्ति कलौ युगे -

## 10. Business Model for LDCs

साईं इतना दीजिये, जा में कुट्टम समाय / मैं भी भूखा न रहूँ साधु ना भूखा जाय // – कबीर

Internationally, the power system operation function is carried out by organizations which can be differentiated into 4 groups <sup>[18]</sup> based on the business model adopted viz. (1) Vertically integrated Utilities (VIU), (2) Legally Unbundled Transmission System Operator (LTSO), (3) Independent Transmission System Operators (ITSO), (4) Independent System Operators. In this context the following extracts from the ‘Statement on the future of Electricity System Operation’ is extremely relevant.

*“The office of the gas and the electricity markets (Ofgem) and National Grid believe that a more independent electricity system operator can realize benefits for consumers by enabling a more secure, competitive and flexible system. Such an electricity system operator should be underpinned by a governance structure that mitigates potential or perceived conflict of interest, and ready to adapt further as system challenges continue to evolve.”*

### 10.1. Prevailing business model

The Load Despatch Centres (LDCs) in India are primarily knowledge oriented statutory organizations which operate in a multiple-utility, multiple-user environment. The LDCs have been given statutory mandate under the Electricity Act 2003 to serve as the apex body for ensuring reliable & integrated operation of the state/regional/national electricity grids while ensuring optimum scheduling and dispatch of electricity within & across their control area jurisdiction as specified in the Grid Standards and the Grid Code regulations (IEGC & State Grid Codes).

As enshrined in the Electricity Act 2003, the Load Despatch Centres (SLDCs, RLDCs & NLDC) in India are mandated to be operated by a Government company or any authority or corporation established the applicable Acts. Presently, the five Regional Load Despatch Centres (RLDCs) & the National Load Despatch Centre (NLDC) are being operated by the Power System Operation Corporation Ltd. (POSOCO), a schedule-A, Govt. of India Enterprise under the Ministry of Power (MoP), whereas the organization structure for State Load Despatch Centres varies across the states. Barring the state of Himachal Pradesh, in all other states the SLDC operates under the umbrella organization of the respective state transmission company (i.e. State Transmission Utility). In Himachal Pradesh (HP), the SLDC operates as an independent authority namely ‘State Load Despatch Authority’. Thus, in India, the RLDCs/NLDC follow the ISO model whereas most of the SLDCs follow the TSO model.

Section 28 (4) of the Act empowers the RLDCs to levy and collect fees and charges from the users (viz. generating companies and licensees involved in inter-state transmission of electricity) as specified by the Central Electricity Regulatory Commission (CERC). Similarly, as per section 32 (3) Capacity Building of Indian Load Despatch Centres

of the Act, SLDCs are entitled to levy & collect fees & charges from the generating companies and licensees involved in intra-state transmission of electricity as approved by the respective State Commission. The following figure (Fig. 11) gives a brief over-view of the existing revenue model at different SLDCs across the country.

The FOR sub-group attempted to analyse the existing revenue model of different LDCs by person to person interaction and by referring to the various LDC Fees & Charges regulations, petitions & orders on Aggregate Revenue Requirement (ARR) of LDCs issued by various state commissions and the Central Commission. A summary table showing the URLs for different LDCs, LDC wise Fees & Charges Regulation & ARR order is given as Annexure-2, 3 and 4. The table-15gives a brief over view of the analysis done by the sub group in this matter.

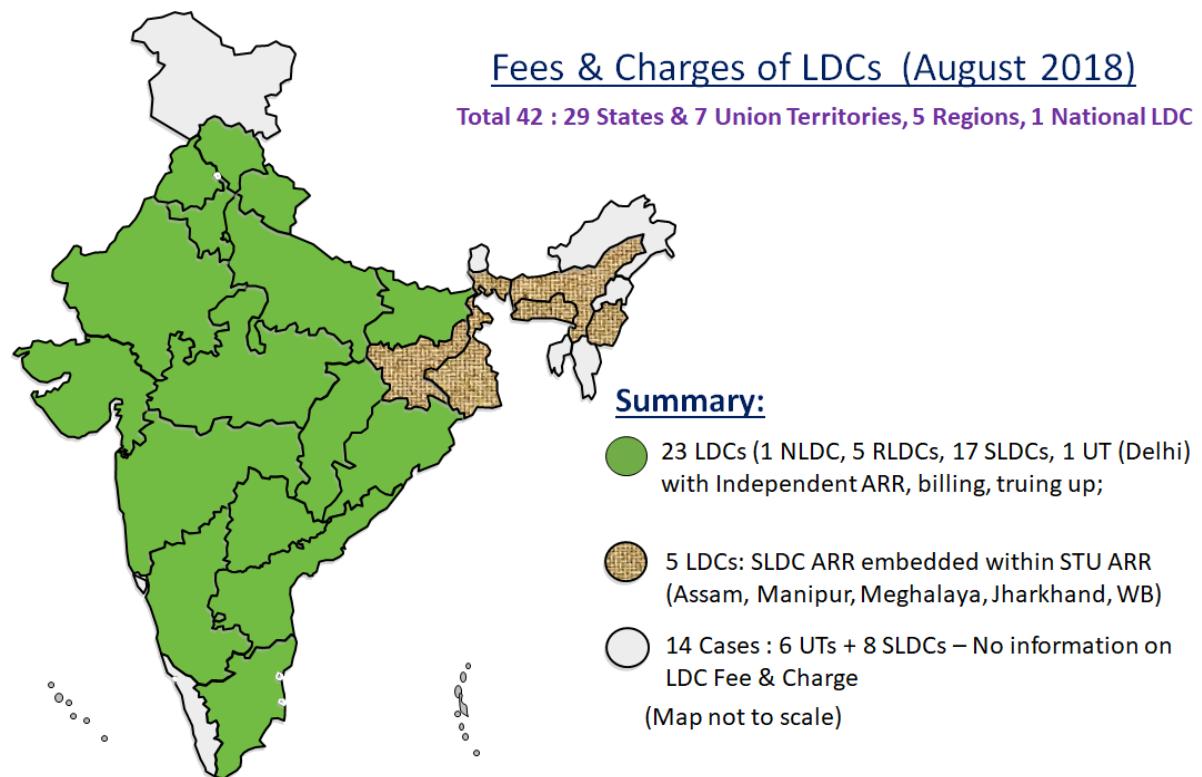


Figure 11: Existing Revenue Model - Fee & Charges of LDCs in India

Key observations are summarized under:

- For the 5 RLDCs & NLDC there is an independent revenue model based on the CERC Regulations. There is periodic notification of Fees & Charges Regulation by the Commission, petition filing by the LDCs, approval, billing, collection & trueing up of Fees & Charges as per order of the Central Commission.
- Out of 29 states, SLDC Fees & Charges Regulation is available for 22 states and for 21 states the State Commissions have issued specific orders, approving the SLDC fees & charges.
- For Sikkim, the regulation is available, however the SLDC is yet to file the ARR petition.

Table 15: Summary of analysis of Fees & Charges (F&C) of LDCs across India

#### A. State Load Despatch Centres

| Region           | No. of LDCs | F&C Reg. available | F&C Order available | Analysed  | Remarks  |
|------------------|-------------|--------------------|---------------------|-----------|--|
| WR               | 5           | 4                  | 4                   | 4         | <b>Goa:</b> SLDC F&C Regulation yet to be notified                                       |
| ER               | 5           | 5                  | 4                   | 4         | <b>Sikkim:</b> SLDC F&C Regulation notified; ARR petition yet to be filed by SLDC        |
| NR               | 7           | 6                  | 6                   | 6         | <b>J&amp;K:</b> SLDC F&C Regulation yet to be notified                                   |
| NER              | 7           | 3                  | 3                   | 3         | <b>Arunanchal Pradesh, Tripura, Nagaland, Mizoram:</b> F&C Regulation yet to be notified |
| SR               | 5           | 4                  | 4                   | 4         | <b>Kerala:</b> F&C Regulation yet to be notified   |
| <b>Sub-Total</b> | <b>29</b>   | <b>22</b>          | <b>21</b>           | <b>21</b> | Fees & Charge order not available: 8 SLDCs   |

#### B. Load Despatch Centres for Union Territories (UT):

Fees and charges regulation and order could be located only for Delhi (UT). For the UTs the regulations / orders on LDC fees & charges could not be located.

#### C. Regional & National Load Despatch Centres

| S No             | LDC name | Regulation available for | F&C Order available for | Analysed | Remarks   |
|------------------|----------|--------------------------|-------------------------|----------|---|
| 1                | ERLDC    | 1                        | 1                       | 1        | As per the CERC (RLDC Fees & Charges) Regulations 2015 & Orders |
| 2                | NERLDC   | 1                        | 1                       | 1        |   |
| 3                | NRLDC    | 1                        | 1                       | 1        |   |
| 4                | SRLDC    | 1                        | 1                       | 1        |   |
| 5                | WRLDC    | 1                        | 1                       | 1        |   |
| 6                | NLDC     | 1                        | 1                       | 1        |   |
| <b>Sub-Total</b> | <b>6</b> | <b>6</b>                 | <b>6</b>                | <b>6</b> |   |

Total Number of LDCs (whose Fees & Charges) are analysed = 28

- d) Further, in 4 cases (Assam, West Bengal, Manipur & Meghalaya), the SERC has approved the SLDC ARR, however the same is embedded in the ARR of the parent organization (STU or electricity department) & there is apparently no separate account for SLDC ARR. Similarly, for Jharkhand, STU has filed the SLDC-ARR petition, however same has not been allowed by SERC for lack of justification. Thus, the SLDC charge is embedded in STU ARR. Apparently, these 5-SLDCs have limited financial autonomy.

#### 10.2. Salient features of existing revenue model of LDCs

The revenue model of different LDCs were studied from the Fees & charges regulations & orders of the regulatory commissions (SERCs & CERC). Key observations are summarized under:

- 1) **Revenue Model of SLDCs:** Most of the SLDCs operate under the umbrella organization of state transmission utilities (STUs). In most of the states the SLDC expenses constitute an integral part of the multi-year-tariff order of the state commission. Key features of different

SLDC revenue model as observed during the analysis of the Fees & Charges regulations and orders issued by the state commissions are summarized under:

- a) There is mandate in most of the SERC regulations/orders to segregate the SLDC ARR & SLDC accounts from those of the parent transmission company (STU). The SLDC ARR account is segregated from STU account in many of the states barring a few smaller states.
- b) Most of the SLDCs earn revenue under 3 major heads viz.
  - 1) SLDC charge (collection at monthly, quarterly or half yearly basis)
  - 2) Grid Connection Fees or Registration Fee from new intra-state users
  - 3) Other income such as scheduling & rescheduling charges, STOA application fee, REC application fee, miscellaneous receipts etc.
- c) The intra-state entities who pay the SLDC Fees and Charges vary widely from state to state. These users of services of SLDC are generally the Distribution Licensees, Open Access customers, Generating Stations, intra-state Buyers and Sellers etc. connected to state grid etc.
- d) Intra-state transmission licensees are not users of SLDCs in most states barring a few (Odisha, Chhattisgarh). STUs being the parent company are not liable to pay SLDC charge.
- e) **Registration Fee/Grid Connection Fee:**
  - Most of the SLDCs charge one time registration fee from the new intra-state users barring a few exceptions (Chhattisgarh, Uttar Pradesh) wherein there is provision periodic renewal of registration.
  - In Chhattisgarh, user registration is valid for a period of 10 years. In Uttar Pradesh, the users viz. generating stations are liable to pay annual fees based on installed capacity.
  - The registration fee is a fixed amount irrespective of the user category in most states & this amount varies from Rs.10,000 to 1 lakh across the SLDCs.
  - In a few cases (viz. Chhattisgarh & Uttar Pradesh), the SLDC registration fee depends upon the type of user and installed capacity (MW) for generators.
- f) **Components of Annual Charge:** The annual charge of SLDCs primarily comprises of the following components in most cases:
  - i. Return on Equity (ROE)
  - ii. Interest on Finance Charge
  - iii. Depreciation
  - iv. Operation & Maintenance (O&M)
    - Employee Cost

- Administrative & General expenses
    - Repair & Maintenance expenses
  - v. Interest on working capital
  - vi. RLDC charge, ULDC charge & other statutory fees
  - vii. Applicable Taxes & Duties
  - viii. Adjustment towards other income/revenue surplus
  - ix. Any other incidental expenditure for discharging functions of SLDC.
- g) Employee cost is a part of O&M expenses in most of the states except a few viz. Odisha, West Bengal, Jharkhand where Human Resource Expense is treated as a separate head. Contribution to pension fund is not covered under employee cost for a few states (Madhya Pradesh & Chhattisgarh) which is separately approved by the SERCs as per actual figures submitted by SLDCs.
- h) Working capital comprises of O&M expenses, receivables for one month, maintenance spares (a fixed % age of O&M) in most cases. Interest on Working Capital is linked to SBI Prime Lending rate as on 1<sup>st</sup> of April with some additional basis points for most SLDCs.
- i) **SLDC Charge Rate Computation:** SLDC Charge Rate computation & application varies across the SLDCs as given under:
- Rs/MW based on Installed Capacity for Generating stations,
  - Rs/MW based on allocation /contracted capacity (i.e. Long /Medium Term network access) for Sellers, Distribution Licensees/ Buyers
  - Rs/Circuit Km on Intra-State Tr. Licensees (except STU)
  - Rs/Weighted Average circuit Km for Intra-State Tr. Licensees (eg. Haryana)
  - Rs/kWh (0.5 paise/kWh) on scheduled energy to licensees (in West Bengal)
  - Rs/MW of Transmission Access (based on co-incident demand) (Maharashtra)
  - As monthly System Operation charge & Market Operation Charge (80:20) w.r.t. Installed Capacity/Contracted capacity (in Odisha, Chhattisgarh).
  - In Odisha, the SLDC SOC and MOC rate on Generating stations & Transmission licensees is expressed as Rs/MW/Month, where-as monthly charges are apportioned to Distribution licensees/buyers in the ratio of their approved energy consumption in MUs. In Haryana, the Generators/Sellers, Buyers/Distribution Licensees, Transmission Licensees share the SLDC charge in the ratio, 46% : 46% : 8% on the basis of installed capacity (MW) for generators, allocated transmission capacity (MVA) for distribution licensees and weighted average circuit Km for Transmission Licensees.

j) **Treatment of Other Income**

- Income generated from other than Annual SLDC charges viz. grid connection fee, scheduling/rescheduling charge, STOA charges etc. are offset during truing-up in subsequent year ARRs in most states.
  - There is provision for using 50% of revenue earned from operating & scheduling charge for capital/infrastructure expenditure in Madhya Pradesh. Similarly for UP SLDC there is provision for using 50% of Annual Fee collected [from generating companies having long term (>5yr) agreements], for funding future capex with NIL return on equity.
  - Some states transfer the surplus generated out of other income to the parent company with a mutual arrangement of short-term liquidity support.
  - Some SLDCs manage the surplus revenue generated from other income by reinvesting and/or parking in FDs. However, SERCs apply holding cost on this surplus revenue.
  - Unlike RLDCs, provision for LCD Fund is missing in most SLDCs.
- k) **LDC Development Fund:** In some of the states viz. Odisha & Maharashtra, SERCs have allowed the SLDCs to create & maintain SLDC Development Fund out of the registration fee & other income for funding capital expenses, as margin money for raising loan, funding R&D projects, other contingent expenses under approval of the Commission.
- SLDC Uttarakhand has used the LCD fund for software development for open access, forecasting, scheduling etc. SLDC Odisha has used this for procurement of computers, peripherals, VPS screen etc.
  - Utilization of LCD fund by the SLDCs has been critically reviewed by the users & SERCs in case of SLDC Odisha. SERC has disallowed the amount claimed as Interest on Working Capital by SLDC for FY 2018-19 in view of huge sum (~ Rs. 35 crore) lying in LCD fund.
  - A few other states like Gujarat & West Bengal have provisions for maintaining some forms of reserve fund.
- l) **Capital expenditure (Capex):** The SLDCs provide a detailed 5 year capex plan during filing of ARR petition.
- Capex is a part of approved Annual Charge in many SLDCs & funded as a combination of debt & equity with recovery in the form of return on equity (ROE), Depreciation, Interest on loan etc.
  - In some states normative ROE is 14% (post tax), whereas its provided as 15.5% (pre-tax) base rate which is subsequently grossed up w.r.t. corporate tax rate.
  - Maximum allowed depreciation is 90% on all capital assets except IT equipment and software which are 100% depreciable.

- There is provision for funding Capex from LDC reserve fund in some states (viz. Gujarat, Odisha, Maharashtra, Uttarakhand, Uttar Pradesh).
  - In Madhya Pradesh, 50% of the scheduling & operating charge can be used for funding capex.
  - However, such capex funding from LDC reserve fund attracts 0% return on equity, interest on loan & depreciation etc.
  - In some states, SERC approval is mandatory for capital expenditure exceeding a certain limit (Rs. 5 lakh in Madhya Pradesh, Rs. 1 crore in Delhi).
- m) Control Period is 5 years in most of the states and the SLDCs/STUs need to file the Fees & Charges petition at the beginning of the control period with a detailed plan on capital & non-capital expenditure (i.e. O&M, employees cost etc.).
- n) **Trueing Up & Mid Term Review:** There is provision of annual truing-up in many states whereas some SLDCs file mid-term review & trueing up petitions before the commission after 2 years for evaluation of actual vs approved ARR etc.
- o) **Billing & Collection of LDC charges:**
- Most of the SLDCs collect the approved annual charge on monthly basis.
  - Some of the SLDCs (viz. AP, Telangana, and Bihar) collect the approved expenses in 2 parts viz. monthly operating cost & half yearly capital cost.
  - SLDC West Bengal bills its users (DISCOMs) on quarterly basis on volumetric basis at a flat rate (0.5 paise/kWh).
  - SLDC Madhya Pradesh bills approved annual charge on half yearly basis.
  - There is provision of penalty on late payment & rebate for timely payment.
  - SLDC Delhi, Uttarakhand have a provision for dispute resolution wherein the aggrieved SLDC user can approach the commission within 60 days, subject to payment of 90% of billed amount under protest.
- p) **Other Observations:**
- i. The employee cost comprises of 70-80% of the approved ARR of most SLDCs
  - ii. Capital expenditure constitutes 20-30% of ARR in most of the SLDCs
  - iii. Human Resource Expenditure is a part of O&M Expense in most of the SLDCs
  - iv. HRD expenses are a part of Admin & General Expenses in most SLDCs

2) **Revenue Model of RLDCs/NLDC:** The major revenue source primarily comprises of 2 components for RLDCs & NLDC viz. Registration fee & monthly charge.

- a) **Grid Access or Registration Fee** is the onetime fee charged on any entity seeking connection to the grid and for getting registered as a user of the LDC;
- b) **Monthly Charge** of the RLDCs as derived from approved annual charge is shared among the users (viz. Generating Companies/Sellers, Distribution

Companies/Buyers and inter-state Transmission licensees) on the basis of installed capacity (in MW) and/or contracted capacity (MW) or transmission network access (LTA, MTOA) granted (in MW) or the length of transmission network commissioned (in circuit Km).

- c) ***Other Income:*** Apart from the above two sources, there are other sources of income viz. Application Fee & Operating charges for scheduling of short term open access (Bilateral & Collective) transactions, charges for facilitating REC & PAT mechanisms, and other receipts viz. interest etc. These incomes are kept in a contingency reserve for meeting unforeseen contingent expenses.
- d) ***LDC Development Fund:*** The income (after meeting the running expenses viz. human resource expense, operation & maintenance, corporate office expense, tax liability etc.) are transferred to a fund known as LDC Development Fund which is a regulated reserve that can be used by the RLDCs/NLDC under regulatory oversight of the Commission.
- e) ***Other salient feature of RLDCs/NLDC revenue model are:***
  - i. Functional Autonomy: Independent Organisation (POSOCO)
  - ii. Independent Revenue Stream for each of the RLDCs & NLDC
  - iii. Periodic Regulations at the beginning of every (5 year) control period
  - iv. Independent Filing of Fee & Charge petition & Approval by Commission
  - v. Monthly Billing & Collection from Users
  - vi. Provisional truing up / reconciliation – annually by RLDCs/NLDC,
  - vii. Final truing up at end of Control Period
  - viii. 7 Components of Fees & Charges – HR Expense is a separate Head
  - ix. LDC Development Fund (LDCDF) under Oversight of the CERC
  - x. Capex, Training, Certification, R&D, CSR etc. funded by LCD Fund
  - xi. 12 Objective KPIs for Performance Linked Incentive (PLI)
  - xii. Regulatory Provision for Monthly Certification linked Incentive

The following figure (fig. 12) give a brief account of the existing revenue model for the RLDCs/NLDC.

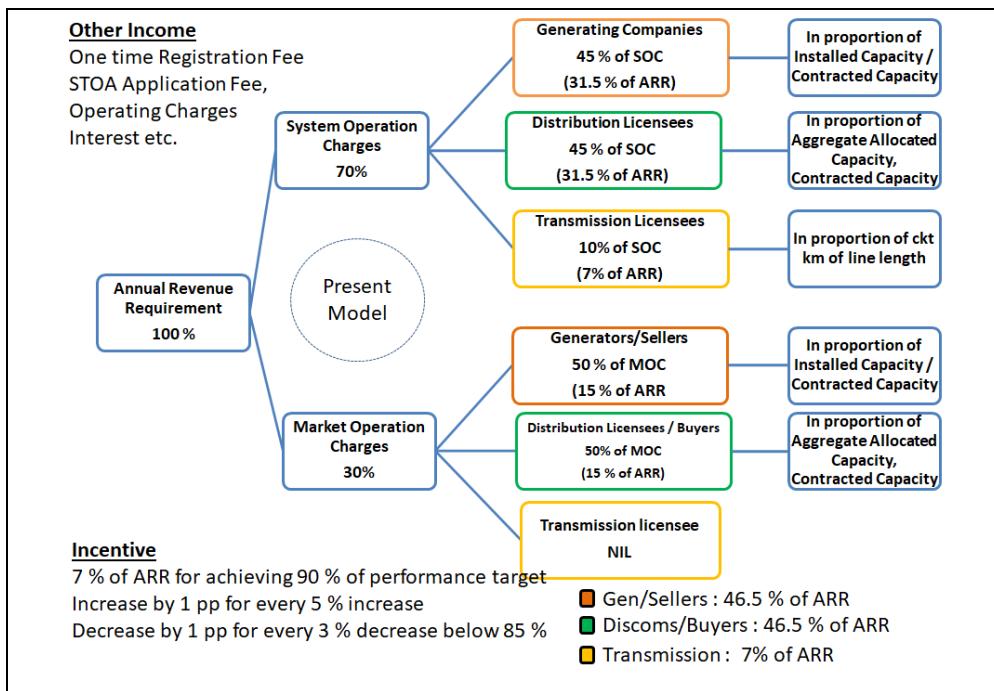


Figure 12: Existing revenue model of RLDCs/NLDC

### 10.3. Business Model of other control centres – Airport Authority

The sub-group deliberated on the scope for emulating or borrowing from the business models existing in other control centre based organizations viz. the centres managed by the Airport Authority of India. The airport authority follows the following business model:

- For Profit, Civil infrastructure based high capex organization
- Revenue from operations – Development fee charged per flight (per passenger)
- Revenue from leasing out commercial space

The following web-links gives details on revenue model of AAI.

<https://www.aai.aero/en/business-opportunities/investors-annual-reports> ;

[https://www.aai.aero/sites/default/files/Rationalization\\_Licence\\_Fee\\_Land\\_Space.pdf](https://www.aai.aero/sites/default/files/Rationalization_Licence_Fee_Land_Space.pdf) ;

<http://aera.gov.in/upload/uploadfiles/files/AERAACCT.pdf>;

The following table (table-16) gives a comparison of the nature & business model of control centres for power system operation and air-traffic control centres. Upon study of both the models it emerged that structure, purpose & functioning of LDCs & AAI are widely different. Accordingly, both follow distinct business models suitable for their organizations. Thus it was felt by the sub-group that considering the intent & spirit of the Electricity Act as to unique role of power system operators, the fees & charges based regulated & profit neutral business model fits best for LDCs.

*Table 16: Comparison of business models for LDCs & the AAI*

| Attributes          | Load Despatch Centres (LDCs)                                | Airport Authority (AAI)   |
|---------------------|---|---|
| Vision              | Secure Grid Operation with reliability efficiency & economy | Focus on profitable operation at major airports through continuing efforts on cost reduction and enhancing non-aeronautical revenue |
| Core functions      | 24x7 Grid Operation, Market operation etc.                  | Airport infrastructure development, Air-Traffic control, Navigation services  |
| Nature of Business  | Statutory. Profit neutral, regulated                        | For profit  |
| Nature of job       | Mission critical, precision in decision                     | Mission critical for air-traffic control  |
| Revenue model       | Fees & Charge as approved by ERCs                           | Per passenger development charge  |
| Billing, Collection | Reimbursement of Expenses                                   | Volumetric (per unit) model   |
| Other functions     | Several other statutory functions                           | Limited / NIL   |
| Customers           | Generators & Licensees                                      | Passengers, Airlines, Stores  |
| Other income        | STOA charge   | Leasing out commercial space etc.   |

#### 10.4. Users of Load Despatch Centres

The term ‘User’ has been defined in the CERC (RLDC Fees & Charges) Regulation as the generating companies, distribution licensees, buyers, sellers and inter-State transmission licensees who use the inter-state transmission network or the associated facilities and services of National Load Despatch Centre and Regional Load Despatch Centres. These users share the monthly fees & charges of the RLDCs. Further, there are certain other entities viz. the trading licensees, Power Exchange etc. who pay one time registration fee for getting registered as users. At state level, though this term is not defined explicitly in most cases (except a few viz. Chhattisgarh, Odisha), the regulations have specified the entities who use the services of the SLDCs & hence are liable to pay SLDC charges. Most of the Fees & charges regulations have a provision which mandates the LDCs to maintain & publish a list of users on their websites & report to the respective commissions on annual basis. It was observed that intra-state transmission licensees and STUs are not liable to share SLDC charges in most of the states. The following table gives an over view of different categories of users of LDC services across the states as specifies in the respective LDC Fees & Charges regulations. Abbreviations used in the following table for brevity are as under:

G: Generating Company, S: Sellers; D: Distribution Licensee / DISCOMs, B: Buyers;; T: Transmission Licensee / TRANSCO, LT: Long Term, MT: Medium Term; OAC: Open Access Customers, PX: Power Exchange; CPP: Captive Power Plants, RES: Renewable Energy Sources

*Table 17: Users of services of Load Despatch Centres (LDCs) as per regulation*

| S No | LDC Name       | Users of LDC Services                                       | Remarks  |
|------|----------------|---|--|
| 1    | Gujarat        | G, D, MTOA Applicants                                       | T: exempted  |
| 2    | Maharashtra    | D, OA   | G, T are exempted  |
| 3    | Madhya Pradesh | D, OAC  | G: pay connection fee only   |
| 4    | Chhattisgarh   | Intra-state entities with Long & Medium Term Access (S,B,T) | STOA, stand-alone generators, CPPs<br>RES, liable to pay Reg. Fee only |

| S No | LDC Name         | Users of LDC Services        | Remarks  |
|------|------------------|------------------------------|--|
| 5    | Bihar            | G, D, T, OAC, CPP            |  |
| 6    | Jharkhand        | G, D, B, S, OAC              |  |
| 7    | Odisha           | G, D, T, B, S, OAC           |  |
| 8    | West Bengal      | G, D, OAC                    | Presently only DISCOMs are paying SLDC charges                 |
| 9    | Sikkim           | G, T                         | SLDC yet to file ARR petition                                  |
| 10   | Delhi            | G, D, T, LT/MTOA customer    |  |
| 11   | Himachal Pradesh | G, D , B, S, OAC             | Transco (HPPTC) pays one-time fee                              |
| 12   | Punjab           | G, D , B, S,                 | Presently, ARR is being recovered from PSPCL; Transco exempted |
| 13   | Uttarakhand      | G, D, T, B, S                | Presently, ARR is being recovered from DISCOM (UPCL)           |
| 14   | Haryana          | G, S (46%); D,B (46%);T (8%) | Weighted Average ckt. km is considered for 'T'                 |
| 15   | Uttar Pradesh    | G, D                         | GENCOs/CPP pay only SLDC fee                                   |
| 16   | Rajasthan        | G, D, T, LT/MTOA customers.  | Presently ARR is being recovered from DISCOMs and OAC only.    |
| 17   | Assam            | D                            |  |
| 18   | Manipur          | D                            |  |
| 19   | Meghalaya        | G, T                         | Distribution licensee exempted.                                |
| 20   | Andhra Pradesh   | G, D, Trading Licensee       |  |
| 21   | Telangana        | G, D, T, Trading licensees   |  |
| 22   | Karnataka        | D                            |  |
| 23   | Tamil Nadu       | LT/MT/ST Customers           |  |
| 24   | ERLDC            | G, D, T, S, B                | One time registration fee for traders,                         |
| 25   | NERLDC           | G, D, T, S, B                | One time registration fee for traders,                         |
| 26   | NRLDC            | G, D, T, S, B                | One time registration fee for traders,                         |
| 27   | SRLDC            | G, D, T, S, B                | One time registration fee for traders,                         |
| 28   | WRLDC            | G, D, T, S, B                | One-time fee for traders, NHPTL                                |
| 29   | NLDC             | Through RLDC (Users)         | One-time fee for traders, PX                                   |

## 10.5. Comparative Study of ARRs of LDCs

Comparative study of approved ARR of different LDCs for the FY 2018-19 gave some key insights which are summarized in subsequent sub-sections.

### 10.5.1. Clustering of LDCs

The sub-group attempted to group the different LDCs based on different parameters viz. generation capacity (MW) handled, average energy catered by the control area under the LDC, length of EHV Transmission network handled by the LDC and the installed renewable generation capacity (MW). Accordingly, a weighted average score (WAS) was worked out. This exercise revealed that there are 13 large LDCs (with WAS > 9000), 10 medium LDCs (3000<WAS<9000) and 19 small LDCs

(WAS < 3000). The following figure shows the clustering of 42 LDCs in India into 3 groups as large, medium & small.

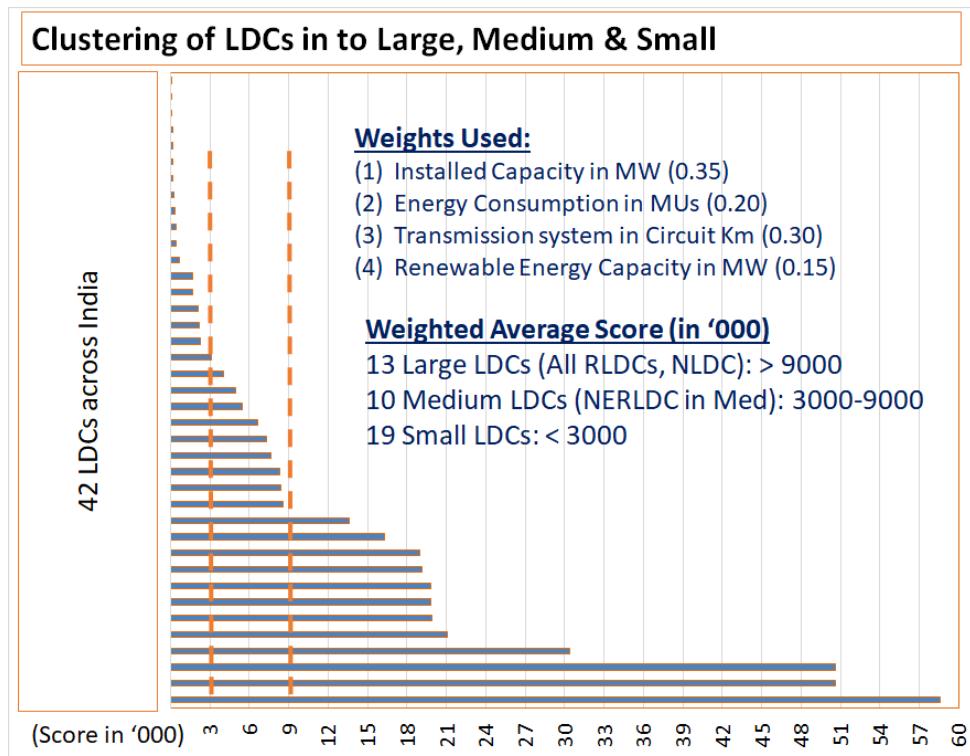


Figure 13: Clustering of LDCs into Large, Medium & Small

#### 10.5.2. HR Expenses

The following figures (fig. 14 & 15) give a comparison of HR expense of different LDCs across India for the FY 2018-19 based on approved figures. It can be inferred that HR expenses constitute the single largest component of the approved aggregate revenue requirement (ARR) of the LDCs.

#### 10.5.3. Operation & Maintenance Expenses

Barring the RLDCs & a few SLDCs, the Operation & Maintenance expense of LDCs comprise 3 components viz. Human resource expenses, Administrative & General expenses (AG), Repair & Maintenance expense (RM). For RLDCs and a few SLDCs (Odisha, West Bengal, Jharkhand) HR expense is booked under a separate head as per the regulation. The figure-16 indicates that HR expenses being much larger compared to AG & RM, there is a need for making HR expense a separate head in the Fees & Charges regulations of LDCs.

## Approved Employee Expenses for FY 2018-19 (in ₹ crore)

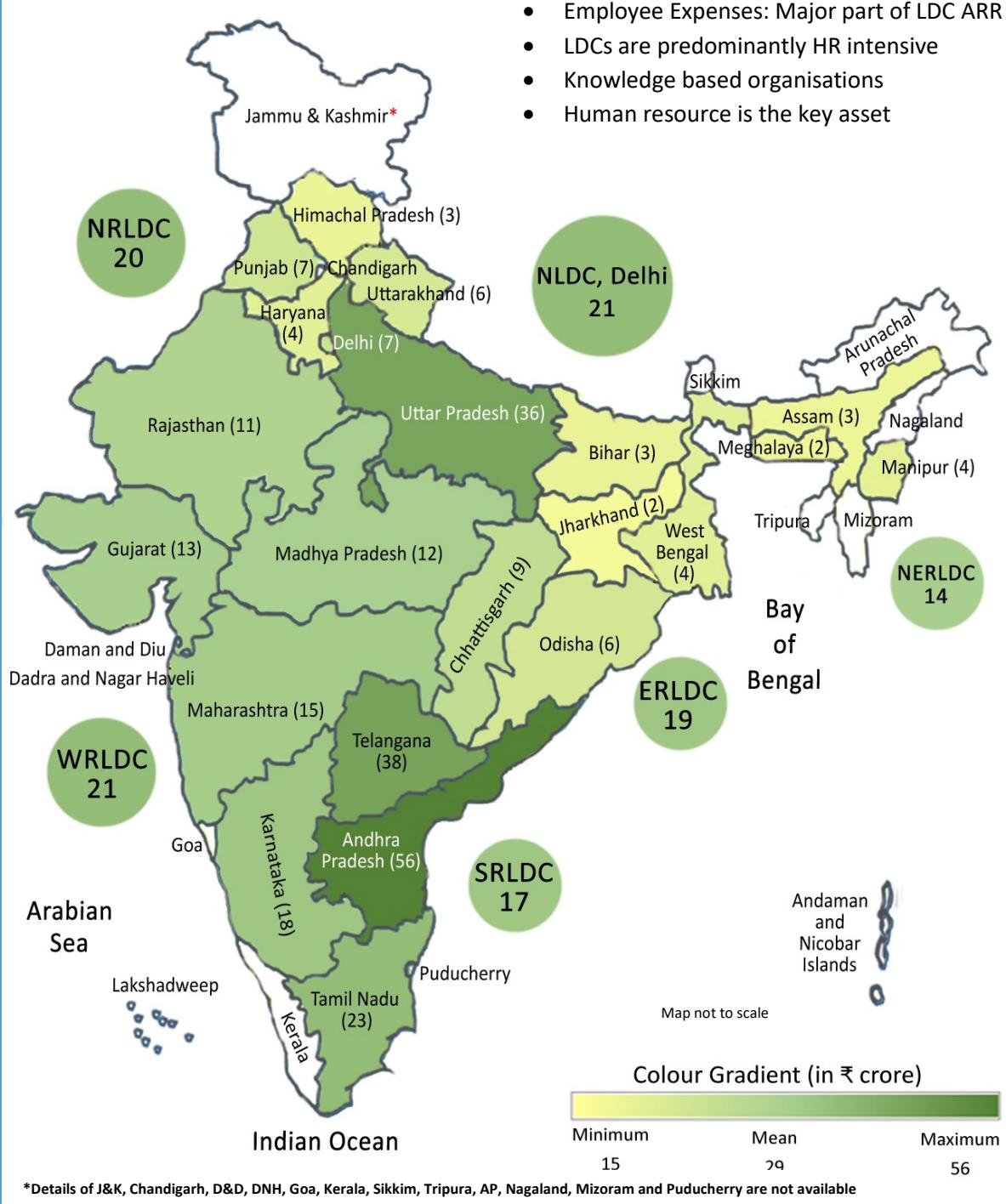


Figure 14: Approved HR expenses of LDCs across India for FY 2018-19

## HR Expenses as % of ARR (after adjusting other income) for FY 2018-19



\* Details of J&K, Sikkim, AP, Mizoram, Nagaland, Tripura, DNH, D&D, Chandigarh, Puducherry and Kerala are not available

Figure 15: HR expense to ARR ratio for LDCs across India

This analysis further reinforces the proposition that LDCs being knowledge based organisations are primarily HR intensive in nature.

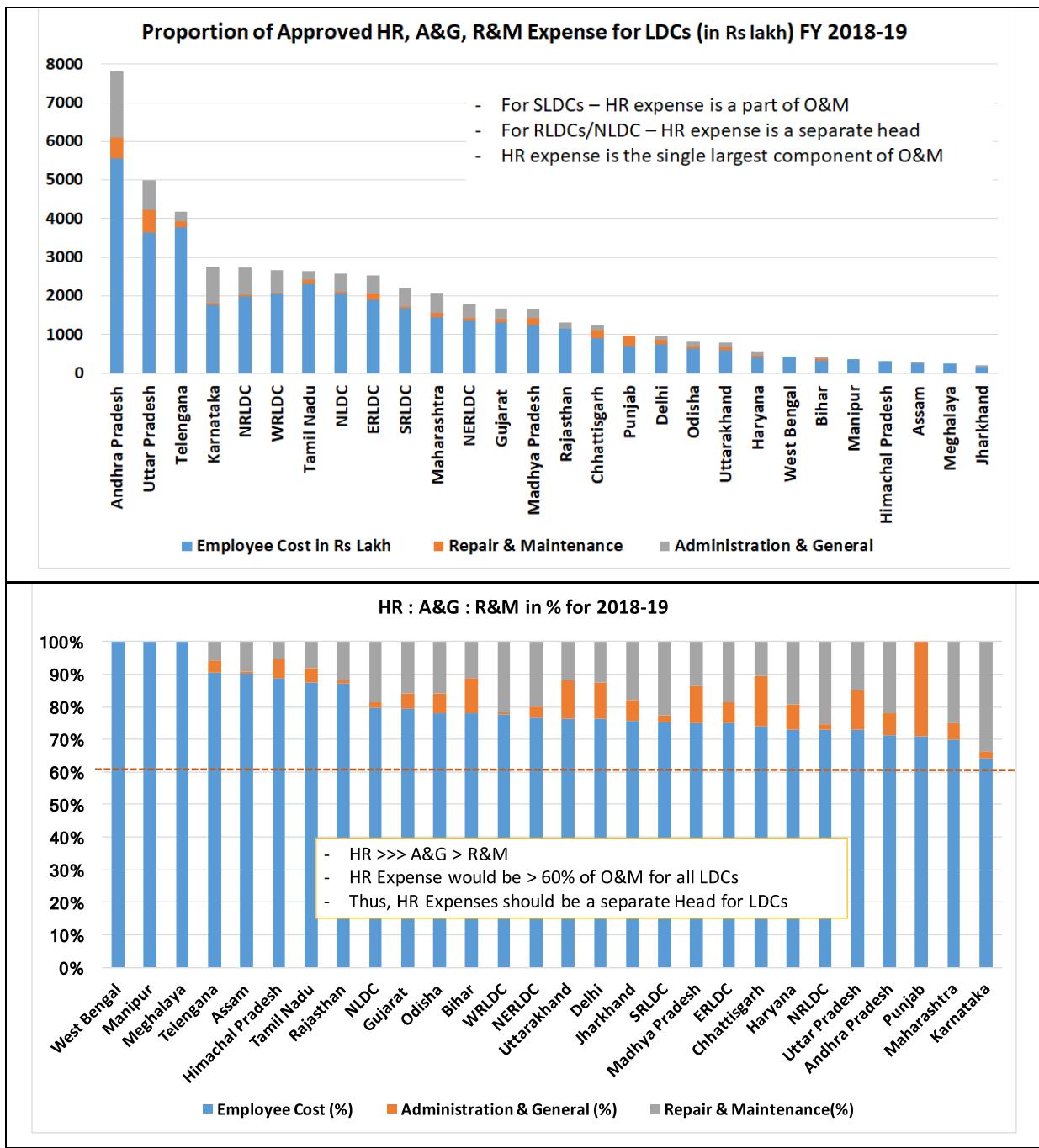


Figure 16: Relative proportion of components of O&M Expenses for FY 2018-19

#### 10.5.4. Capital Expenditure

On comparing approved Capital expenditure of different LDCs for FY 2018-19, it was observed that barring a few cases, the typical capital outlay constitutes 20-30% of ARR. Thus, LDCs are low capex units. For a few of the LDCs (viz. NLDC ) a higher Capex to ARR ratio was observed for FY 2018-19 on account of higher outlay for developing major civil infrastructure for the specific period.

#### **10.5.5. HRD Expense**

Human resource is the key asset in a knowledge oriented organization like the LDCs. Capacity building of the human resource is paramount for building LDCs as a sustainable institution that would keep track with the ever changing regulatory regime & technological upgradation in the sector. Performance & efficiency of the power system operation requires continuous training & capacity building for skill upgradation of the LDC personnel. The national training policy has envisaged that at least 5% of the employee expenses to be earmarked for Human Resource Development (HRD). Thus adequate fund must be allocated for Human Resource Development (HRD) outlay of LDCs. Presently, the HRD expenses are being booked under the head of Admin & General expenses. It is desirable that HRD is made a part of HR expenses so that monitoring of National Training Policy norms could be done more effectively.

#### **10.5.6. Certification based incentive**

Maharashtra is the only state where there is monthly certification based incentive payment to the eligible system operators in line with G B Pradhan Committee recommendations. Further, SLDC Telangana has allowed payment of one time cash award for its certified system operators. Such schemes are yet to be implemented elsewhere in the country despite having a clear mandate in certain regulations.

#### **10.5.7. Typical range of ARR for LDCs**

The sub-group analyzed the approved aggregate revenue (ARR) for the FY 2018-19 for different load dispatch centres in the country. Subsequently, it was attempted to arrive at a typical range of ARR for a typical large, medium & small LDC with break-up for different heads. For calculation of range of different heads, the following approach was adopted.

A median LDC was chosen in each category of (large, medium & small LDC). With reference to figures of median LDC the lower & upper range was selected for different heads. Capital Expenditure was considered as 25% of ARR. Replacement expenditure was assumed to be 20% of the Capex. It was observed that considering 13 large, 10 medium & 19 emerging/small LDCs the typical Annual Revenue requirement by all LDCs pan India works out in the range of Rs. 900 – 1400 crore. Considering annual energy consumption of the order of 1200 billion units (source: CEA [www.cea.nic.in](http://www.cea.nic.in)) at all India level, the range of LDC charge per unit of energy works out as 0.75 – 1.17 paisa / kWh.

Table 18: Typical ARR range for different LDCs in India

| S.No. | Attributes                          | Typical range for LDC Aggregate Revenue Requirement (Fig. in Rs Lakh) for a FY |         |           |           |          |                    |   |
|-------|-------------------------------------|--|---------|-----------|-----------|----------|--------------------|---|
|       |                                     | Category of LDCs   |         |           |           |          |                    | Remarks   |
|       |                                     | Sub-Heads  | Unit    | Large     | Med       | Small    | Total              |   |
| 1     | Number of LDCs                      |  | No.     | 13        | 10        | 19       | 42                 | SLDC(29), UT(7)                                   |
| 2     | HR Requirement                      |  | No.     | 100-150   | 70-100    | 30-50    |                    | RLDC(5), NLDC(1)                                  |
| 3     | Employee Cost/HR Expenses           | Salary & Perquisites<br>Incentives<br>HRD & Certification<br>Miscellaneous     | Rs Lakh | 2500-4500 | 1700-2200 | 400-600  | 57100-91900        |   |
| 4     | Capital Expenditure                 | ROE<br>Interest on Loan<br>Depreciation  | Rs Lakh | 500-800   | 400-600   | 80-200   | 12020-20200        | Assuming Capex =25% of ARR                        |
| 5     | Expenditure (REPEX)                 | SCADA Upgradation<br>IT Expenditure  | Rs Lakh | 100-200   | 90-120    | 20-60    | 2580-4940          | Assuming Repex =20% of Capex                      |
| 6     | Operation & Maintenance             | Admin & General<br>Repair & Maintenance<br>Communication<br>SCADA AMC          | Rs Lakh | 500-700   | 400-550   | 40-50    | 11260-15550        |   |
| 7     | Interest on Working Capital         |  | Rs Lakh | 90-100    | 60-100    | 30-70    | 2340-3630          |   |
| 8     | Statutory Charges, Duties, Taxes    |  | Rs Lakh | 140-180   | 100-140   | 30-50    | 3390-4690          | Assuming 15% of ARR as Profit & 29% tax on profit |
| 9     | Typical ARR for a FY                |  | Rs Lakh | 3830-6480 | 2750-3710 | 600-1030 | 88690-140910       |   |
|       | Total (ARR) for All LDCs pan India: | (Rs Crores)  |         |           |           |          | Rs 900-1400 Crores |   |

This figure is much less than the margin (2 - 4 paise per unit) allowed to trading licensees and it appears fairly reasonable w.r.t. to the volume & complexity of the functions carried out by the LDCs. Further, the pan India figure appears reasonable considering that of international ISOs (ref. Annexure-6) as given under.

Table 19: Operating Expenses in Different ISOs (Source: ISO Annual Reports, 2016)

| Description        | PJM | NYISO | SPP | IESO | MISO | ERCOT | CAISO | AESO |
|--------------------|-----|-------|-----|------|------|-------|-------|------|
| Operating Expenses | 338 | 175   | 213 | 177  | 330  | 181   | 198   | 1780 |

(Approx. Figures in Million \$ USD)

The report of the ISO/RTO Council (November 2005) titled “The Value of Independent Regional Grid Operators” have identified the key factors that characterize the ISO costs. The relevant extracts are given under:

“Several factors characterize ISO/RTO costs: costs are largely fixed for each ISO/RTO; a high proportion is related to highly skilled labour costs; and there is a heavy dependence on specialized information technology (IT) tools. Reliability and market services rely upon a high level of fixed cost elements. The magnitude and quality of critical elements such as information technology (hardware and software such as EMS/SCADA and state estimators or market management and billing systems) and control room operators vary little with the volume of services provided – MWh flows, transactions processed, or customers served.”

#### 10.5.8. Issues & challenges in existing model:

Key challenges observed in the existing business model of different LDCs are summarized under.

- a) Segregation of SLDC & STU ARR accounts are yet to be done for a number of SLDCs
- b) There is a need for expanding the existing user base in view of the changing scenario.

- c) Contracted capacity (LTA/MTOA) based sharing of LDC charge needs a review, since some entities/users (viz. ESIL) avail significant services of LDC, without sharing LDC charge as they have only grid connectivity without LTA/MTOA. Similarly, users of grid reliability services like EHV labs (NHPTL) do not share monthly charge despite availing significant services.
- d) The transmission licenses are not considered as users in most LDCs. For others, they share a disproportionate amount of LDC charge compared to the services rendered by LDCs.
- e) There is wide variation in revenue (ARR) structure of LDCs even though functions are similar. Thus there is a need for harmonization of ARR structure across LDCs.
- f) Most LDC regulations don't have an objective framework for performance evaluation.
- g) Certification linked incentive is yet to be operational in most of the LDCs barring a few.
- h) There is lack of reserve fund (LDC Development Fund) in most of LDCs. Adjustment of other income in subsequent year ARR leaves no scope for reserve creation. Application of holding charge for keeping reserve funds acts as a dis-incentive for many LDCs.
- i) NIL RoE & depreciation on capex funded from LDC Development fund tends to deplete the LDC net-worth leaving no scope for replenishing the assets.
- j) Human Resource expense is part of O & M in most SLDCs
- k) HRD & Training expenditure is being booked under 'Admin & General' head which limits the HR capacity building and meeting norms of National Training policy in most LDCs.
- l) Inadequate manpower at LDCs constrains sparing LDC employees for capacity building as recommended by past task forces/committees of MoP on LDC strengthening.
- m) Retaining trained man-power in SLDCs is a challenge in view of SLDC – STU transfer
- n) Certification based incentive yet to be implemented in most LDCs
- o) Load serving entities such as Essar Steel India Ltd. (ESIL) who are granted connectivity to inter-state transmission system without any LTA/MTOA are not sharing LDC charge despite having considerable amount of drawal (700-800 MW) from the ISTS grid.

## **10.6. Recommended principles for model fees & charges regulation**

### **1. Segregation of SLDC accounts from Transmission business:**

The LDCs perform a distinct statutory function under the Electricity Act and regulatory framework of the Commission. There is clear mandate from the various regulatory commissions to segregate the accounts of transmission business of STUs from LDC operations and carryout separate filing of ARR petitions for SLDCs, maintain separate books of accounts for SLDC charges billing, collection & reconciliation. However, for some of the states, the segregation of SLDCs fees & charges accounts from the STU accounts is yet to be done. It is thus suggested that segregation of LDC ARR accounts must be carried put at all the LDCs as soon as possible.

### **2. Expanding the existing user base of LDCs:**

Since the LDCs are providing significant coordination services to a host of entities other than the conventional users (Generating Stations, Distribution Licensees, Transmission Licensees etc.), and in view of the envisaged functions in a future RE-rich grid, the existing LDC user base needs to be expanded to include EHV Test Labs (e.g. National High Power Test Laboratory), QCAs, Aggregators, Electric Vehicle Charging Stations, Demand Response service providers etc. It is recommended that the Power Exchanges should be considered as a user of SLDC also (in addition to NLDC).

### **3. Simplification of LDC Charge & billing:**

There is growing convergence of System Operation (SO) and Market Operation (MO) activities. Several products (ramping, load following, peaking, reserves) in the electricity market are being introduced to complement reliability (system operation function). Thus methodology for computation, recovery and reconciliation of fees and charges of LDC need further simplification. Further, in the changing regulatory regime with growing convergence of SO & MO functions, segregation of SO-service user & MO service user is a virtually notional one & does not cause any material value addition to the process of billing & collection. Thus it is suggested that a consolidated charge (Annual LDC Charge) could be considered in place of existing bifurcation into 2 components (i.e. system operation & market operation charges).

### **4. Equitable Sharing of LDC Charges:**

It was observed that the recovery from certain LDC users like transmission licensees was disproportionate to the services being availed from LDC by these users. In some of the SLDCs the transmission licensees are not liable to pay LDC charges despite the fact that a lot of resource & effort is deployed at LDCs in rendering coordination services to them viz. switching & protection coordination for first time charging of new transmission elements, shut-down coordination for routine maintenance, transmission network restoration etc. Thus it is suggested that the Transmission Licensees be made users of LDCs in all states & union territories. Further, This Annual LDC charge would be levied equitably among the 3 categories of users viz. Generating Stations/Sellers, Distribution Licensees/Buyers and Transmission Licensees in the ratio 33.33% : 33.33% : 33.34% as given under (at Fig. 17). Within a particular category of users, the charges may be apportioned in proportion of installed capacity and/or aggregate allocated/contracted capacity (in case of generating company/ Seller or Distribution licensee/Buyer) and/or circuit kilometers of transmission lines (in case of transmission licensees).

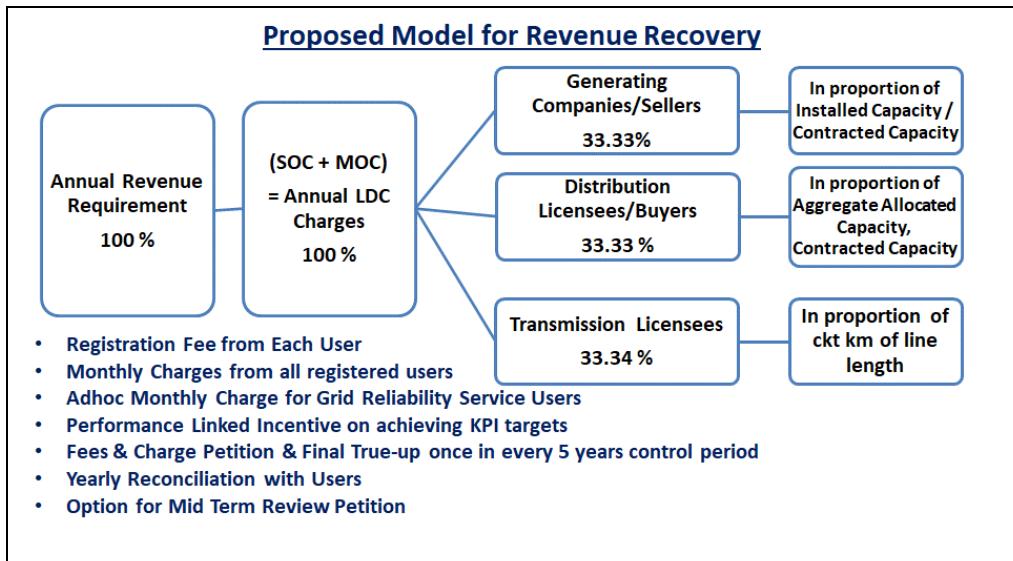


Figure 17: Proposed revenue recovery model for LDCs

### 5. Monthly charge for other Users:

The sub-group recommends that apart from the one-time User registration fee all the users of LDCs who use the services on regular basis, should be explicitly charged every month on a fixed MW quantum (say 100 MW in line with connectivity regulations of the CERC). Such adhoc monthly charges could be levied of users of grid reliability services viz. the National High Power Test Laboratory (NHPTL) & other load entities who are granted connectivity to the grid without any LTA/MTOA (viz. ESIL etc.). The above formulation ensures that the Users get a rough idea of their liability ex-ante without having to wait for the monthly bills raised by the LDCs. It also simplifies the collection of charges as well as post-facto reconciliation.

### 6. Harmonization of ARR Components/Heads:

The sub-group observed huge diversity in the methodology for computation of Annual Revenue Requirement of LDCs. Harmonization of the methodology across all LDCs is desirable. The sub-group recommends that the expenditure incurred by the LDCs are computed/approved under the distinct heads viz.:

- a. Return on Equity;
- b. Interest on Loan Capital;
- c. Depreciation;
- d. Operation & Maintenance (O&M) expenses (excluding Human Resources but including Administrative & General expenses excluding HRD, Repair and maintenance expenses, communication expenses);
- e. Human resource (including HRD) expenses;
- f. Corporate office expenses (excluding HRD and communication expenses);
- g. Interest on working capital
- h. Other incidental expenses (viz. taxes, duties, etc.) for discharge of LDC function

- (i) ***HR Expense as a separate Head:*** The LDCs are considered HR intensive, CAPEX-lite and profit-neutral units. It was observed that human resource (HR) expenses constitute a major component of overall expenditure incurred by LDCs. Thus it is suggested that HR expense be made a distinct accounting head & separated from O&M expenses. Further, the man power needed for effective functioning of load dispatch centres shall be duly filed by the LDCs in their petitions which will be approved by the appropriate commission. This approved manpower shall form the basis for calculation of HR expenses for the LDCs.
- (ii) ***HRD Expense under HR expenses:*** As mentioned earlier training & capacity building is a major thrust area for sustainability & growth of LDCs as an institution. Thus in line with National Training Policy, monitoring of human resource development(HRD) activities can be done more effectively by booking annual HRD expenditure under HR expenses head instead of Administrative & General Office expenses.
- (iii) ***Communication Expenses under O&M:*** The various functions discharged by LDCs are primarily dependent on Information Technology & Communication infrastructure which require regular maintenance & upgradation. Hence it is suggested that communication expenses be booked under O&M head.

## 7. Objective KPIs & Performance linked incentive:

It was observed by the sub-group that provision for objective performance evaluation criteria viz. key performance indicators (KPIs), is missing in most of the SLDCs. Accordingly, there should be provision for performance linked incentive (PLI) for LDCs, which would be linked to achieving a certain level of performance defined under a set of Key Performance Indicators as would be specified by the respective Commission(s). Performance linked incentive design should be such as to boost the efficiency & motivation of system operators and avoid direct or indirect perverse incentive in any form. Accordingly, it is suggested that this incentive be defined in the regulation as a base %age of the annual gross turnover/gross revenue with scope for pro-rated increase subject to increase in performance index / score of the LDC in the identified areas of evaluation. Since gross turn over / gross revenue includes approved LDC expenses as well as other income of LDCs this would help create a wider corpus for payment of PLI subject to applicable guide lines (DPE or appropriate Government Authority).Since performance evaluation is an after-the-fact activity, it is suggested that the LDCs may file separate petition for approval of the corpus for performance linked incentive after end of each financial year. Further, the billing of the approved PLI amount to the users would be done in the same methodology as being done for monthly LDC charges.

## 8. Certification & Retainer-ship

LDCs perform a distinct statutory & mission critical job. Accordingly, for ensuring regular skill upgradation & validation of proficiency and for keeping abreast the LDC personnel with latest developments in the sector, there is a need for periodic training, evaluation & certification. As recommended by past task forces of the Ministry of Power, GoI<sup>[5]</sup> there is a framework for Capacity Building of Indian Load Despatch Centres

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certification of system operators for Basic, Specialist & Management level. Monthly certificate retainer-ship amount to the certified employees is desirable for their motivation. Further, for effective implementation of this framework, it is desirable to have at least 75% of executives in a load dispatch centre, certified. This could be made a distinct KPI for payment of PLI to LDCs. Further, it is desirable that a certified operator must spend a specified tenure (of say 3-5 years) at the LDC after obtaining the certificate for sustainable functioning of LDCs.

#### **9. LDC Empowerment Reserve:**

There is provision for creation of a reserve i.e. LDC development fund for the RLDCs & a few SLDCs (Odisha, Uttarakhand & Maharashtra) under over-sight of the regulatory commissions. It has been learnt from the experience of the LDCs having such reserve, that the reserve fund has given ample financial autonomy & comfort to the LDCs in handling capital expenditure, procurement of additional IT infrastructure & software and meeting other unforeseen contingent expenses. However, such reserves are missing in most of the SLDCs.

Thus, it is suggested that for providing financial autonomy & for long term sustainability, provision may be made in the Fees & Charges regulations for creation of a **contingency reserve** for meeting unforeseen, short-term contingent expenses and a long term reserve namely **LDC empowerment reserve** for meeting capital expenses, R&D expenses, raising margin money for loan, mandated CSR expenses, unforeseen expenses such as engaging consultants for new technology, exploratory studies, pilot projects etc. The contingency reserve could be made out of income from STOA application fee & operating charges, scheduling/rescheduling charges, REC/PAT charges and other receipts collected by LDCs. The LDC Strengthening reserve (LDCSR) could be created by depositing the fees & charges collected under the heads viz. Registration/Grid Connection Fee, ROE, Depreciation, Interest on Loan etc. after meeting of running expenses, payment of statutory taxes etc. The following points could be considered for managing the LCDE reserve.

- a. ROE & depreciation may be allowed for Capex created from LDCS Reserve
- b. LDCE reserve may be reviewed from time to time by the regulatory commissions
- c. Surplus amount in contingency reserve after meeting contingency expenses would be periodically transferred to LDCS reserve

#### **10. Empowerment of Heads of LDCs**

In order to ensure functional autonomy of the LDCs it is desirable that the heads of LDCs be empowered to take independent decision in the matters such as transfer of employees to/from the LDCs, nominating LDC personnel for training and for participating in conferences, seminars for paper presentation, pursuing higher studies etc. Based on the foregoing analysis, inferences and study of the best practices & challenges in existing business model of different LDCs, the sub-group has attempted to draft a model regulation namely – ‘Model LDC Fees & Charges regulations’ which is given at Annexure-18.

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## 11. Key Performance Indicators

निंदक नियरे राखिए, आँगन कुटी छवाय, बिन पानी, साबुन बिना, निर्मल करे सुभाय – कबीर

### 11.1. Performance evaluation of system operators

Electricity Act 2003 mandates that the Load Despatch Centres shall ensure integrated and stable operation of the power system with security, reliability, economy and efficiency in accordance with the Grid Standards and various other regulations by CEA / CERC. As per the study report published by the Centre on Regulation Study, the System Operators perform the “*coordination function which differs from both regulation and operation of the network, to cope with the significant pecuniary and non-pecuniary externalities which link the now increasingly separated functions of running the network, providing services over it and protecting the end users*”. The Study identifies the key coordination functions as - traffic management, network access and network expansion decision making.

The Electricity Act further mandates that the Load Despatch Centres shall be responsible for optimum scheduling and despatch of electricity in accordance with the contracts entered into with the licensees or the generating companies. The Act also mandates non-discriminatory Open Access in the network for facilitating completion in the electricity market. The access to the network is to be facilitated by the System Operator who has the powers to curtail the transactions in case of congestion/threat to grid security.

The key result areas and key performance indicators at the organizational / individual level needs to be suitably defined and aligned to achieve the system level goals envisaged in the statute / regulations. This in itself is a complex task. It becomes further challenging in a multi-control area / multi-utility environment; federal structure of governance; evolving regulatory regime; and diversity in the prevailing organization structure of Load Despatch Centres in India. The System Operators are asset-lite entities that do not fund investments or hold significant assets other than computer control systems and the power vested in the LDC are a proxy for vertical integration wherein they have to perform their function without using a high powered incentive system.

The Electricity Policy Research Group Working Paper titled “Lessons from the History of Independent System Operators in the Energy Sector, with applications to the Water Sector” by Michael G. Pollitt articulates the problem for performance evaluation of System Operators as under:

*“The ISO remains a complex entity producing a large number of outputs for which it would be difficult to design a comprehensive set of performance metrics which could form the basis of an external evaluation of its performance.”*

The issue of performance evaluation of LDCs was deliberated by Hon’ble CERC in the Statement of Reason to the Regulations on RLDC Fees and Charges, 2009. The Hon’ble CERC had recognized the need for specifying the KPIs. The relevant extracts are quoted below:

*“3.7.1....The services provided by RLDCs/NLDC however fall in a different category. The Commission believes that employee’s incentives such as Performance Related Pay (PRP) need to be considered as part of the Human Resource expenses. However in a regulatory regime 100 % pass through of such expenses would necessarily have to be linked to the performance. For this purpose the Commission would come out with suitable Key Performance Indicators (KPIs) for RLDCs/NLDC and the pass through of PRP expenses would be linked to the performance of the RLDCs/NLDC vis-à-vis these KPIs. This had been a recommendation of the Satnam Singh Task Force also.”*

Subsequently the Explanatory Memorandum to the Draft Fees and Charges of RLDC Regulations 2014 elaborated the need for the KPIs as under:

*“2.17.....Apart from the purpose of incentive, the key performance indicators of RLDCs are also necessary due to following reasons:*

- a) *It will bring the transparency in power system operations and ensure the credibility of system operators among stakeholders;*
- b) *There is no provision in the existing regulation such as Indian Electricity Grid Code, 2010 which provide for assessment of performance of RLDCs/NLDC. The overall performance assessment of RLDCs/NLDC for maintaining reliability and grid discipline, administration of wholesale electricity markets and organizational effectiveness are not available in existing regulations;*
- c) *The increasing number of market participants, capacity addition in generation and transmission business increases expectation from load despatcher to administer wholesale market operations effectively in a non-discriminatory manner as envisaged under the Act;*
- d) *The RLDCs/NLDC are invested with the statutory functions under the Act and regulations of the Commission. Therefore the performance of the RLDCs and NLDC is required to be assessed through suitable performance indices;*
- e) *Earlier, RLDC function was exercised under Central Transmission Utility and fees and charges were recovered through ULD&C Charges which was collected with transmission charges. The performance of RLDCs was not separately identified for NLDC/RLDCs. At*

*present, Power system operation function has been separated from transmission activities.*

*Therefore the performance of power system operation is required to be evaluated separately for each RLDCs and NLDC;*

- f) *The reliability of power supply to end consumer reflects combined effect of distribution, transmission and system operator's contribution. In order to know the contribution of system operator, the performance indices will be helpful."*

The LDCs have similar responsibilities and functions. They are mandated to be neutral, non-discriminatory and transparent in discharging their statutory functions. The System Operators are considered to be profit neutral. Thus the key performance indicators for LDCs would be distinct from the KPIs of the generating companies, transmission licensees or distribution licensees which would be commercial entities with clear profit motive.

The CIGRE Working C2.35 conducted an international survey on '*Power System Operator Performance: Corporate, Operations, and Training Goals and KPIs used.*' The results were published in the CIGRE Technical Brochure No. 677 in Mar 2017. It recommended that companies should define and possibly quantify goals and performance indicators at all key levels (corporate, operations, training), but at operations level at first; companies to track power system operation performance through performance indicators (KPI's) on a continual basis; companies to cooperate on the issue of operations performance, to compare and benchmark metrics and results, at the regional or even continental base.

At the International level there have been several projects on benchmarking Transmission System Operators. One of them was by the TSO Comparison Group that comprises of 22 members. The group benchmarks the performance of the member TSOs against the resources used for five processes viz. Operations Planning, Scheduling, Real-time Operation, after the fact and Support. The measures used for evaluating the performance of System Operations are listed below:

- a. Average Interruption Time, defined as Energy not Supplied divided by transported energy;
- b. Voltage control, defined as the number of voltage excursions;
- c. Average Overall System Deviation, defined as frequency deviation for Area
- d. Control Error for interconnected networks;
- e. Response time to Area Control Error or Frequency Error;
- f. Accuracy of peak load forecast;

## **11.2. Existing KPIs & MOUs for LDCs in India**

The MoP, GoI Task Force on 'CAPEX and Issues related to Emoluments for personnel in Load Despatch Centres' had recommended as under:

*“The performance of LDC could be evaluated against Key Result Areas in System Operation, Market Operation, and Logistics while the performance of the individual could be assessed with the help of a Performance Management System or Performance Appraisal System. The Key Result Areas for evaluation of performance of LDCs in System Operation, Market Operation and Logistics must be clearly defined and consist of parameters (Performance Indicators) on which LDCs have a fair degree of control. Likewise the elements in the Performance Management System should suitably capture the attributes, competencies and skills required for the position of the individual and the individual’s performance on the assigned responsibilities during the evaluation period. The parameters for performance evaluation of the LDCs and individuals can be expressed in physical, monetary or qualitative terms and they must be measurable, comparable and consistent.”*

The Task Force had suggested KRAs for LDCs under the following and Performance Indicators for measuring the performance of LDC and broad elements of the PMS for measuring the performance of individuals. These KPIs were studied along with the existing regulations of SERCs and CERC on SLDC/RLC fees and charge were studied. The CERC (Fees and Charges of RLDC and related matters), Regulations, 2015 provides for recovery of incentive by the RLDC based on achievement of the following Key Performance Indicators.

Further, issues related to emoluments of LDC personnel has been dealt in detail by this (Satnam Singh) Task force.

*Table 20: Key Performance Indicators for RLDCs/NLDC notified by CERC in 2015*

|   | Key Performance Indicators                       |    | Key Performance Indicators        |
|---|--|----|-----------------------------------|
| 1 | Reporting of Interconnection meter error         | 7  | Availability of SCADA Systems     |
| 2 | Reporting of Grid Incidents and Grid Disturbance | 8  | Availability of website           |
| 3 | Reporting of Voltage Deviation Index             | 9  | Availability of Standby Supply    |
| 4 | Reporting of Frequency Deviation Index           | 10 | Variance of Capital Expenditure   |
| 5 | Reporting of System Reliability                  | 11 | Percentage of Certified employees |
| 6 | Average processing time of shut down request     |    |                                   |

The incentives for the RLDCs/NLDC (at organization level) is linked to achieving targets stipulated by the Hon’ble CERC. It was noted that the objective KPIs for performance evaluation of SLDC functions is generally lacking although few SERCs do evaluate the SLDC performance on other aspects such as – Implementation of recommendations of the Pradhan committee.

POSOCO was formed in 2010 as a wholly owned subsidiary company of POWERGRID (designated Central Transmission Utility). As per the guidelines of the Department of Public Enterprises,

POWERGRID had a Memorandum of Understanding with the Ministry of Power, Government of India. The parameters in the above MoU primarily oriented towards the POWERGRID's role as a transmission utility. Subsequently when POSOCO was notified as a Government of India Undertaking w.e.f 03<sup>rd</sup> January 2017, POSOCO signed a separate MoU with the MoP. The parameters in the MoU cover the financial aspects (turnover, profit after tax), Outage Coordination efficiency, SCADA system availability, Reporting of Weekly Transmission Losses and Interface Energy Metering Errors, Implementation of Automatic Generation Control and organizing workshops under Forum of Load Despatchers.

### **11.3. Performance metrics - International Practice**

As per the CIGRE Technical Brochure 677 on 'Power system operator performance: corporate, operations and training goals and KPI's used', "*the general direction of electricity supply industry evolvement in liberalized environment is moving to the situation where many of the key business components (like cost of service, tariffs etc.) will be recognized/paid for based on demonstrated operations performance. In the area of operational reliability (term dominantly used in North America) performance metrics/KPIs are very well developed and employed, while situation in Europe (ENSO-E) in the same area (called now security) is yet to be improved i.e. to develop suitable metrics. The work in this area is already in progress."*"

All the Independent System Operators in the United States are designated as not-for-profit with performance metrics notified by the Regulatory Commission. The relevant extracts from ISO/RTO Performance Metrics- FERC Staff Report AD10-5-000 are as under:

*"The three major categories of performance metrics are reliability, market benefits and organizational effectiveness. The reliability performance metrics, discussed first, were chosen to measure the reliability of day-to-day operations in metrics such as compliance with national and regional reliability standards, dispatch, forecasting and Special Protection Schemes as well as to measure long-term reliability in metrics such as long-term generation and transmission planning. The market benefits metrics were chosen to measure the performance of ISOs/RTOs based on market prices, congestion management costs and resource availability and to measure the efficiency of ISO/RTO markets in price convergence and competition metrics. Finally, the organization effectiveness metrics were chosen to measure ISO/RTO performance in accomplishing their objectives in a cost-effective manner that provides value to market participants."*

The aforementioned FERC staff paper proposed performance metrics under three categories- Reliability, Market benefits and Organizational Effectiveness. Few of the metrics that could be relevant in the Indian context are listed below:

*Table 21: Performance Metrics for ISOs proposed by FERC Staff*

| S N. | Performance Metric  | S N. | Performance Metric   |
|------|---|------|--|
| 1    | Number of violations of Reliability Standards             | 8    | Unscheduled Flows  |
| 2    | Compliance with operating reserve standards               | 9    | Unserved energy caused by violations                           |
| 3    | Compliance to Control Performance Standards or ACE limits | 10   | % of planned outages studied within the established timeframes |
| 4    | Load forecast Accuracy                                    | 11   | % of outages cancelled by ISO after having previously approved |
| 5    | Wind Forecast Accuracy                                    | 12   | Reliability of Special Protection Schemes                      |
| 6    | Energy Management System availability                     | 13   | System Lambda  |
| 7    | Energy Market Price Convergence                           | 14   | Customer Satisfaction  |

The Electricity System Operator Regulatory and Incentives Framework from April 2018' by the Office of Gas and Electricity Markets, supporting the Gas and Electricity Markets Authority (OFGEM) in United Kingdom observed that the KPIs for Electricity System Operator should assess their contribution while acting as a residual balancer; facilitating competitive markets; facilitating whole system outcomes and supporting competition in networks. In response to the above working paper by OGEM, several performance metrics were proposed by the National Grid (TSO in UK). Several of them could be relevant in the India context. These are listed below:

*Table 22: Performance Metrics proposed by National Grid to OFGEM*

| S No. | Performance metrics  |
|-------|--|
| 1     | Compliance to Grid Code  |
| 2     | Accuracy of transmission system demand forecasts shared with the market participants   |
| 3     | Average customer satisfaction survey score for the ESO across the survey base          |
| 4     | Balancing services cost  |
| 5     | Diversity in balancing services markets (Herfindahl-Hirschman index in reserve market) |
| 6     | Whole Systems thinking by co-ordination across transmission and distribution systems   |
| 7     | Congestion cost and volume of within-year system access and outage requests            |
| 8     | Accessibility of market related data for stakeholders                                  |

The Electricity Policy Research Group in its report titled '*What can we learn from international comparators about how we should structure an incentives framework for the future GB electricity system operator to help maximize consumer welfare*' suggests that the incentives framework for ISO should such that

- the ISO/RTO is incentivised to maximise system welfare and control both external market costs (i.e. for balancing the system) and internal costs (i.e. system operator)

- the ISO/RTO manages the best overall actions for its customers in a dynamic setting where trade-offs need to be made between current and future costs.
- an ISO/RTO builds trust with its stakeholder community via appropriate levels of engagement and transparency of decision making and information

Few relevant extracts from the report are quoted below.

*“The Regulation of the SO is not primarily about assessing the efficient amount of revenue the SO requires but about the efficiency of its ancillary service procurement process, its system optimization (to set procurement levels) and its stakeholder governance process.”*

*“ISOs are themselves regulatory bodies responsible for real time system operation and for taking a view about the future development of the system and hence must be sufficiently resourced. They must be subject to regulatory oversight but they also have to provide appropriate levels of voice, accountability and training to their stakeholder community which may be expensive in themselves.”*

*“High levels of internal and external oversight of ISO decision making are associated with impressive amounts of publicly available information on ISO performance. Decisions around the SO are becoming more complex and subject to high levels of uncertainty. This suggests that high levels of monitoring and attention to the capacity to learn quickly from new information would seem to be important as we move towards a system with high shares of intermittent distributed renewables. State of the Market Reports provide excellent examples of regular updates on key recommendations for future market design.”*

The CIGRE Technical Brochure No. 677 titled ‘Power system operator performance: Corporate, operations and training goals and KPI’s used by Working Group C2.35Working Group C2.35 defined operational goals and KPI’s in six categories as below at table-23. Details are given as Annex.14A.

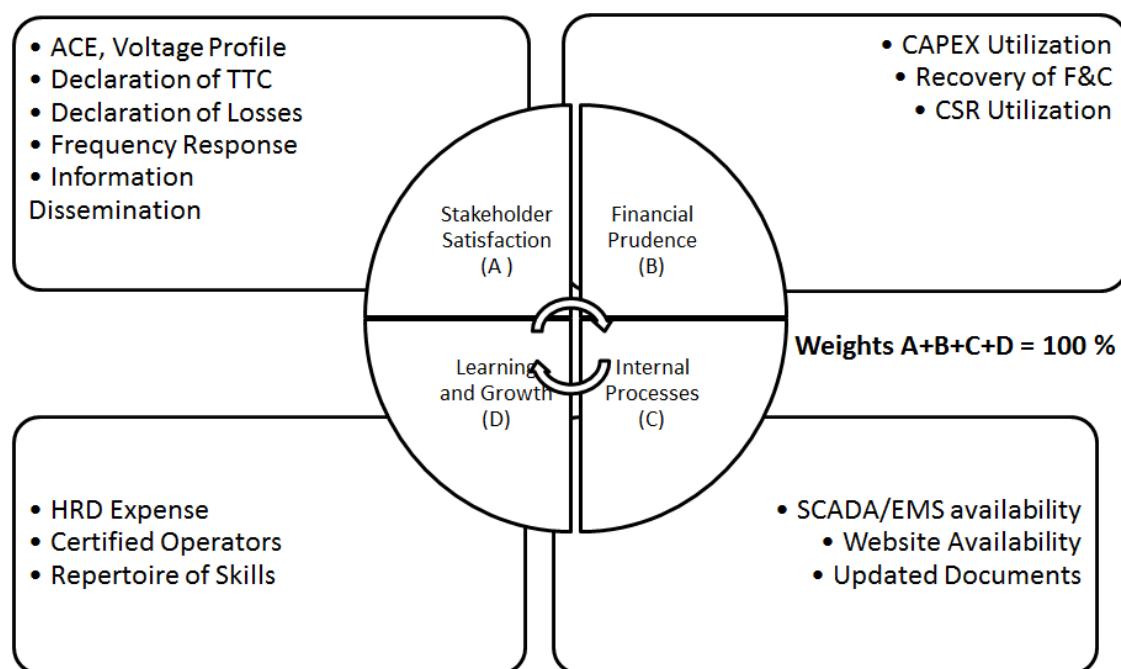
*Table 23: Categories of KPIs as defined by CIGRE WG C2.35*

| S No. | Categories of KPIs                    |
|-------|---------------------------------------|
| 1     | Grid Security and Reliability         |
| 2     | (Good) Operational Practices          |
| 3     | Operational Safety and Environment    |
| 4     | Economical Operations                 |
| 5     | Customer Focus                        |
| 6     | Employee Satisfaction and Development |

#### 11.4. Recommended KPIs for LDCs

After reviewing the available reference material the sub-group deliberated on the possible KPIs for performance evaluation of the LDCs. Considering the diversity of resources and the organization structure it was concluded that apart from having parameters to measure the operational performance of the power system, the KPI framework should also assess the resource adequacy, internal processes and capacity building of HR. The sub-group was also of the view that the KPIs should be Specific, Measurable, Achievable, Relevant and time bound. Accordingly a detailed list of KPIs for LDCs were evolved. The same is enclosed as Annex-14B.

It was also concluded that the Balanced Scorecard Approach [Kaplan & Norton] could be adapted to evaluate the performance of LDCs in four dimensions – Stakeholder satisfaction; Learning and Growth; Adequacy and Efficiency of Internal Process; and Financial prudence. Different weightages could be assigned to each of these dimensions such that the total weight comes to 100%. LDC Incentives to be linked to achieving the target score in the Balance Score Card. The performance related pay for individuals to be linked to LDC performance plus management appraisal as per individual KPIs



**KPIs may be chosen from the list, Performance Related Pay to be linked to achieving KPI targets**

Figure 18: Framework for Performance Assessment of LDCs

**The KPIs under ‘Stakeholder satisfaction’ could be as under:**

- Maintain System Reliability
  - Area Control Error within IEGC limits
  - Maintain Voltage profile within IEGC limits
  - Computation and monitoring of Frequency Response Characteristics
  - Demand and RE Forecasting
  - Updating power map, Operating & Recovery procedure, Reactive Document
- Strengthening System resilience
  - Coordinating Black Start Drills, Organizing System recovery workshops
  - Fail-over Test of Back up Control Centre
  - Annual review of SPS, Islanding Schemes, Protection Coordination
- Facilitate Power System and Market functioning
  - Timeliness in Processing Transmission Outage Applications, STOA Applications
  - Timeliness in Declaration of Transfer Capability, Transmission Losses
  - Timeliness of Issuing Energy Statements and Accounts
- Information Dissemination and Sensitivity to stakeholder concerns
  - Reporting Grid Events as per Standards
  - Operational Feedback to Transmission Utility
  - Publishing Annual Compendium
  - Organizing Stakeholder meet
  - Updated documents – Power Maps / Operation Procedure / Restoration
  - Mandated MIS reports, Operational feedback, Grid Event reports

**The KPIs for assessing the adequacy and efficiency of internal processes could be as under:**

- a. Availability of Civil Infrastructure and Amenities
  - Infrastructure security, access control - Biometric Access, CCTV
  - Redundant sources of auxiliary supply, UPS
  - Conference room, video conferencing, conference calling, visitors lounge
  - Rest room for personnel in shift duty
  - Space cooling and lighting
  - Transport facility for pick up and drop for personnel in shift duty
  - Gym, recreation facility, indoor games, cafeteria, resource centre, first Aid kit
  - Energy Audit, Energy Efficiency targets achieved
  - Utilizing RE to meet energy Consumption of LDC premises
- b. Availability of Information Technology and Communication Systems
  - Redundant communication for data & speech communication for Main & Backup
  - LAN, Personal Computers, Laptops, Intranet, Mobile Apps, Internet etc.

- Compliance to Information Security Systems / Cyber Security / Safety / IMS
  - Application Software - Scheduling, STOA, AMR, Energy Accounting, Billing
- c. Availability of Decision Support System
- SCADA / EMS / WAMS for power system visualization
  - Application software for simulations, optimization
  - Application software for developing displays and power maps
  - Systems for Data Repository, Data Analytics, Statistical Analysis
  - ISO/IMS/OHSAS Certification
  - Standard Operating Procedures

**The KPIs for assessing the ‘learning and growth aspects could be as under:**

- a. Adequacy of HR as approved by ERC
  - Executive to non-executive ratio
  - Certified Operators as a percentage of total employees
  - Personnel from - Legal, Economics, HR, Corporate Communications disciplines
- b. Talent Management- Availability of personnel with appropriate skills
  - Grid Event Analysis Skills - Protection
  - Simulation Skills, Optimization Skills – GAMS, PLEXOS
  - Data Analytics Skills – Statistical tools
- c. Innovation - Pilot projects, New Technology Adoption

**The KPIs for assessing financial prudence could be as under**

- a. Revenue collection efficiency
  - % Recovery of Fees and Charges
- b. Utilization of Approved expenses
  - Approved CAPEX Utilization without time and cost overrun
  - HRD as % of HR expenses
  - CSR budget utilization
  - Timely Clearance of vendor bills
- c. Statutory compliance
  - Preparation of Financial Statements
  - Audit of Accounts
  - Audit of the regulatory pool accounts

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## 12. Recommendations

उद्यमेनैव सिद्धान्ति कार्याणि न मनोरथः । न हि सुप्तस्य सिंहस्य प्रविशन्ति मुखे मृगाः ॥

### 12.1. Institutional capacity building

Institutional capacity building could be seen as a way of promoting and developing good governance. There are two dimensions to it - tangibles and non-tangibles. The tangibles (hard capabilities) include physical assets such as infrastructure, machinery, natural resources, organizational structure and systems, legal frameworks and policies. The intangibles (soft capabilities) on the other hand, have to do with social skills, experience, creativity, social cohesion, social capital, values, motivation, habits, traditions, institutional culture etc. The former is relatively easier to do. However, the latter being difficult to measure are often overlooked. **Sustainable development requires suitable interventions in both the dimensions** as shown under. [Source: [https://www.vegvesen.no/ attachment/112627](https://www.vegvesen.no/attachment/112627)]

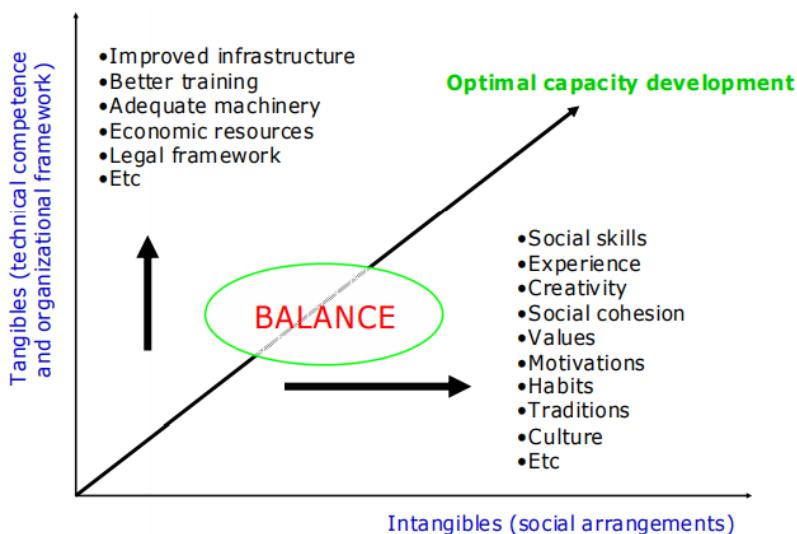


Figure 19: Dimensions of Institutional Capacity Building

### 12.2. Change management

The sub-group appreciated the tremendous increase in complexity as far as Load Despatch Centre (LDC) operations are concerned over the last decade. From a peak demand of about 97 GW being met in 2008-09 to 176 GW in 2018-19 coupled with a sharp rise in Renewable Energy (RE) generation capacity from about 13 GW to about 70 GW during the same period, there has been a paradigm shift in system operation.

The sub-group felt that in the coming decade, De-carbonisation, Digitalization, Decentralization and Distributed generation (the 4Ds) would profoundly impact LDC operations and calls for a radical overhaul of technology and skill sets. So while the past reports on the subject of LDC empowerment

were studied, the LDCs now need an enabling framework to leapfrog and handle the challenges ahead.

Thus, the key factors<sup>[100]</sup> that impact the overall performance of a Load Despatch Centre viz. business model, business environment, human resource adequacy, skill & knowledge (on how to perform) operating aids (resources to perform), organization culture & working environment, goal setting & performance evaluation criteria etc. need to be duly recognized by both internal & external stakeholders & the policy makers and regulators while framing policies & regulations governing the working of LDCs.

### **12.3. Diversity of LDCs**

The sub-group realized that each LDC varies from the others with respect to system size, complexity, state of markets etc. There can be no ‘one size fits all’ and based on various criteria such as Installed Generating Capacity, Installed RE capacity, peak MW, energy consumption, transmission system etc., the LDCs can be categorized into emerging(small), medium and large with staffing requirements worked out accordingly.

### **12.4. Decision support systems for LDCs**

The subgroup emphasizes the need for proper Decision Support Systems at LDCs for a heightened Situational Awareness (SA). The Decision Support Systems would vary from the conventional Supervisory Control and Data Acquisition Systems (SCADA), Energy Management System (EMS) to advanced tools like Wide Area Measurement Systems (WAMS) and Dynamic Security Assessment (DSA). The Renewable Energy Management Centres (REMCs) are an added requirement for RE rich states. These call for an appropriate life cycle management of these decision support systems so as to keep them state of the art and relevant to the operators.

### **12.5. Distribution System Operators**

With decentralized distributed generation leading to bidirectional flow of power besides the envisaged separation of carriage and content at the distribution level, the sub-group recommends the establishment of Distribution System Operators (DSOs) in each state which would interact with the State LDCs (SLDCs) to keep the system secure.

### **12.6. Information and Communication Technology**

For an effective and efficient wholesale electricity markets operating closer to real time, robust Information and Communications Technology (ICT) is the key. Failure of ICT systems at LDCs Capacity Building of Indian Load Despatch Centres

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would lead to a market disturbance which is akin to a grid disturbance. The subgroup recommends that the ICT functions which had hitherto been part of the Decision Support department (SCADA/EMS) at LDCs must be made a full-fledged functional division so as to handle the future challenges. High obsolescence rates, cyber security, third party software vs in-house capability besides vendor development must be suitably factored by the ICT teams at LDCs.

Since the various functions discharged by LDCs are primarily dependent on Information Technology & Communication infrastructure which require regular maintenance & upgradation, it is suggested that communication expenses be booked under Operation & Maintenance head in computation of Annual Charge.

### **12.7. Civil infrastructure & Ergonomics**

The importance of civil infrastructure and ergonomics cannot be over-emphasized. The sub-group recommends that from a physical security perspective, the LDCs need to be housed in a separate independent building with the right ergonomics for a control centre environment. The human factors should be suitably considered for Video Projection Systems, control centre operator desks with adequate space for future expansion. With increasing stakeholder interactions and outreach required by LDCs, multiple conference rooms and conferencing systems are an absolute requirement. The sub-group further recommends that considering resilience to disasters, main and back up control centres need to be operated on Main-I and Main-II philosophy.

### **12.8. Real time operation desks**

The sub-group recognizes the importance of real time operation, with nearly 25-30% of the LDC strength involved in this critical activity. The sub-group recommends that the Human Resource budget for real time operation should duly factor training, business travel, special assignments, leave entitlements etc. Accordingly, there should be five (5) groups for real time operation so that the leave reserves are available. Further each shift should have three (3) to eight (8) persons so that even the Decision Support Systems and ICT part are taken care of and 24 x 7 reliability ensured. The personnel in shift operations should have the minimum facilities like comfortable seating/environment, night shift reimbursement, pick up/drop for night shift in case campus residential facilities are not available, facilities for rest etc. so as to retain qualified personnel.

### **12.9. Multidisciplinary aspect of LDCs**

Hitherto, the LDC personnel were predominantly from the power systems/electrical/electronics discipline of engineering. In view of the multi-dimensional role of LDCs, it is essential that other

specializations such as law, meteorology, computer sciences, public policy, economics, statistics, data sciences, finance and commerce are also encouraged and the LDCs are nurtured as centres of excellence. As these skills are built over a period of time and entails long-term commitment and motivation, **the sub-group recommends that the head of LDC shall be suitably empowered in matters related to transfers, posting, training, certification and professional engagement and career progression of the staff working in the LDCs**

### **12.10. Human resource diversity**

The sub-group feels that the LDCs are an executive oriented organization and recommends that the Executive : non-Executive ratio should typically be of the order of 95: 5. The typical number of executives for an emerging/small LDC would be in the range of 30-50, a medium LDC should be 70-100 while for a large LDC it should be in the range of 100-150. These are full time staff and excludes the outsourced and/or security staff. For large LDCs, there could be a few sub-LDCs with 15-25 staff per sub-LDC. **It is desirable that one of these sub-LDCs acts as the Main-II (back up) to the main SLDC in the event of any disaster.**

All the RE-rich states and regions would have a co-located Renewable Energy Management Centre (REMC). The GIZ report titled ‘Detailed Project Report for Establishment of Renewable Energy Management Centres (REMC)”, May 2015 under the Green Energy Corridors (GEC) project has recommended on staffing of REMCs.

### **12.11. Human-ware vs IT-ware**

For the medium and large LDCs, the IT systems would be much more evolved and complex. The sub-group feels that **there would be a combination / trade-off between the ‘human ware’ and the ‘IT ware’**. Advanced IT system deployment, skill enhancement of the LDC staff and outsourcing of peripheral services like house-keeping, horticulture, civil and electrical maintenance could optimize the requirements of ‘human ware’.

### **12.12. Governance of data**

In view of the evolving demand from multiple agencies including academia, industry, public authorities etc. for the various data generated & managed by LDCs the sub group felt the need for promulgation of a suitable regulation by the appropriate commission(s) for management & administration of operational data by LDCs. It is desirable that **the regulation takes care of the issues & challenges associated with managing & sharing of various type & nature of data by the LDCs**. Some of the key aspects as summarised under.

- Compliance to RTI Act & other statutory provisions
- Responsibility & accountability on data sharing
- All India Network Model – steady state & dynamic model data,
- Information uniformity & symmetry
- Nature of data, data granularity, data modelling, duration of archival

### **12.13. Human Resource Development in LDCs**

Human Resource Development (HRD) is the key to LDCs becoming centres of excellence. Minimum seven (7) days training per person per year must be ensured. Policies to encourage acquisition of higher qualification and taking up applied research are desirable. HRD expenses should be treated as part of HR expenses rather than Administrative and General (A & G) expenses and should be at least 5% of the HR expenses as HRD expenses are really an investment. The Forum of Load Despatchers (FOLD) should be strengthened to take up a larger role in hand holding new/small/emerging SLDCs and in institutional capacity building of the LDCs through working groups, physical visits, national/international exposure. The expenditure on FOLD activities incurred by LDCs should be suitably factored in the fees and charges.

### **12.14. Certification of LDC personnel**

On the issue of certification of LDC operators, the sub-group recommends that the same continues to be voluntary rather than mandatory. It is important that certification comes as a culture rather than a mandate. In order to encourage the same, a provision of operator certificate retainer ship is desirable. **The sub-group recommends that at least 75% of the executives in a LDC are certified for basic level and 10-15% are certified specialist level with this number going up progressively.**

### **12.15. Model fees & charges regulations**

The sub-group recommends a methodology of computation of the Annual Revenue Requirement (ARR) across all LDCs and recovery thereof from all the users in line with the draft Model Regulations enclosed as part of the report. The salient features are:

- a. One time user registration fees as well as recurring monthly charges
- b. Removing the artificial segregation between System Operation and Market Operation charges considering the growing convergence in these two areas and having a consolidated charge instead.
- c. Distinct heads like Return on Equity, Interest on loans, depreciation, HR expenses (including HRD), Operation and Maintenance expenses (excluding HR expenses but including R&M, A&G,) and Interest on Working Capital etc.

- d. Rationalizing the sharing of the monthly charges between generation, transmission and distribution entities and making it equal between these three groups (one third each) to recognize the increased time and resources of LDCs deployed for transmission related activities.
- e. The Appropriate Commission would place special category users like Electric Vehicle charging stations, Battery Energy Storage Services (BESS), short circuit testing laboratories etc. into either of the above categories appropriately for the purpose of billing LDC fees and charges.
- f. Provision for LDC empowerment reserves & contingency reserves to take care of any unforeseen requirements.
- g. Provision for monthly certificate retainer-ship

#### **12.16. HR Expense as separate head**

The LDCs are considered HR intensive, CAPEX-lite and profit-neutral units. It was observed from analysis that human resource (HR) expenses constitute a major component (~ 70%) of overall expenditure incurred by the LDCs. Thus it is suggested that **HR expense be made a distinct accounting head & be separated from O&M expenses** (as being done at present by most of the SLDCs). Further, the man power needed for effective functioning of load dispatch centres shall be duly filed by the LDCs in their petitions which will be approved by the appropriate commission. This approved manpower shall form the basis for calculation of HR expenses for the LDCs.

#### **12.17. Performance Evaluation**

It was observed by the sub-group that provision for objective performance evaluation criteria viz. key performance indicators (KPIs), is missing in most of the SLDCs. Periodic performance evaluation of LDCs is imperative for improving efficiency of operation as well as for motivation of the LDC personnel. Accordingly, there should be provision for performance linked incentive (PLI) for LDCs, which would be linked to achieving a certain level of performance defined under a set of Key Performance Indicators (KPIs) as would be specified by the respective Commission(s).

Performance linked incentive should be designed in such a way that, while it would boost the efficiency & motivation of system operators and it won't directly or indirectly give any perverse incentive in any form. Accordingly, it is suggested that this incentive be defined in the regulation as a base %age of the annual gross turnover / gross revenue with scope for pro-rated increase subject to increase in performance index / score of the LDC in the identified areas of evaluation. Since gross turn over / gross revenue includes approved LDC expenses as well as other income of LDCs this would help create a wider corpus for payment of PLI subject to applicable guide lines (DPE or appropriate Government Authority).

The Appropriate Commission(s) may notify the Key Performance Indicators (KPIs) for LDCs utilizing a balanced scorecard approach covering stakeholder satisfaction, financial prudence and internal processes besides learning and growth dimension. A set of KPIs have been identified under each of these dimensions. The Appropriate Commission could assign suitable weightage to each of these dimensions and identify 3-4 KPIs for each dimension. The subgroup also recommends that **there should be appropriate incentive schemes for LDC personnel linked to these KPIs** which is recovered from the users.

### **12.18. Benchmarking**

There is a need for benchmarking the LDCs on several performance evaluation parameters under the aegis of forum of load despatchers (FOLD). This would be based on their performance as a unit evaluated on various parameters related to system operation, market operation, usage of technology, adopting best utility practices, implementation of various task force/committee recommendations etc. Details of the modalities such as evaluation criteria, periodicity, expenditure etc. could be worked out by the FOLD under a dedicated working group. Such benchmarking would ensure harmonization of best practices across the LDCs as well as bring in efficiency in operation & would help in developing the LDCs as sustainable knowledge institutions of national repute.

### **12.19. Reward programs**

Healthy competition amongst the peer group is an established method for bringing in efficiency and building collaboration amongst members of the fraternity. Accordingly, it is desirable to conduct periodic reward & recognition programs under the aegis of FOLD under some identified categories viz. best performing LDC in system operation, best LDC for implementing regulatory reforms, most progressive LDC of the year, the Tech-Savvy LDC of the year etc. Detailed modalities for evaluation & selection could be worked out by a moderation committee constituted within the FOLD. This would encourage the best players to maintain their performance while motivate others to come forward thereby gradually raising the bar of load dispatching as a faculty in India.

### **12.20. Roadmap for Implementation**

The sub-group has also recommended a roadmap for implementation of the recommendations made in the report to ensure that LDCs are ready to take on the challenges over the next decade.

### **12.20.1.Estimating an emerging LDC**

It was discussed on several meetings on the subgroup that a specific road map is desirable for establishing a fresh load dispatch centre which would act as a reference /guideline for the emerging LDCs in the country. Based on the deliberations, the following roadmap was worked out.

*Table 24: Suggested Steps for establishing an Emerging LDC*

| S No. | Major Activities   |
|-------|--|
| 1     | Detailed Project Report and Fund tie up by STU / Govt. for LDC Infrastructure, Communication and Telemetry |
| 2     | Identify a Mentor STU/SLDC   |
| 3     | Identification of staff to oversee LDC construction activities   |
| 4     | Visit by identified LDC staff to other LDCs  |
| 5     | Establish Physical Infrastructure- Land / Building   |
| 6     | Establishment of Control Centre Equipment and IT infrastructure  |
| 7     | Posting of additional Staff for LDC Operations   |
| 8     | Commissioning of Control Centre  |
| 9     | Orientation Training, Hands on training for Operations   |
| 10    | Commencement of Operations   |
| 11    | Filing of Petition for Fees and Charges  |
| 12    | Approval of Fees and Charge Petition   |
| 13    | Creation of a separate Bank Account for LDC and Regulatory Pool  |

**It is felt that implementation of the above recommendations would ensure functional and financial autonomy for the LDCs, necessary for discharging their statutory functions and is an essential step for ring fencing of LDCs, ensuring neutrality and credibility.**

## 12.20.2.Roadmap for implementation in existing LDCs

The sub-group also worked out a road map for implementing various recommendations by the existing LDCs in the country. The following table gives the envisaged actions along with indicative time lines for implementation.

*Table 25: Suggested Roadmap for Implementation of Recommendations of Sub Group*

| Step | Activity  | Action by | Target (days) |
|------|---|-----------|---------------|
| 1    | Workshops in each SLDC on the report of the sub group   | SLDC/RLDC | 15            |
| 2    | Publication of draft Regulations for Fees & Charges of Load Despatch Centre in line with Model F&C Regulation   | ERC       | 30            |
| 3    | Interactive session with Stakeholders to emphasize the need for institution building/strengthening of LDCs and elaborate on the principles of LDC fees and charge regulations | ERC       | 45            |
| 4    | Notification of Regulations for Fees and Charges of Load Despatch Centre after public hearing   | ERC       | 90            |
| 5    | Registration of Users of LDC  | LDC       | 100           |
| 6    | Separation of financial accounts for LDCs and Identification of Assets and Liabilities of LDCs  | STU       | 120           |
| 7    | Preparation of organization Chart for LDC and Identification of Human Resources for LDCs. Identification of list of Certified Operators                                       | STU       | 130           |
| 8    | Creation of separate Bank Account for LDC and a separate Bank Accounts for Regulatory Pool funds to be managed by LDCs  | LDC       | 150           |
| 9    | Preparation of CAPEX plan for upgradation of SCADA, IT and civil infrastructure of LDCs   | LDC       | 150           |
| 10   | Preparation of plan for application software relevant for the respective LDC  | LDC       | 180           |
| 11   | Preparation of plan for capacity building of HR personnel in LDC to ensure minimum 7 man-days of training to every employee of LDC  | LDC       | 180           |
| 12   | Submission of Petition for approval of Fees and Charges of Load Despatch Centre in respective ERC   | LDC       | 210           |
| 13   | Approval of Fees and Charges for Control period   | ERC       | 300           |
| 14   | Commencement of billing of LDC fees and charges   | LDC       | 330           |
| 15   | 1 <sup>st</sup> Review of progress in the activities for F&C utilization  | ERC       | 365           |

**It is felt that implementation of the above recommendations would ensure functional and financial autonomy for the LDCs, necessary for discharging their statutory functions and is an essential step for ring fencing of LDCs, ensuring neutrality and credibility.**

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## Bibliography

- [1]. Government of India, Electricity Act 2003, <http://www.cercind.gov.in/Act-with-amendment.pdf>
- [2]. Ministry of Power, Govt. of India, ‘Report of the Committee on Manpower, Certification and Incentives for System Operation and Ring fencing Load Despatch Centres’, Ministry of Power Government of India Aug 2008  
[https://powermin.nic.in/sites/default/files/uploads/Report\\_of\\_the\\_Committee\\_on\\_Manpower\\_Certification\\_and\\_incentives.pdf](https://powermin.nic.in/sites/default/files/uploads/Report_of_the_Committee_on_Manpower_Certification_and_incentives.pdf)
- [3]. Ministry of Power, Govt. of India, ‘Report of the Task Force on Capital Expenditure and Issues Related to Emoluments for Personnel in Load Despatch Centres’, Mar 2009  
[https://powermin.nic.in/sites/default/files/uploads/Task\\_Force\\_Report.pdf](https://powermin.nic.in/sites/default/files/uploads/Task_Force_Report.pdf)
- [4]. Ministry of Power, Govt. of India, ‘Report of the Task Force on Manpower Selection, Recruitment Procedure and Tenures for Personnel in State Load Despatch Centres’, Jun 2009  
[https://powermin.nic.in/sites/default/files/uploads/Report\\_of\\_the\\_Committee\\_on\\_Manpower\\_Certification\\_and\\_incentives.pdf](https://powermin.nic.in/sites/default/files/uploads/Report_of_the_Committee_on_Manpower_Certification_and_incentives.pdf)
- [5]. Ministry of Power, Govt. of India, ‘Report of the Combined Committee for Training and Certification of System Operators’, Mar 2010
- [6]. Report on Open access and Theory, Forum of Regulators, Nov 2008  
[http://www.forumofregulators.gov.in/Data/Reports/FOR%20Report%20on%20Staffing%20of%20ERCs-11.11.2008.pdf](http://www.forumofregulators.gov.in/Data/Reports/FOR%20Report%20on%20Open%20Access-Theory%20and%20Practices-08-04-2009.pdf)
- [7]. Report on Staffing of Electricity Regulatory Commissions, Forum of Regulators, Sep 2008
- [8]. <http://www.forumofregulators.gov.in/Data/HomePage/FOR%20Report%20on%20Staffing%20of%20ERCs-11.11.2008.pdf>
- [9]. Government of India, Report of The Working Group on Power for Twelfth Plan (2012-17), Jan 2012,  
[http://planningcommission.gov.in/aboutus/committee/wrkgrp12/wg\\_power1904.pdf](http://planningcommission.gov.in/aboutus/committee/wrkgrp12/wg_power1904.pdf)
- [10]. CERC, ‘Statement of Reason to the RLDC Fees and Charges, Regulations’, 2009
- [11]. CERC, ‘Explanatory Memorandum to the Draft Fees and Charges of RLDC, Regulations’, 2014
- [12]. CERC (Fees and Charges of RLDC and related matters), Regulations, 2015
- [13]. Letter No. 15/27/2009-Regulations for Fees & Charges Levied by SLDCs from Chairperson CERC to Chairmen, All SERCs.
- [14]. CERC Order in the matter of ‘Clarity regarding control areas and demarcation of scheduling responsibility between RLDCs and SLDCs’, Petition No. 58/2008 (suo motu), 7, May 2008,  
<http://www.cercind.gov.in/07012008/Petition-No-58-2008-suo-motu.pdf>
- [15]. Central Electricity Authority (Furnishing of statistics, returns and information) regulations, 2007  
[http://www.cea.nic.in/regulations\\_sri.html](http://www.cea.nic.in/regulations_sri.html)
- [16]. Ministry of Power, Government of India, ‘Draft National Electricity Policy’, June 2018,  
[http://niti.gov.in/writereaddata/files/new\\_initiatives/NEP-ID\\_27.06.2017.pdf](http://niti.gov.in/writereaddata/files/new_initiatives/NEP-ID_27.06.2017.pdf)
- [17]. Airports Regulatory Authority of India, ‘Terms and conditions for determination of tariff for airport operator, guidelines’, 2011, <http://aera.gov.in/upload/uploadfiles/files/guidelines/188.pdf>.
- [18]. Mallika Chawla, Michael G. Pollitt, “Global Trends in Electricity Transmission System Operation: Where Does the Future Lie?”, The Electricity Journal, Elsevier, Volume 26, Issue 5, June 2013, Pages 65-71, <https://doi.org/10.1016/j.tej.2013.05.004>
- [19]. Michael G. Pollitt, “Lessons from the History of Independent System Operators in the Energy Sector, with applications to the Water Sector”, EPRG Working Paper 1125, Cambridge Working Paper in Economics 1153, Electricity Policy Research Group, University of Cambridge, Aug 2011, <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.900.8839&rep=rep1&type=pdf>
- [20]. Michael G. Pollitt and Stephen J. Steer,“ Economies of Scale and Scope in Network Industries: Lessons for the UK water and sewerage sectors”, Working Paper, Electricity Policy Research Group, University of Cambridge, July 2011, <http://www.econ.cam.ac.uk/research-files/repec/cam/pdf/cwpe1152.pdf>
- [21]. Karim L. Anay, Michael G. Pollitt, “What can we learn from international comparators about how we should structure an incentives framework for the future GB electricity system operator to help maximise consumer welfare?”, Electricity Policy Research Group, University of Cambridge, Final report to OFGEM, Dec 2017, [https://www.ofgem.gov.uk/system/files/docs/2017/12/eprg\\_report\\_on\\_international\\_system\\_operator\\_regulation.pdf](https://www.ofgem.gov.uk/system/files/docs/2017/12/eprg_report_on_international_system_operator_regulation.pdf)
- [22]. Beatriz Arizu, William H. Dunn Jr. and Bernard Tenenbaum, “Transmission System Operators – Lessons From The Frontlines”, Energy & mining sector board discussion paper series paper no.4 Jun 2002, <http://documents.worldbank.org/curated/en/622701468781814067/pdf/280870Transmission0systems0EMS0no-04.pdf>
- [23]. Richard Flaman ‘CAPACITY ASSESSMENT AND DEVELOPMENT In a Systems and Strategic Management Context’ Technical Advisory Paper No. 3 Management Development and Governance Division Bureau for Development Policy, United Nations Development Programme, January 1998

- <https://www.cbd.int/doc/pa/tools/Capacity%20assessment%20and%20development.pdf>
- [24]. Joe Bolger, ‘Capacity Development: Why What and How’, Canadian International Development Agency, Policy Branch, Occasional Series, Vol. 1, No.1, May 2000  
[http://www.hiproweb.org/fileadmin/cdroms/Biblio\\_Renforcement/documents/Chapter-1/Chap1Doc1.pdf](http://www.hiproweb.org/fileadmin/cdroms/Biblio_Renforcement/documents/Chapter-1/Chap1Doc1.pdf)
- [25]. Govindan G. Nair, ‘Nurturing capacity in developing countries From consensus to practice’, Capacity Enhancement Briefs, The World Bank Institute, Nov, 2003  
<http://siteresources.worldbank.org/INTCDRC/Resources/CDBrief01.pdf>
- [26]. M.R. Bhagavan and I. Virgin ‘Generic Aspects of Institutional Capacity Development in Developing Countries,’ Stockholm environment Institute, 2004  
<https://pdfs.semanticscholar.org/ecd7/3f3b451762ff60123ce6e801ffd80cac6559.pdf>
- [27]. M. D. Langaas, J. Odeck and K. Bjørvig, ‘The concept of institutional capacity building and review of road sector projects’, Norwegian Public Roads Administration, Norway,  
[https://www.vegvesen.no/\\_attachment/112627](https://www.vegvesen.no/_attachment/112627)
- [28]. Office of Gas and Electricity Markets, ‘The Electricity System Operator Regulatory and Incentives Framework from April 2018’, Final Decision, February, 2018,  
[https://www.ofgem.gov.uk/system/files/docs/2018/02/policy\\_decision\\_on\\_electricity\\_system\\_operator\\_regulatory\\_and\\_incentives\\_framework\\_from\\_april\\_2018.pdf](https://www.ofgem.gov.uk/system/files/docs/2018/02/policy_decision_on_electricity_system_operator_regulatory_and_incentives_framework_from_april_2018.pdf)
- [29]. Albert DiCaprio, Timo Kaukonen, John Campbell, Bart Franken, Christian Lakenbrink “Benchmarking of System Operation Costs for 21 International Transmission System Operators”, The Group of International Comparison of Transmission System Operation Practices, <http://www.oas.gr/wp-content/uploads/2010/09/TSO-Comparison-Group-Benchmarking-of-System-Operation-Costs-for-21-International-Transmission-System-Operators.pdf>
- [30]. Robert S. Kaplan, ‘Conceptual Foundations of the Balanced Scorecard’, Harvard Business School Working Paper 10-074, 2010, [https://www.hbs.edu/faculty/Publication%20Files/10-074\\_0bf3c151-f82b-4592-b885-cdde7f5d97a6.pdf](https://www.hbs.edu/faculty/Publication%20Files/10-074_0bf3c151-f82b-4592-b885-cdde7f5d97a6.pdf)
- [31]. Shmuel Oren, George Gross, Fernando Alvarado, “Alternative Business Models for Transmission Investment and Operation”, National Transmission Grid Study, 1999  
<http://oren.ieror.berkeley.edu/pubs/Authority1999.pdf>
- [32]. “Statement on the future of Electricity System Operation”, Department for Business, Energy and Industrial Strategy (BEIS),  
[https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment\\_data/file/582899/Statement\\_on\\_the\\_Future\\_of\\_Electricity\\_System\\_Operation1350.pdf](https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/582899/Statement_on_the_Future_of_Electricity_System_Operation1350.pdf)
- [33]. Dieter Helm, “Regulatory Reform and The System Operator Model”, Cross Regulation Network: Paper 7
- [34]. Brunekreeft Gert, Goto Mika, Meyer Roland, Maruyama Masahiro, Hattori Toru, “Unbundling of electricity transmission system operators in Germany: An experience report”, Bremen Energy Working Papers, No. 16  
<https://www.econstor.eu/bitstream/10419/103347/1/800132300.pdf>
- [35]. William W. Hogan, “INDEPENDENT SYSTEM OPERATOR (ISO) FOR A COMPETITIVE ELECTRICITY MARKET”, Center for Business and Government John F. Kennedy School of Government Harvard University, Jun 1998  
<https://sites.hks.harvard.edu/fs/whogan/swit0698.pdf>
- [36]. Paul L. Joskow, “INDEPENDENT SYSTEM OPERATORS (VI + Access Rules vs. ISO vs. ITSO)”, Massachusetts institute of technology, 28 Sep 2007,  
<https://economics.mit.edu/files/1577>
- [37]. Report on “Options for future European Electricity System Operation”, Directorate-General for Energy Internal Energy Market, <https://ec.europa.eu/energy/sites/ener/files/documents/15-3071%20DNV%20GL%20report%20Options%20for%20future%20System%20Operation.pdf>
- [38]. Report on “Future Arrangements for the Electricity System Operator: Response to Consultation on SO Separation”, OFGEM, 3 Aug 2018,  
[https://www.ofgem.gov.uk/system/files/docs/2017/08/future\\_arrangements\\_for\\_the\\_electricity\\_system\\_operator\\_-\\_response\\_to\\_consultation\\_on\\_so\\_separation.pdf](https://www.ofgem.gov.uk/system/files/docs/2017/08/future_arrangements_for_the_electricity_system_operator_-_response_to_consultation_on_so_separation.pdf)  
[https://www.ofgem.gov.uk/system/files/docs/2017/10/so\\_Regulatory\\_Framework\\_Workshop\\_1.pdf](https://www.ofgem.gov.uk/system/files/docs/2017/10/so_Regulatory_Framework_Workshop_1.pdf)
- [39]. Business Plan 2017-2019, Independent Electricity System Operator,  
<http://www.ieso.ca/-/media/Files/IESO/Document-Library/corporate/financial/Business-Plan-2017-2019-IESO-20170201.pdf?la=en>
- [40]. IESO Strategic Plan 2016–2020,  
[http://www.ieso.ca/-/media/files/ieso/document.../plans/ieso-strategic-plan\\_2016-2020.pdf](http://www.ieso.ca/-/media/files/ieso/document.../plans/ieso-strategic-plan_2016-2020.pdf)
- [41]. Kristin Ralff-Douglas, Marzia Zafar, “Electric Utility Business and Regulatory Models”, California Public Utilities Commission Policy & Planning Division, 8 Jun 2015  
[http://www.cpuc.ca.gov/uploadedFiles/CPUC\\_Public\\_Website/Content/About\\_Us/Organization/Divisions/Policy\\_and\\_Planning/PPD\\_Work/PPDElectricUtilityBusinessModels.pdf](http://www.cpuc.ca.gov/uploadedFiles/CPUC_Public_Website/Content/About_Us/Organization/Divisions/Policy_and_Planning/PPD_Work/PPDElectricUtilityBusinessModels.pdf)
- [42]. 3<sup>rd</sup> Legislative Package Input Paper 1: Unbundling, An ERGEG public document, 5 Jun 2007  
<https://www.ceer.eu/documents/104400/-/8839d2f4-41b4-2966-deab-17de6325982e>

- [43]. Mark Pickering, “Towards an independent system operator for South Africa”, Energy Research Centre, University of Cape Town, Oct 2010  
[http://www.erc.uct.ac.za/sites/default/files/image\\_tool/images/119/Papers-2010/10Pickering-Independent\\_System\\_Operator.pdf](http://www.erc.uct.ac.za/sites/default/files/image_tool/images/119/Papers-2010/10Pickering-Independent_System_Operator.pdf)
- [44]. Depreciation, Provisions and Reserves, <http://www.ncert.nic.in/ncerts/l/keac107.pdf>.
- [45]. Accounting Standard (AS) 12, Accounting for Government Grants  
[http://www.mca.gov.in/Ministry/notification/pdf/AS\\_12.pdf](http://www.mca.gov.in/Ministry/notification/pdf/AS_12.pdf)
- [46]. Federal Energy Regulatory Commission Staff Report “ISO/RTO Performance Metrics”, 21 Oct 2010,  
<https://www.ferc.gov/legal/staff-reports/10-21-10-rto-metrics.pdf>
- [47]. Report on 2015 ISO/RTO Metrics, New England States Committee on Electricity, Nov 2015
- [48]. Report on NYISO Performance Metrics and Other Information, 2010 ISO/RTO Metrics  
[http://www.nyiso.com/public/webdocs/media\\_room/press\\_releases/2010/ISO-RTOs\\_Report\\_Performance\\_Metrics\\_12072010\\_2\\_.pdf](http://www.nyiso.com/public/webdocs/media_room/press_releases/2010/ISO-RTOs_Report_Performance_Metrics_12072010_2_.pdf)
- [49]. Tata Management Training Centre Case Study: Tata Power Delhi Distribution Limited Building a customer centric organization, TMTTC Journal: TPDDL Case Study Aug 2011
- [50]. Code of Business Conduct and Ethics for Board Members and Senior Management Personnel,  
<https://posoco.in/wp-content/uploads/2018/02/Code-of-Business-Conduct-and-Ethics-for-Board-Members-and-Senior-Management-Personnel.pdf>
- [51]. T. E. Dy Liacco, “An Overview of Practices and Trends in Power system Control Centres”, The Cleveland Electric Illuminating Company and Case Western Reserve University, Cleveland, Ohio, USA
- [52]. T. E. Dy Liacco, S.K. Mitter, R.K. Babickas, T.J. Kraynak, “Multi Level Approach to Power System Decision Problems – The Optimizing Level”, The Cleveland Electric Illuminating Company
- [53]. Tomas E. Dy liacco, “The Adaptive Reliability Control System”, IEEE transactions on Power Apparatus and Systems vol. Pas-86, no. 5 May 1967
- [54]. Felix F.WU, Khosrow Moselhi, Anjan Bose, “Power System Control Centres: Past, Present and Future”, Proceedings of the IEEE, Vol.93, No.11, Nov 2005, <https://core.ac.uk/download/pdf/37883669.pdf>
- [55]. N.S.Sodha, A.S.Kushwaha, A.K.Mishra, Nirmit Mohan, “Future Grid Control Centres for Indian Power System”, D2-115, CIGRE 2012
- [56]. CIGRE Joint Working Group D2/C2.41, ‘Advanced Utility Data Management and Analytics for Improved Operation Situational Awareness of EPU operations’, June 2018
- [57]. Kjell Sand, Poul Heegaard, “Next Generation Control Centres – State of art and future scenarios version 2.0”, Norwegian University of Science and Technology, 31 Oct 2015  
<https://smartgrids.no/wp-content/uploads/sites/4/2015/11/Next-Generation-Control-Centres-Sand-Heegaard.pdf>
- [58]. RT Guttromson, FL Greitzer, ML Paget, A Schur, “Human Factors for Situation Assessment in Power Grid Operations”, Pacific Northwest National Laboratory, Aug 2007  
[https://www.pnnl.gov/main/publications/external/technical\\_reports/PNNL-16780.pdf](https://www.pnnl.gov/main/publications/external/technical_reports/PNNL-16780.pdf)
- [59]. Yousu Chen, Zhenyu Huang, Ning Zhou, “An Advanced Framework for Improving Situational Awareness in Electric Power Grid Operation”, Proceedings of the 18th World Congress The International Federation of Automatic Control Milano (Italy) August 28 - September 2, 2011
- [60]. Federico Milano, “Three-dimensional visualization and animation for power systems analysis”, Electric Power Systems Research 79 (2009) 1638–1647
- [61]. I.H. Miller, I.P. Bates, D.W. Husband, B.V. O’Neil, “Development of Control Centre Facilities for Victorian Power System”, CIGRE International Conference on Large High Voltage Electric Systems, Aug 30-Sep 7, 1978
- [62]. Alejandro Díaz, Kayvaun Rowshankish, Tamim Saleh, “Why data culture matters”, McKinsey Quarterly, Sep 2018
- [63]. J.M. Delforge, F. Denis, J. Ernould, J.P. Waha, “Power System Control Organisation in Belgium (Hierarchical structure of the control centres) ”, CIGRE International Conference on Large High Voltage Electric Systems, Aug 30-Sep 7, 1978
- [64]. Mini S. Thomas, John Douglas McDonald, ‘Power System SCADA and Smart Grids’, CRC Press, ISBN 9781482226744, 1st edition, Published April 13, 2015
- [65]. Parmod Kumar, V.K. Chandna, Mini S. Thomas, “Ergonomics in Control Centre Design for Power System”, 2006 IEEE Power India Conference, 10-12 April 2006
- [66]. J.B Molendijk, “Philosophy Concerning the Founding of a New Regional Power System Control”, CIGRE International Conference on Large High Voltage Electric Systems, Aug 30-Sep 7, 1978
- [67]. GiZ, ‘Detailed Project Report for Establishment of Renewable Energy Management Centres (REMC)’, May 2015, [https://forumofld.in/download/giz\\_wp-1-2-detailed-project-report-on-remc-concept/?wpdmdl=237](https://forumofld.in/download/giz_wp-1-2-detailed-project-report-on-remc-concept/?wpdmdl=237)
- [68]. Best practices and guidelines to the State on data security, privacy confidentiality, and protection, <http://meity.gov.in/writereaddata/files/guidelines.pdf>
- [69]. Grid@75 - National Grid 75th Anniversary,  
[http://www.nationalgrid75.com/wp-content/uploads/75-years\\_FINAL.pdf](http://www.nationalgrid75.com/wp-content/uploads/75-years_FINAL.pdf)
- [70]. Human Resource Accounting, Chapter-2,

- [http://shodhganga.inflibnet.ac.in/bitstream/10603/148281/8/08\\_chapter%202.pdf](http://shodhganga.inflibnet.ac.in/bitstream/10603/148281/8/08_chapter%202.pdf)
- [71]. Anita Singh, "Human Resource Accounting at Infosys- A Case Study", Research Gate  
<https://www.researchgate.net/publication/305723324>
- [72]. Inderpal Singh, "Human Resource Accounting: Indian Scenario", Delhi Institute of Advanced Studies
- [73]. Frank L. Greitzer, Robin Podmore, Marck Robinson, Pamela Ey, "Naturalistic Decision Making for Power System Operators", Proceedings of NDM9, the 9<sup>th</sup> International Conference on Naturalistic Decision Making London, UK, June 2009,  
[https://www.researchgate.net/publication/220302299\\_Naturalistic\\_Decision\\_Making\\_for\\_Power\\_System\\_Operators](https://www.researchgate.net/publication/220302299_Naturalistic_Decision_Making_for_Power_System_Operators)
- [74]. Ma Lu, Yan Yanling,, Zheng Hong, "Study on Performance Appraisal Index for R & D Staff Performance Based on PC-FA", Proceedings of the 7th International Conference on Innovation & Management
- [75]. Peter M. Senge, "THE FIFTH DISCIPLINE", Currency Doubleday, New York London Toronto Sydney Auckland
- [76]. Margarita IŠORAITĖ, "The Balanced Scorecard Method: From Theory to Practice",  
<http://www3.mruni.eu/~int.economics/3nr/Isoraite.pdf>
- [77]. Julia Zhu, Sabina Shibalayeva, "How Can You Measure the Productivity of Knowledge Workers?", Cornell University ILR School DigitalCommons@ILR, Nov 2017
- [78]. The future of the Electricity System Operator, National Grid, Viewpoint on the regulatory and incentives framework, Sep 2017  
<https://www.nationalgrideso.com/sites/eso/files/documents/SO%20regulation%20viewpoint%20final%202022%20Sept.pdf>
- [79]. Esa Rantanen, "Electric power control center visualization using Geographic Data Views", ResearchGate, <https://www.researchgate.net/publication/4302329>
- [80]. Letter No. NLDC/2018/132-POSOCOs Inputs on Draft National Electricity Policy, 2018 from GM, NLDC to Under Secretary (R & R Division), Ministry of Power, Govt. of India.
- [81]. Jon Stern, Martin Cave, Guido Cervigini, 'Role of System Operators in network industries', Study Report, Centre for Regulation in Europe, July 2012, <http://www.cerre.eu/publications/role-system-operators-network-industries>, [http://www.cerre.eu/sites/cerre/files/120710\\_CERRE\\_RoleOfSO\\_FinalReport.pdf](http://www.cerre.eu/sites/cerre/files/120710_CERRE_RoleOfSO_FinalReport.pdf)
- [82]. Albert DiCaprio, Timo Kaukonen, John Campbell, Bart Franken, Christian Lakenbrink 'Benchmarking of System Operation Costs for 21 International Transmission System Operators' [www.tsocomparison.com](http://www.tsocomparison.com)
- [83]. CIGRE Technical Brochure No. 53, Bulk Electricity System Operational Performance Measurement Systems and Survey Results, WG 39.05, July 1989
- [84]. CIGRE Technical Brochure No. 524, 'Control Centre Operator Requirements, Selection, Training and Certification', WG C2.33, Feb 2013
- [85]. CIGRE Technical Brochure No. 677, 'Power System Operator Performance: Corporate, Operations, and Training Goals and KPIs used.', March 2017
- [86]. CIGRE Technical Brochure No. 733, 'System operation emphasizing DSO/TSO interaction and coordination Joint Working Group C2/C6.36, June 2018
- [87]. CIGRE Working Group C2.35 report, 'VIU/TSO/RTO operations performance: GOALS, KPI'S, their quantification and use at different levels of decision making', 2015
- [88]. CIGRE Working Group 39.05, Ole Gjerde, Olav B. Fosso, Paul Giesbertz, Les Clarke, Per-Anders Löf, Ben Li, Al DiCaprio, Hubert Lemmens, Chai Ming Mak, Veli-Jukka Pyötsiä, Juan Bogas , "Changes in the Business and Interfaces of System Operators facing Liberalisation and Restructuring" CIGRE 30-203, Session 2002
- [89]. CIGRE Working group JWG C2/C5.5, 'Development and Changes in the Business of System Operators'
- [90]. CIGRE Working group, 'Market Operators – Their Evolution, Current Organisation and Future Structure', C2/C5.05, July 2015
- [91]. CIGRE Working Group 39.03, G.Krost, S.Allamby, J.Bogas Galvez, A.Carrano, N.Cukalevski, O.Gjerde, H.Jones, R.Knöpfel, P.Lehtonen, Y.Logeay, S.Lutterodt, Z.Malek, R.Marconato, L.Oroszki, R.Skiold, U.Spanel, D.Szymanski, D.Visser, "Impacts Of Operators' Selection And Training On Power System Performance", CIGRE 39-102, Session 1998
- [92]. CIGRE Working Group 30.03, T.M. Papazoglou, L. Roszki and D. Visser, "Efficient Teamwork and Interpersonal Communication in Control Centres in the new Power system Environment" WG 39.03, CIGRE 39-101, Session 2000
- [93]. CIGRE Working Group 30.03, Hugh Jones, Rolf Knöpfel, Pasi Lehtonen, Sarah Lutterodt, "Certification and Competency Evaluation of System Operators" WG 39.03, CIGRE 39-103- Session 2000
- [94]. CIGRE Working Group 30.03, Gerhard Krost, Steve Allamby and Pasi Lehtonen, "Organization and Justification of Power System Operators Training" WG 39.03, CIGRE 39-102, Session 2000
- [95]. CIGRE Working Group 30.03, "Operator Performance Requirements and Training needs In the commercial environment" by Steve Allamby, Juan Bogas, Ninel Cukalevski, Gilberto Flores, Ole Gjerde, Neso A. Mijuskovic, Udo Spanel, Glenn, Weiss On behalf of WG 39.03, CIGRE 39-104, Session 2000
- [96]. Les Clarke and Mike Lee, "The Interaction Between the System Operator and the Market Functions in England and Wales", CIGRE 39-204, Session 2000

- [97]. Charles J. Frank and Robert J. Miller, "Human Factors Review of Dispatch Control Centres", IEEE Transactions on Power Apparatus and Systems, Vol PAS-101, No. 6 June 1982
- [98]. CIGRE Working Group 30.03, "Operator Performance Requirements And Training Needs In The Commercial Environment Steve Allamby", Juan Bogas, Ninel Cukalevski, Gilberto Flores, Ole Gjerde, Neso A. Mijuskovic, Udo Spanel, Glenn Weiss, WG 39.03, CIGRE 39-104, Session 2000
- [99]. CIGRE Working Group 30.03, N.cukalevski, S. Allamby, H.Jones, G. Flores, W De Smet, "The Impact of Deregulation and Market Trading on the Requirements for and Future Development of Operator Training Simulators", WG 39.03, CIGRE 39-104, Session 2002
- [100]. CIGRE Working Group 39.03, ' Improving Human Performance in the Control Centre', Electra No. 174, October 1997
- [101]. Governance and regulation of Power Pools and System Operators an International Comparison - J Barker, Jr B Tenenbaum – World Bank 1997  
<http://documents.worldbank.org/curated/en/246191468743186525/Governance-and-regulation-of-power-pools-and-system-operators-an-international-comparison>
- [102]. S.K. Soonee, Lokesh Chandra, S.R. Narasimhan, Vivek Pandey, "Institutional Capacity Building of Load Despatch Centres in India", C2-211, CIGRE session 2012,  
[https://www.researchgate.net/publication/296786705\\_Institutional\\_capacity\\_building\\_of\\_the\\_load\\_despatch\\_centres\\_in\\_India](https://www.researchgate.net/publication/296786705_Institutional_capacity_building_of_the_load_despatch_centres_in_India)
- [103]. S. K. Soonee, Devendra Kumar, Samir Chandra Saxena and Sunil Kumar, 'Visualization and Human Factors in Electric Power System Operation', Dept. of Electrical Engineering, ITBHU, ICPSODR-2006, [http://www.wrldc.org/docs/VHPSO\\_FINAL.pdf](http://www.wrldc.org/docs/VHPSO_FINAL.pdf)
- [104]. S.K. Soonee, Vivek Pandey, 'Transparency in Power System Operation in India', Candour 2006- An inhouse journal of POWERGRID Vigilance department,  
[https://www.researchgate.net/publication/293332146\\_Transparency\\_in\\_Power\\_System\\_Operation\\_in\\_India](https://www.researchgate.net/publication/293332146_Transparency_in_Power_System_Operation_in_India)
- [105]. Vivek Pandey, Kiran, Momaya, 'Relevance of Knowledge Management at Power System Operation Control Centres in India', 'Productivity' Vol.48, No.1, National Productivity Council, April-June 2007, [https://www.researchgate.net/publication/237122070\\_Relevance\\_of\\_Knowledge\\_Management\\_at\\_Power\\_System\\_Operation\\_Control\\_Centres\\_in\\_India](https://www.researchgate.net/publication/237122070_Relevance_of_Knowledge_Management_at_Power_System_Operation_Control_Centres_in_India)
- [106]. IEEE publication (0-7803-9525-5/06/\$20.00 ©2006 IEEE) on Ergonomics in Control Centre Design for Power System, authored by Parmod Kumar, Member, IEEE, V.K. Chandna, and Mini S. Thomas, Senior Member, IEEE.
- [107]. IEEE paper on Power System Control Centre: Past, Present and Future by Felix F. Wu, Khosrow Moslehi and Anjan Bose.
- [108]. Manual of Air Traffic Services (MATS) with Document Identification No. ED/ATM/2015/V4.0-MATS-PRT1.
- [109]. ISO 11064 Standard prepared by International Organization for Standardization consisting of the following parts, under the general title Ergonomic design of control centres: Part 1: Principles for the design of control centres, Part 2: Principles for the arrangement of control suites, Part 3: Control room layout, Part 4: Layout and dimensions of workstations, Part 5: Displays and controls, Part 6: Environmental requirements for control rooms, Part 7: Principles for the evaluation of control centres, Part 8: Ergonomic requirements for specific applications.
- [110]. [http://www.aaians.org/atm-publications?tid=12&tid\\_1=All&tid\\_2=All&keys=](http://www.aaians.org/atm-publications?tid=12&tid_1=All&tid_2=All&keys=)
- [111]. <https://bawarchitecture.com/expertise/human-factors-engineering/iso-11064/>
- [112]. Short videos showing Glimpses of Control Rooms  
 National Grid Control Centre: <https://youtu.be/vX0G9F42puY>  
 California ISO: <https://youtu.be/b5jNiu-TdnQ>  
 New York ISO: <https://youtu.be/WJu15TsEGQk>  
 AEMO Control Centre, Australia: <https://youtu.be/ca5xnMYucGk>  
 TERNA Italy: <https://youtu.be/f0eLhIghsII>  
 Renewable Energy Control centre: <https://youtu.be/W6RaXiKiaSk>  
 Google Data Centre - Security and Space Cooling: <https://youtu.be/XZmGGAbHqa0>  
 Load Despatcher 1946 <https://youtu.be/CVH9gHIN7gM>

## **Annexure-1: Constitution of the FOR TC Sub-Group & TOR**

### **FORUM OF REGULATORS (FOR)**

No.1/14/2015-Reg.Aff. (FSDS)/CERC

Dated: 12th April, 2018

#### **Sub: Constitution FOR Technical Committee Sub-Group on Load Despatch Centres (LDCs) - Institution Building and Strengthening**

**1.** Government of India constituted a committee in 2008 to examine issues relating to manpower, certification and incentives for the LDC personnel and also for ring-fencing the LDCs to ensure their functional and financial autonomy. In the Eighteenth Meeting of the "Technical Committee for Implementation of Framework on Renewables at the State Level" held at Delhi on 23rd February, 2018, in the presence of Chairperson, CERC/FOR, it was deliberated that institutional building of the LDCs in India needs fresh impetus in view of the fast changing energy landscape viz. renewable integration, REMCs, synchrophasor technologies, electric vehicles, markets, etc. and rapidly evolving regulatory framework. **2.** In view of above, it was decided to form a Sub-Group to survey and identify the best practices in all LDCs in India. The sub-group may recommend suitable measures and roadmap for institution building and strengthening of the LDCs. Accordingly, the Competent Authority has constituted the Sub-Group comprising of the following members:-

- |   |  |
|---|--|
| 1. Shri S.K. Soonee, Advisor, POSOCO            | : <b>Chairman of the Working Group</b> |
| 2. Head- SLDC, Tamil Nadu                       | : Member                               |
| 3. Head- SLDC, Gujarat                          | : Member                               |
| 4. Head -SLDC, Rajasthan                        | : Member                               |
| 5. Head -SLDC, Maharashtra                      | : Member                               |
| 6. Head -SLDC, Telangana                        | : Member                               |
| 7. Head -SLDC, West Bengal                      | : Member                               |
| 8. Representative of CERC                       | : Member                               |
| 9. Representative of POSOCO                     | : Member                               |
| 10. Ms. Shilpa Agrawal, Jt. Chief (Engg.), CERC | : <b>Member Convener</b>               |

**3.** The Sub-Group may co-opt any other member as it deems fit.

**4.** The broad Terms of Reference (TOR) for the Sub-Group are:

**(a)**To survey various practices in all LDCs in India and international system operators, evolve and recommend Key Performance Indicators (KPIs) to be defined by the Regulatory Commissions; **(b)**To Review Functions of LDCs and Suggest the Future Requirements in View of Megatrends like Large Scale Integration of Renewables, Storage, Electric Vehicles, Prosumers and Introduction of markets; **(c)**To Evolve the Suitable Business Model of LDCs for Financial Autonomy and Funding Mechanism for both the Capital Costs & Recurring Costs to be future-ready; **(d)**To Identify the Infrastructure, System Logistics, Cyber Secure Information and Communication Requirements for LDCs Functioning in terms of Hardware, Software and Ergonomic Spatial Upgradation; **(e)**To assess the human resource requirement along with skill-set required for the Future Power System Operation and other Support Functions; **(f)**To Evolve Framework for Attracting, Development and Retaining Talent at LDCs in Terms of emoluments, selection/recruitment procedures along with training and certification of System Operators; **(g)**Any other suggestions related to above

**5.** The Sub-Group shall submit its report to the Technical Committee within a period of two months from the date of issue of this order.

**sd/-**

(Sushanta K Chatterjee)

Joint Chief (RA)

## Annexure-2: Websites of Load Despatch Centres in India

| S.No. | State            | Website URL   |
|-------|------------------|---|
| 1     | Gujarat          | <a href="https://www.sldcguj.com/">https://www.sldcguj.com/</a>   |
| 2     | Maharashtra      | <a href="https://mahasldc.in/">https://mahasldc.in/</a>   |
| 3     | Madhya Pradesh   | <a href="http://www.sldcmpindia.com/">http://www.sldcmpindia.com/</a>   |
| 4     | Chhattisgarh     | <a href="http://www.sldccg.com/">http://www.sldccg.com/</a>   |
| 5     | Bihar            | <a href="http://www.bsptcl.in/SLDC.aspx?GL=12">http://www.bsptcl.in/SLDC.aspx?GL=12</a>   |
| 6     | Odisha           | <a href="http://www.sldcorissa.org.in/">http://www.sldcorissa.org.in/</a>   |
| 7     | West Bengal      | <a href="http://www.wbsldc.in/">http://www.wbsldc.in/</a>   |
| 8     | Himachal Pradesh | <a href="http://www.hpsldc.com/">http://www.hpsldc.com/</a>   |
| 9     | Punjab           | <a href="http://www.punjabsldc.org/">http://www.punjabsldc.org/</a>   |
| 10    | Uttarakhand      | <a href="http://uksldc.in/">http://uksldc.in/</a>   |
| 11    | Haryana          | <a href="http://haryanasldc.org.in/">http://haryanasldc.org.in/</a>   |
| 12    | Uttar Pradesh    | <a href="http://www.upsldc.org/home">http://www.upsldc.org/home</a>   |
| 13    | Rajasthan        | <a href="http://sldc.rajasthan.gov.in/mis">http://sldc.rajasthan.gov.in/mis</a>   |
| 14    | Delhi            | <a href="https://www.delhisldc.org/HomeSldc.aspx">https://www.delhisldc.org/HomeSldc.aspx</a>   |
| 15    | Andhra Pradesh   | <a href="http://apps.aptransco.co.in/openaccess/Forms/CESLDC_Login.aspx">http://apps.aptransco.co.in/openaccess/Forms/CESLDC_Login.aspx</a> |
| 16    | Telangana        | <a href="http://tsslfdc.in/index.jsp">http://tsslfdc.in/index.jsp</a>   |
| 17    | Karnataka        | <a href="http://kptclsldc.com/">http://kptclsldc.com/</a>   |
| 18    | Tamil Nadu       | <a href="http://tnebldc.org/">http://tnebldc.org/</a>   |
| 19    | Kerala           | <a href="http://www.sldckerala.com">www.sldckerala.com</a>  |
| 20    | Assam            | <a href="http://www.aegclsldc.org">www.aegclsldc.org</a>  |
| 21    | Meghalaya        | <a href="http://meeclsldc.nic.in/">http://meeclsldc.nic.in/</a>   |
| 22    | Mizoram          | <a href="https://sldc.mizoram.gov.in/">https://sldc.mizoram.gov.in/</a>   |
| 23    | NLDC             | <a href="https://posoco.in/">https://posoco.in/</a>   |
| 24    | NRLDC            | <a href="https://nrldc.in/">https://nrldc.in/</a>   |
| 25    | WRLDC            | <a href="http://wrldc.in/">http://wrldc.in/</a>   |
| 26    | ERLDC            | <a href="http://erldc.in/">http://erldc.in/</a>   |
| 27    | SRLDC            | <a href="http://srldc.in/">http://srldc.in/</a>   |
| 28    | NERLDC           | <a href="http://nerldc.org/">http://nerldc.org/</a>   |

NB: SLDC websites for the states viz. Goa, Jharkhand, Sikkim, J&K, Manipur, Nagaland, Tripura, Arunanchal Pradesh and UTs viz. Chandigarh, DD, DNH, Puducherry, AN, Lakshadweep could not be located.

### **Annexure-3: SERC Regulations on SLDC Fees & Charges**

| <b>S.No.</b> | <b>State</b>     | <b>URL of SERC Regulations on SLDC Fees &amp; Charges</b>   |
|--------------|------------------|---|
| 1            | Gujarat          | <a href="http://www.gercin.org/uploaded/document/32cce6db-6f9d-4a69-9b8a-62255e00cc20.pdf">http://www.gercin.org/uploaded/document/32cce6db-6f9d-4a69-9b8a-62255e00cc20.pdf</a>   |
| 2            | Maharashtra      | <a href="http://www.mercindia.org.in/pdf/Order%2058%2042/MYT%20Regulations%202015_Gazette.pdf">http://www.mercindia.org.in/pdf/Order%2058%2042/MYT%20Regulations%202015_Gazette.pdf</a>   |
| 3            | Madhya Pradesh   | <a href="http://www.mperc.nic.in/sldc.pdf">http://www.mperc.nic.in/sldc.pdf</a>   |
| 4            | Chhattisgarh     | <a href="http://www.cserc.gov.in/admin/upload_news/032618_085353.pdf">www.cserc.gov.in/admin/upload_news/032618_085353.pdf</a>  |
| 5            | Bihar            | <a href="https://berc.co.in/rules-regulations/regulations/consolidated-regulations/1184-levy-and-collection-of-fees-and-charges-by-sldc-regulations-2006">https://berc.co.in/rules-regulations/regulations/consolidated-regulations/1184-levy-and-collection-of-fees-and-charges-by-sldc-regulations-2006</a>   |
| 6            | Odisha           | <a href="http://www.orerc.org/C-81-2010 _ SLDC _ Fees _ and _ Charges _ Regulation.pdf">http://www.orerc.org/C-81-2010 _ SLDC _ Fees _ and _ Charges _ Regulation.pdf</a>   |
| 7            | West Bengal      | <a href="http://wberc.net/wberc/regulation/under_2003_Act/regulation52/SAR_127_Department%20of%20WBERC.pdf">http://wberc.net/wberc/regulation/under_2003_Act/regulation52/SAR_127_Department%20of%20WBERC.pdf</a>   |
| 8            | Jharkhand        | <a href="http://jserc.org/pdf/regulations/gazette_699.pdf">http://jserc.org/pdf/regulations/gazette_699.pdf</a>   |
| 9            | Sikkim           | <a href="http://www.sserc.in/final_regulations">http://www.sserc.in/final_regulations</a>   |
| 10           | Himachal Pradesh | <a href="http://new1.hperc.org/File1/mytsldc11.pdf">http://new1.hperc.org/File1/mytsldc11.pdf</a>   |
| 11           | Punjab           | <a href="http://pserc.in/pages/notification_no_94.pdf">http://pserc.in/pages/notification_no_94.pdf</a>   |
| 12           | Uttarakhand      | <a href="http://uerc.gov.in/Rules%20and%20regulation/UERCRegulations/Regulations,%202015/MYT%20Regulations,%202015/UERC%20(Terms%20&amp;%20Conditions%20of%20Multi%20Year%20Tariff)%20Regulations,%202015.pdf">http://uerc.gov.in/Rules%20and%20regulation/UERCRegulations/Regulations,%202015/MYT%20Regulations,%202015/UERC%20(Terms%20&amp;%20Conditions%20of%20Multi%20Year%20Tariff)%20Regulations,%202015.pdf</a> |
| 13           | Haryana          | <a href="https://herc.gov.in/writereaddata/pdf/20121205.pdf">https://herc.gov.in/writereaddata/pdf/20121205.pdf</a>   |
| 14           | Uttar Pradesh    | <a href="http://www.uperc.org/App_File/SLDCREGULATIONS2004HINDI-ENGLISH-pdf119201160016AM.pdf">http://www.uperc.org/App_File/SLDCREGULATIONS2004HINDI-ENGLISH-pdf119201160016AM.pdf</a>   |
| 15           | Rajasthan        | <a href="http://rerc.rajasthan.gov.in/Regulations/Reg%2034.pdf">http://rerc.rajasthan.gov.in/Regulations/Reg%2034.pdf</a>   |
| 16           | Delhi            | <a href="http://www.derc.gov.in/Regulations/DERCRegulations/Regulations2007/sldc%20regulation.pdf">http://www.derc.gov.in/Regulations/DERCRegulations/Regulations2007/sldc%20regulation.pdf</a>   |
| 17           | Andhra Pradesh   | <a href="http://www.aperc.gov.in/aperc1/assets/uploads/files/21bc3-1-of-2006-new.pdf">www.aperc.gov.in/aperc1/assets/uploads/files/21bc3-1-of-2006-new.pdf</a>  |
| 18           | Telangana        | <a href="http://www.aperc.gov.in/aperc1/assets/uploads/files/21bc3-1-of-2006-new.pdf">www.aperc.gov.in/aperc1/assets/uploads/files/21bc3-1-of-2006-new.pdf</a>  |
| 19           | Karnataka        | <a href="http://www.karnataka.gov.in/kerc/Regulations/Regulations/SLDCRegulations-FinalCorrections-July04.pdf">http://www.karnataka.gov.in/kerc/Regulations/Regulations/SLDCRegulations-FinalCorrections-July04.pdf</a>   |
| 20           | Tamil Nadu       | <a href="http://www.tnerc.gov.in/regulation/Tariff/MYT18-1-E.pdf">http://www.tnerc.gov.in/regulation/Tariff/MYT18-1-E.pdf</a>   |
| 21           | Assam            | <a href="http://www.aerc.nic.in/Addendum%20-%20MYT-2015.pdf">http://www.aerc.nic.in/Addendum%20-%20MYT-2015.pdf</a>   |
| 22           | Meghalaya        | <a href="http://meghalaya.gov.in/megcms/sites/default/files/rules/Levy_&amp;_Coll_of_State_Load_Despatch_Centre_Fees_&amp;_Charges_Regulations_2009.pdf">http://meghalaya.gov.in/megcms/sites/default/files/rules/Levy_&amp;_Coll_of_State_Load_Despatch_Centre_Fees_&amp;_Charges_Regulations_2009.pdf</a>   |
| 23           | Manipur (JERC)   | <a href="https://jerc.mizoram.gov.in/downloads/file/226">https://jerc.mizoram.gov.in/downloads/file/226</a>   |

NB: URL of SERC Regulations on SLDC Fees & Charges for the states/UTs viz. Goa, DD, DNH, J&K, Chandigarh, Kerala, Puducherry, Andaman & Nicobar Islands, Lakshadweep, Nagaland, Mizoram, Tripura and Arunachal Pradesh could not be located.

#### **Annexure-4: SERC Orders on SLDC Fees & Charges**

| <b>S.No.</b> | <b>State</b>     | <b>URL</b>  |
|--------------|------------------|---|
| 1            | Gujarat          | <a href="http://www.gercin.org/uploaded/document/50320903-7668-4b92-8919-94a0be5d15c7.pdf">http://www.gercin.org/uploaded/document/50320903-7668-4b92-8919-94a0be5d15c7.pdf</a>   |
| 2            | Maharashtra      | <a href="http://www.mercindia.org.in/pdf/Order%2058%2042/Notice%20-20%20of%202016-22072016.pdf">http://www.mercindia.org.in/pdf/Order%2058%2042/Notice%20-20%20of%202016-22072016.pdf</a>   |
| 3            | Madhya Pradesh   | <a href="http://mperc.nic.in/260518-PNo-65-2017.pdf">http://mperc.nic.in/260518-PNo-65-2017.pdf</a>   |
| 4            | Chhattisgarh     | <a href="http://www.cserc.gov.in/admin/upload_regulation/041718_105708.pdf">www.cserc.gov.in/admin/upload_regulation/041718_105708.pdf</a>  |
| 5            | Bihar            | <a href="https://berc.co.in/orders/tariff/transmission/1130-tariff-order-of-state-load-despatch-centre-sldc-for-fy-2017-18">https://berc.co.in/orders/tariff/transmission/1130-tariff-order-of-state-load-despatch-centre-sldc-for-fy-2017-18</a>   |
| 6            | Odisha           | <a href="http://www.orerc.org/ORDERS/2017/C-78-2017.PDF">http://www.orerc.org/ORDERS/2017/C-78-2017.PDF</a>   |
| 7            | West Bengal      | <a href="http://www.wberc.gov.in/sites/default/files/WBSETCL_Tariff%2017-18.pdf">http://www.wberc.gov.in/sites/default/files/WBSETCL_Tariff%2017-18.pdf</a>   |
| 8            | Jharkhand        | <a href="http://jserc.org/pdf/tariff_order/jusnl2018.pdf">http://jserc.org/pdf/tariff_order/jusnl2018.pdf</a>   |
| 9            | Himachal Pradesh | <a href="http://hperc.org/File/sldecmyt15-19.pdf">http://hperc.org/File/sldecmyt15-19.pdf</a>   |
| 10           | Punjab           | <a href="http://pserc.in/pages/Tariff%20Order%20PSTCL%20for%20FY%202018-19.pdf">http://pserc.in/pages/Tariff%20Order%20PSTCL%20for%20FY%202018-19.pdf</a>   |
| 11           | Uttarakhand      | <a href="http://uerc.gov.in/ordersPetitions/orders/Tariff/Tariff%20Order/2018-19/Tariff%20Orders%20for%20FY%202018-19/Tariff%20Order%20of%20SLDC%20for%20FY%202018-19.pdf">http://uerc.gov.in/ordersPetitions/orders/Tariff/Tariff%20Order/2018-19/Tariff%20Orders%20for%20FY%202018-19/Tariff%20Order%20of%20SLDC%20for%20FY%202018-19.pdf</a>       |
| 12           | Haryana          | <a href="https://herc.gov.in/writereaddata/orders/o20170530.pdf">https://herc.gov.in/writereaddata/orders/o20170530.pdf</a>   |
| 13           | Uttar Pradesh    | <a href="http://www.uperc.org/App_File/UPPTCLMYTTariffOrder-pdf1130201744046PM.pdf">http://www.uperc.org/App_File/UPPTCLMYTTariffOrder-pdf1130201744046PM.pdf</a>   |
| 14           | Rajasthan        | <a href="http://rerc.rajasthan.gov.in/TariffOrders/Order283.pdf">http://rerc.rajasthan.gov.in/TariffOrders/Order283.pdf</a>   |
| 15           | Delhi            | <a href="http://www.derc.gov.in/ordersPetitions/orders/Tariff/Tariff%20Order/TO2008-09 / Annual % 20 Revenue % 20 Requirement % 20 (ARR) % 20 of %20SLDC%20for%202008-09.pdf">http://www.derc.gov.in/ordersPetitions/orders/Tariff/Tariff%20Order/TO2008-09 / Annual % 20 Revenue % 20 Requirement % 20 (ARR) % 20 of %20SLDC%20for%202008-09.pdf</a> |
| 16           | Andhra Pradesh   | <a href="http://www.aptransco.gov.in/transco/images/SLDC%20order%20for%203rd%20controlperiod.pdf">http://www.aptransco.gov.in/transco/images/SLDC%20order%20for%203rd%20controlperiod.pdf</a>   |
| 17           | Telangana        | <a href="https://www.ttransco.in/it_uploads/Tariff_SLDC.pdf">https://www.ttransco.in/it_uploads/Tariff_SLDC.pdf</a>   |
| 18           | Karnataka        | <a href="https://www.karnataka.gov.in/kerc/courtorders2018/1.%20KPTCL%20-%20CONTENTS.pdf">https://www.karnataka.gov.in/kerc/courtorders2018/1.%20KPTCL%20-%20CONTENTS.pdf</a>   |
| 19           | Tamil Nadu       | <a href="http://www.tnerc.gov.in/orders/Tariff%20Order%202009/2017/TariffOrder/SLCDORDER-11-08-2017.pdf">http://www.tnerc.gov.in/orders/Tariff%20Order%202009/2017/TariffOrder/SLCDORDER-11-08-2017.pdf</a>   |
| 20           | Assam            | <a href="http://www.aerc.nic.in/tariff%20order%20dated%2019.03.2018%20-%20AEGCL.pdf">http://www.aerc.nic.in/tariff%20order%20dated%2019.03.2018%20-%20AEGCL.pdf</a>   |
| 21           | Meghalaya        | <a href="http://mserc.gov.in/orders/TariffOrders_2018/MePTCL_Tariff_2018-19.pdf">http://mserc.gov.in/orders/TariffOrders_2018/MePTCL_Tariff_2018-19.pdf</a>   |
| 22           | Manipur          | <a href="https://www.jerc.mizoram.gov.in/page/tariff-orders.html">https://www.jerc.mizoram.gov.in/page/tariff-orders.html</a>   |

NB: URL of SERC Orders on SLDC Fees & Charges for the states/UTs viz. Goa, DD, DNH, Sikkim, J&K, Chandigarh, Kerala, Puducherry, Andaman & Nicobar Islands, Lakshadweep, Mizoram, Nagaland, Tripura and Arunachal Pradesh could not be located.

**Annexure-5: Survey Questionnaire**  
**Survey-I**

**(To be filled by each executive of the LDCs)**

**Survey of Load Despatch Centres in India**

Please tick the option most appropriate in your case

1. Personal details

| i) Present workplace          | ii) Age  | iii) Highest qualification  |
|-------------------------------|--|---|
| National Load Despatch Centre | <input type="checkbox"/> 20 to 25 years<br><input type="checkbox"/> 25 to 35 years<br><input type="checkbox"/> 35 to 45 years<br><input type="checkbox"/> 45 to 55 years<br><input type="checkbox"/> >55 years | <input type="checkbox"/> Diploma<br><input type="checkbox"/> Graduate<br><input type="checkbox"/> Postgraduate<br><input type="checkbox"/> Doctorate<br><input type="checkbox"/> Others |
| Regional Load Despatch Centre |  |   |
| State Load Despatch Centre    |  |   |

iv. Discipline during graduation/diploma

| Engineering   | Humanities   | Others  |
|---|--|---|
| <input type="checkbox"/> Electrical<br><input type="checkbox"/> Electronics<br><input type="checkbox"/> Instrumentation<br><input type="checkbox"/> Computer<br><input type="checkbox"/> Telecommunications<br><input type="checkbox"/> Mechanical<br><input type="checkbox"/> Civil<br><input type="checkbox"/> Others | <input type="checkbox"/> Economics<br><input type="checkbox"/> Law<br><input type="checkbox"/> Management<br><input type="checkbox"/> Others | <input type="checkbox"/> Science<br><input type="checkbox"/> Others |

v. Position in the organization

- Top (Chief Engineer & above/General Manager & above)
- Senior (Superintending Engineer/Addl. General Manager/Dy. General Manager/Asst. GM)
- Middle (Executive Engineer/Chief Manager/Manager)
- Assistant Engineer/ Supervisor to Dy. Manager
- Others please specify.....

vi. Which of the following describes your job function? (Select all that apply)

- System Operator – Reliability
- System Operator – Balancing and Transmission
- System Operator – Balancing and Interchange
- System Operator – Transmission Operator
- Engineer
- Manager/Supervisor/Lead
- Trainer
- Operations Support
- SCADA/IT
- Compliance
- Other, please describe:

vii. Total work experience (Please tick in appropriate box in each row)

|                         | Less than<br>1 year | 1 year<br>to<br>10 years | 10 years<br>to<br>20 years | More than<br>20 years |
|-------------------------|---------------------|--------------------------|----------------------------|-----------------------|
| In Load Despatch Centre |                     |                          |                            |                       |
| In generation           |                     |                          |                            |                       |

|                                |  |  |  |  |
|--------------------------------|--|--|--|--|
| In transmission & Distribution |  |  |  |  |
| In regulatory Commission       |  |  |  |  |
| In another industry/department |  |  |  |  |
| Total                          |  |  |  |  |

2. Mission critical services are those where failure of execution or faulty execution may have far reaching effects. System Operation is a mission critical service. Please tick in the column closest to your opinion

| S No. | Statement  | Strongly Agree | Agree | Neither Agree nor disagree | Disagree | Strongly disagree |
|-------|--|----------------|-------|----------------------------|----------|-------------------|
| a.    | Professionals such as aircraft pilots who are involved in mission critical services undergo rigorous training and certification process before taking up responsibility. Adopting a similar approach in system operation would improve the overall standards of system operation in India. |                |       |                            |          |                   |
| b.    | Power system operation is a public service where ethics are very important   |                |       |                            |          |                   |
| c.    | System Operator must carry out his duties in a transparent and non-discriminatory manner   |                |       |                            |          |                   |

### 3. Acquiring higher qualification

- a. Your opinion on acquiring higher qualification
  - Yes, I feel it is important and I am interested
  - Yes, I feel it is important but I am not interested
  - No, it is not required therefore I am not interested
  - No, it is not required but still I am interested
  - Can't say
- b. Support from the organization for acquiring higher qualification
  - Not allowed in my organization
  - Only correspondence or part-time course course is allowed
  - Even study leave can be easily availed for pursuing full time course
  - My Organization has tie-up with different institute for full-time programs
  - Don't know/Can't say
- c. Your action regarding acquiring higher qualification
  - Yes, I have applied for/ pursuing/completed
  - No, I have not applied for/ pursuing/completed/ not relevant/ not interested

### 4. Career progression within your organization

- a. Recruitment in your organization is
  - Direct at induction level
  - Lateral
  - Deputation

- Others
- b. Mode of promotion up to Superintending Engineer or Addl. General Manager level is
  - Vacancy based
  - Normal progression
- c. As per your assessment the criteria for promotion (up to Executive Engineer/ Sr. Manager) in your organization is
  - Merit based
  - Seniority based
  - Merit cum seniority based

**5. Professional engagements**

- a. Number of opportunities to attend development programs such as training, conferences, seminar, meetings, workshops, regulatory commission hearings etc.
  - More than one every year
  - At least one every year
  - None
- b. Duration of development programs/ training attended in last one year
  - More than one week
  - Less than one week
  - Nil
- c. Official foreign visits for training, workshop, conference, testing etc.
  - More than one every year
  - One every year
  - Occasionally
  - None

**6. In your opinion the quantity of work in your load despatch Centre is**

- Adequate
- Too much
- Too little

**7. In your opinion the nature of work in your load despatch Centre is**

- Challenging and interesting
- Just like in any other office
- Monotonous and boring

**8. The best thing that you like about your LDC**

- It is located in a city and almost all facilities like hospital, schools, recreation, shopping are available
- It provides a very good exposure of several aspects such as technical, social, commercial, economics, political
- It is a small place and you know every body
- All of the above and other reasons as well

**9. Your opinion about your load despatch centre** (Please tick option closest to your opinion))

| S No. | Statements  | Strongly Agree | Agree | Neither Agree nor disagree | Disagree | Strongly disagree |
|-------|---|----------------|-------|----------------------------|----------|-------------------|
| a.    | Simulation/ System studies are carried out in your load despatch centre before approving a major shut down                                    |                |       |                            |          |                   |
| b     | Whenever an emergency shut down is to be approved the concerned switching/network diagram is seen always                                      |                |       |                            |          |                   |
| c.    | Requisition from ISGS is prepared by only seeing previous day's figures and open access transactions  |                |       |                            |          |                   |
| d.    | Requisition from ISGS are filled after carrying out load forecasting most of the time   |                |       |                            |          |                   |
| e.    | Tripping time of a transmission line or generating unit is most of the time seen from the Exception list, Sequence of Events                  |                |       |                            |          |                   |
| f.    | Instructions for generation backing down given from your control room to the generating stations within your jurisdiction are complied always |                |       |                            |          |                   |
| g.    | Transfer capability of your system is assessed regularly  |                |       |                            |          |                   |
| h.    | Transfer capability is checked before finalising the schedules  |                |       |                            |          |                   |
| i.    | Important data regarding power flow, energy, frequency, voltage etc. is stored mostly in electronic form                                      |                |       |                            |          |                   |
| j.    | Most of the data required for preparing reports for senior officials is obtained from paper files / log sheets etc.                           |                |       |                            |          |                   |
| k.    | After major disturbance in your system SoE records are taken out and analysed   |                |       |                            |          |                   |
| l.    | Responsibility of technical feasibility for planned shut down of elements within your system is with staff in general shift                   |                |       |                            |          |                   |
| m.    | Feeders opened in your shift for load shedding are generally restored before the end of the shift   |                |       |                            |          |                   |
| n.    | Any abnormal value observed in the SCADA display is always cross-checked and validated by shift personnel                                     |                |       |                            |          |                   |
| o.    | Dispatcher training simulator (DTS) should be used by the operators for hands on training   |                |       |                            |          |                   |
| p.    | Synchrophasor Based Real Time Monitoring of Grid should be available for shift operators  |                |       |                            |          |                   |

**10. A young engineering graduate who is posted in your LDC**

- Makes all efforts to continue to be posted there as long as possible
- Makes all efforts to move out to a different place as soon as possible
- Is transferred outside LDC within one or two years
- Joins a different organization after some time

**11. If a young engineering graduate is posted in your LDC he/she is**

- Posted in shift operation within one a few days/weeks
- Posted in shift operation after he/she has worked in general shift
- Generally, not posted in shift
- Can't say

**12. If a new person (young or old) is posted at your LDC, he/she**

- Undergoes structured training in system operation (within or outside LDC)
- Learns his/her job on his own as he works along
- Is attached with a person who continuously guides him formally / informally and ensures that he quickly grasps all aspects of system operation

**13. In case someone you know has two offers one at your load despatch centre and second in some other department in the same city with similar salary and compensation you would**

- Strongly recommend him to choose your LDC
- Recommend him to join the other department
- Leave it for him to take his own decision
- Can't say

**14. If you had a choice you would like to work in**

- Same department within Load Despatch Centre
- Another department within Load Despatch Centre
- In power sector but outside Load Despatch Centre
- Any other industry

**15. Your opinion about other executives in your Load Despatch Centre (Tick the box which is closest to your opinion)**

| S No. | Statement  | Strongly Agree | Agree | Neither Agree nor Disagree | Disagree | Strongly disagree |
|-------|--|----------------|-------|----------------------------|----------|-------------------|
| a.    | Most executives in your LDC can Log in / log out of the SCADA system without help from others  |                |       |                            |          |                   |
| b.    | Most executives in your LDC can open switching diagrams, network diagrams, summary diagrams etc. in the SCADA system without help from others without help from others |                |       |                            |          |                   |
| c.    | Most executives in your LDC can Retrieve data from SCADA system without help from others   |                |       |                            |          |                   |
| d.    | Most executives in your LDC can Draw the network of their system (at least up to 220 kV) by heart  |                |       |                            |          |                   |
| e.    | Most executives in your LDC can draw the 400-kV network of their region by heart   |                |       |                            |          |                   |
| f.    | Most executives in your LDC can prepare a report in Microsoft Word regarding anticipated power supply position without help from others                                |                |       |                            |          |                   |
| g.    | Most executives in your LDC can confidently work in Microsoft excel  |                |       |                            |          |                   |
| h.    | Most executives in your LDC can check their email without help from others   |                |       |                            |          |                   |
| i.    | Most executives in your LDC can surf the internet without help from others   |                |       |                            |          |                   |
| j.    | Most executives in your LDC can prepare a 10-slide presentation in Microsoft Power Point without help from others  |                |       |                            |          |                   |
| k.    | Most executives in your LDC can retrieve SoE data from SCADA system without help from others   |                |       |                            |          |                   |
| l.    | Most persons coming in shift remember important telephone numbers by heart   |                |       |                            |          |                   |

| S No. | Statement   | Strongly Agree | Agree | Neither Agree nor Disagree | Disagree | Strongly disagree |
|-------|---|----------------|-------|----------------------------|----------|-------------------|
| m.    | Most executives in your LDC would readily come during odd hours in case of a grid contingency as they feel that they would get something to learn                                   |                |       |                            |          |                   |
| n.    | Most executives in your LDC would readily come during odd hours in case of a grid contingency as they feel only they can handle the situation                                       |                |       |                            |          |                   |
| o.    | Most of the executives in your LDC are involved in activities related to scheduling, energy accounting, open access, billing  |                |       |                            |          |                   |
| p.    | Most of the executives are aware about the challenges and solutions about RE Integration  |                |       |                            |          |                   |
| q.    | Most of the executives in your LDC have prior experience of working in the GENCO  |                |       |                            |          |                   |
| r.    | Most of the executives in your LDC have prior experience of working in the DISCOM   |                |       |                            |          |                   |
| s.    | Most of the executives in your LDC have prior experience of working in the Transmission sector  |                |       |                            |          |                   |
| t.    | Most of the executives in your LDC are trained, certified and proactively respond to the system contingencies in a specific time frame  |                |       |                            |          |                   |
| u     | Most of the executives in your LDC are aware about Rules and Regulations and importance of communication sent from the control room with regard to commercial disputes/legal issues |                |       |                            |          |                   |
| v.    | Accountability and responsibility of each official in control room is defined   |                |       |                            |          |                   |

16. Which activity takes up or consumes more than 50 % of the time the control room of your load despatch centre
- Opening /Restoring feeders and attending calls regarding the power supply position
  - Supervision of system parameters, contingency analysis, reactive power management
  - Preparation of daily or exceptional reports
  - Others

17. Instructions for generation backing down given from your control room to the generating stations within your jurisdiction
- Are complied only after the higher officials from your organization exert pressure on the higher officials of the generating station
  - Are complied sometimes but not always
  - Are complied immediately by the generating stations
  - Not complied at all
18. When most of the system parameters (frequency, voltage, line loading etc.) are normal and you see an abnormal value on the SCADA display, you try to investigate yourself (Cross checking, validating) and report/document if no solution is found
- Report to the concerned SCADA personnel immediately
  - Simply record it in log book or register and forget about it
  - Ignore it as you consider it to be someone else's job
  - Can't say
19. You look at the alarms displayed in the SCADA system
- Frequently
  - Once a while
  - Only when brought to your notice by someone else
  - Never as it is not important
  - Don't know about it
  - Can't say
20. In case a shutdown is requested by any agency for the same day in your shift then you
- Approve immediately by issuing a code/message/telephonic instruction
  - Discuss all concerned (internal and external) and then approve
  - Discuss only with higher-officials
  - Postpone it for the next shift
21. While handing over the shift to the next group
- Inform only the feeders to be opened or restored
  - Nothing special is done as everything is available in SCADA system
  - Everything is explained verbally only
  - Everything is written in log book and also explained verbally
22. While taking over the shift from other group you
- Only read the log book
  - Simply see the system parameters
  - Discuss with shift personnel in other RLDC/SLDC
23. In case of system contingency, you
- Discuss within your team and take corrective action immediately
  - Immediately inform the higher up and respond as per their instruction
  - Do not do anything till other load Despatch Center advises/requests
24. After issuing a switching instruction you
- Keep track of it till it is implemented
  - Concentrate on other activities and let the field staff implement it on their own
  - Cancel the code if the operation is not done within reasonable time
25. Operation reports prepared during the shift are checked
- Only by person preparing the report
  - Only by the shift in-charge
  - Only by higher ups
  - By more than one of the above
26. When the grid is perfectly normal the discussion within or other LDC is regarding
- New elements commissioned and future planning/expansion of power system
  - System conditions in the past few hours and the likely scenario till the end of shift

- Subjects other than system operation
27. If you want to know the bus arrangement in a substation without calling the substation you
- Would refer a written document
  - Would ask the concerned SCADA personnel
  - Would ask your shift-in-charge since you are sure he knows it
  - Would obtain from SCADA displays without anybody's help
28. Your comments and suggestions to enhance the standard of system operation in India
- 

Name:

Designation:

Name of LDC:

### Survey-II

**(To be filled by the Members of the committee/Volunteers visiting the SLDC with the help of concerned SLDC officials)**

The objectives of this survey are briefly stated below:

- To assess the profile of the personnel involved in System Operation in India
- To assess the infrastructure/logistics/amenities available at LDCs in India
- To assess the motivational level of the persons posted at LDCs
- To assess the extent up to which the functions of system operator are carried out at various LDCs in the country

**Members/ volunteers may fill the following survey with the help of SLDC officials.**

Name of the LDC..... | Name(s) of the Member(s)/Volunteer(s):.....

| FOLD Survey                  |   |            |             |         |            |       |
|------------------------------|---|------------|-------------|---------|------------|-------|
| Name of the LDC:             |   |            |             |         |            |       |
| Name of coordinating person: |   |            |             |         |            |       |
| Designation                  |   |            |             |         |            |       |
| Contact No.                  |   |            |             |         |            |       |
| E-mail ID                    |   |            |             |         |            |       |
| EMPLOYEE PROFILE IN THE LDC  |   |            |             |         |            |       |
|                              |   | Executives | Supervisors | Workmen |            | Total |
|                              |   |            |             | Skilled | Un-Skilled |       |
| 1.                           | <b>Total Number of Employees</b>  |            |             |         |            |       |
|                              | Function wise Division (please write down functions and mention Manpower against each function at your LDC) eg. System operation, Market operation etc. |            |             |         |            |       |
| i                            |   |            |             |         |            |       |
| ii                           |   |            |             |         |            |       |
| iii                          |   |            |             |         |            |       |

|    |   |  |  |  |  |  |
|----|---|--|--|--|--|--|
|    | <i>May attach a copy of your current Organisation Chart</i> |  |  |  |  |  |
| 2. | <b>Gender wise</b>  |  |  |  |  |  |
|    | Male  |  |  |  |  |  |
|    | Female  |  |  |  |  |  |
|    | Transgender   |  |  |  |  |  |
| 3. | <b>Age Group-wise (Years)</b>                               |  |  |  |  |  |
|    | 20-30   |  |  |  |  |  |
|    | 30-40   |  |  |  |  |  |
|    | 40-50   |  |  |  |  |  |
|    | 50-60   |  |  |  |  |  |
| 4. | <b>Average Number of Persons in Shift</b>                   |  |  |  |  |  |
|    | Morning   |  |  |  |  |  |
|    | Evening   |  |  |  |  |  |
|    | Night   |  |  |  |  |  |
|    | Reserve   |  |  |  |  |  |
| 5. | <b>Number of individuals with following qualification</b>   |  |  |  |  |  |
|    | Diplomas  |  |  |  |  |  |
|    | Graduate degree   |  |  |  |  |  |
|    | Post-Graduate Degrees                                       |  |  |  |  |  |
|    | Doctorates  |  |  |  |  |  |
|    | Others  |  |  |  |  |  |
| 6. | No. of Female employees in shift                            |  |  |  |  |  |
| 7. | Average tenure of a person                                  |  |  |  |  |  |
| 8. | Average number of transfers/yr.                             |  |  |  |  |  |

#### **INFRASTRUCTURE**

|    |  |                        |    |
|----|--|------------------------|----|
|    |  | <b>Please tick one</b> |    |
|    |  | Yes                    | No |
| 1. | Official canteen/Pantry where one can get at least tea/coffee is available |                        |    |
| 2. | Meal Facility available (On Charge basis)                                  |                        |    |
| 3. | Meal Facility available (Non-charge basis)                                 |                        |    |
| 4. | Rest facility for System Operators   |                        |    |
| 5. | Facility to take shower/ bath  |                        |    |

|     |   |             |               |
|-----|---|-------------|---------------|
| 6.  | Resource Centre/Library (Books, periodicals, Magazines,) is available   |             |               |
| 7.  | Gym facility  |             |               |
| 8.  | Crèche Facility   |             |               |
| 9.  | Video Conferencing facility   |             |               |
| 10. | LDC has a back-up control Centre to deal effectively with Disaster(s)   |             |               |
| 11. | LDC has a dedicated training facility   |             |               |
| 12. | LDC has tie-up with different institutes for Regular Training   |             |               |
| 13. | Desktops for offline work are available   |             |               |
| 14. | LDC has infrastructure for forecasting of Renewable Energy(Y/N)   |             |               |
| 15. | LDC has infrastructure for LOAD forecasting (Y/N)   |             |               |
| 16. | Dedicated leased line for communication is in operation   |             |               |
| 17. | Transport facility after attending night shift is available for executives  |             |               |
| 18. | Transport facility after attending night shift is available only for shift in charge  |             |               |
| 19. | Transport facility after attending night shift is available for all personnel of the control room up to a convenient location |             |               |
| 20. | Individual login is required to access the critical software/ Server Room   |             |               |
| 21. | Viewing Gallery   |             |               |
| 22. | Is the Control centre sound proof   |             |               |
| 23. | Bio-metric Access to Control Room   |             |               |
| 24. | Temperature Control in Control Centre   |             |               |
| 25. | Company residential colony  |             |               |
| 26. | Conference Room(s)  |             |               |
| 27. | Is the LDC Wi-Fi enabled?   |             |               |
| 28. | Do System Operators use mobile phones for inter-control centre communication?   |             |               |
| 29. | Does LDC have a website?  |             |               |
| 30. | Does LDC have any ISO certification? (please annex the details)   |             |               |
| 31. | Availability of First aid kit at easily accessible location   |             |               |
| 32. |   | Comfortable | Uncomfortable |
| a.  | Work environment is   |             |               |
| b.  | Work space is   |             |               |
| c.  | Seating arrangement is  |             |               |

#### **LEARNING & DEVELOPMENT POLICIES, PRACTICES, PROCESSES**

|    |  |                 |   |
|----|--|-----------------|---|
| 1  | No. of Basic Level Certified System Operators  |                 |   |
| 2  | No. of Regulatory Specialists  |                 |   |
| 3  | No. of Reliability Specialists   |                 |   |
| 4  | No. of SCADA and IT Experts  |                 |   |
| 5  | Incentive for Certification (Yes/No) - if Yes, give details  |                 |   |
| 6  | Average no. of Training Man-days per executive   |                 |   |
| 7  | Average no. of Training Man-days per non-executive   |                 |   |
| 8  | Average no. of days for Internal Training per employee (Organised by the organisation)   |                 |   |
| 9  | Average days of external training per employee   |                 |   |
|    |  | Please tick Y/N |   |
|    |  | Y               | N |
| 10 | Induction Training conducted for New Joinees   |                 |   |
| 11 | Duration of Induction Training (in months)   |                 |   |
| 12 | Do you have an annual Training Calendar?   |                 |   |
| 13 | Does your LDC impart training on Health & Safety, First Aid?   |                 |   |
| 14 | Does your LDC impart training on communication skills?   |                 |   |
| 15 | Does your LDC impart training on MS Office?  |                 |   |
| 16 | Does your LDC impart training on SCADA System?   |                 |   |
| 18 | Do you have a mechanism for measuring Training Effectiveness?  |                 |   |
| 19 | Is there a mechanism for dissemination of the knowledge learnt by an employee to others within the organisation? (please annexe the details) |                 |   |
| 20 | Is there a repository of Training material within the LDC  |                 |   |
| 21 | Is there a process for Study Leave for employees?  |                 |   |
| 23 | Are employees sponsored for part-time/ full-time Academic degree programmes  |                 |   |
| 24 | Does your LDC provide behavioural/inter-personal training  |                 |   |
| 25 | On Site training opportunities are available   |                 |   |

Name of the LDC:

Name of the Committee Member(s)/Volunteers (who has completed the survey):

\*\*\*

## Annexure-6: Survey of International ISOs/TSOs

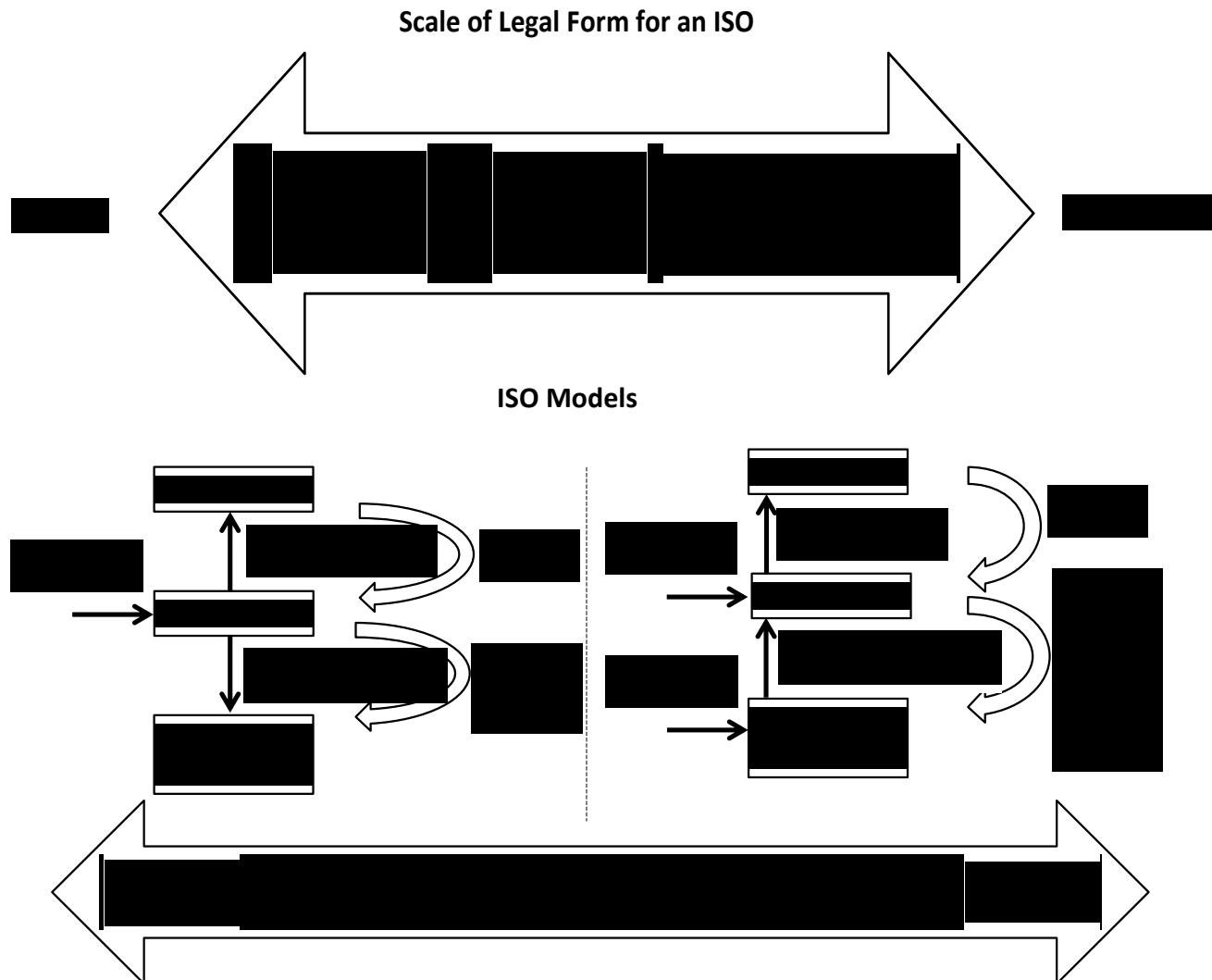
### Introduction

The various aspects related to employee benefits, organization structure and infrastructure related aspects in the ISOs in North America, TSOs in European nations, etc. are analysed. The data is taken from the respective web-sites and other references available in public domain for the ISOs/ TSOs.

**Independent System Operator model:** The ISO model requires that the transmission and generation assets within a vertically integrated utility company are physically and legally separated. In this market model, the ISO is solely responsible for operation and dispatch, of all loads to meet demand across the entire system. The ISO is also responsible for ‘settling’ the market and is the single interface for generators within the system.

Many ISO models (Figure – 20) exist worldwide (USA, Canada, South America, Scotland, Australia); these models have variances associated with market rules, governance, the regulator’s role and the scope of tasks performed by the ISO.

The **shallowest model** is the “outsourced ISO” model. In this model, the ISO has a range of responsibilities but undertakes little or no work itself. In the **“deepest” versions** of the ISO model, the ISO assumes responsibility for all of the functions of the system operator, and these are removed from the vertically integrated utility, leaving the utility with the asset ownership.



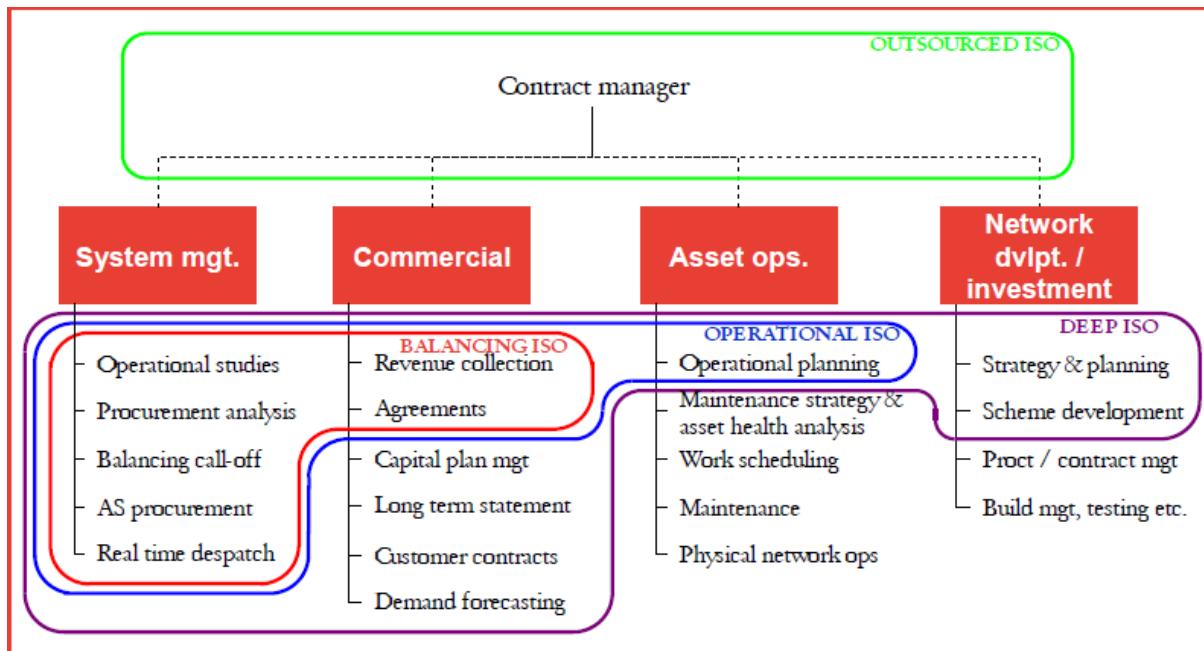


Figure 20: International ISO Models & Characteristics (Source: Frontier Economics)

## 1. Governance Structure

No two of the federally regulated RTOs/ISOs and the one state-regulated ISO have the same governance structure. These structures are not dictated by the regulator, but rather, they are the result of each RTO/ISO's understanding of its region and its charter to serve the interests of the organization's members and stakeholders (as interpreted by each RTO/ISO). A general structure depicting the major aspects of the Governance Structure international ISOs is shown in figure-21.

### Board of Directors

|   |   |
|---|---|
| <b>Technical and Regulatory Committee</b>                   | <b>Chief Executive Officer</b>                            |
| <b>People and Remuneration Committee</b>                    | <b>Chief Finance Officer</b>                              |
| <b>Finance and Audit Committee</b>                          | <b>Chief Information Officer</b>                          |
| <b>Power System Operation and Planning Committee</b>        | <b>VP (System Operations and Planning)</b>                |
| <b>Corporate Governance and Strategy Planning Committee</b> | <b>VP (Market Operations)</b>                             |
|   | <b>VP (Human Resources)</b>                               |
|   | <b>VP (Commercial)</b>                                    |
|   | <b>VP (External Affairs and Corporate Communications)</b> |
|   | <b>VP (General Counsel, Law and Compliance)</b>           |
|   | <b>VP (Corporate Secretary)</b>                           |

Figure 21: Typical Governance Structure in an International ISO

The Board of Directors are assisted by various Committees directly reporting to it and the members in various committees are nominated and selected by the Board itself from the renowned energy-sector experts in the industry and academia. In almost all the international ISOs, the number of employees ranges between 500 to 1000 nos.

## 2. Major functions

The Independent System Operators worldwide provides a different set of functions facilitating system operation, market operation, power system studies, ancillary services, congestion management, planning, metering and settlement, accounts and services, etc. Some of the major functions are listed in **table-28** below. In order to ensure reliability of the grid, the Ancillary Services of the ISOs play a crucial role. A comparison of the Ancillary Services being practiced by various ISOs is listed in **table 29.** below

*Table 26: Major functions by ISOs*

| <b>Major functions of an ISO</b>  |
|---|
| <b>A. System Operation:</b> Load Despatching, Reliability, Planning and Standards Development, Transmission Service Studies, Generation Interconnection Studies   |
| <b>B. Market Operation:</b> Day-ahead and Real-time Market Facilitation, Transmission rights Market Facilitation, Capacity Market Facilitation, Ancillary Services Market Facilitation, Market Monitoring and Administer Compliance with Market Rules |
| <b>C. Customer Accounts and Services:</b> Meter Reading, Customer Records and Collection, Informational and Instructional Advertising to encourage safe use of electric equipment   |

*Table 27: Ancillary Services between ISOs in USA and GB*

|                          | <b>Type of Ancillary Services</b>       | <b>Details</b>   |
|--------------------------|---|--|
| Regulation/<br>Frequency | <b>Regulation</b>                       | Regulation Service, Regulation Up, Regulation Down   |
|                          | <b>Regulation (Performance)</b>         | Regulation UP Mileage, Regulation DOWN Mileage<br>Regulation Service, Regulation Movement, Regulating Mileage  |
|                          | <b>Frequency Response</b>               | Mandatory Frequency Response, Dynamic FFR, Static FFR  |
| Reserves                 | <b>Spinning Reserve</b>                 | Ten-Minute synchronized reserve, Ten-minute spinning reserve,<br>Synchronized reserve, Responsive reserve  |
|                          | <b>Non-spinning Reserve</b>             | Ten-minute non-spinning reserve, Thirty-minute operating<br>reserve, Non-synchronized reserve, Supplemental reserve  |
|                          | <b>Ramp Reserves</b>                    |  |
|                          | <b>Reserve</b>                          | BM Startup, Fast Reserve, Optimal Reserve Services, Short Term<br>Operating Reserve (committed), Short Term Operating Reserve<br>(flexible), Short Term Operating Reserve (premium flexible) |
| Others                   | <b>Reactive Power (voltage support)</b> | Mandatory reactive power service, Enhanced reactive power<br>service   |
|                          | <b>Black-start</b>                      |  |

(Source (table-28 & 29): Report on “What can we learn from international comparators about how we should structure an incentives framework for the future GB electricity system operator to help maximise consumer welfare?” of Energy Policy Research Group, University of Cambridge, 2017)

### 3. Spatial Infrastructure and facilities

The ISOs require an independent and secure campus with state-of-the-art control room, data centre, bigger video-wall, etc. for load despatch and other functions. A comparison of the spatial infrastructure available with ISOs in North America is listed below.

| Description | ERCOT (US) | MISO (US)     | ISO-NE (US)   | NYISO (US)    | CAISO (US)     |
|-------------|------------|---------------|---------------|---------------|----------------|
| Campus Area | 6,000      | 50,000 sq.ft. | 90,000 sq.ft. | 64,000 sq.ft. | 277,000 sq.ft. |

The facilities for employees such as fitness centre, café, mom's room with lactation facilities, crèche, break-out rooms, kitchens equipped with coffee machines, microwaves, toasters and fridges, shower changing facilities, bike-racks, Informal meeting areas, Electric sit/stand work points, harbour focus pods, T-Pod Micro-rooms, smart-lock lockers, etc. are very common in the premises of ISOs.

#### 4. Payment for Services

Every ISO in North America and other continents have a revenue stream through which they are paid for their services. The details of payment for services of some of the ISOs worldwide are listed in **table-31** below.

*Table 28: ISOs paid services (Source: Respective web-sites of ISOs)*

| S. No. | Utility                                 | Country | Services for fees & charges  |
|--------|---|---------|--|
| 1      | <b>Alberta Electric System Operator</b> | USA     | <ul style="list-style-type: none"> <li>• Transmission tariff,</li> <li>• Energy market charge,</li> <li>• Renewable electricity program charges</li> <li>• Interest</li> </ul>   |
| 2      | <b>California ISO</b>                   | USA     | <ul style="list-style-type: none"> <li>• Grid Management Charges for Market Services</li> <li>• Grid Management Charges for System Operations</li> <li>• Grid Management Charges for Congestion Revenue Rights Services</li> <li>• Generation Interconnection Studies</li> <li>• Generator Non-compliance Fines</li> </ul> |
| 3      | <b>Midcontinent ISO</b>                 | USA     | <ul style="list-style-type: none"> <li>• Cost Recovery Adder</li> <li>• FERC Assessment Fees</li> <li>• Tariff Services</li> <li>• Engineering Studies</li> <li>• Grant Revenue</li> </ul>   |
| 4      | <b>New York ISO</b>                     | USA     | <ul style="list-style-type: none"> <li>• Rate Schedule 1 Tariff Charge</li> <li>• FERC Fees Recovery</li> <li>• Planning Studies Revenue</li> <li>• Fees and Services</li> <li>• Grant Revenue</li> <li>• Interest Income</li> </ul>   |
| 5      | <b>PJM</b>                              | USA     | <ul style="list-style-type: none"> <li>• Service Fees</li> <li>• Deferred Regulatory Income</li> <li>• FERC Fees Reimbursement</li> <li>• Study and Interconnection Fees</li> <li>• Membership Fees</li> </ul>   |
| 6      | <b>SPP</b>                              | USA     | <ul style="list-style-type: none"> <li>• Administrative Fees</li> </ul>  |
| 7      | <b>ERCOT</b>                            | USA     | <ul style="list-style-type: none"> <li>• System Administration Fees</li> <li>• Reliability Organization Pass Through</li> </ul>  |
| 8      | <b>Ontario IESO</b>                     | Canada  | <ul style="list-style-type: none"> <li>• System Fees</li> <li>• Smart Metering Charge</li> <li>• Investment Income on funds passing through market settlement and application fees</li> <li>• Market Sanctions &amp; Payment Adjustments</li> <li>• Government Programs</li> </ul>   |

Each ISO has a separate revenue stream and the annual report with balance sheet is put in public domain at the end of each financial year. A comparison of the key figures in revenue structure is given in table-5 below.

Table 29: Operating Expenses in Different ISOs (Source: Annual Reports, 2016)

| Description        | PJM | NYISO | SPP | IESO | MISO | ERCOT | CAISO | AESO |
|--------------------|-----|-------|-----|------|------|-------|-------|------|
| Operating Expenses | 338 | 175   | 213 | 177  | 330  | 181   | 198   | 1780 |

(Figures Approx. in Million USD)

## 5. Involvement of Stakeholders

The involvement of stakeholders in various processes of ISO plays an important role at several levels. The stakeholders participate and give feedback on various levels to the ISO related to its functions and requirements.

## 6. Presence on Social Media

The ISOs are available on social media platforms such as Facebook, Twitter, LinkedIn, YouTube, etc. A comparison list is mentioned in **table-6** below:

Table 30: ISOs on Social Media Platforms

| Description              | Facebook  | Twitter   | LinkedIn  | YouTube   |
|--------------------------|---|---|---|---|
| PJM (US)                 | <a href="https://www.facebook.com/pjminterconnect/">https://www.facebook.com/pjminterconnect/</a>   | <a href="https://twitter.com/pjminterconnect?lang=en">https://twitter.com/pjminterconnect?lang=en</a>   | <a href="https://in.linkedin.com/company/pjm-interconnection">https://in.linkedin.com/company/pjm-interconnection</a>                             | <a href="https://www.youtube.com/user/pjminterconnection">https://www.youtube.com/user/pjminterconnection</a>                   |
| ERCOT (US)               | <a href="https://www.facebook.com/ERCOTISO/">https://www.facebook.com/ERCOTISO/</a>   | <a href="https://twitter.com/ERCOT_ISO?ref_src=twsrc%5Egoogle%7Ctwcamp%5Eserp%7Ctwgr%5Eauthor">https://twitter.com/ERCOT_ISO?ref_src=twsrc%5Egoogle%7Ctwcamp%5Eserp%7Ctwgr%5Eauthor</a>           | <a href="https://in.linkedin.com/company/ercot">https://in.linkedin.com/company/ercot</a>   | <a href="https://www.youtube.com/channel/UCh02fjTQg2G16GlveDGmD5w">https://www.youtube.com/channel/UCh02fjTQg2G16GlveDGmD5w</a> |
| MISO (US)                | <a href="https://www.facebook.com/Midcontinent-Independent-System-Operator-226989491013050/">https://www.facebook.com/Midcontinent-Independent-System-Operator-226989491013050/</a> | <a href="https://twitter.com/miso_energy?ref_src=twsrc%5Egoogle%7Ctwcamp%5Eserp%7Ctwgr%5Eauthor">https://twitter.com/miso_energy?ref_src=twsrc%5Egoogle%7Ctwcamp%5Eserp%7Ctwgr%5Eauthor</a>       | <a href="https://in.linkedin.com/company/midwest-iso">https://in.linkedin.com/company/midwest-iso</a>   | <a href="https://www.youtube.com/channel/UC-Txl6baj2nOt7I8fkpy5-g">https://www.youtube.com/channel/UC-Txl6baj2nOt7I8fkpy5-g</a> |
| Description              | Facebook  | Twitter   | LinkedIn  | YouTube   |
| ISO-NE (US)              | --NA--  | <a href="https://twitter.com/isonewengland?ref_src=twsrc%5Egoogle%7Ctwcamp%5Eserp%7Ctwgr%5Eauthor">https://twitter.com/isonewengland?ref_src=twsrc%5Egoogle%7Ctwcamp%5Eserp%7Ctwgr%5Eauthor</a>   | <a href="https://in.linkedin.com/company/iso-new-england">https://in.linkedin.com/company/iso-new-england</a>                                     | --NA--  |
| NYISO (US)               | --NA--  | <a href="https://twitter.com/newyorkiso?lang=en">https://twitter.com/newyorkiso?lang=en</a>   | <a href="https://in.linkedin.com/company/nyiso">https://in.linkedin.com/company/nyiso</a>   | <a href="https://www.youtube.com/channel/UCZrKqN1ZrObaghXm-K7PIQg">https://www.youtube.com/channel/UCZrKqN1ZrObaghXm-K7PIQg</a> |
| CAISO (US)               | <a href="https://www.facebook.com/CaliforniaISO/">https://www.facebook.com/CaliforniaISO/</a>   | <a href="https://twitter.com/California_ISO?ref_src=twsrc%5Egoogle%7Ctwcamp%5Eserp%7Ctwgr%5Eauthor">https://twitter.com/California_ISO?ref_src=twsrc%5Egoogle%7Ctwcamp%5Eserp%7Ctwgr%5Eauthor</a> | <a href="https://in.linkedin.com/company/california-iso">https://in.linkedin.com/company/california-iso</a>                                       | <a href="https://www.youtube.com/channel/UCQTJYOWTq4OEQzLK5VYxgUA">https://www.youtube.com/channel/UCQTJYOWTq4OEQzLK5VYxgUA</a> |
| SPP (US)                 | <a href="https://www.facebook.com/SouthwestPowerPool/">https://www.facebook.com/SouthwestPowerPool/</a>   | <a href="https://twitter.com/SPPorg?ref_src=twsrc%5Egoogle%7Ctwcamp%5Eserp%7Ctwgr%5Eauthor">https://twitter.com/SPPorg?ref_src=twsrc%5Egoogle%7Ctwcamp%5Eserp%7Ctwgr%5Eauthor</a>                 | <a href="https://in.linkedin.com/company/southwest-power-pool">https://in.linkedin.com/company/southwest-power-pool</a>                           | <a href="https://www.youtube.com/channel/UCtWhPnhYOVQGUfMMTVRNQ">https://www.youtube.com/channel/UCtWhPnhYOVQGUfMMTVRNQ</a>     |
| Ontario IESO             | <a href="https://www.facebook.com/OntarioIESO/">https://www.facebook.com/OntarioIESO/</a>   | <a href="https://twitter.com/IESO_Tweets?ref_src=twsrc%5Egoogle%7Ctwcamp%5Eserp%7Ctwgr%5Eauthor">https://twitter.com/IESO_Tweets?ref_src=twsrc%5Egoogle%7Ctwcamp%5Eserp%7Ctwgr%5Eauthor</a>       | <a href="https://in.linkedin.com/company/ieso">https://in.linkedin.com/company/ieso</a>   | <a href="https://www.youtube.com/channel/UCKPdbl46ECJrwJ-XJBEIRsw">https://www.youtube.com/channel/UCKPdbl46ECJrwJ-XJBEIRsw</a> |
| Alberta IESO             | --NA--  | <a href="https://twitter.com/theaeso?lang=en">https://twitter.com/theaeso?lang=en</a>   | <a href="https://in.linkedin.com/company/aeso">https://in.linkedin.com/company/aeso</a>   | <a href="https://www.youtube.com/channel/UCSOriIEFre5myLWhKZGDsEw">https://www.youtube.com/channel/UCSOriIEFre5myLWhKZGDsEw</a> |
| AEMO (Australia)         | <a href="https://www.facebook.com/AEMOenergy/">https://www.facebook.com/AEMOenergy/</a>   | <a href="https://twitter.com/AEMO_Media?ref_src=twsrc%5Egoogle%7Ctwcamp%5Eserp%7Ctwgr%5Eauthor">https://twitter.com/AEMO_Media?ref_src=twsrc%5Egoogle%7Ctwcamp%5Eserp%7Ctwgr%5Eauthor</a>         | <a href="https://in.linkedin.com/company/australian-energy-market-operator">https://in.linkedin.com/company/australian-energy-market-operator</a> | <a href="https://www.youtube.com/user/AEMOenergy">https://www.youtube.com/user/AEMOenergy</a>                                   |
| Transpower (New Zealand) | <a href="https://www.facebook.com/transpowernz/">https://www.facebook.com/transpowernz/</a>   | <a href="https://twitter.com/transpowernz?lang=en">https://twitter.com/transpowernz?lang=en</a>   | <a href="https://in.linkedin.com/company/transpower">https://in.linkedin.com/company/transpower</a>   | <a href="https://www.youtube.com/user/TranspowerNZ/featured">https://www.youtube.com/user/TranspowerNZ/featured</a>             |

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## Annexure-7: Ergonomics for LDCs

### A. Standards on Ergonomics

Ergonomic design of Control Centre helps in Speed & accuracy in identification and resolution of problems, alertness of operator, accessibility of desired information in least possible time, motivate a two-way interactive approach, etc. A broad standard for control centre ergonomics i.e. ISO 11064 is available and widely used by several control centres world-wide. The ISO 11064 standard is divided into seven (07) parts as listed in *table-1* below.

*Table 31: Extracts from ISO 11064 Standards*

| ISO 11064   | Steps to be followed   |
|---|--|
| Part 1:<br>Principles for the design of control centers     | <ul style="list-style-type: none"> <li>▪ As a human centered approach, the design begins with the operator.</li> <li>▪ End users participate in the iterative design process working with an interdisciplinary design team, and provide task and link analysis, and risk assessment information which is documented as the design basis.</li> <li>▪ The goal is an error tolerant yet safe design.</li> </ul>          |
| Part 2:<br>Principles for the arrangement of control suites | <ul style="list-style-type: none"> <li>▪ Based on information obtained from a task and link analysis, square footages are estimated, adjacencies are determined and the space is laid out to facilitate all activities housed in the control room.</li> </ul>  |
| Part 3:<br>Control room layout                              | <ul style="list-style-type: none"> <li>▪ Ergonomic principles and the task and link analysis drive the layout of workstation arrangements, off-workstation visual displays and control room maintenance.</li> </ul>  |
| Part 4:<br>Layout and dimensions of workstations            | <ul style="list-style-type: none"> <li>▪ The needs of the operator and other users are the focus of the workstation design, utilizing ergonomic principles to determine the overall dimensions of the visual-display based workstations.</li> </ul>  |
| Part 5:<br>Displays and controls                            | <ul style="list-style-type: none"> <li>▪ Maximizing the safe, reliable, efficient, and comfortable use of graphic screen displays and controls is the goal of the human machine interface.</li> </ul>  |
| Part 6:<br>Environmental requirements for control centers   | <ul style="list-style-type: none"> <li>▪ The overall environment in a control room needs to be optimized to positively affect operator performance.</li> <li>▪ Lighting, acoustics, temperature, humidity, and vibration all are key factors that play into operator awareness.</li> </ul>   |
| Part 7:<br>Principles for the evaluation of control centers | <ul style="list-style-type: none"> <li>▪ The post occupancy evaluation after a control center is up and running is the final step to determine if the design is successful.</li> <li>▪ The operators provide valuable feedback having been involved in the project from the beginning.</li> <li>▪ Lessons learned are evaluated, documented and recommendations for improvements (if any) are communicated.</li> </ul> |

## B. Ergonomic Solutions in Industry

The control centre in a SCADA set up is the place from where the operator / system engineer monitors the health of the power system and issues necessary control instructions. The operator / system engineer at the control centre undergoes a variety of muscular stresses while working for long durations, which degrades the quality of work. The proper design of the control center will ensure ease of functioning for the operator without experiencing stress in vital body parts. Proper care should be taken to install the different equipment for monitoring and controlling the Power System in suitable atmosphere and housing. Broadly, the classification can be done for the systems and different equipment in a SCADA control centre as listed in *table-35* below.

*Table 32: Classification of ergonomic requirements for a control room*

| Description   | Details  |
|---|--|
| Control room / operator console   | The layout of the control room shall be such that the various personnel sitting in the room can work on the consoles and interact with each other effectively and efficiently. The design must ensure the minimum space for the VDU and different consoles installed to carry out the functional requirement, attached washroom, printer, water and the tea facility inside the room itself, writing board, etc.   |
| Server room / computer hardware   | The server room includes server panels, racks, trenches, heavy cabling, consoles includes the necessary software and the SCADA software as installed in the control room.  |
| Telemetry and communication room  | The communication room includes communication equipment panels, racks, trenches, heavy cabling, etc.   |
| Training and development room   | The training and development room hosts the training consoles, necessary software and the SCADA software as installed in the control room, printer, LCD display system, Personal Computer, writing board, water and tea facility inside the room itself, PA system and a wash room.  |
| Conference hall   | The dimension of the conference room shall include the conference table, chairs, PA system, Fax, machine, Xerox machine, LCD display system, Personal Computer, printer and wash room.   |
| Auxiliary facility room viz. entertainment room, exercise room, refreshment room, rest room and changing room | <p>Rooms in the control center premises such as entertainment room, exercise room, refreshment room, rest room, changing room, UPS and battery room.</p> <p>The entertainment room includes a TV system, an audio system, PA system, tea / coffee arrangement, half bed, playing equipment viz. carom board, chess etc.</p> <p>The exercise room includes yoga and meditation trainer, light music and necessary equipment for keeping the operator mentally fresh and healthy for removal of temporary stress in the different parts of the body.</p> <p>The refreshment room includes the arrangement for tea/ coffee, a light refreshment, a TV set to reduce the temporary stress.</p> |
| UPS and battery room  | The UPS and the battery room is the backbone of the control center, which supports all the necessary equipment. It provides the required illumination in the control room and the server room.   |
| Miscellaneous rooms   | For other facilities such as Store, generators, Cooling system, LT Panels, Fire-fighting equipment, etc.   |

Various solutions are available in the industry to design and implement the utility control room in an ergonomic manner as per the ISO 11064: Part 1 to Part 7. Some of the considerations are listed in *sub-sections* below. Some of the considerations are listed in *sub-sections* below

### **1) Human Factors Engineering Overview**

In any control room with operators or managers, it is evident that optimizing the human performance results in reduced operation risk, which leads to a safe action and safe workers, which benefits everyone.

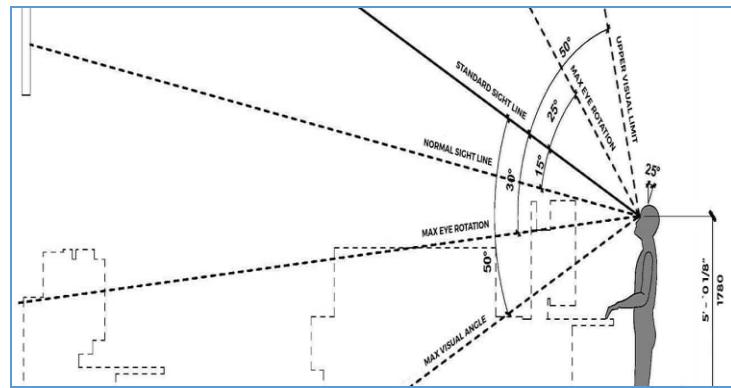


Figure 22: Human Factors Engineering in Control Room

Ignoring human factors in control room design (Figure – 22) can have catastrophic consequences for the plant, its workers, and the surrounding environment, which can lead to a traumatized and/or incapacitated workforce and costly lawsuits that take decades to resolve. Human Factors Engineering applies science-based knowledge concerning a human being's physical and psychological capabilities and limitations to the design of devices and systems for human use. There is no more relevant place to implement this science than in the design of a control room.

### **2) Standard Implementation – As per ISO 11064**

Your control room needs to comply with the requirements of ISO 11064, whether your safety-critical industry is oil, natural gas, mineral extraction, transportation or chemical production.



Figure 23: Control Centre - Video-Wall, Access to multiple displays, gallery

The International Organization for Standardization (ISO) specifies the standard principles for the ergonomic design of control centers—including layout and dimensions of workstations (Figure – 23). It's a tome of control room best practices, the purpose of which is to enhance human performance and promote safety best practice.

### **3) Fatigue Management**

It is conclusive that excessive operator fatigue was determined to be a contributory factor in numerous disasters in the petrochemical, mining and transportation industries over the last 25 years. Safety is critical in your line of work—therefore so is fatigue management.



Figure 24: Facilities for Grid Operators to Mitigate Stress

The operation of the LDCs requires high response capacity, identify risks, and anticipate the behaviour of the intermittent energies, Operator's Alertness (Highest Importance). The various operator combat problems such as tiredness and monotonous wear of back, shoulders and neck shall be addressed by proper ergonomic design. The facilities for grid operators to mitigate stress are shown in Figure – 24.

#### 4) Abnormal Situation Management

Good control room design puts an emphasis on the operator having the right information at the right time, to enable the de-escalation of the abnormal situation in as short a window of time as humanly possible, and it all depends on your operators being able to assimilate information quickly and effectively. This central concept lies at the heart of all BAW Architecture control rooms, and all design decisions emanate from it like concentric rings from a stone thrown into a pond.

#### 5) Abnormal Situation Prevention

The optimal place to be is to prevent abnormal situations in the first place, where the operator can predict and adjust process variables before they culminate in an abnormal situation with multiple alarms sounding and systems shutting down.

This is dependent on providing the right information in the right place at the right time through the control system interface and the person to person interactions. This is the principle behind effective design for abnormal situation prevention.

It includes consideration of the control system and equipment, as well as its arrangement and the optimal placement and orientation of control consoles. This is crucial to ensure that a steady state does not escalate into abnormal situation.

#### 6) Abnormal Situation Management: De-escalation & Emergency Response

If an abnormal situation is not effectively brought under control, there is potential for the control room or an alternative space to need to become the nerve center of incident command. First the alarms sound, and the switch from the abnormal situation to an emergency becomes the reality. It's at this point that the next level of BAW's abnormal situation management kicks in. The continuum may include some or all of the following:

- Diagnosis of the problem. Where is it originating? What is the nature of the deviation?
- Action to prevent escalation and bring the situation under control.

- Site-wide alarm, tells everyone to get to a safe place.
- Situation assessment. Fight the fire/explosion or perform rescue operation?
- Determine if an evacuation is needed.
- Determine whether additional support from civilian authorities is needed.

The incident command room, which may be the control room must support the incident command team to perform quickly, effectively, and without error.

## 7) Control Room Ergonomics

The control room is no ordinary workspace. While a typical office worker may ponder the best place for paper clips, your operators are dealing 24/7 with controlling and monitoring safety-critical processes. They need workspaces that are optimized to enable them to perform at the highest standard during all operational scenarios, particularly abnormal situations and emergencies where operator response is time critical. The basic elements that need to be taken into account to optimize an ergonomic control room (Figure – 25) are listed below.

- Prioritized arrangement of equipment to support task performance
- Clear presentation and visibility of critical information
- Layout to support control room interaction and team work
- Adjustable furniture to physically fit the end user which is also comfortable and supportive
- Work environment which enhances performance through attention to issues such as lighting, noise and thermal comfort

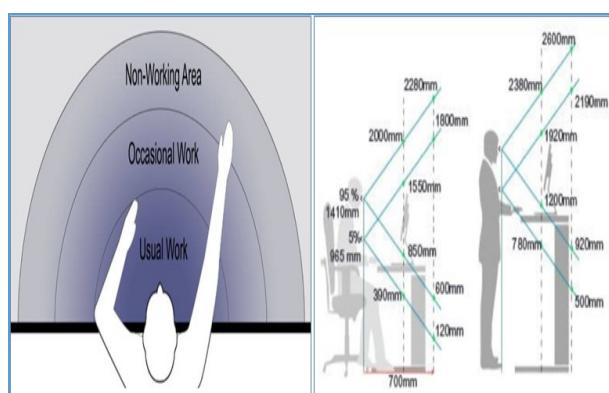


Figure 25: Ergonomics in Different Work-Areas in the Control Room

## 8) Organizational Change Management

Organizational change management (OCM) is an aspect of human factors engineering that looks specifically at the impact of organizational change on the people and processes within an organization, rather than the technical aspects of change, known as Change Management.

In a control room consolidation or a move to a new plant, new processes are always typically introduced, the following questions must be asked as part of risk assessment:

- What are the changes, and how do they impact people?
- What are the new changes to roles and responsibilities?
- Is there a reduction or addition to staff and how will they coordinate?
- Has the chain of command changed and will supervisory roles be eroded?
- Are operators doing more tasks (or fewer) than before? Both can have a negative influence on performance
- Are they being asked to step into roles for which they lack skill, experience or competency?

- Is training being provided systematically for any technology that has been introduced, with sufficient time for practice and familiarization in a range of operational scenarios?
- Have any new tasks been clearly documented and communicated?
- If new supervisors or management personnel are being introduced, do they have experience at that site or a similar site, and if so, to what degree?

## 9) Workload Analysis

It is a complex area of human factors engineering that employs measurement and prediction methods to control room operations, to optimize human performance, and ultimately, safety (Figure – 26).

Work Load Analysis (WLA) is essentially part of human factors engineering that seeks to address risk mitigation proactively through analyzing and addressing weaknesses in the control room system. It is an investment in process optimization that in the long run can avert potential litigation, and save time, money and lives.

A WLA may use secondary task performance techniques, which simulates a primary task in a controlled environment, then adds and subtracts tasks to see how performance degrades, how and when error might occur and how reaction time might change.

Another key technique is subjective workload measurement, whereby operators are simply asked to rank their workload before, during and after the tasks required of them. The most well-known of this category of techniques was developed by NASA and is known as the Task Load Index (NASA-TLX).



*Figure 26: Different Work-Loads in Different Parts of Control Room*

## 10) Control Room Layout

Control room layout design is a specific area of human factors engineering (HFE) that seeks to optimize the work area layout of the control room. No matter how optimized other HFE elements are, if the room configuration is at odds with the demands of the operators, safety and performance will suffer.

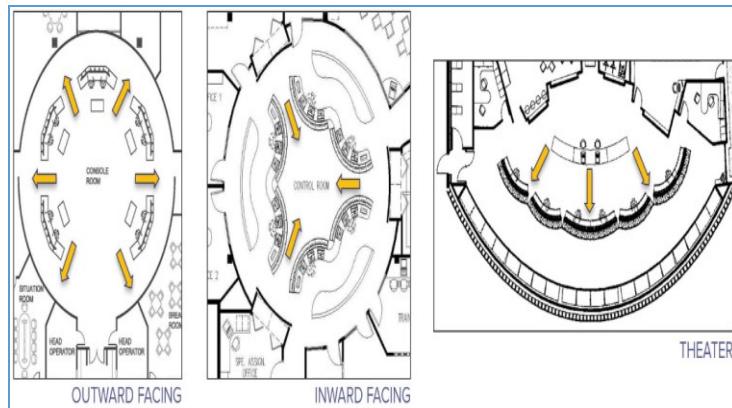
The major considerations are as follows –

- Relative console placement in control room layout
- Console orientation strategies in control room layout

The control room layout must support interactions that need to happen between operators, while avoiding noise interference. The control room layout does not occur in isolation as the building layout is also taken into account to ensure desirable traffic and circulation routes, while enabling operators to have good access to the facilities that they need. The console design and orientation will also affect the control room layout.

The detailed analyses of operator interactions will also be used to inform the console orientation (Figure – 27), such as:

- Outward Facing
- Inward Facing
- Theater



*Figure 27: Various Orientations of Consoles in Control Room*

To decide on which of these three console orientation strategies best suits the unique needs of each control room, the communication interactions and line of sight requirements shall be referred. To determine the right layout strategy for the control room is the last piece of a multifaceted HFE puzzle that informs all of our designs.

### 11) Control Room Console Design

Control room console design is a specific area of human factors engineering (HFE) that seeks to optimize the workspace in the immediate vicinity of the operator. A control room console unit consists of computer monitors, keyboard, communications equipment and other equipment essential to the operator's task mounted on a desk or sit/stand workstation. The optimal configuration of these elements can have profound implications for the safety, health and performance of the people operating within mission-critical, 24/7 environments (Figure – 28).

The basic steps to be analyzed are as listed below.

- Avoiding catastrophe by learning from history
- Ergonomic sit-stand workstation offers significant health benefits

Modern workstations need to encourage postural variation. According to the National Institute of Health, there is growing evidence that sedentary behaviour is associated with negative health outcomes. The studies were controlled for, and were independent of, other physical activity engaged in by study participants. Results confirm that prolonged occupational sitting:

- Has acute negative effects on metabolism
- Is associated with greater cardiovascular morbidity
- Is associated with chronic back pain
- Promotes weight gain
- Is associated with chronic diseases that result in premature death

Prolonged sitting can also promote fatigue and general discomfort. An adjustable sit-stand station is recommended by the National Institutes of Health worldwide to address these ill effects. The height-adjustable surface may be the entire desk or a retrofitted attachment that raises and lowers a computer screen, keyboard and mouse.



Figure 28: Ergonomically Designed Furniture for Shift Operators

## 12) Human Machine Interface

Human machine interface (HMI) design is an area of Human Factors Engineering (HFE) that focuses on optimizing the control system interface to ensure safe and efficient human performance. By analyzing the instruments and equipment people use to do their tasks—from software screens to control panels—HFE uses a scientific approach to ensuring the best possible interface between a human and the system.

Displays and controls need to meet detailed and specific criteria, such as the size, shape, spacing, positioning, color, and texture of controls. In terms of visual displays, there are also criteria related to information grouping, positioning, size, color, and contrast with many more levels of detail.

Auditory information is also very important. The intensity and frequency of sounds can be manipulated to optimally transmit information, and different sound patterns must be employed for different alarms to indicate different messages.

Tactile information is also examined in an HMI design. The shape, texture and position of certain control elements provide cues to function. The principle of proximity should be considered such that if things are close to each other, one expects them to be functionally linked. This principle can be used to good effect in designing the panel, so that elements are positioned according to function and create separation between elements which are not linked.

### C. Ergonomics in Aviation Sector

The control centre design ergonomics is of utmost concern to mitigate the stress and fatigue of grid operators. Several such measures are taken in Aviation Sector especially in Air Traffic Control area. The Airport Authority of India publishes a Manual of Air Traffic Services (MATS) for use and guidance of its ATS personnel with a purpose to establish procedures, provide information and instructions which are essential for the provision of safe and efficient air traffic services at airports where air traffic services are provided by Airports Authority of India.

In the MATS released in 2015 and amended in October-2016 with Document Identification No. ED/ATM/2015/V4.0-MATS-PRT1, a specific section 3.5 on “Stress/Fatigue mitigation of Air Traffic control Officers (ATCOS) – Rest & Relief” is included. Some of its relevant extracts are mentioned in *table-3* below.

Table 33: Stress,Fatigue mitigation at air traffic control centres (source: AAI)

| Section in document                                      | Description   | Relevance for LDCs |
|--|---|--------------------|
| Chapter 3, Section 3.5, Clause 3.5.1                     | Fatigue is defined as a mental weariness resulting from exertion. Fatigue can be mental or physical and can manifest as either somnolence (decreased wakefulness) or as a general decrease in attention. Fatigue can <i>cause problems for individuals who perform tasks that require constant concentration</i> , such as air traffic control. Additionally, the nature of air traffic control <i>requires shift work, which can exacerbate fatigue because it often requires individuals to work at times when they would normally be sleeping or sleep at times when they would normally be awake.</i> | Yes                |
| Chapter 3, Section 3.5, Clause 3.5.1, Sub-clause 3.5.1.1 | Each station should ensure <i>provision of adequate rest and relief mechanisms</i> which need to be standardized including size of the rest room, number of beds to be made available, facilities such as <i>television, water dispensers with provision of both hot and cold water, refrigerators, microwave ovens, massage chairs, reclining chairs, Library facilities</i> with both aviation subject & general materials, <i>well-equipped gym, individual storage locker facility, etc.</i>  | Yes                |
| Chapter 3, Section 3.5, Clause 3.5.1, Sub-clause 3.5.1.2 | The period on operational position (ATC Channel) should be adjusted to avoid the performance degradation considering the volume and complexity. WSO/ Supervisors of units shall ensure proper relief of the controllers who are working on channel.   | Yes                |
| Chapter 3, Section 3.5, Clause 3.5.1, Sub-clause 3.5.1.3 | No operational duty shall exceed a period of two hours without there being taken at the end of that period a break/relief of 30 minutes except for supervisory positions and non ATC positions viz., EEP, DEP, ARO, FIC, AIS, etc. However, this period can be extended at airports with lean air traffic.  | No.                |
| Chapter 3, Section 3.5, Clause 3.5.1, Sub-clause 3.5.1.4 | Periods of operational duty between 2300 hrs IST to 0600 hrs IST during night shift may be extended to a maximum of four hours before relief is provided. This relief period may be of longer duration.   | No.                |
| Chapter 3, Section 3.5, Clause 3.5.1, Sub-clause 3.5.1.5 | The duty period along with relief period of ATCOs shall be mentioned in the roster by ATS in-charge.  | No.                |
| Chapter 3, Section 3.5, Clause 3.5.2                     | All airports/ATC centres to establish procedures to rotate controllers through challenging and less demanding positions during each shift to mitigate the potential for fatigue to occur.   | No.                |
| Chapter 3, Section 3.5, Clause 3.5.1, Sub-clause 3.5.3.1 | There shall be an <i>interval of not less than 12 hours between the conclusion of one period of duty and the commencement of the next period of duty.</i>   | Yes.               |
| Chapter 3, Section 3.5, Clause 3.5.1, Sub-clause 3.5.4.1 | Arrangement may be made for controllers to be <i>trained in stress relieving mechanisms such as Yoga, Meditation, etc. at regular interval</i> by station in-charge.  | Yes.               |

## Annexure-8: Improving Human Performance in Control Centres

The rapidly changing technological and business environment for system operations demands higher levels of operator performance than ever before. A broad overview of the multi-disciplinary aspects (Figure – 29) that contribute to operator performance is needed. The implicit comparison between what the literatures has to tell us and actual utility practice indicates that control centers have gone a long way to implement state-of-the-art methods in control center design and are making substantial strides in the areas of computer- based operating aids and decision making.

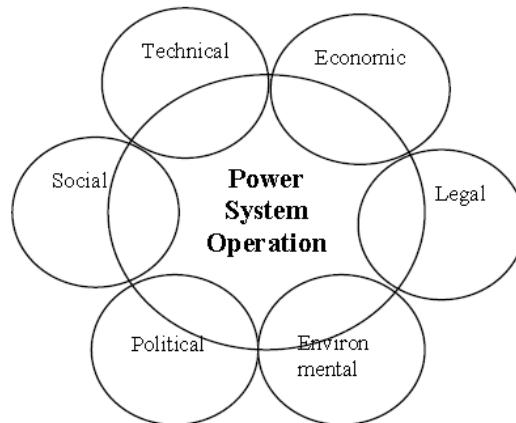


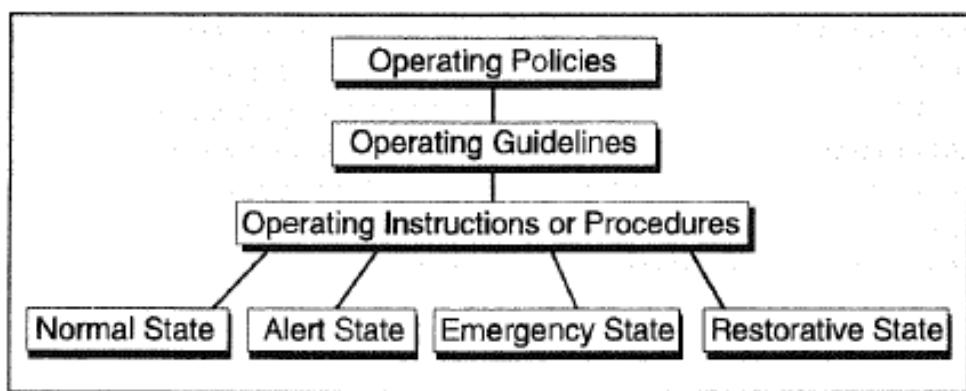
Figure 29: Multi-disciplinary Aspects of Power System Operation

Motivational and organizational practices vary considerably from one control center to another. Many utilities have succeeded in creating a climate where the system operator is given professional status and decision-making authority (Figure – 30). Other utilities may wish to consider increased professionalism as a target to strive for. The areas of goal setting and performance measurement are also areas where more attention is needed, especially in view of the increased business pressures on utilities in many parts of the world.

|   | Data Requirements   | Timeliness  | Number of Options   | Complexity of Decision |
|---|---|---|---|------------------------|
| <b>Routine Decisions</b>                                  | <ul style="list-style-type: none"> <li>• Little data</li> <li>• Readily available</li> <li>• Little analysis</li> </ul>   | <ul style="list-style-type: none"> <li>• Time is not significant</li> </ul> | <ul style="list-style-type: none"> <li>• Few options</li> <li>• Often driven by procedure</li> </ul>                    | Minimal                |
| <b>Normal Operating Decisions</b>                         | <ul style="list-style-type: none"> <li>• Data readily available</li> <li>• Operator gets additional data, as needed</li> <li>• Requires data analysis for quality</li> </ul>                              | <ul style="list-style-type: none"> <li>• Sufficient time</li> </ul>         | <ul style="list-style-type: none"> <li>• Many options</li> <li>• Options often at multiple points in process</li> </ul> | Medium                 |
| <b>Operating Decisions in Emergency/Restorative State</b> | <ul style="list-style-type: none"> <li>• Data may be incorrect or not readily available</li> <li>• Careful analysis required</li> <li>• May need analysis assistance from supervisor or others</li> </ul> | <ul style="list-style-type: none"> <li>• Time may be limited</li> </ul>     | <ul style="list-style-type: none"> <li>• Many options at multiple points in response</li> </ul>                         | High                   |

Figure 30: Decision Making by System Operators

The realistic system may migrate from ‘normal’ to ‘abnormal’ state on account of perturbations internal to the system or external to the system. Usually the inbuilt control system is capable of automatically maintaining system stability during normal as well as abnormal states. However at times the control system may fail or malfunction, causing the system to migrate into an unsafe zone rather quickly. At this stage the system operator who is closely supervising the system must quickly sense the change in system behaviour (what is happening?), identify the underlying causes (why it is happening?), anticipate the future state (what might happen?) and make necessary interventions to prevent degeneration (Figure – 31). This is generally termed as ‘situational awareness’ and is defined as a mental model of our operating environment and our place in it. It often consists of four processes including perception, comprehension, projection, and prediction [Loughran and Stahl, November 2000, ‘Gaining and Shared Situation Awareness’].



*Figure 31: Hierarchy of Operation Policies and Procedures*

### 1) Psychological Factors

There is broad agreement that system operations can be a high-stress job position. An extensive body of research documents the causes and effects of stress in the work place. The concept of stress has qualitative as well as quantitative dimensions. There are negative as well as positive aspects of stress. Some simplified conclusions to be interpreted cautiously include:

- Stress to a certain level improves performance. Performance tends to deteriorate both under the intense stress of a critical emergency and in the absence of stimulation or some level of challenge.
- Complicated tasks are more affected by stress than simple tasks.
- When dealing with several tasks in parallel, the secondary tasks are more affected by stress than the primary task.
- Short-term memory is affected by stress.
- Stress will cause a more primitive style of decision making.
- Lonesome work can increase stress.

The references also give suggestions on how to prevent the negative stress:

- The work should contain variation and opportunities for improvements.
- The physical and mental strain of the work should not be unreasonable.
- Individuals should feel that they are in control of their tasks.
- Individuals should have adequate knowledge and skills for the task.
- Adequate training should be provided.
- There should be continuous feedback on the performance of the individual.
- There should be a good social environment and team spirit at work.
- There should be a social safety net for individuals who fail.
- The MMIs should be well designed with adequate feedback on actions.

- Disturbances like noise, etc. should be minimized.

The research endorses the need to keep the operator active (hence busywork); the active operator will recognize situations and failures faster. The difficulties in switching from passive monitoring to active problem solving have been recognized in several studies. In disturbed conditions, the operator should be able to rely on operating aids or advisory tools (expert systems) because of the complexity of the tasks to be performed and the likelihood that decision making may be impaired. Operator confidence in their own skills and knowledge derived from good training can mitigate the stress experienced in emergency operating conditions.

Another psychological consideration is the compatibility of shift teams. Operators must be able to work together, particularly in emergencies. Some utilities keep shift teams together; others change the composition of the team as part of the normal shift rotation. A few utilities have only one operator on shift, particularly in regional or distribution control centers. The absence of human contact may have a negative impact on performance. Many control centers encourage operator participation in industry groups and seminars or visits to other control centers on an occasional basis. This opportunity to interact with operators in other control centers can enhance the team feeling and help to mitigate stress. Stresses associated with shift work are a factor that can affect operator performance. A considerable amount of research exists on the effects of the human body's 'Circadian Rhythms.'

Some countries follow strict legislation or union rules concerning shift rotations. Most control centers have 24-hour rotations with a mixture of 8 and 12-hour shifts. Operators are often hesitant to change to 12-hour shifts, but where such shifts have been adopted, they are generally preferred. Limited access rules apply to nearly all the control centers. Security cards appear to be the most common method for controlling entry. Visitors are normally limited to a viewing area, usually separated by a window or screen from the actual floor of the control center. Restricted access is generally considered necessary to give operators a feeling of security and minimize unnecessary distractions.

#### **Reference:**

1. *Improving Human Performance in Control Centre: CIGRE-IEEE Joint Working Group 39.03* (Convenor: G. Krost, Germany), S. Lutterodt (Main Author), Y. Logeay (France), K. Knoepfel (Switzerland), R. Skjold (Sweden)
2. *Article on Relevance of Knowledge Management at Power System Operation Control Centres in India | Published in the Journal titled "Productivity" published by National Productivity Council in April-June 2007 issue, Vol.48, No.1 by Sh. Vivek Pandey & Sh. K. Momaya*

## **Annexure-9: Knowledge Management in Load Despatch Centres**

### **A. Introduction:**

Socio-technical systems are complex systems. They comprise of several sub-systems with interrelationships that mutually influence each other's performance. The coordination services offered by the power system operators are unique and mission critical. While the performance of the subsystems could be improved by requisite investments in technology and other infrastructure, the performance of the power system operators would be a function of their domain knowledge, problem solving skills and motivation to deliver. Unlike the commercial organizations competition in power system operation is not against any other organization but against the randomly occurring combination of expected and unexpected events

LDC role falls under the realm of essential public service and is presently being carried out within the government set up and under regulatory oversight. The activities have to be limited within a code of discipline and commercial rules specified by the regulators. A diverse constituency has a stake in power system operation. This includes generating utilities, transmission utilities, distribution companies, consumers, manufacturers, market intermediaries, academic institutions, technologists, economists, lending agencies, planners, administrators, government authorities, regulatory bodies, legislature, judiciary and many others. Decisions have to evolve after a considerable formal and informal interaction among stakeholders and system operators are subject to heightened value-laden expectations for neutrality, fairness, transparency and accountability. This makes power system operation a multidisciplinary in nature and calls for an understanding of all related areas apart from the technical aspects. Considering the diversity of expertise required a control centre, expecting a single individual to have proficiency in every area would be unrealistic. Therefore pooling of expertise and effective knowledge management appear to be the most practical alternative to achieve the desired objective.

Knowledge Management (KM) is one of the key driving vehicles for the digital transformation, especially in the context of LDCs. Digital data needs to be appropriately used considering the LDC's critical knowledge assets: its core competencies, intellectual property rights, market and industry comprehension, and customer understanding and expectations. KM is the art of transforming information & intellectual assets into enduring value for LDCs and stakeholders of the power sector.

The core objective of KM is to provide the right information to the right people at the right times to help people share experiences and insights, and to improve the productivity of teams. Various data science techniques are being used to accomplish KM objectives. LDCs need to map the strategic and critical knowledge for complete digital transformation. This helps in identifying those knowledge assets that digital transformation can leverage, as well as highlights gaps in an LDC's knowledge network. KM prevents LDC personnel from constantly reinventing the wheel, provides a baseline for progress measurement, reduces the burden on expert attrition, makes visual thinking tangible, and manages effectively large volumes of information to help employees serve their clients better and faster. KM, in the current scenario, is a necessary game changer.

### **B. Strengthening of Forum of Load Despatchers (FOLD)**

Each LDC may exchange operational knowledge and experience with their neighbouring LDCs in the region where they have a role in operational planning coordination between LDCs, including facilitating visits and exchange of experiences between System Operators. NLDC/RLDCs/SLDCs play an active role in the Forum of Load Despatchers (FOLD) meetings for knowledge sharing and dissemination. The active participation from State Load Despatch Centres (SLDCs) enables seamless understanding of new policies and regulations developed at the central level. It is important that vital inputs from the FOLD meetings may be passed onto the administrators, planners and regulators by the LDCs for course correction in their decision making and thinking approaches.

### **C. Knowledge as a Strategic Resource**

Knowledge management is going to play a strategic role in operational security initiatives. Although the knowledge-based view of strategy has significantly advanced, less is known about how knowledge becomes a strategic resource. LDCs, through FOLD & FOR sub-groups, have already leveraged the enormous amount of data and information available through big data analytics in various ground breaking reports. Therefore, the knowledge and data management should be assigned to a particular department/set of individuals in LDCs so that the strategic use of data may be made in the interest of overall Indian grid security and reliability.

### **D. System Operators as Knowledge Workers**

Knowledge management relies on knowledge workers. High performance and competitive advantage today increasingly comes from the particular, hard-to-duplicate know-how of a power sector's most-skilled knowledge workers. The system operators are, world-wide, known as knowledge workers. The policy makers and regulators may motivate, compensate and incentivize the system operators so that they can perform in the most stressful of the times. There should be adequate support staff for taking care of the peripheral activities and the core focus of the system operators should be on the reliability and security of the Indian grid.

### **E. Need for Knowledge Mapping**

In order to achieve a more efficient knowledge management, five fundamental aspects of knowledge work require fresh thinking: the value of the relationship with a larger objective; the settings in which work is done; the organization of workflows and how individual contributors add value; the technologies used to support higher achievement; and the degree to which employment arrangements are tailored to individuals. In knowledge-based environments such as LDCs, teams must develop a systematic approach to integrating knowledge resources throughout the course of projects in order to perform. Self-managing teams engaged in knowledge-intensive work can perform more effectively by combining autonomy and external knowledge to capture the benefits of each while offsetting their risks. The complementarity between having autonomy and using external knowledge is contingent, however, on characteristics of the knowledge and the task involved. There is a need for knowledge mapping of every individual work domain in LDCs to extract the value of the knowledge creation and dissemination. There is also a need to upgrade to knowledge management systems and tools for comprehensive knowledge repository and analysis.

### **F. Need for Hyper Specialization**

Highly specialized knowledge workers are great assets to the organizations, especially LDCs. Research demonstrates that only domain-specific expertise -the kind that teams underuse when facing higher pressure- increases significantly team performance. The specialist level courses being conducted by NPTI have to be upgraded in accordance with the dynamic policies, regulations and technologies. New specialist courses in areas like big-data analytics etc. have to be introduced in line with the futuristic thinking. As knowledge work expands and technology advances, we've entered an era of hyper specialization: work previously done by one person is divided into more-specialized pieces done by multiple people, achieving improvements in quality, speed, and cost. LDCs need to capitalize on hyper specialization's possibilities by dividing knowledge work into discrete tasks, recruit specialized workers such as data scientists, meteorologists, cognitive and behavioral scientists etc. ensure the quality of the work, and integrate the pieces into a final whole.

### **G. Knowledge Management leading to Innovation**

Knowledge management requires innovations in both internal processes and systems. Research shows that organizations with a broad knowledge base are more likely to achieve innovation in the presence of internal knowledge sharing rather than market knowledge acquisition. In contrast, organizations

with a deep knowledge base are more capable of developing innovation through market knowledge acquisition rather than internal knowledge sharing. Broader horizons with respect to innovation objectives and knowledge sources are associated with successful innovation. LDCs have both broad and deep knowledge base in the areas of power system operation, power market operation, renewable integration etc. Therefore, there is a need for innovation in both internal processes and systems of LDCs. There is a need to develop the internal resources along with recruiting and retaining the best talent as the best knowledge nurtures great innovations.

Knowledge management strategies should focus on:

- Knowledge-sharing technology development, that is able to integrate within one single platform all knowledge management needs, supported by an intelligent search engine.
- Knowledge content development, focused on informal/tacit knowledge, as well as knowledge gaps.
- Companywide involvement of senior experts and knowledge worker is essential within the content development projects.
- Transparent knowledge management processes and well-defined roles and responsibilities within the knowledge creation, sharing and application.
- Cultural change / change management project to support the whole organization in realizing its knowledge management strategy. Individual incentives should also be included to encourage active involvement within knowledge sharing.

The KM initiatives presently being pursued are steps in the right direction for capability building in LDC. However, the participation in these initiatives is still lukewarm mainly on account of cultural prejudices and a natural resistance to change. These could be addressed through suitable interventions. Individual counselling and behavioral workshops could be found useful in tackling personality and culture related issues. Special attention needs to be given for improving reading and communication skills.

On the KM front more focused initiatives on the lines of SECI model of socialization; externalization, combination and internalization could also be considered. Standard KM techniques such as knowledge portals and mentoring techniques could be also explored. Electronic performance support systems (EPSS), embedded hypertext based helps, multimedia or other technologies could be extensively deployed.

Organizations performing system operation function would have to move beyond narrow interests and create shared infrastructure for training, capability building, R&D and KM. Effective networking between system operators in different control centres through formal and informal channels would help in developing trust and technical solidarity. This would also help in nurturing the profession in India. Efforts are also required towards developing a metrics for measuring the impact of KM initiatives. Capability Maturity Models similar to those used in software industry could be developed in LDC to assess the gap between the present and desired maturity level.

Productivity of knowledge activities is key to competitiveness and success. It demands sound strategy implementation on wise choices. Strategic choices on implementation approaches will play a critical role in leveraging KM for competitiveness (Ganeshraj and Momaya, 2006). Organizations in India need to move much beyond technology (often IT)-centric approaches of KM to people/culture-centric KM approaches where knowledge creation and use becomes a joyful way of life.

**Reference:** Article on Relevance of Knowledge Management at Power System Operation Control Centres in India | Published in the Journal titled "Productivity" published by National Productivity Council in April-June 2007 issue, Vol.48, No.1 by Sh. Vivek Pandey & Sh. K. Momaya

## Annexure-10: Situational Awareness

“Situation awareness (SA) is, simply put, understanding the situation in which one is operating.” SA can be more comprehensively defined as the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future. The inherent challenge of SA is to maximize human understanding and comprehension without increasing operator stress. SA consists of the following stages (ref. *Fig. 32*):

- **perception** of elements in the environment
- **comprehension** of current situation
- **projection** of future status

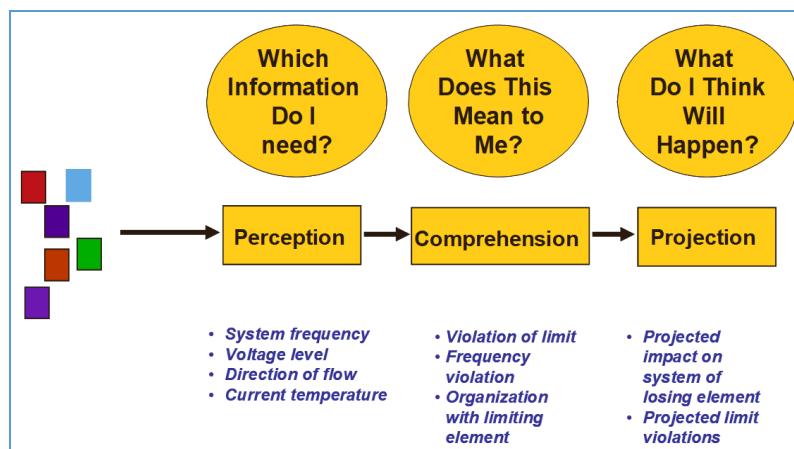


Figure 32: Situational Awareness with tentative examples

An advanced analytics and visualization framework (AAVF) is required to present the grid operator with real-time conditions in a timely, prompt manner. A good AAVF provides the ability to efficiently analyze and present data for decision making; this includes the ability to navigate and drill down to discover additional information, such as the impact and specific location of a problem. In other words, operators do not just want to know “we have a problem”; operators want to know how to fix the problem.

In the most limited sense, an operator establishes SA based on a more or less complete and more or less accurate mental picture of the physical status in his/her control area. With increasing information and knowledge about other control areas, the operator’s mental picture expands to encompass a partial picture of physical status in adjoining areas, which affect the SA of one’s own control area. Finally, to have shared SA for optimal ‘sense-making’, an operator also needs to be aware of the operational situation in outside control areas: what are other operators thinking and doing and planning to do, what actions are underway, how is the status evolving or expected to evolve.

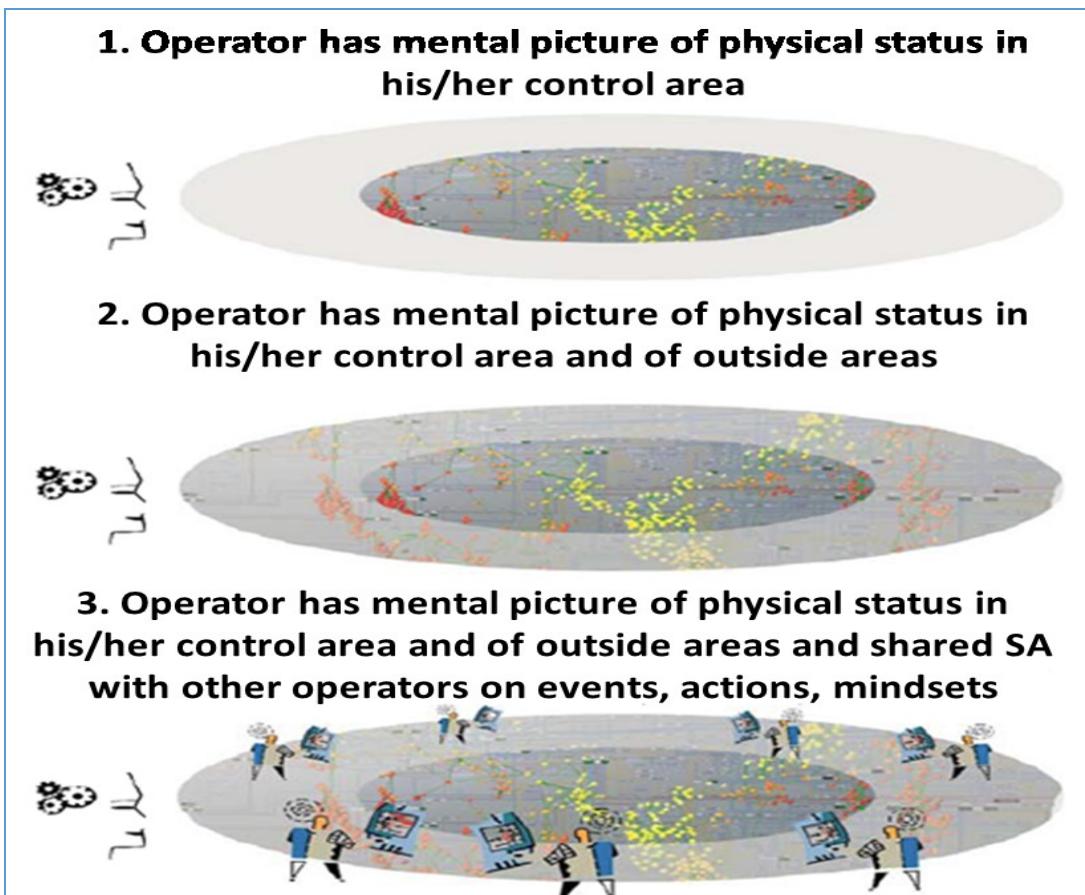


Figure 33: Increasing SA Outside of One's Control Area towards Shared SA

The SCADA system at Load Despatch Centres is associated with various applications such as Alarms, State Estimation, Generation Applications, Network Applications, etc. In order to bring the concept of Situational Awareness in this entire set of SCADA and EMS applications, it is required to provide the information to the grid operator in graphical displays which can be comprehended and understood easily. Some of such displays are illustrated in sub-sections below:

#### a) Contours and 3-Dimensional Bar displays

One of the best ways to visualize the areas-of-alert is the displays with contour and 3-D Bars effects. Some of such displays are shown in *figures* below (fig. 34-45):

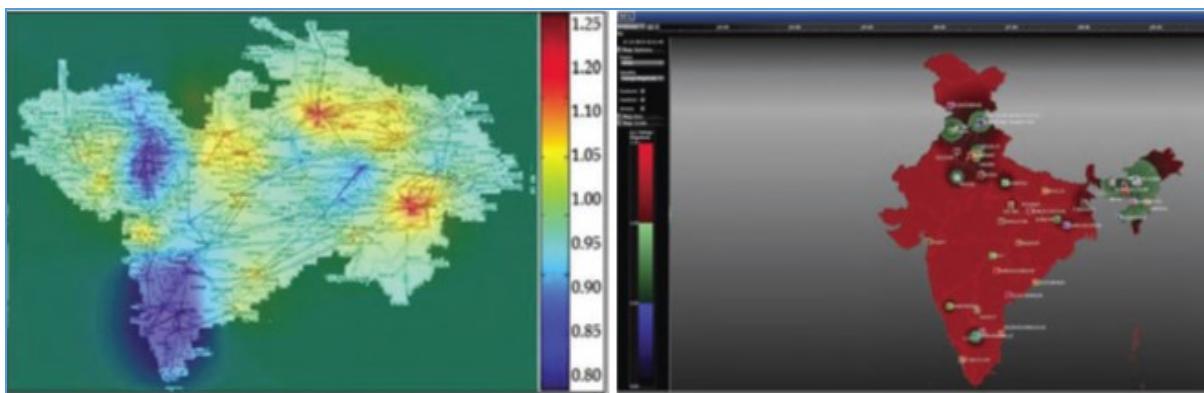


Figure 34: Sample contour displays being used by grid operators in LDCs

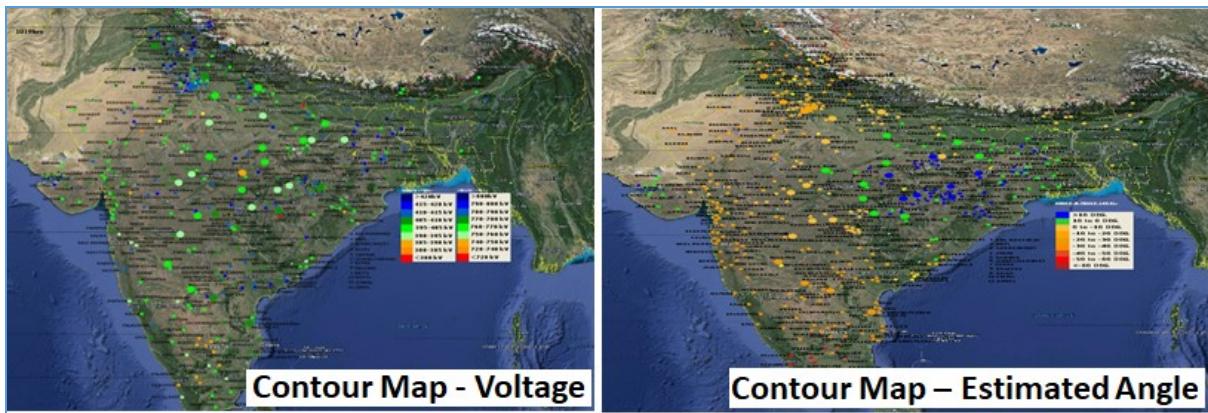


Figure 35: Contour displays (voltage and estimated angles) used in NLDC



Figure 36: Contour displays (Voltage and Estimated Angles) used in SRLDC

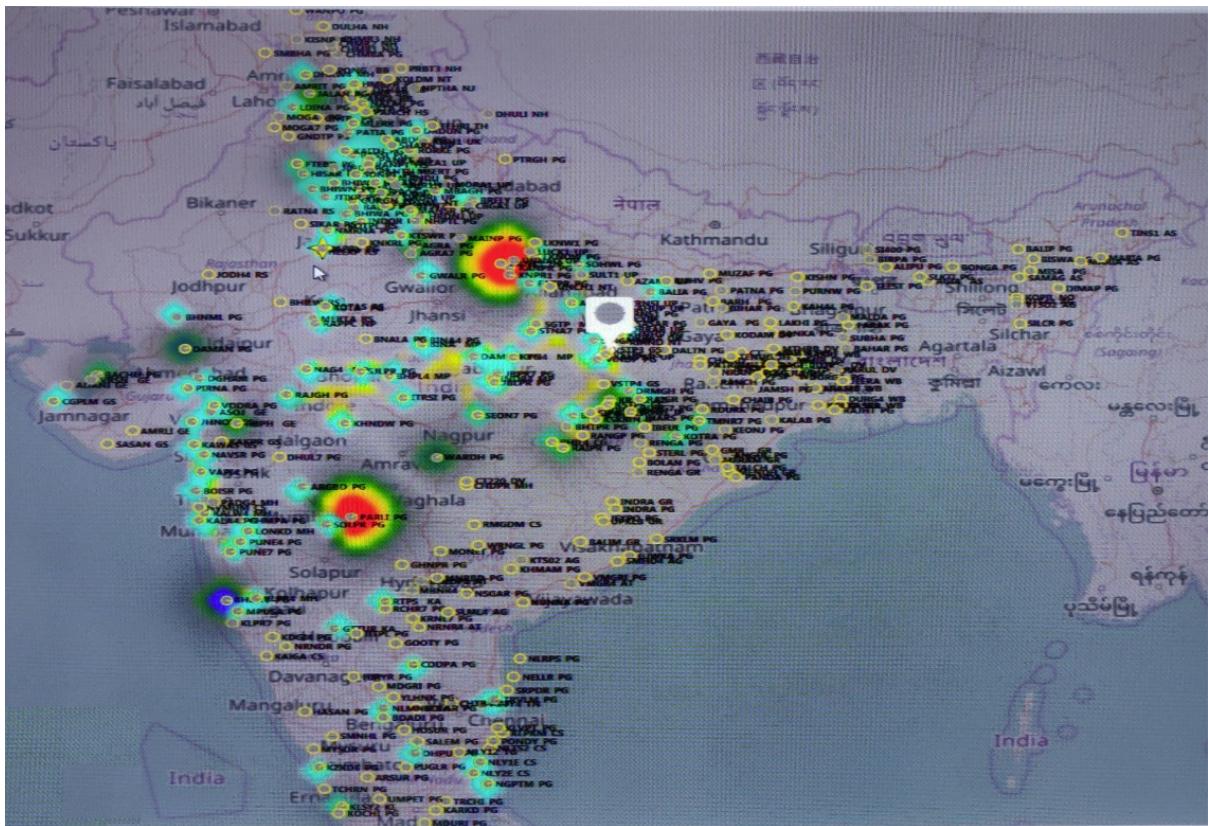


Figure 37: Contour display (Voltage and Frequency) used in NLDC

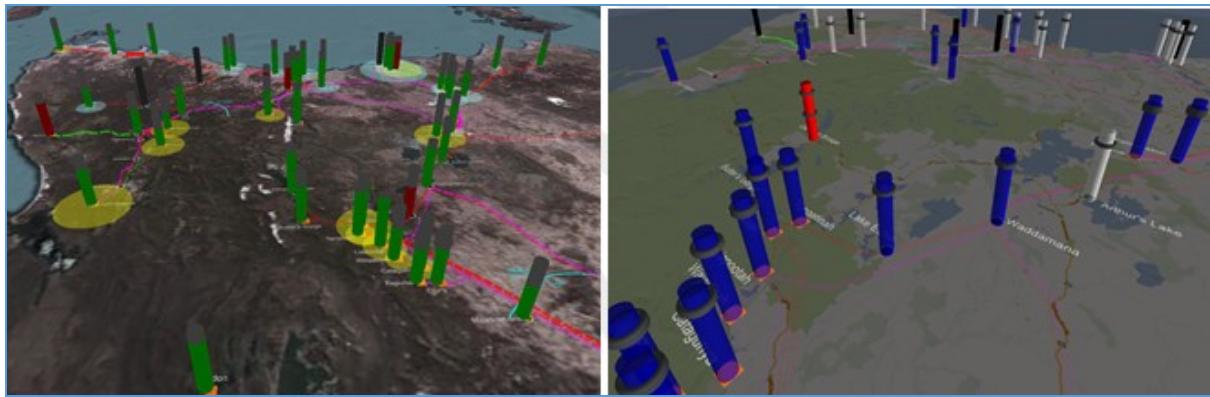


Figure 38: 3-D Effects showing grid parameters in different Conditions

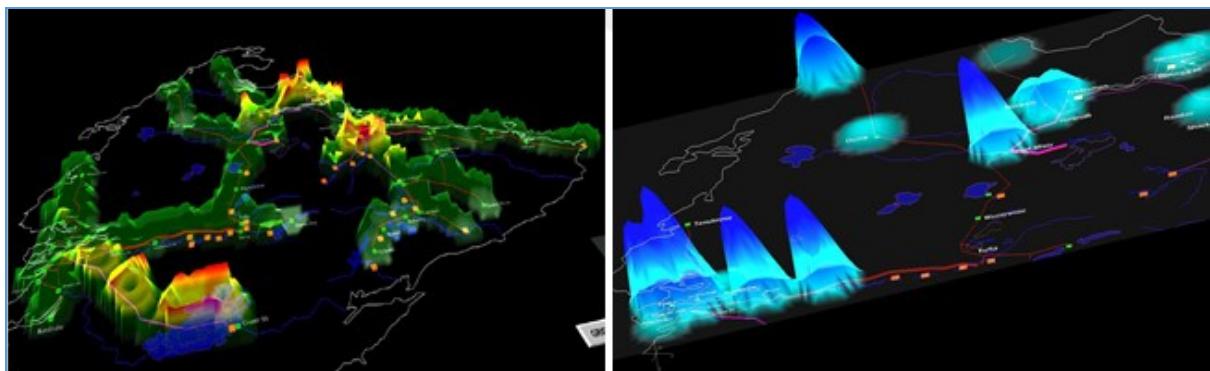


Figure 39: Combination of Contour-effects and 3-D Cones effects

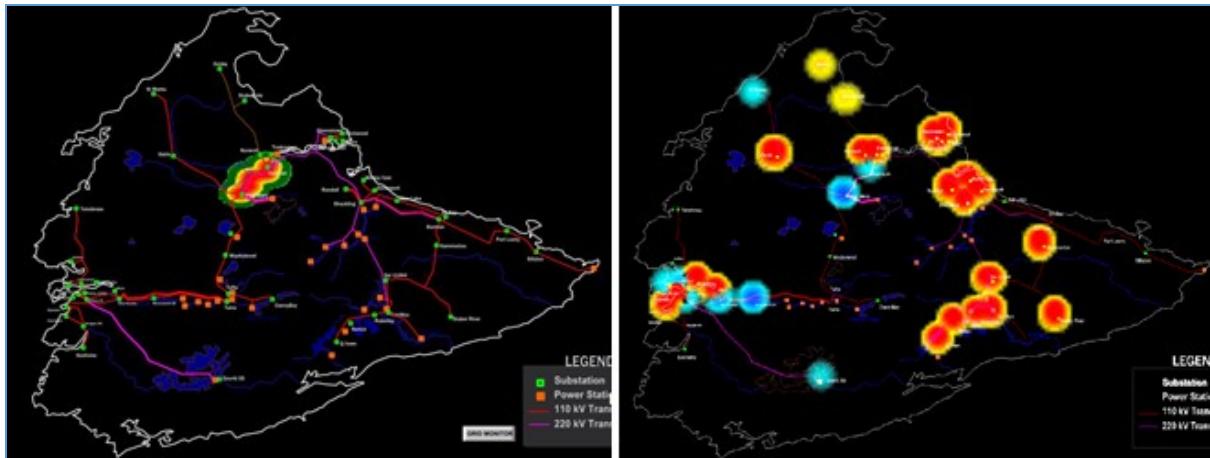


Figure 40: Sample display of contour-effects to highlight areas of concern

The advanced graphical displays with contours of different power system parameters could be shared on mobile devices (refer **fig.41**) which can help in quick and coordinated decision making.

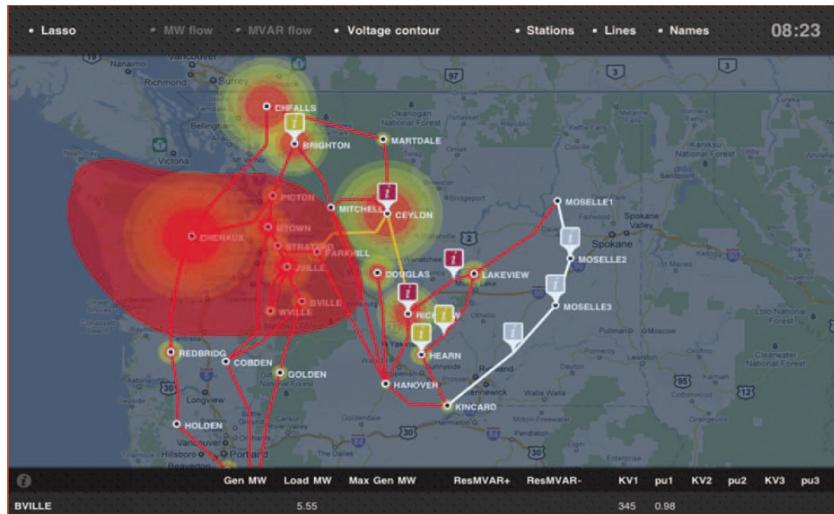


Figure 41: Sample Displays for iPad, Mobiles for Shared, decentralized decision

### b) Animation Effects in Displays

Animation in power system displays (refer *figure-42*) can be very effective to help operators interpret displays by directing their attention to the most important information for a particular task or situation. It also enhances an operator's understanding of system behavior.

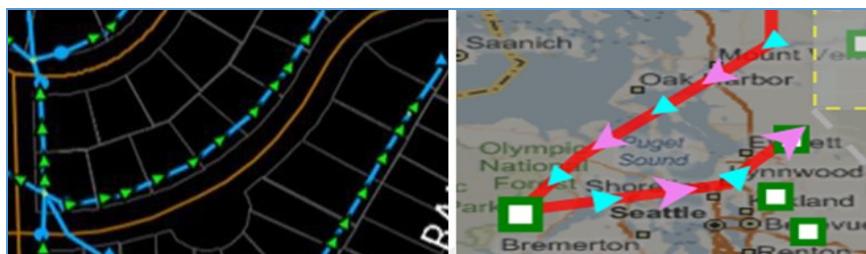


Figure 42: Example of Animated Power Flow Arrows in Transmission Lines

### c) Customized Dynamic Dashboards

The customized dynamic dashboards are one of the most effective ways of putting the related-information together in a single display in order to help the grid operator in fast decision making. These dashboards may be application specific or User's requirement specific to facilitate users to identify the problematic areas in the power system. Some of such dynamic displays could be as below:

- Power flow monitoring
- State Estimator performance monitoring
- Automatic Generation Control performance monitoring
- Monitoring of Total Transfer Capability (TTC) / Available Transfer Capability (ATC)
- Grid Stability Monitoring
- Hydro Generation monitoring
- Weather Data ( Wind speed & direction , Temperature etc.) monitoring

Some snapshots of such dynamic dash boards are shown in *figure 43* below:

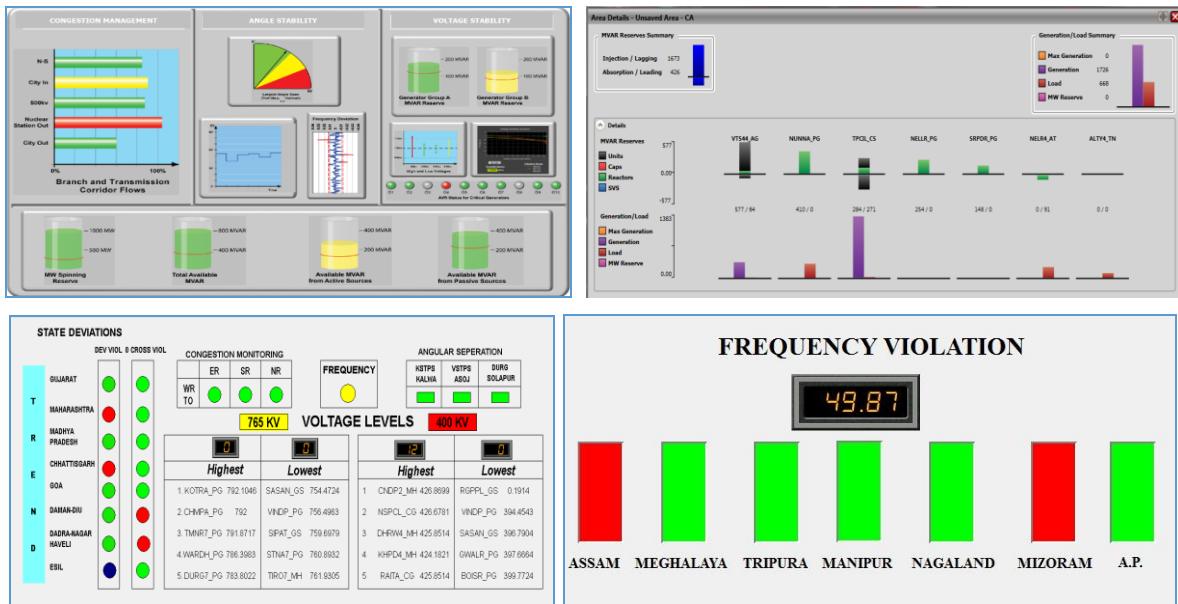
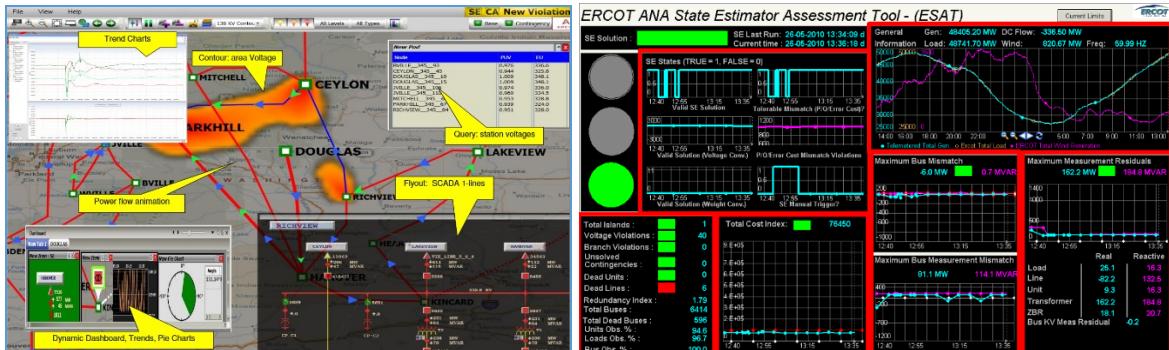


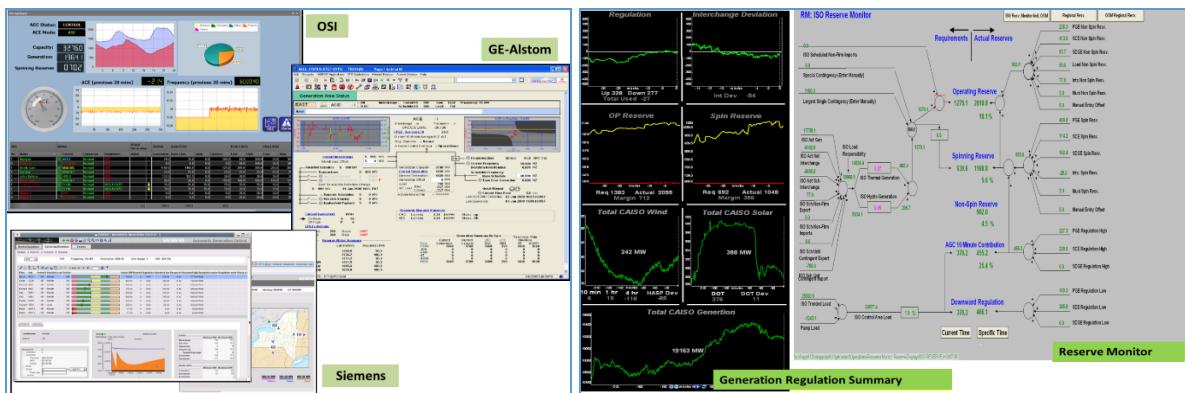
Figure 43: Dynamic dash board

### Deviations and Violations display



### Trends, Contour Effects of Power Flow

### State Estimator Performance Monitoring



### Sample AGC Dashboards

### Generation Regulation & Reserve Monitor

Figure 44: Snapshots of sample Dynamic Dashboards

#### d) Displays based on PMU Data

**Power System Stability Curve:** This curve displays the state of the complete power system. This kind of “fever curve” is calculated from all available measured values for which the limiting values

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are defined. The user can assign parameters for which measured values are to be included in the calculation. The curve is calculated from the weighted distances between the measured values and their limiting values. The curve can be displayed by defining the time range. It is divided into defined time steps. In the on-line mode, the right end of diagram shows the current value.

If any of the actual limits is violated by any measurement, the PSS curve changes the colour to red. Trends to instability can be easily recognized by a rising level of the PSS curve. A customer can optimize the settings of the limiting values, such that the PSS curve shows the appropriate sensitivity of the power system.

**Real-time Stability Assessment:** Voltage stability is always an operational reliability concern for modern power systems. Voltage monitoring and control have been traditionally based on SCADA and EMS. Due to the inherent limitations of these systems and applications, such as slow data sampling rate, slow data communication rates, time-consuming computation, and model inaccuracies, a complete assessment of system voltage stability condition may take several minutes to perform. Motivated by the advantage of technology of Synchrophasors and their wide installation in the current power systems around world, PMU-based voltage stability monitoring applications (refer *figure-45*) are appearing now, which can improve the power system voltage stability and security.

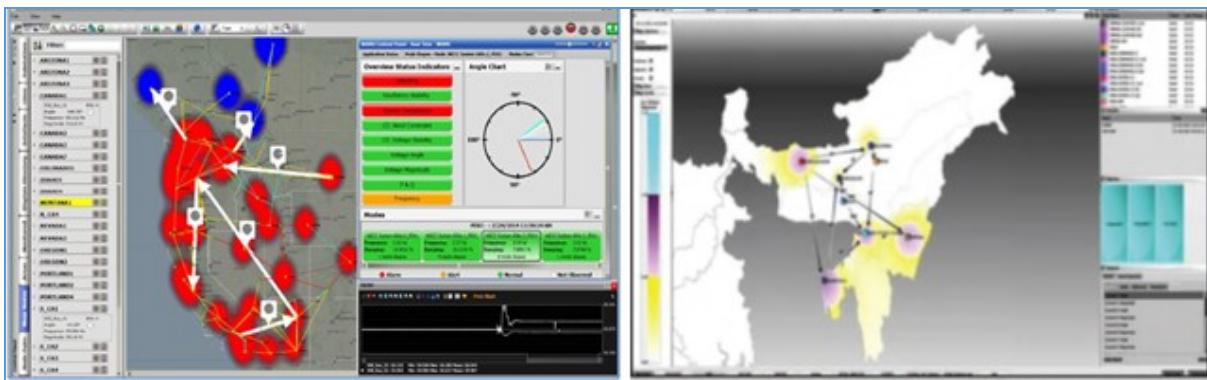


Figure 45: Sample Displays for Synchrophasor-based Stability Monitoring

**Angle Differences:** The phase angle difference of the voltages between different PMUs can be displayed in graphical form. The locations form triangles which are shown in colour (see *figure 17* below). In the *figure-46* below, one of the stations is defined as the reference PMU and shown in a white frame. If a PMU has a positive phase angle difference in comparison to the reference PMU, the phase angle leads. If a PMU has a negative phase angle difference in comparison to the reference PMU, the phase angle lags. The colour deviations indicate angle differences.

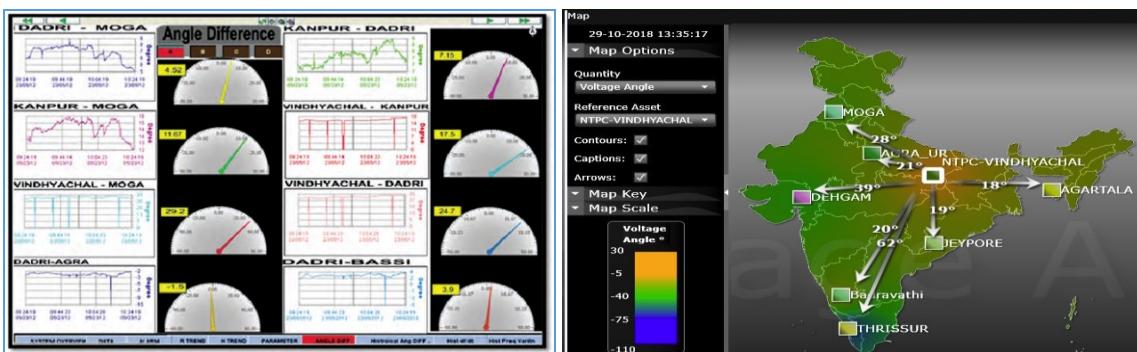


Figure 46: Phase Angle Difference of the Voltages between Different PMUs

**Island State Detection:** The objective of island state detection is to use the measured values of the frequency ( $f$ ) and the rate of change of frequency ( $df/dt$ ) available in each PMU to determine whether separated networks have formed. If there is islanding between two or more substations, then the

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detected islands are displayed in the schematic display as coloured areas. If only one substation is in the island, the area around the substation is displayed as a square.

#### e) GIS Based Visualization

In many situations, the grid operator wants to visualize the exact location of the sub-station and path of the transmission lines (refer **figure-47**), its corresponding terrains, respective wind zones etc so as to operate the grid in a better manner. It helps in following ways to be grid operator –

- **Shutdown requests:** Judging the line crossings so as to facilitate/validate the sanctity of shutdown requests raised for under-construction lines, maintenance of lines, etc.
- **Feedback to the planners:** By better understanding of the exact path of the transmission lines, the respective feedback can also be given to power system planners regarding corridor congestion, construction of new lines, etc.
- **Disaster management:** Finding the transmission lines to be hit by cyclones, thunderstorms and other calamities in which the affected path is depicted and put in public domain by IMD.
- **Situational awareness:** Real-time manoeuvring of weather data acquired from the sub-stations and putting it on exact location of the map so as to help in better visualization and improving the situational awareness to the operator and help in better and accurate forecasting for wind and solar stations.

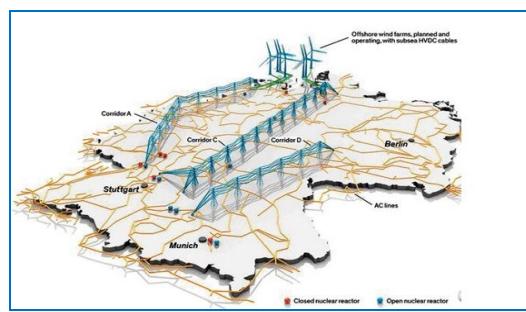


Figure 47: Towers Position on Map for Visualization

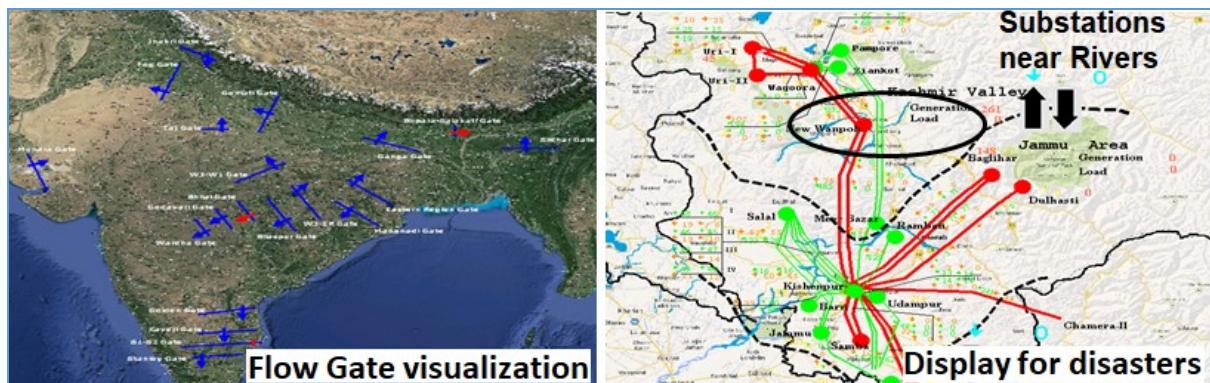


Figure 48: Geographical maps for flow-gate representations, grid condition assessment

## Annexure-11: Typical Human Resource Requirement for LDCs

*Table 34: Typical HR requirement for LDCs*

| S.No. | Resource Area                                  | Small - Large LDC |                   |                  |
|-------|--|-------------------|-------------------|------------------|
|       |  | Top Management    | Middle Management | Lower Management |
| 1     | <b>Head - LDC</b>                              | 1-2               | 8-12              | 1                |
| 2     | <b>System Operation</b>                        |                   |                   | 9-22             |
| 2(a)  | Real Time Operation                            |                   |                   |                  |
| 2(b)  | Operational Planning & Reliability Assessment  |                   |                   |                  |
| 2(c)  | Forecast Simulations, Optimization             |                   |                   |                  |
| 2(d)  | Testing & Protection                           |                   |                   |                  |
| 2(e)  | Data Analytics, Research                       |                   |                   |                  |
| 2(f)  | MIS, Compliance                                | 1-2               | 5-8               | 5-14             |
| 2(g)  | Availability Verification, Operation feedback  |                   |                   |                  |
| 3     | <b>Market Operation</b>                        |                   |                   |                  |
| 3(a)  | Scheduling & Ancillary Despatch                |                   |                   |                  |
| 3(b)  | Reconciliation                                 |                   |                   |                  |
| 3(c)  | Metering & Accounting                          |                   |                   |                  |
| 3(d)  | Regulatory Account Administration              |                   |                   |                  |
| 3(e)  | STOA   | 1-2               | 4-6               | 4-13             |
| 3(f)  | Market Oversight                               |                   |                   |                  |
| 3(g)  | Renewables, Economy & Efficiency               |                   |                   |                  |
| 4     | <b>Decision Support</b>                        |                   |                   |                  |
| 4(a)  | SCADA/EMS                                      |                   |                   |                  |
| 4(b)  | WAMS   |                   |                   |                  |
| 4(c)  | DTS, Knowledge Management                      |                   |                   |                  |
| 4(d)  | Back up Control Centre                         | 1-2               | 3-6               | 3-14             |
| 4(e)  | Compliance                                     |                   |                   |                  |
| 4(f)  | Display Design                                 |                   |                   |                  |
| 5     | <b>Information Technology</b>                  |                   |                   |                  |
| 5(a)  | Communication Network                          |                   |                   |                  |
| 5(b)  | IT-Hardware                                    |                   |                   |                  |
| 5(c)  | IT-Software                                    |                   |                   |                  |
| 5(d)  | UPS, Auxiliary Supply                          | 1-2               | 2-4               | 2-5              |
| 5(e)  | Website, Intranet, Data Repository             |                   |                   |                  |
| 6     | <b>Law and Regulatory Affairs</b>              |                   |                   |                  |
| 6(a)  | Grid Integration, User Registration            |                   |                   |                  |
| 6(b)  | Policy & Regulatory Affairs                    |                   |                   |                  |
| 6(c)  | Fees & Charges Petition                        |                   |                   |                  |
| 6(d)  | Documentation, Vetting                         |                   |                   |                  |
| 7     | <b>Human Resource &amp; Administration</b>     | 1-2               | 2-5               | 2-15             |
| 7(a)  | HR Planning, Selection, Recruitment            |                   |                   |                  |
| 7(b)  | HRD, Professional Engagement, Certification    |                   |                   |                  |
| 7(c)  | Performance Appraisal                          |                   |                   |                  |
| 7(d)  | Administration, Welfare, CSR                   |                   |                   |                  |
| 8     | <b>Finance &amp; Accounts</b>                  | 1-2               | 2-5               | 2-18             |
| 8(a)  | Revenue  |                   |                   |                  |
| 8(b)  | HR Expenses, HRD Expenses                      |                   |                   |                  |
| 8(c)  | O&M, A&G Expenses                              |                   |                   |                  |
| 8(d)  | Reconciliation, Compliance, Tax, Audit         |                   |                   |                  |
| 9     | <b>Infrastructure Services</b>                 | 1-2               | 2-5               | 2-7              |
| 9(a)  | Civil Maintenance                              |                   |                   |                  |
| 9(b)  | Physical Security, Access Control, Fire Safety |                   |                   |                  |
| 9(c)  | Ergonomics and Space Cooling                   |                   |                   |                  |
| 9(d)  | Canteen, Recreation Centre                     |                   |                   |                  |
| 9(e)  | Energy Efficiency                              |                   |                   |                  |
| 10    | <b>Contracts</b>                               | 1                 | 1-3               | 1-5              |
| 10(a) | Procurement                                    |                   |                   |                  |
| 10(b) | Scrap Disposal                                 |                   |                   |                  |
| 10(c) | Outsourcing                                    |                   |                   |                  |

## **Annexure-12: Functions and Staff Requirement at a Sub-SLDC**

Few States have identified the need of establishing Sub-SLDCs looking to diversity of load due large geographic area, network expansion and renewable energy integration etc.

### **Case Study: Gujarat**

In Gujarat under the Western Region System Unified Load Despatch Scheme - 2005, the three sub SLDCs were established and are functioning in the State since 2005. The functions performed from Sub SLDCs are as under:

- 1) To assist SLDC to ensure integrated operation of the power system in a state.
- 2) To assist SLDC for monitoring grid operations.
- 3) To assist SLDC in supervision and control over the intra-State transmission system within their area.
- 4) Coordination with SLDC/ DISCOM LMU/Other users for smooth grid operation.
- 5) Maintenance of SCADA system & other equipment installed at Sub-SLDC.
- 6) Corrective actions for accurate telemetry.
- 7) RTU maintenance within the jurisdiction of Sub-SLDC.
- 8) New RTU installation, commissioning and integration with existing SCADA system.
- 9) Monitoring of all communication equipment's & links.
- 10) Coordination with field offices and SLDC for planning outage / Emergency Outage and during incident/disturbance in the grid.
- 11) Primary Reporting to SLDC in case of any incident / disturbance
- 12) Collection of various data for preparing various daily reports. -
- 13) To establish database and records with respect to various parameters of Power system.

Typical staff set-up required at Sub SLDC (Table – 1).

- Head of Sub SLDC - Executive Engineer
- SCADA & IT operation - 1 Nos. Deputy Engineer, 1 Nos. Junior Engineer, 1 No. Electrician
- Fieldwork (RTU Installation, Maintenance) -1 Nos. Deputy Engineer & 1 Nos. Junior Engineer
- Shift operation: - 5 Nos. Deputy Engineer, 4 Nos. Assistant
- General - 1 No. Deputy Engineer, 3 Nos. Assistant

*Table 35: Typical Staff Setup Required at Sub-SLDC (Case – Gujarat)*

|                    |                |
|--------------------|----------------|
| Executive Engineer | 1 Nos.         |
| Deputy Engineer    | 8 Nos.         |
| Junior Engineer    | 2 Nos.         |
| Electrician        | 1 Nos.         |
| Assistant          | 7 Nos.         |
| <b>Total</b>       | <b>19 Nos.</b> |

### **Case Study: Maharashtra**

The functions performed by Sub-LDC are as under:

- 1) Monitoring and Control of all grid elements below 220 kV level.
- 2) 220 kV grid elements monitoring and reporting abnormalities/tripping.
- 3) Outage management of 220 kV grid elements as per approval of SLDC.
- 4) Outage management for grid elements of 132 kV and below to be carried out by sub-LDC and daily report of the same be submitted to SLDC.
- 5) Reporting of tripping /occurrence and restoration of element for 132 kV and below.

- 6) Monitoring and control of Renewable Energy generators within control area and report daily injection data to SLDC
- 7) Monitor and control of Tap changing operation of ICTs for 220 kV and below.
- 8) Monitor and control of Tap changing operation of Power Transformer.
- 9) Switching operations of EHV capacitors and capacitors connected to 33 kV
- 10) Load management of distribution load as per instructions of SLDC i.e. monitoring of planned, distress load control instructions from SLDC.
- 11) Monitoring and reporting of feeder switching operations carried out through Automatic Demand Management System from SLDC.
- 12) Daily system operation report preparation and forwarding to SLDC.

Initially the required man power to be carved through existing employee strength of MSETCL. Subsequently, after approval of O & M cost under ARR of SLDC for MYT control period (i.e. FY 2020-21 to FY 2023-24) by MERC, staff may be absorbed under SLDC. Till such time staff at sub-LDC will be under administrative control of respective zone and under technical control of SLDC. Sub-LDC to be headed by the Executive Engineer (Division status). E.E. Sub-LDC to report S.E. (Operation) SLDC. Additional E.E. as shift in-charge and Dy.EE/A.E to assist AEE. The typical staff set-up required at Sub SLDC is tabulated at Table – 2.

*Table 36: Typical Staff Setup Required at a Sub-SLDC (Case – Maharashtra)*

| S. No. | Name of post          | Designation     | Responsibility  | No. of posts |
|--------|-----------------------|-----------------|---|--------------|
| 1      | In-Charge of sub- LDC | E.E.            | Overall in-charge reporting to SLDC   | 1            |
| 2      | Shift in-charge       | A.E.E.          | Shall work as shift in-charge for the grid under area of jurisdiction   | 5            |
| 3      | Shift Engineer        | Dy. E.E. / A.E. | Monitoring of grid under area of jurisdiction   | 5            |
| 4      | Shift Assistant       | Operator        | Assist in shift duty for communication of instructions and miscellaneous works.   | 5            |
| 5      | Technician Grade IV   | Helper          | Help in maintaining auxiliary systems (power supply, air conditioning etc.)   | 5            |
| 6      | Operation and SCADA   | A.E.E.          | a. For maintaining SCADA, communication, real time data verification  | 2            |
| 7      |                       | Dy. E.E. / A.E. | b. Collection of system data, report preparation, outage planning and management communication with SLDC and sub-stations | 4            |

(\*): The staff indicated at Sr. No. 4&5 can be arranged through outsourcing.

| S | Designation           | Pay Group | Requirement for each Sub- |
|---|-----------------------|-----------|---------------------------|
| 1 | Executive Engineer    | I         | 1                         |
| 2 | Additional Executive  | I         | 7                         |
| 3 | Dy. EE/AE             | II        | 9                         |
| 4 | Operator *            | III       | 5                         |
| 5 | Technician Grade IV * | IV        | 5                         |

Functions and Staff Requirement at Main-II/back-up Control Centre

Case Study: Gujarat

All the LDCs have established backup control centre as a part of disaster management. In normal course, backup Control Centre shall be functioning as hot standby to Main Control Centre. In order to

ensure maintenance and upkeep of the back-up, it could be established in another RLDC (for regional/national LDC) or in a Sub-LDC (for State LDC). It should have following features:

1. Independent channel for availability of all the required data
2. Dual communication link availability between each control centre.
3. Equipped with CCTV camera
4. Equipped with security system. Access to authorize person only in server room.
5. Independent functionality of LDC website.
6. Video conferencing and necessary telecommunication equipment.
7. RTnet solution availability
8. Access of all necessary software

Suitable actions to be taken to ensure readiness to take over from the Main LDC any time

1. Daily log report of each servers to be checked
2. SCADA data base at both control centre to be maintained up to date
3. All communication links between different control centres to be monitored

*Table 37: HR requirement at a typical Main-II / back-up centres*

|                         |                                      |
|-------------------------|--------------------------------------|
| Superintending Engineer | 1 Nos.                               |
| Executive Engineer      | 1 Nos.                               |
| Deputy Engineer         | 2 Nos. (SCADA & IT and General work) |
| Deputy Engineer (Shift) | 5 Nos.                               |
| Supporting staff        | 7 Nos. (Five in shift)               |
| <b>Total</b>            | <b>16 Nos.</b>                       |

### Annexure-13: Functions and Staff Requirement at REMC

Renewable energy management centres (REMC) is being established adjacent to SLDC for smooth integration of renewables in the grid. The following key functions have been identified under REMC:

1. To establish infrastructure to capture 100 % real time data of RE generation
2. RE forecasting and scheduling activity,
3. RE database (static data, weather data etc.) management (Historical, real time data etc.), Load forecasting activity,
4. Analysis of forecasting accuracy,
5. Coordinating with all FSPs
6. REMC forecasting and scheduling application,
7. Monitoring of forecasting of FSPs and Internal tool,
8. Monitoring real time operational in respect of RE generation,
9. Interlinking between REMC scheduling software and SLDC scheduling software,
10. Real time data communication activity,
11. Establishment and maintenance communication infrastructure,
12. Database and other activity as per regulation with RE developers,
13. Co-ordination between FSPs, RE developers & QCAs.

Looking into challenges identified for integration of RE, it desirable to have following staff setup at REMCs.

*Table 38: HR requirement for a typical REMC*

|                         |   |
|-------------------------|---|
| Superintending Engineer | 1 Nos.                                    |
| Executive Engineer      | 1 Nos. (Forecasting, Scheduling, SCADA)   |
| Deputy Engineer         | 2-3 Nos. (Forecasting, Scheduling, SCADA) |
| Junior Engineer         | 1-2 Nos. (General, SCADA & IT support)    |
| Deputy Engineer (Shift) | 5 Nos.                                    |
| Junior Engineer (Shift) | 5 Nos.                                    |
| Supporting staff        | 5-7 Nos. (Five in shift)                  |

The GIZ report titled ‘Detailed Project Report for Establishment of Renewable Energy Management Centres (REMC)”, May 2015 under the Green Energy Corridors (GEC) project has recommended in section 8 (on staffing of REMCs) as under:

- “.....
- *REMC should be part of the xLDC as a specialist group for renewables energy management*
  - *REMC team can be staffed with 5 teams of 2 persons each operating in 3 shifts for operations.*
  - *A separate team of Renewable Energy experts comprising of 4 people is further recommended to be in a general shift. The hierarchy of the 4 experts will be such that there is one Divisional Head who would report to the Head of Load Despatch Centre (LDC). Under him there will be one Chief. Under the Chief, there would be 2 executives reporting. The hierarchy structure will be similar to the organization chart of a typical LDC proposed in the Gireesh Pradhan Committee report. The role of the executives preliminary would be data acquisition system, energy management system, coordination with SLDC, technology management, telemetry, real time supervision control.*
  - *REMC and xLDC staff should be rotated.*
  - *An Exchange program between Indian official and global grid operators should be implemented.”*

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## **Annexure-14A: KPIs - Extracts from CIGRE, C2TB 577, March 2017**

Evaluating power system operations performance and operator performance is need of the hour as failure to achieve required level of performance will have large financial consequences. Evaluating performance would be a major motivator for system operator to define, track, analyze and improve.

CIGRE working group WG C2.35 explored power system operations performance, its goals and key performance indicators (KPI's) and published a report in March 2017. The major inferences from the report are given below.

The report was focused on operations performance and its relation with operator training goals and operator performance quantification and measurement.

The goals for operation level and Key Performance Indicators (KPI) should be defined at corporate level and these operation level goals and KPIs are used for operation training program design and operator accreditation.

A questionnaire was circulated among TSO/ISOs and questionnaire survey has also revealed that

- Performance goals and KPIs exist but normally limited to reliability but rarely to whole operations and training domains
- There are many similarities among ISO/TSOs in performance goals and KPIs but at same time demonstrate differences due to different terminology and definitions used.
- In operational planning, training etc. performance goals/metrics are not at the level where operational reliability metrics are quantified and standardized.

Based on survey results the working group recommended the following

- If operation level goals are non-existent companies should define and quantify goals and performance goals at corporate, operation and training levels.
- With the help of information and communication technology companies should track performance through operational goals and KPIs
- The performance metrics are to be compared and benchmarked at regional or even continental base.

The summary of survey questionnaire circulated among 16 ISO/TSOs is given below. The questionnaire is related to what KPIs are linked to achieve corporate, operational and training goals.

The corporate goals are

- To ensure a safe, reliable and uninterrupted supply of electricity
- Drive growth/further strengthening of leading position
- Integrated energy market
- Deliver Operational Excellence and Quality Efficient Operations
- Engage people
- Stimulate Innovation

The KPI linked to achieve corporate goals are

1. Most of companies answered Energy not supplied as KPI linked to goal ‘To ensure a safe, reliable and uninterrupted supply of electricity’
2. To achieve the goal “Drive growth/further strengthening of leading position following KPIs are linked
  - a. Delivery of reliability assessment to the board
  - b. Project delivery
  - c. Performance monitoring

- d. Asset growth
- 3. The following KPIs are linked to goal ‘Integrated energy market’
  - a. Transmission capability
  - b. No mistakes in customer settlement
  - c. Interconnector congestion management
  - d. Amount of wind energy curtailed
- 4. The KPIs related to ‘Deliver operation Excellence and quality efficient operations’ are
  - a. Voltage control
  - b. Frequency control
  - c. Interruptions
  - d. Software deployment quality
- 5. The KPI related to ‘Engage people’ is customer satisfaction
- 6. The KPI related to ‘Stimulate Innovation’ is Demand forecast

The operational goals are

- Grid Security and Reliability
- (Good) Operational Practices
- Operational Safety and Environment
- Economical Operations
- Customer Focus
- Employee Satisfaction and Development

The KPI linked to achieve operational goals are

1. To ensure Grid security and reliability following KPIs are used
  - a. Frequency deviation
  - b. Voltage deviation
  - c. N-1 violation
  - d. Average interruption restoration
  - e. Energy not supplied per year
2. The KPIs linked to operational practices are
  - a. Demand forecast assessment
  - b. Outage planning
  - c. Quality of measurement data
  - d. Number of new documents or updates
  - e. Chain agreement with other parties
3. KPIs explicitly used for Operational safety and environment are
  - a. Switching incidents
  - b. Accident rate and severity
  - c. Injury rate
4. KPIs linked to economical operations are
  - a. Dispatch balancing costs
  - b. Constraint costs
  - c. Reserve constraint unit commitment
  - d. Economic dispatch execution
  - e. Facilitating market
5. KPIs linked to customer focus are
  - a. Customer queries
  - b. Customer satisfaction queries
  - c. Number of complaints
6. KPIs linked to Employee satisfaction and development are
  - a. Resources and capabilities to deliver
  - b. Absenteeism

The KPI linked to achieve training goals are

1. Percentage or number of successful certification
2. Percentage of trainees meeting planned training schedule
3. Percentage of passing certification for the first time
4. Average training time to meet certification
5. Average training days per operator per year
6. Measure of company-external trainings
7. Qualitative rating of all training activities, based on evaluations
8. Operator performance over time
9. Inter-ISO/TSOs trainings with neighbours
  - a. Cross visits between neighbouring TSOs dispatchers
  - b. Common training workshops
  - c. Common simulation sessions

The working group also analyzed operational security performance indicators monitored within ENSTO-E.

In ENSTO-E there are no specific corporate goals however certification and training for real time operators and system operators outside the control room. The operational security performance indicators include the following

- Number of tripped transmission system elements per year per TSO;
- Number of tripped power generation facilities per year per TSO;
- Energy not supplied per year due to unscheduled disconnection of demand facilities per TSO;
- Time duration and number of instances of being in the alert and emergency states per TSO;
- Time duration and number of events within which there was a lack of reserves identified per TSO;
- Time duration and number of voltage deviations exceeding the ranges per TSO;
- Number of minutes outside the standard frequency range and number of minutes outside the 50% of maximum steady state frequency deviation per synchronous area;
- Number of system-split separations or local blackout states; and
- Number of blackouts involving two or more TSOs.

NERC has defined system performance metrics to provide feedback for improving the Reliability Standards. These System performance metrics are different from metrics in a standard which are used to determine compliance.

The NERC has eighteen metrics to ensure adequate level of reliability. All reliability indicators are given below.

- Boundary
  - System Voltage Performance
  - Interconnection frequency response
- Contingencies
  - Transmission related events resulting in loss of load
  - Average percent non recovery disturbance control standard events
  - Disturbance control events greater than most severe single contingency
- Integrity
  - Interconnected Reliability operating limit
  - Protection
  - Activation of under frequency load shedding
  - Automatic transmission outages caused by failed protection equipment
- Adequacy
  - Planning reserve margin
  - Transmission constraint mitigation
  - Energy emergency Alert 3
  - Energy Emergency Alert 2

- Automatic transmission outages initiated by failed protection system equipment
- Automatic transmission outages initiated by human error
- Automatic transmission outages initiated by failed ac substation equipment
- Element availability percentage
- Transmission system unavailability

At NERC the certification and examination is centralized. The certification is based on education and examination.

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## Annexure-14B: List of Possible Key Performance Indicators for LDCs

1. Adhering deviation limit in a time block as per the DSM regulation of CERC:

| <b>If deviation (in time block) maintain within the limits</b> | <b>Rewards</b> |
|--|----------------|
| For less than 50% of time block                                | 0              |
| More than 50% and less than 60% of time block                  | 2              |
| More than 60% of time block                                    | 4              |

2. Maintaining voltage profile as per the range specified in IEGC on 400 KV nodes:

| <b>If voltage controlled in a range of 380 KV to 420 KV in a day</b>                   | <b>Rewards</b> |
|--|----------------|
| Less than 50% of the time ( <i>one minute resolution</i> ) in a year                   | 0              |
| More than 50% and less than 70% of the time ( <i>one minute resolution</i> ) in a year | 2              |
| More than 70% of the time ( <i>one minute resolution</i> ) in a year                   | 4              |

Remark: The nodes where reactors are under prolonged forced outage shall not be considered.

3. Availing outages which are approved in OCC meeting of RPC:

| <b>If No. of OCC approved outages availed</b> | <b>Rewards</b> |
|---|----------------|
| Less than 50% in a year                       | 0              |
| More than 50% and less than 70% in a year     | 2              |
| More than 70% in a year                       | 4              |

\*\*If outage defer by RLDC, then it is considered to be availed.

4. Declaration of Transfer capability:

| <b>Declaration of Transfer capability</b> | <b>Rewards</b> |
|---|----------------|
| If yearly basis                           | 0              |
| If six monthly basis                      | 2              |
| If quarterly basis                        | 4              |

5. Performing black start mock drill of stations having black start resources in a Year:

| <b>If Mock drills arranged</b> | <b>Rewards</b> |
|--------------------------------|----------------|
| If 'No'                        | 0              |
| If Less than or equal to two   | 2              |
| If More than two               | 4              |

6. Arranging islanding scheme review meeting once in a Year:

| <b>Arranging islanding scheme review meeting once in a Year:</b> | <b>Rewards</b> |
|--|----------------|
| If no meeting is arranged  | 0              |
| If meeting is arranged in a Year                                 | 4              |

7. Arranging protection committee meeting:

| <b>Arranging meeting with State GENCOs in a Year:</b> | <b>Rewards</b> |
|---|----------------|
| If no meeting is arranged                             | 0              |
| If only one meeting is arranged in a Year             | 2              |
| If more than one meeting is arranged in a Year        | 4              |

8. Submission of major occurrence report (500 MW load / generation loss or tripping of both 400 KV bus in 400 kV substation) timely:

|   | <b>Rewards</b> |
|---|----------------|
| If average of occurrence report submitted is more than 15 working days in prescribed format     | 0              |
| If average of occurrence report submitted in between 10 to 15 working days in prescribed format | 2              |
| If average of occurrence report submitted in between 05 days to 10 working days                 | 4              |

### **Renewable Desk:**

9. Accuracy in day ahead wind forecasting:

| <b>Accuracy in day ahead wind forecasting:</b>  | <b>Rewards</b> |
|---|----------------|
| Below 30% error in less than 50% time blocks    | 0              |
| Below 30% error in within 50 to 70% time blocks | 2              |
| Below 30% error in more than 70% time blocks    | 4              |

10. Accuracy in day ahead solar forecasting:

| <b>Accuracy in day ahead solar forecasting:</b> | <b>Rewards</b> |
|---|----------------|
| Below 30% error in less than 50% time blocks    | 0              |
| Below 30% error in within 50 to 70% time blocks | 2              |
| Below 30% error in more than 70% time blocks    | 4              |

11. Accuracy in day ahead load forecasting:

| <b>Accuracy in day ahead load forecasting</b>  | <b>Rewards</b> |
|--|----------------|
| Below 5% error in less than 50% time blocks    | 0              |
| Below 5% error in within 50 to 70% time blocks | 2              |
| Below 5% error in more than 70% time blocks    | 4              |

12. Meeting with RE developers:

| <b>Meeting with RE developers:</b> | <b>Rewards</b> |
|------------------------------------|----------------|
| If no meeting is arranged          | 0              |
| If meeting is arranged in a Year   | 4              |

13. Renewable Energy Potential Utilisation at SLDC:

| <b>% of Renewable Generation for Auxiliary Consumption of SLDC</b>                       | <b>Rewards</b> |
|--|----------------|
| Less than 10% Renewable Generation of Total Yearly consumption of SLDC                   | 0              |
| Less than 20% but more than 10% Renewable Generation of Total Yearly consumption of SLDC | 2              |
| Greater than 20% Renewable Generation of Total Yearly consumption of SLDC                | 4              |

### **SCADA & IT**

14. RTU availability for 400 KV Substations and for all generating plant:

| <b>If RTU availability remains</b> | <b>Rewards</b> |
|------------------------------------|----------------|
| Below 80% in a year                | 0              |
| From 80 to 90% in a year           | 2              |
| More than 90% in a year            | 4              |

15. SCADA system availability in main control centre:

| <b>If SCADA system remains available</b> | <b>Rewards</b> |
|--|----------------|
| Below 90% in a year                      | 0              |
| Between 90 to 95% in a year              | 2              |
| More than 95% in a year                  | 4              |

16. SCADA system availability in backup control centre:

| <b>If SCADA system remains available</b> | <b>Rewards</b> |
|--|----------------|
| Below 90% in a year                      | 0              |
| Between 90 to 95% in a year              | 2              |
| More than 95% in a year                  | 4              |

17. Speech communication options (land line, PLCC, Mobile, satellite etc.):

| <b>Speech communication options</b> | <b>Rewards</b> |
|-------------------------------------|----------------|
| If only one options available       | 0              |
| If two options available            | 2              |
| More than two options available     | 4              |

18. Data communication link availability with RLDC and Sub SLDCs:

| <b>If SCADA system remains available</b> | <b>Rewards</b> |
|--|----------------|
| Below 90% in a year                      | 0              |
| Between 90 to 95% in a year              | 2              |
| More than 95% in a year                  | 4              |

19. EMS functionality with converged solution:

| <b>If EMS functionality with converged solution remains available</b> | <b>Rewards</b> |
|---|----------------|
| Below 90% in a year   | 0              |
| Between 90 to 95% in a year   | 2              |
| More than 95% in a year   | 4              |

20. WAMS system availability:

| <b>If WAMS system remains available</b> | <b>Rewards</b> |
|---|----------------|
| Below 90% in a year                     | 0              |
| Between 90 to 95% in a year             | 2              |
| More than 95% in a year                 | 4              |

21. Tripping analysis through WAMS analytics:

| <b>For occurrence</b>          | <b>Rewards</b> |
|--------------------------------|----------------|
| Below 60 Nos in a year         | 0              |
| Between 60 to 80 Nos in a year | 2              |
| More than 80 Nos in a year     | 4              |

22. SLDC website availability:

| <b>If SLDC website remains available</b> | <b>Rewards</b> |
|--|----------------|
| Below 90% in a year                      | 0              |
| Between 90 to 95% in a year              | 2              |
| More than 95% in a year                  | 4              |

23. EASS (Energy accounting and scheduling software) availability:

| <b>If EASS(Energy accounting and scheduling software) solution remains available</b> | <b>Rewards</b> |
|--|----------------|
| Below 90% in a year  | 0              |
| Between 90 to 95% in a year  | 2              |
| More than 95% in a year  | 4              |

24. Cyber security audit of SLDC, Sub-SLDC and Back up SLDC hardware and software:

| <b>If Cyber security audit of SLDC, Sub-SLDC and Back up SLDC carried out</b> | <b>Rewards</b> |
|---|----------------|
| If 'No'   | 0              |
| Carried out once in year  | 2              |
| Carried out for twice in a year   | 4              |

25. Automatic meter reading solution availability for ABT meters:

| <b>If Automatic meter reading solution availability for ABT meters remains available</b> | <b>Rewards</b> |
|--|----------------|
| For 70% meters in a year   | 0              |
| Between 70 to 85% of meters in a year  | 2              |
| More than 85% of meters in a year  | 4              |

26. Inspection of RTUs by SLDC:

| <b>Inspection of RTUs by SLDC in a year</b> | <b>Rewards</b> |
|---|----------------|
| Less than 10% RTU inspection                | 0              |
| Between 10 to 15% in a year                 | 2              |
| More than 15% in a year                     | 4              |

27. Biometric access to SCADA server room and control room:

| <b>Biometric access to SCADA server room and control room</b> | <b>Rewards</b> |
|---|----------------|
| If not provided   | 0              |
| If provided and in working condition                          | 4              |

28. If main control room, SCADA server room or other important assets of SLDC are under CCTV camera surveillance:

| <b>IF Main control room, SCADA server room or other important assets of SLDC are under CCTV camera surveillance</b> | <b>Rewards</b> |
|---|----------------|
| If No   | 0              |
| If provided and in working condition  | 4              |

#### Scheduling:

29. Issuances of provisional SEA bill:

| <b>Issuances of provisional SEA bill</b>  | <b>Rewards</b> |
|---|----------------|
| In M+1 (May) month for M (April) month--- Within 3 working days after publication of REA by RPC---for more than and equal to ten months                 | 4              |
| In M+1 (May) month for M (April) month--- Within 3 working days after publication of REA by RPC ----for more than eight months and less than ten months | 2              |
| In M+1 (May) month for M (April) month--- Within 3 working days after publication of REA by RPC ----for less than eight months                          | 0              |

30. Issuances of Final SEA:

| <b>Issuances of final SEA bill</b>   | <b>Rewards</b> |
|--|----------------|
| In M+1 (May) month for M (April) month---within 15 working days after issuing provisional SEA --for more than and equal to ten months                | 4              |
| In M+1 (May) month for M (April) month---within 15 working days after issuing provisional SEA ---for more than eight months and less than ten months | 2              |
| In M+1 (May) month for M (April) month---within 15 working days after issuing provisional SEA ---for less than eight months                          | 0              |

31. Processing of Open Access applications:

| <b>Processing of Open Access applications</b>                                | <b>Rewards</b> |
|--|----------------|
| Less than 60% applications processed in time frame given in regulation       | 0              |
| Between 60% to 80 % applications processed in time frame given in regulation | 2              |
| More than 80% applications processed in time frame given in regulation       | 4              |

32. Open Access application data on website and furnishing to regulators:

| <b>(GERC &amp; web) data of Open Access applications</b> | <b>Rewards</b> |
|--|----------------|
| Next month of succeeding month                           | 0              |
| After 15 <sup>th</sup> of succeeding month               | 2              |
| Before 15 <sup>th</sup> of succeeding month              | 4              |

#### Accounting

33. Issuances of UI bill:

| <b>Preparation of UI bill</b>   | <b>Rewards</b> |
|---|----------------|
| Within the six week after the R0 bill of specified week published by RPC - More than 34 weeks in a year                     | 4              |
| Within the six week after the R0 bill for specified week published by RPC - More than 26 weeks and up to 34 weeks in a year | 2              |
| Within the six week after the R0 bill for specified week published by RPC - Less than equal to 26 weeks in a year           | 0              |

34. Issuances of intrastate REC (Reactive Energy charges) Account:

| <b>Issuances of intrastate REC Account</b>  | <b>Rewards</b> |
|---|----------------|
| Within four week after the Intrastate R0 bill of UI/DSM Account of specified week published by SLDC - More than 44 weeks in a year              | 4              |
| Within the Four week after the R0 bill of UI/DSM Account for specified week published by SLDC - More than 36 weeks and up to 44 weeks in a year | 2              |
| Within the Four week after the R0 bill of UI/DSM Account for specified week published by SLDC - Less than equal to 36 weeks in a year           | 0              |

35. Issuances of Monthly State Transmission Loss:

| <b>Issuances of Monthly State Transmission Loss</b>                                    | <b>Rewards</b> |
|--|----------------|
| Within the next 25(M + 25days) working days for the month "M". for ten months/year.    | 4              |
| Within the next month beyond 25 working days for the Month M – more than 8 months/year | 2              |
| Within the next month beyond 25 working days for the Month M - Less than 8 months/year | 0              |

36. Accuracy of Metering Data for DSM bill preparation:

| <b>Accuracy of Metering Data of DSM bill</b>  | <b>Rewards</b> |
|---|----------------|
| More than 44 Nos. UI account shall be prepared in a year using 90% or more active Meters                  | 4              |
| Less than 44 and more than 36 Nos. UI account shall be prepared in a year using 90% or more active Meters | 2              |
| Less than 36 UI account shall be prepared in a year using 90% or more active Meters                       | 0              |

#### Finance, Accounts and HR

37. Issuances of invoices of SLDC fees and charges:

| <b>Issuances of invoices of SLDC fees and charges</b>                                       | <b>Rewards</b> |
|---|----------------|
| Within first 10 working days for the previous month - more than equal to ten months         | 4              |
| Within first 10 working days for previous month - more than 08 months & less than 10 months | 2              |
| Within first 10 working days for the previous month - less than eight months                | 0              |

38. Clearance of vender payments:

| <b>Clearance of vender payments</b>                                    | <b>Rewards</b> |
|--|----------------|
| Less than 60% payments clearing within Terms & condition specified     | 0              |
| Between 60 to 80% payments clearing within Terms & condition specified | 2              |
| More than 80% payments clearing within Terms & condition specified     | 4              |

39. Clearance of employee payments (if employee applies in first fortnight of the month):

| <b>Clearance of vender payments</b>  | <b>Rewards</b> |
|--|----------------|
| Less than 50 % payments in current month salary or before 05 <sup>th</sup> of succeeding month                   | 0              |
| More than 50 % and less than 80% payments in current month salary or before 05 <sup>th</sup> of succeeding month | 2              |
| More than 80% payments in current month salary or before 05 <sup>th</sup> of succeeding month                    | 4              |

40. Training and certification:

| <b>Training and certification (certificate in valid condition)</b>                         | <b>Rewards</b> |
|--|----------------|
| At the end of financial year, number of certified system operators at SLDC - less than 50% | 0              |
| At the end of financial year, number of certified system operators - From 50% to 75%       | 2              |
| At the end of financial year, number of certified system operators - more than 75%         | 4              |

41. No of man days allotted for Trainings / workshops / seminars:

| <b>No of men days allotted for Trainings / workshops / seminars:</b>  | <b>Rewards</b> |
|---|----------------|
| If average men days are less than five allotted for Training / workshops / seminars for SLDC engineers Or <b>Any one of engineers has not undergone for training at least for three days.</b>                     | 0              |
| If average men days are more than five and less than equal to seven allotted for Training / workshops / seminars for SLDC engineers   | 2              |
| If average men days are more than seven allotted for Training / workshops / seminars for SLDC engineers Or <b>Any one of engineers has undergone for training / workshops / seminars at least for three days.</b> | 4              |

42. Amenities at SLDC:

1. Library
2. Gymnasium
3. Indoor sports room
4. Change room with Locker facility
5. Canteen (for tea, coffee and breakfast)
6. Transportation facility to Employee
7. Refresher / rest room availability
8. Refresher / rest room for ladies
9. Vehicle parking
10. Conference room equipped with VC facility
11. First aid kit
12. Company residential colony
13. Mobile charging facility
14. Visitors area
15. Allotment of Rain coat and Woollen jacket once in a two year
16. Wi-Fi facility

| <b>Amenities at SLDC</b>                            | <b>Rewards</b> |
|---|----------------|
| Less than equal to five amenities                   | 0              |
| More than five and less than equal to ten amenities | 2              |
| More than ten amenities                             | 4              |

## **Annexure-15: Consolidated Agenda and Minutes of Meetings**

### **1<sup>st</sup> meeting (through VC, 20.08.2018): Agenda**

#### **1) Co-opting members to the sub-group**

The Sub-group comprises of representatives from six SLDCs- two from Southern Region, two from Western Region, one from Northern Region and one from Eastern region. Thus all regions are covered except North-east. Besides, there are representatives from CERC and POSOCO. The notification for constitution of the committee by FOR states that the sub-group may coopt any other member as deemed fit. Considering the terms of reference as well as the relevance of the work of the sub-group to all the SLDCs and the power sector as a whole it is proposed that the sub-group may co-opt one member from the North-east and one member from the academia.

#### **2) Interpretation of the Terms of reference and identifying the major activities**

The terms of reference (ToR) of the sub-group are as under:

- h) To survey various practices in all LDCs in India and international system operators, evolve and recommend Key Performance Indicators (KPIs) to be defined by the Regulatory Commissions
- i) To review functions of LDCs and suggest the future requirements in view of megatrends like Large Scale Integration of Renewables, Storage, Electric Vehicles, Prosumers and Introduction of markets
- j) To evolve the suitable Business Model of LDCs for Financial Autonomy and Funding Mechanism for both the Capital Costs & Recurring Costs to be future-ready
- k) To Identify the Infrastructure, System Logistics, Cyber Secure Information and Communication Requirements for LDCs Functioning in terms of Hardware, Software and Ergonomic Spatial Upgradation
- l) To assess the human resource requirement along with skill-set required for the future Power System Operation and other Support Functions
- m) To evolve Framework for Attracting, Development and Retaining Talent at LDCs in Terms of emoluments, selection/recruitment procedures along with training and certification of System Operators
- n) Any other suggestions related to above

**Members may like to share their thoughts on the ToR and suggest other areas that could be deliberated by the Sub-Group.**

#### **3) Compilation of best practices, primary data collection and analysis**

The terms of reference indicates survey and review of the existing best practices and the institutional framework. The success stories and challenges experienced by the LDCs/ISO in India and other countries under the prevailing regulations/ institutional set-up needs to be compiled and analyzed. Considering the wide scope of ToR and in order to get a first-hand feel of the challenges and aspirations of System Operators the following course of actions is proposed-

- a) Survey & Interaction with SLDC staff (at least one each region)
- b) Compilation / Analysis of SERC orders on Fees & Chares in a common template
- c) Literature Survey from other sectors using fungible commodity viz. petroleum, gas, water
- d) International Literature Survey to find out the institutional arrangement in place for other ISOs (Continental Europe, Australia, Brazil, USA etc.)
- e) Review of past 10 year experience (success story, lessons learnt and challenges) post GB Pradhan Committee Recommendations (2008)
- f) Envisioning the Future viz. Need for DSO, Dealing with Aggregators, Coal linkages, Derivatives, Financial contracts and other such unchartered territories of LDCs)
- g) Compilation of HR best practices

- h) Compilation of new skill sets required for LDCs
- i) Identification of avenues for expansion of FOLD activities, providing exposure to HR through deputation
- j) Development of Technology roadmap, norms for civil and IT infrastructure
- k) Identification of future avenues for expanding foot prints of LDCs
- l) Model Regulations for SLDC fees and charges
- m) Development of detailed time line and suggested roadmap for implementation of recommendations
- n) Discussion of the Interim recommendations in the FOLD

**4) Any other item with the permission of the chair**

**5) Date and venue of the next meeting**

**1<sup>st</sup> meeting (through VC, 20.08.18): Minutes**

1. The 1<sup>st</sup> meeting of the Sub-Group of the Technical Committee of FOR, to recommend suitable measures and roadmap for Institution Building and Strengthening of the LDCs, was held on 20<sup>th</sup> July 2018 through Video conference. The list of participants is enclosed at Annexure-I. The Order on Constitution of Subgroup is attached.
2. Chairman of the Sub-Group, Shri S.K. Soonee welcomed the members and expressed happiness over the enthusiastic participation from the members along with younger colleagues. He requested the members to contribute liberally to prepare a roadmap for institution building and strengthening of Load Despatch Centres.
3. Jt. Chief (Engg.), CERC presented the background of the constitution and the Terms of Reference of the Sub-Group. The Presentation is attached.
4. During their initial remarks, the members complimented Forum of Regulators for constituting the Sub-Group and appreciated the exhaustive scope of work for the Sub-Group. They opined that the recommendations of the sub-group should be action oriented and it should suggest mechanisms to overcome the challenges in HR adequacy and retention of capable staff.
5. Representative of SLDC, Maharashtra stated that at Maharashtra following steps have been taken by the SLDC:
  - a. Financial autonomy through opening of separate bank account
  - b. CE, SLDC have powers equivalent to Executive Director.
  - c. Training and workshop of SLDC officers is through Corporate Office.
  - d. Any transfer can happen only after approval of CE, SLDC.
6. Representative of Rajasthan suggested that there should be separate Regulatory Affairs division, there should not be frequent transfers and SLDC person should be incentivized.
7. Sh. B. B. Mehta, Gujarat suggested that IT partner may be engaged for automation in SLDC and exploring application of artificial intelligence in SLDC. He also shared their experience of IIIT which suggested Ergonomics for Gujarat SLDC.
8. The Sub-Group deliberated on various agenda items and the following decisions were taken by the Sub-Group:
9. Following members would be coopted to the Sub-Group:
  - a. Dr. Anoop Singh, Associate Professor, IIT-Kanpur would be coopted as member of the Sub-Group to represent the academia.
  - b. SLDC Meghalaya would be coopted as members of the Sub-Group to represent North-eastern States. Mr. Frederick Kharshiing, SE, SLDC, Meghalaya has been nominated to the Sub-group.

- c. Sh. S.R. Narasimhan, GM, NLDC shall be coopted as a member of the Sub-Group.
- 10. A web-group would be created for exchange of information in the electronic form.
- 11. The online survey and analysis of existing Human Resources and infrastructure at the SLDCs would be completed in the next few days with the help of POSOCO.
- 12. The sub-group would visit all the seven SLDCs for a detailed interaction on the following aspects:
  - a. Existing ERC Regulations and orders on fees and charges notified by respective SERCs and suggested amendments. Success stories, lessons learnt and challenges being experienced in the implementation of recommendations of Pradhan Committee and other MoP Task Forces on strengthening of LDCs under the existing Fees and Charge Regulations/Orders
  - b. Existing and Envisaged roles/responsibilities of LDCs in the emerging scenario at the IntraState, Interstate and International level. The requirement of resources and Skill sets for the following emerging functional areas of LDCs. List of other functional areas for SLDCs is attached at Annexure-II.
    - i. IT services and administration
    - ii. Monitoring fuel adequacy
    - iii. Renewable Energy Management Centre
    - iv. Coordination with Distribution System Operators (DSO), Electrical vehicle charging
    - v. Electricity Market Economics,
    - vi. Market coordination with emerging financial markets in electricity
    - vii. Big Data Analytics, Pattern Recognition
    - viii. Applied Research
    - ix. Policy and regulatory advocacy
  - c. Functional activities of LDCs amenable to outsourcing without compromising on cyber and infrastructural security. Present practices in this regard, challenges experienced and the possible solutions
  - d. Existing Key Performance Indicators and the suggested SMART KPIs (Specific, Measurable, Achievable, Relevant and Time bound) in each functional area of SLDC
  - e. Best HR practices in respect of recruitment, training, development, motivation, team building, retention, social security, emoluments, monetary/non-monetary incentives to retain talent and encourage excellence in LDC functioning
  - f. Exchange programme of personnel between inter-control centres for learning/exposure could be organized at mutual convenience of the respective utilities.
  - g. Views of NPTI/PMI regarding feasibility of commencing PG diploma course on the functional areas of Load Despatch Centre would be sought from NPTI / PMI. This is required for creating a pool of skilled personnel for recruitment at LDCs.

**Staff of the SERC of the respective State would also be invited for deliberations at the SLDC. Debriefing session would be organized through VC for wider participation.**

- 13. The tentative schedule for visit to SLDCs would be as under:
  - a. SLDC Rajasthan (Jaipur): Last week of July (Say 28<sup>th</sup> Jul, 2018)
  - b. SLDC Gujarat (Vadodara) : First week of August (Say 04<sup>th</sup> Aug, 2018)
  - c. SLDC Maharashtra (Kalwa): Second week of August
  - d. SLDC Tamil Nadu (Chennai): Third week of August
  - e. SLDC Telangana (Hyderabad): Fourth week of August
  - f. SLDC West Bengal (Kolkata): Fifth week of August
  - g. SLDC Meghalaya (Shillong): First week of September

Exact dates may be finalized through a web group. The first meeting shall be in Jaipur on 28.7.2018.

- 14. The terms of reference of this Sub-Group would be shared as an agenda item in the next FOLD meeting. The SLDCs making presentation of their best practices in FOLD shall be encouraged to include their views/suggestions on the areas listed out in the ToR of the Sub-Group.
- 15. Sub-Group would seek assistance of POSOCO on following areas
  - a. Best practices of international ISOs (by interacting informally with international experts).

- b. Recommendations from the report of the peer-review conducted by Mr. Bob Staton through USAID under the GtG initiative would also be compiled.
  - c. Envisaged international transactions and interface with Load Despatch Centres of neighboring countries
16. The Sub-Group would seek consolidated recommendations from FOLD on the Technology Road map for LDCs and spatial ergonomics for control centre.
17. CE, SLDC Gujarat would prepare a template of ideal IT infrastructure (software, hardware, analytics) for an SLDC. The template would also recommend a practical approach for implementation of the IT infrastructure based on their own experience and the practices at other LDCs such as Telangana.
18. A Model Regulation on LDC fees and charges would be prepared to facilitate implementation of the recommendations of the sub-group
19. On the suggestion of discussing ring-fencing of SLDCs as an additional agenda item, Chairman of the Sub-Group stated that the subject had already been deliberated by the earlier committees/task forces set up the Ministry of Power. It was agreed that the subject of restructuring and ring-fencing, technical challenges in system operation (such as intra-state balancing, DSM) and market operation (Open Access, settlement etc.) was beyond the scope of this Sub-Group. It was decided that the Sub-group shall focus on the strengthening the infrastructure, work processes and HR capability building.
20. The documents that can be used as reference are as follows:
- a. MoP: Pradhan Committee Report (2008)  
[https://powermin.nic.in/sites/default/files/uploads/Report\\_of\\_the\\_Committee\\_on\\_Manpower\\_Certification\\_and\\_incentives.pdf](https://powermin.nic.in/sites/default/files/uploads/Report_of_the_Committee_on_Manpower_Certification_and_incentives.pdf)
  - b. FOR: Open Access Theory and Practice (2008)  
<http://www.forumofregulators.gov.in/Data/Reports/FOR%20Report%20on%20Open%20Access-Theory%20and%20Practices-08-04-2009.pdf>
  - c. MoP: Satnam Singh Task Force Report (2009)  
[https://powermin.nic.in/sites/default/files/uploads/Task\\_Force\\_Report.pdf](https://powermin.nic.in/sites/default/files/uploads/Task_Force_Report.pdf)
  - d. FOR: Recommendation for SLDC fees and charges (2009)  
<http://www.forumofregulators.gov.in/Data/Reports/SLDC.pdf>
  - e. FOR: SAMAST Report (2016)  
<http://www.forumofregulators.gov.in/Data/WhatsNew/SAMAST.pdf>
21. Chairman of the Sub-group thanked all the members for their generous contributions in the deliberations. He sought cooperation from all members for compilation of the draft report of the Sub-Group by mid-September and final report by September end.

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## **2<sup>nd</sup> meeting (28.07.2018 at Jaipur): Agenda**

### **1) Review of progress made since the last meeting on 20<sup>th</sup> July 2018**

- a. Co-opting of members done.
- b. Agenda for FOLD meeting on 7<sup>th</sup> August 2018 covering the sub-group's constitution and suggestions being sought issued (Attachment\_I)
- c. Key functional areas identified and enclosed as part of the minutes of the first meeting. (Attachment-II)
- d. Mails sent to CAISO and MISO and preliminary response attached as Attachment\_III and IV.
- e. Mails sent to USAID for sending the peer review reports of survey done in 2016-17. Peer review reports for Gujarat and Karnataka received (Attachment\_V and VI; for internal reference only).
- f. Draft Key Performance Indicators sent by SLDC Gujarat (Attachment\_VII).
- g. FERC Common Metrics for RTO-ISO (Attachment\_VIII).

Members may study the above documents and make preliminary remarks, if any. Detailed discussion could be done after study of the documents.

- 2) Inputs by Professor Anoop Singh, co-opted member from IIT Kanpur
- 3) Presentation by SLDC Rajasthan on the best practices in the functional areas as per Attachment\_II and their suggestions on Key Performance Indicators.
- 4) Discussion on the areas covered in the presentation and any other item.
- 5) Break for lunch between 1315-1415 hours. (VC can be disconnected)
- 6) After lunch, a tour of the entire SLDC/REMC complex and discussion with the engineers from 1430-1630 hours.
- 7) Interactions conclude.

## **2<sup>nd</sup> meeting (28.07.2018 at Jaipur): Minutes**

- 1. The second meeting of the FOR Technical Committee sub-group was held at SLDC Jaipur on 28<sup>th</sup> July 2018. The list of participants is enclosed. Members from SLDC Tamil Nadu and SLDC West Bengal attended through Video Conference. Representatives of Gujarat SLDC, ERLDC,NLDC, Telangana, Tamil Nadu also attended the meeting thrugh Video Conference.
- 2. Chairman of the Sub-Group, Shri S.K. Soonee welcomed the participants and thanked CE (SO&LD) Jaipur for hosting the meeting at a short notice. He also thanked Dr. Anoop Singh from IIT Kanpur and Shri S.R. Narasimhan, GM NLDC for agreeing to be a member and also attending the meeting. He advised Member convener to ensure that the coopted member from SLDC Meghalaya receives the formal invitation as well as other resource material being posted on the webgroup created for the purpose.
- 3. Member convener apprised the members regarding the progress made since the last meeting as under
  - a. Agenda for FOLD meeting on 7<sup>th</sup> August 2018 seeking suggestions from the FOLD members on the ToR of the sub-group had been sent.
  - b. A draft List of Key functional areas of an SLDC has been prepared and shared with the sub-group members for their suggestions. The same has also been shared with FOLD Mebers for their suggestions.
  - c. Emails seeking suggestions and inputs from international experts has been sent and the preliminary response received from them has been circulated in the Sub-Group.
  - d. Draft Peer review (conducted in 2016-17) reports for Gujarat and Karnataka received from USAID has been shared with Sub-Group members.

- e. Draft Key Performance Indicators have been circulated by SLDC Gujarat.
  - f. FERC Common Metrics for RTO-ISO have also been shared with Members.
4. Dr. Anoop Singh said that he had been associated with the capability building programs for the Regulatory Staff and would be keen to contribute in the FOR Sub-Group. He mentioned that the role of SLDCs was very relevant for economic operation of the system. He suggested that the Indian system could borrow from the European experience.
5. Chairman said that the Sub-Group looked forward to have an exhaustive literature survey to gather best practices on governance and institution building related aspects of power system operation as well as from other cybernetics. He suggested that the report should contain action plan for a decade, practical and implementable.
6. CE (SO&LD), SLDC Jaipur shared the Organization chart, sanctioned strength and actual strength of SLDC Rajasthan. He suggested that the SLDC needs to be equipped with adequate staff in the technical as well as supporting areas such as – EMS, Energy Accounting, legal/regulatory and finance. He shared that none of the operators in SLDC Jaipur were certified. He stated that incentive for certification was essential to motivate the operators. He also stated that after certification, the officer should not be transferred.
7. The issue of shift roster was also deliberated. CE (LD), Gujarat shared that during the peer-review of SLDC Gujarat coordinated by USAID, the experts had suggested to have 12 hour day-shift instead of 6 hours. Members opined that the 12-hour night shift prevailing in most of the LDCs was very stressful. However due to the constraints in travelling late night and the challenge of comprehending the situation due to frequent shift changeovers the members felt that the number of persons in the Night Shift could be increased instead of reducing the hours of shift duty.
8. SLDC Jaipur gave a demo of the STOMS (Smart Transmission Operation Management System) which was an application software developed for Open Access application processing, Renewable energy verification, scheduling, metering and energy accounting. It was indicated that merit order is being done manually. Further Technical minimu, technical maximum and ramp rate are fed into STOMS. They also clarified that drawl of discom is taken at STU periphery and losses are considered separately. They also mentioned that they have 72 pooling stations and 3 QCAs and scheduling is poolingstationwise. The BG for QCA is 10,000/MW for solar and 40,000/MW for wind.
9. Chairman stated that we should have colabarative approach while learning and one SLDC should learn from experience of other SLDC so that modules are not reinvented. The difficulties already faced by some SLDC and addressed should not be reinvented by another SLDC.
10. The Sub-group also visited the various infrastructure facilities available at SLDC Jaipur.
11. CM, WRLDC said that apart from the infrastructure requirement of Main Control Centre, the Sub-Committee may also examine the infrastructure and resource requirement to maintain the Back up control centre. He shared about the live operation of WRLDC BCC that was conducted on 28.07.2018. CE (SLDC) Gujarat shared that they had operated the BCC and similar exercise was later done by SLDC Chattisgarh. CE (SLDC), Tamil Nadu shared that the operation was conducted from BCC at Madurai during Chennai floods.
12. CE (SLDC), Gujarat gave a presentation on the proposed KPIs for SLDC. Members appreciated the efforts made by SLDC Gujarat team and gave the following suggestions:
- a. Draft KPI-1: Area Control Error may be monitored instead of deviation
  - b. Draft KPI-3: Processing of Outage request could be considered instead of availing outage since availing outage is not in control of SLDC.
  - c. Draft KPI-13: The term Grid Disturbance (GI or GD as per CEA Regulations) may be used instead of major occurrence
  - d. Draft KPI-14: Preparation of Basecase file to be a KPI instead of submission of Nodal data
  - e. Draft KPI-16: Annual report may be reworded as Annual compendium. Essential contents of the compendium may also be indicated
  - f. Draft KPI-21: Conducting Energy Audit instead of RE generation for auxiliary consumption
  - g. Draft KPI-22 & 34: RTU availability shall be a KPI for STU instead of SLDC

- h. Draft KPI-29: The Grid Incidents analyzed as a proportion of total Grid Incidents that occurred may be considered as KPI instead of absolute number
  - i. Draft KPI-31: This KPI may be kept together with KPI 41 to 44
  - j. Draft KPI-32: In cyber security VAPT test
  - k. Draft KPI-49: KPI to be suitably modified to measure the number of training days of individual operator instead of considering average of all
  - l. Additional Amenities to be added in the cafeteria
    - i. e-resources instead of library
    - ii. Yoga room or gymnasium
    - iii. Accessibility for differently abled persons
    - iv. **Multiple** conference rooms
    - v. One room for the auditor
- 13. GM, NLDC shared the detail functional activities and gave a presentation on the internal KPIs of POSOCO. He suggested that the relevant KPI points could be borrowed for preparing the recommended KPIs for LDC. He said that every functional activity of the LDC and every employee in LDC should be covered by one or more KPIs. Chairman suggested that along with detailed KPIs, few high level KPIs could be developed that could be used by SERCs for assessing the performance of SLDC at a macro level. He also stated that KPIs should be ranked importancewise.
- 14. After further deliberations following decisions were taken
  - a. Member Convener would formally invite representative of SLDC Meghalaya and confirm that the same is received. This has been done subsequently.
  - b. Member Convener would write to the concerned SERC to nominate one representative of the SERC staff for participation in meeting of the Sub-Group at respective SLDC.
  - c. Views of all FOLD members on the Draft Key Performance Indicators prepared by SLDC Gujarat shall be taken from FOLD members. Internal KPIs of POSOCO and CERC KPIs also to be considered
  - d. Draft IT Policy for LDC shall be prepared by SLDC Gujarat. Inputs shall be taken from the FOLD.
  - e. POSOCO shall provide assistance to the sub-group as under
    - i. URL of SLDC websites to be created for ready reference. Harmony in respect of website contents is desired instead of standardization
    - ii. URL of SERC fees and charge regulations and orders to be compiled for ready reference
    - iii. List of references to be compiled
    - iv. The SLDC survey shall be completed. Survey Analysis to be presented in the next meeting
  - f. Following aspects shall be covered in the report of the sub-group
    - i. One section on Data, Modeling and Data Repository on the concept of ‘Grandfather-Father-Son’ to be added in the report.
    - ii. Suggestions to strengthen communication between Regulators and SLDCs and to facilitate visit of personnel from one LDC to the other.
    - iii. Finance & Accounts personnel to be engaged in clearing and reconciliation of commercial transactions
    - iv. Administration of Regulatory Pool Account - Taxation Issues
    - v. Outsourcing of core activities like EMS could lead to decline in internal capabilities of the SLDC staff. Hence the Sub-group to suggest measures to be taken for ensuring adequacy and capability of human resources
  - g. Draft Index of the report shall be developed and deliberated in the next meeting.
  - h. Dr. Anoop Singh may carry out a literature survey and share relevant references on governance and institutional capacity building of LDCs. A brief presentation on Centre for Energy Regulation may be done in the next meeting.
  - i. It was suggested that a visit to Air traffic Control may be planned to understand the ergonomics and other aspects.
  - j. The next meeting shall be held on 06<sup>th</sup> August 2018 in SLDC Gujarat.

Participation of Second meeting of Sub-Group on Load Despatch Centres (LDCs)- Institutional Building and Strengthening on 28.7.2018 at SLDC Building, Heerapura, Jaipur

|    | Name            | Designation            | Organization     |
|----|-----------------|------------------------|------------------|
| 1. | Sheela Mishra   | SE (SSDA-SLDC)         | SLDC , Rajasthan |
| 2. | A.K. Arya       | SE (SOLD)              | SLDC, Rajasthan  |
| 3. | S.R.Narasimhan  | General Manager, NLDC  | POSOCO           |
| 4. | Anoop Singh     | Associated Professor   | IIT, Kanpur      |
| 5. | R.P. Sharma     | CE(LD), RVPNL , Jaipur | RVPNL Jaipur     |
| 6. | S.K. Soonee     | Advisor                | POSOCO           |
| 7  | N Bhaskar       | CE/SLDC                | TSTRANSCO        |
| 8  | P. Suresh Babu  | SE, SLDC               | TSTRANSCO        |
| 9  | Vivek Pandey    | Chief Manager          | POSOCO           |
| 10 | P.K. Gupta      | SE(Energy Accounting)  | RVPN, Rajasthan  |
| 11 | B B Mehta       | CE                     | SLDC, Gujarat    |
| 12 | Neeraj Kumar    | Chief Manager          | NRLDC, New Delhi |
| 13 | KVN Pawan Kumar | Dy. Manager            | NLDC, POSOCO     |
| 14 | Siddharth Arora | RO,                    | CERC             |
| 15 | M.K.Verma       | Xen (SOLD)             | SLDC, Rajasthan  |
| 16 | Shilpa Agarwal  | Joint Chief Engg.      | CERC             |

### **3<sup>rd</sup> meeting (06.08.2018 at SLDC Vadodara): Agenda**

1. Opening Remarks by the Chairman
2. Literature Survey & Inputs from Dr. Anoop Singh
3. Presentation by SLDC Gujarat
  - a. IT Road Map
  - b. Items w.r.t. ToR of the Sub-Group
4. Presentation on Technology Road Map by ERLDC/NRLDC team
5. Revised Draft Key Performance Indicators (KPIs)
6. Survey Summary by GM, NLDC
7. Discussion of Report Outline (draft)
8. URL of SLDC websites
9. Visit of SLDC Premises
10. Any other item

### **3<sup>rd</sup> meeting (06.08.2018 at SLDC Vadodara): Minutes**

1. The 3<sup>rd</sup> meeting of the sub-group was held at SLDC Gujarat (Vadodara) on 06.08.2018. List of participants is enclosed as Annexure-I.
2. Chairman of the Sub-group thanked CE (SLDC) Gujarat for the arrangements and stated that SLDC Gujarat being one of the leading SLDCs in the country could contribute immensely within the sub-group as well as in hand-holding other SLDCs.
3. Chairman of the sub-group welcomed Member, GERC and the participants. He said that the visit to different LDCs was revealing the huge diversity in the practices and infrastructure facilities in different LDCs. He opined that the report of the sub-group should contain the essence of all SLDCs and suggest areas where harmonization was desirable. He hoped that the report of the sub-group would be evidence based and would have a long-shelf life. He suggested that the Grid operators could work with the regulators and propose the desired amendments in the system.
4. POSOCO representative apprised the participants about the work done by Sub-group so far.
5. Member (T), GERC stated that he was pleased to see the impressive work done by the sub-group in the last two meetings. He said that sub-group report would assist in capacity building of LDCs and it would be guiding factor of all regulators
6. CE, SLDC Gujarat presented the proposed technology roadmap for LDCs. The presentation is attached as Annexure-II. Following areas were highlighted:
  - a. Strengthening Decision support System – SCADA, WAMS, REMC, Dedicated displays for weather and general news
  - b. Recommended IT infrastructure – Corporate LAN, Office LAN, Redundant servers, Data Repository, Cyber Security Systems, Secure transfer data (other than SCADA) between LDCs, Multiple Video conferencing facilities, Voice logging
  - c. Desirable Supporting Applications – Website, ERP, Application software for Outage management and Application software recommended in SAMAST, e-payment mechanism
  - d. Role based IT Policy, Cyber Security Audits, ISO certification, CCTV, separate dongle for web surfing, Solutions for Anti- Advanced Persistent Threat
  - e. Redundant Communication infrastructure – Satellite communication in addition to conventional, Generate SMS for information dissemination
  - f. Dedicated HR resources for IT administration

7. POSOCO representative from ERLDC shared the results of the survey of IT infrastructure in LDCs. He agreed with the IT road map proposed by SLDC Gujarat. He opined that the IT survey had revealed the existing Challenges in IT infrastructure due to Distributed architecture, heterogeneous procedures, unstructured infrastructure, low security consciousness, improper scalability planning, partial deployment of existing tools, inadequate HR. He suggested that in addition to the points mentioned by SLDC Gujarat, LDCs need better visualization tools, Advanced situational awareness tools. The presentation made by ERLDC is attached as Annexure-III.
8. The members deliberated on the suggested IT road map and agreed as under
  - a. IT roadmap needs to be forward looking and implementable.
  - b. Modular approach better than Integrated monolith IT solution for diversity and risk mitigation
  - c. Vendor development, Diversity of vendors to be encouraged
  - d. Proven vendors for application software deployed in various LDCs to be listed on FOLD
  - e. Segregate between Must-have and Optional IT solutions
  - f. Pros and cons of Public cloud or Private cloud to be considered before deployment
  - g. Redundancy of communication network essential for all mission critical applications such as SCADA/IT and energy market applications
  - h. Streaming of Commercial Meter Data in Control Centre not desirable
    - i. Automation of Bad data detection in Energy Meter yet to mature unlike SCADA
    - ii. Operator stress due to information overload and incorrect data
    - iii. Operators to be protected from being vulnerable to legal-commercial disputes
  - i. Black box for LDC Operations an essential requirement
    - i. Usage of personnel mobile phones for grid operations to be discouraged
    - ii. All voice communications from the control room to be recorded. Mechanism to record the conversation over the official mobile sets to be explored.
  - j. Ownership of weather stations by LDCs not desirable in view of the maintenance challenges, better to avail IMD
  - k. Governance aspects of Data sharing to be covered in the report
    - i. Classification and definition of sensitive data required
    - ii. Data shared by stakeholders for some purpose should not be shared
    - iii. Regulatory directives to be sought regarding the data to be shared publicly
    - iv. The RTI queries to be directed to website
    - v. Policies for Data sharing, Data retention, Cyber Security evolved by FOLD may be referred by LDCs
  - l. Implementation aspects to be left to LDCs. The choice of in-house development vs Outsourcing; Capex Model or Opex model shall be left to the respective LDCs
9. Member GERC also suggested that classification and definition of sensitive data is required. He opined that the data shared by stakeholders for a specific purpose should not be shared with others without the consent of the original data provider.
10. CE, SLDC Gujarat presented revised KPI list. The same is attached as Annexure-IV. Chairman suggested that the views of other LDCs may also be sought in the FOLD meeting. He suggested to include ‘monitoring and notifying the difference in drawal/injection computed from SCADA and SEM’ as one of the KPI parameters. The views of WBSLDC on suggested KPIs is attached as Annexure-4a.
11. The views of Dr. Anoop Singh regarding KPIs (received on email) were also deliberated. The same are attached as Annexure -4b. The members agreed that Merit Order Dispatching as a KPI parameter was not desirable because transfer capability constraints, ramping constraints, reserve constraints etc. would also have to be honoured in the interest of grid security. It was also agreed that the KPIs should not be over-engineered and the respective ERCs and the LDCs may work together to identify the KPIs relevant in their context.

12. GM, NLDC presented the initial results of the survey. Chairman complimented NLDC for the analysis. It was decided as under:
  - a. Efforts shall be made to get more number of respondents to fill the online questionnaire.
  - b. The number of responses to Survey-1 to be increased with support from RLDCs and SLDCs
  - c. Survey-2 to be re-validated with respective LDCs
  - d. Recommendations in report to be consistent with the survey results
  - e. Irrelevant questions, inconsistent results to be dropped
13. POSOCO representative presented the draft outline of the report. The same is attached as Annexure-5. Following was suggested:
  - a. New chapter on Interface of LDCs with other stakeholders to cover Interaction with Users, DSOs, Aggregators, Forecast Service Providers, Vendors, International agencies; R&D, innovation; highlight the Role of LDC as Record keeper
  - b. Comparative tables for benchmarking and developing normative numbers based on Population, Energy consumption, System size handled by LDC, Generation Capacity under its jurisdiction, Circuit kilometers of Transmission, Number of HR personnel
  - c. Compare the present results with survey results in Pradhan Committee Report
  - d. Have conference calls with international experts
14. During the post lunch session the sub-committee interacted with one representative each from Intra State generators, STU and Open Access Customer. The representatives stated that
  - a. They were happy with the transparency and coordination efforts of the LDCs
  - b. Remarkable improvement was visible in performance of the LDCs in the last one decade
  - c. Frequent interaction between LDC and Users is required for sharing of concerns
  - d. User feedback may be taken by LDCs on frequent intervals
  - e. Harmonization of practices, information on web portal is desirable for convenience of Users
  - f. Deployment of IT solutions for automation is desirable
15. Chairman thanked all the participants.
16. It was decided to hold the next meeting of the sub-group at SLDC Maharashtra on 14.08.2018

| S  | Name                            | Design.       | Organization     |
|----|---------------------------------|---------------|------------------|
| 1  | P.J Thakkar                     | Member        | GERC             |
| 2  | S.K. Soonee                     | Advisor       | POSOCO           |
| 3  | B B Mehta                       | CE            | SLDC Gujarat     |
| 4  | S.R. Narasimhan<br>(Through VC) | GM            | POSOCO-NLDC      |
| 5  | F. E. Kharshiing                | SE            | SLDC Meghalaya   |
| 6  | Vasant Pande                    | SE            | SLDC Maharashtra |
| 7  | P. Suresh Babu                  | SE            | SLDC Telangana   |
| 8  | G. Prem Kumar                   | ADE (SCADA)   | SLDC Telangana   |
| 9  | K. Kamaraju                     | EE            | SLDC Tamil Nadu  |
| 10 | A.Thangappan                    | EE            | SLDC Tamil Nadu  |
| 11 | Vivek Pandey                    | Chief Manager | POSOCO-WRLDC     |
| 12 | Aditya Das                      | Manager       | POSOCO-WRLDC     |
| 13 | Pawan Kumar (VC)                | Dy. Manager   | POSOCO-NLDC      |
| 14 | A.B. Sengupta (VC)              | Dy. Manager   | POSOCO-ERLDC     |
| 15 | S. Konar                        | Chief Manager | POSOCO-ERLDC     |
| 14 | S.H. Patel                      | SE            | SLDC Gujarat     |
| 15 | N.N. Sheikh                     | EE            | SLDC Gujarat     |
| 16 | N.H.Goswami                     | EE            | SLDC Gujarat     |
| 17 | Parag Parmar                    | EE            | SLDC Gujarat     |
| 18 | D.S. Chouhan                    | EE            | SLDC Gujarat     |
| 19 | P.A.Patel                       | EE            | SLDC Gujarat     |
| 20 | A.P.Shah                        | EE            | SLDC Gujarat     |
| 21 | B.M.Shah                        | DE            | SLDC Gujarat     |
| 22 | G.J. Mistry                     | DE            | SLDC Gujarat     |
| 23 | B.C.Solanki                     | DE            | SLDC Gujarat     |
| 24 | H.D. Isamalia                   | DE            | SLDC Gujarat     |
| 25 | C.C.Darji                       | DE            | SLDC Gujarat     |
| 26 | S.L.Agrawal                     | EE            | SLDC Gujarat     |
| 26 | J D Trivedi                     | DE            | SLDC Gujarat     |
| 28 | Ajendra Rathod                  | DE            | SLDC Gujarat     |
| 29 | V.K. Vitaria                    | JE            | SLDC Gujarat     |
| 30 | G.V. Kodiyatar                  | JE            | SLDC Gujarat     |
| 31 | K.C. Data                       | DE            | SLDC Gujarat     |

#### **4th meeting (14.08.2018 at SLDC Kalwa, Maharashtra, ): Agenda**

1. Introductory remarks by Chairman of the Sub-committee
2. Progress review of the FOLD survey
3. Presentation by CE (LD), SLDC Maharashtra covering following aspects
  - a. Civil and infrastructure facilities at SLDC Kalwa
  - b. HR Resources at SLDC Kalwa - Approved vs actual vs envisaged
  - c. HR practices in SLDC Kalwa regarding Induction/training/career growth
  - d. Certification linked incentive schemes in SLDC Kalwa
  - e. SLDC Fees and Charge regulations by MERC- Strengths and challenges
  - f. Interface of SLDC Kalwa with ERC / STU / Genco / Discom / other stakeholders
4. Compilation of SLDC approved Fees and Charges – by POSOCO
5. Learning from experience of ISOs in other countries – by POSOCO
6. Any other item
7. Visit of SLDC premises

#### **4th meeting (14.08.2018 at SLDC Kalwa, Maharashtra, ): Minutes**

1. The 4<sup>th</sup> meeting of the FOR Technical Committee Subgroup was held on 14.08.2018 at SLDC Maharashtra. The list of participants is attached.
2. CE (LD), SLDC Maharashtra welcomed all the delegates.
3. Chairman of the sub-group thanked CE (LD) SLDC Maharashtra and his team for hosting the meeting. He thanked all the participants - who had travelled and also those who were attending the meeting through Video Conference. He stated that contribution of SLDC Maharashtra in the sub-committee was vital because it was handling all kinds of complexities; had the largest the power system among the States; was handling multiple discoms, largest State owned discom; it had elaborate systems and procedures in place; they were pioneers in implementing the recommendations on certification linked incentives; had the experience in creating a new ambience- civil infrastructure for SLDC.
4. The other key points in opening remarks of the chairman of the sub-group were as under:
  - 1) The work done by earlier committees/task forces was on a very macro level; policy level. This sub-group looks at the micro level to facilitate the implementation of the vision.
  - 2) The sub-group had members from LDCs so the report of the sub-group would be “of the LDCs”, “by the LDCs” and “for the LDCs”;
  - 3) The sub-group should assimilate the changes in the sector and envisaged changes in near future; Success stories and implementation challenges faced at State level, interstate level and international level in the last decade should be the bedrock for the future roadmap; Develop an organogram of LDCs in the upcoming scenario; Tomorrow’s operator should be free of mundane issues. Thus the sub-group should evolve the framework for implementation through the model fees and charge regulations
  - 4) Recommendations of the sub-committee should be acceptable to all stakeholders. A roadmap for implementation of the recommendations would enable monitoring the progress;
  - 5) Reach out to the academia; evolve a validated standard model for the Indian system for research purposes

- 6) Regulators and System Operators should remain optimistic and strive to work out solution despite odds. System Operators are well aware of – uncertainties, vulnerabilities, risks, constraints. Challenges could be overcome through collaborative effort; FOLD needs to be more active;
  - 7) Review needed every five year for the envisaged scenario in the next decade ahead; Be prepared to learn-unlearn and relearn
5. SE, SLDC Maharashtra gave a presentation on the infrastructure facilities and the fees and charges approved by MERC. Presentation is enclosed. The salient points are as under:
  - 1) SLDC Maharashtra coordinates with nine (9) transmission utilities, eight (8) distribution licensees as well as public/private generating companies
  - 2) There is an Area Load Despatch Centre at Ambazari in Nagpur
  - 3) Infrastructure safety is through – CCTV surveillance, Motorised road blocker and Mumbai Police
  - 4) No establishment at the ground floor to avoid disruption due to floods
  - 5) Redundant Auxiliary Supply – Two independent AC feeders, UPS, DG set
  - 6) Fire alarm and automatic water spray fire fighting system for office floor; Automatic Fire/Gas Suppression System for equipment floor; Complete suppression of any type of fire/gas within maximum 1.5 minutes without any human interference; Monitored by VESDA system and Fire/Gas controlled by Novec 1230 Gas agent which clean and eco-friendly.
  - 7) All employees except those who have recently joined are certified
  - 8) No Employee can be transferred (In-out) without consent of the Chief Engineer, SLDC Circular-2015/8599 Dt:- 26.06.2015
  - 9) Chief Engineer (LD) given financial powers at par with Executive Director in MSETCL vide Circular- 4947 dt 13.04.2015
  - 10) Appointment of fresh engineers by MSETCL.
  - 11) CE SLDC has been give power by MSETCL Board of Directors to depute its engineers for training, Seminars, workshops etc.
  - 12) MSETCL has 7 nos. Training centers one in each zone.
  - 13) Training Centers are accredited by CEA.
  - 14) Induction level training for 45 days are arranged in these training centers.
  - 15) CE SLDC deputes engineers for training at NPTI Bangalore / Delhi.
  - 16) Other training at IIMs/PGCIL/ABB/Siemens are arranged by MSETCL
  - 17) ERC invites SLDC for discussions on important matters, committees, hearing of other stakeholders
  - 18) SLDC has continuous interaction with control room of MSPGCL, Distribution Licensees (MSEDCL, Tata Power, RInfra)
  - 19) Separate Desk within SLDC to monitor power supply of Greater Mumbai area
6. Representative from NRLDC gave an overview of international ISOs. Presentation and the write up is attached. It was noted that all ISOs in US were not-for-profit. None of the ISOs were government owned and they were also discharging the transmission planning function. Compliance Oversight was a given a major importance. It was decided that the URL of ISOs/TSOs shall be compiled and shared among members for further study and deliberation in the next meeting.
7. Representative from WRLDC shared the highlights of the SLDC fees and charge orders of Gujarat Maharashtra, Rajasthan, West Bengal, Odisha, Tamil Nadu and Telangana. Salient points of his presentation were as under:
  - 1) Employee Cost is a part of O&M expense in most cases
  - 2) RLDC Fees & Charge is part of SLDC Charge
  - 3) SLDC Users are – mainly DISCOMs & OA Customers & GENCOs in most cases where as GENCOs are exempted in some states
  - 4) SLDC Charge is shared on the ratio of
    - Installed Capacity (for GEN) or CC (for DISCOMs/OA) in some states
    - On Transmission Access granted in some of the states
    - On per unit (Rs/kWh) basis in some states (WB)

- 5) Several Non-Tariff incomes (excluded from Annual Charge while truing up) such as Grid Connection Fee, Re-Scheduling charge, OA Charge, Reactive Energy Charge, Interest Income from loan to employees etc.
  - 6) Grid Connection Fee/Registration Fee: Rs 10000 to 20000 per connection in most of the state & 1 Lakh for a few states
  - 7) Provision for re-investing the reserve generated out of non-tariff income/revenue surplus in securities & sharing gain with users
  - 8) Billing on monthly basis; Provision for late payment charge 13. LDC Development Fund yet to be operational in most of the states
  - 9) Objective KPI is absent in most states However some SLDCs are evaluated on the Compliance to Pradhan Committee Recommendation, SLDC to submit Cost Benefit Analysis Report, Utilization of Capex
8. After deliberations following decisions were also taken
- 1) Wherever feasible the LDCs should have a separate office campus with infrastructure security and modern amenities. In case of real estate constraints, the LDC may be housed within a secure commercial complex
  - 2) Most of the LDCs are located in cities where getting accommodation is a challenge. Therefore provision of residential accommodation for the LDC employees is desirable. Alternately the company could accommodate their employees in residential premises taken on lease by the company.
  - 3) Transit Camps / Field hostel / Guestroom facilities needs to be created for transit accommodation for visitors to LDC
  - 4) There shall be adequate redundancy of communication system for LDCs so as to ensure high availability of real-time data, other web-based facilities (scheduling, open access etc.), video conference facility etc. LDCs shall have communication system experts to coordinate with the Communication Service Providers
  - 5) There shall be one annexure in the report showing photographs of the control room of LDCs in India
  - 6) CE (LD), SLDC Maharashtra shall prepare a write up on model civil infrastructure facilities for an LDC. In addition best of facilities available in various LDCs in India and international ISOs, the IS 11064-4:2013 as well as other relevant literature in respect of control centre design and ergonomics shall be referred. The control centre shall have
    - Adequate displays
    - Washroom, restroom adjacent to Control Room
    - Visiting Gallery
    - Space cooling for employees and IT servers shall be separate for better temperature control and energy efficiency
    - Access to Cafeteria should be segregated from access to the control centre
    - Adequate space for future expansion
  - 7) SLDC Maharashtra shall share the relevant circulars for financial and administrative powers (transfer /posting/ training etc.) of CE (LD) MSLDC. The circular regarding certification linked incentive shall also be shared.
  - 8) Following aspects shall be suitably taken care in the Model Fees and Charge Regulations
    - Presently HRD expenses are booked under Administrative and General Expenses. Thus there is a tendency to economize on these expenses. However, LDCs being HR oriented organizations, capacity building of LDC personnel through HRD initiative is vital. Hence in the HRD expenses shall be shown as a separate head in the Model Fees and Charge Regulations. The expenditure on HRD in LDCs shall be benchmarked. The minimum expenditure on HRD shall be 5 % of total HR expenses in line with the National Training Policy
    - Regulatory Funds/Pool funds shall be outside the balance sheet of the LDC
  - 9) Interaction with international experts shall be organized through Skype by NLDC.

- 10) LDC fees and charges shall be explicitly shared among the registered Users of LDC. The formula for sharing shall be such that the Users have *Apriori* knowledge of the charges payable. This aspect shall be deliberated in further detail. Challenges associated with TDS issues related to recovery of RLDC fees and charges shall also be deliberated.
- 11) The report shall have section on Survey of International ISOs/TSOs in respect of infrastructure facilities, organogram, employee benefits etc.
- 12) The LDC survey-2 shall be completed and the fees and charge orders of all SLDCs shall be studied.
9. It was decided to have the next meeting of the sub-group at SLDC Telangana, Hyderabad on 31<sup>st</sup> August 2018.
10. Members expressed the desire to visit SLDC Lucknow to see the new building constructed recently. It was decided that the possibility shall be explored.
11. Chairman thanked the members for their participation

**List of participants**

| 1. | Name (Mr./Ms.)                  | Designation   | Organization/ State |
|----|---------------------------------|---------------|---------------------|
| 2. | S.K. Soonee                     | Advisor       | POSOCO              |
| 3. | Shilpa Agrawal                  | Jt.Chief, Eng | CERC                |
| 4. | B B Mehta                       | CE            | SLDC Gujarat        |
| 5. | S.R. Narasimhan<br>(Through VC) | GM            | POSOCO-NLDC         |
| 6. | Anil Kolap                      | CE            | SLDC Maharashtra    |
| 7  | Vasant Pande                    | SE            | SLDC Maharashtra    |
| 8  | Vivek Pandey                    | C.Manager     | POSOCO-WRLDC        |
| 9  | S. Prabhakar                    | DE            | SLDC Telangana      |
| 10 | V.V. Subrahmanyam               | DE            | SLDC Telangana      |
| 11 | R.P. Sharma                     | CE            | SLDC Rajasthan      |
| 12 | A.K. Arya                       | SE            | SLDC Rajasthan      |
| 13 | M.K. Verma                      | SE            | SLDC Rajasthan      |
| 14 | Aditya Das                      | Manager       | POSOCO-WRLDC        |
| 15 | Virag Shah                      | Sr. Officer   | POSOCO-WRLDC        |
| 14 | Alok Kumar<br>(thru.VC)         | Ch. Manager   | POSOCO-NRLDC        |
| 15 | Anisha Chopra (VC)              | Dy. Manager   | POSOCO-NRLDC        |
| 16 | Seema Dubewar                   | AGM (F&A)     | SLDC Maharashtra    |
| 17 | Ravindra Nagare                 | EE            | SLDC Maharashtra    |
| 18 | Santosh                         | EE            | SLDC Maharashtra    |
| 19 | K.M. Parashar                   | AEE           | SLDC Maharashtra    |
| 20 | Nitin Paunikar                  | DGM (IT)      | SLDC Maharashtra    |
| 21 | Peeyush Sharma                  | SE            | SLDC Maharashtra    |
| 22 | Eknath Dhengale                 | SE            | SLDC Maharashtra    |
| 23 | Deepak Kolhe                    | EE            | SLDC Maharashtra    |

### **5<sup>th</sup> meeting (31.08.2018 at SLDC Telangana): Agenda**

1. Welcome and Introduction
2. Introductory remarks by Chairman of the Sub-committee
3. Opening remarks by CMD-POSOCO
4. Opening remarks by representative of Telangana SERC
5. Presentation by CE (LD), SLDC Telangana covering following aspects
  - a. Civil and IT infrastructure facilities at SLDC – Existing and envisaged
  - b. Future plans for Back-up SLDC
  - c. Functional activities
  - d. HR Resources Approved / Actual / Envisaged
  - e. HR practices regarding Induction/training/career growth
  - f. SLDC Fees & Charge regulations by Telangana ERC- Strengths and challenges
  - g. Interface of SLDC with ERC / STU / Genco / Discom / other stakeholders
6. Analysis of SLDC approved Fees and Charges by WRLDC
7. Survey of LDC HR and infrastructure by NLDC
8. Strawman Structure of the Report by WRLDC
9. Any other item
10. Visit of SLDC premises

### **5<sup>th</sup> meeting (31.08.2018 at SLDC Telangana): Agenda**

1. The fifth meeting of the FOR Technical Committee Sub-group was held in SLDC Telangana at Hyderabad on 31<sup>st</sup> August 2018. The list of participants is enclosed as Annex-I.
2. Director TSTRANSCO welcomed the sub-committee members and CMD, POSOCO. He made the following remarks:
  - The integration of regional grids has enabled utilization of regional diversity
  - Grid operation is now techno-commercial
  - RE and EV would be posing new challenges in the grid
3. Member convener of sub-group thanked all the participants of the 5<sup>th</sup> meeting of the sub-group. She made the following remarks:
  - The sub-group has had four meetings
  - The sub-group has to provide a framework for next 10 years
  - Sub-group should suggest mechanism for incentives, training and skill building of HR
  - She thanked CMD POSOCO for accepting the invitation to attend the meeting and that his inputs will be a valuable contribution to the sub group.
4. Chairman of sub-group thanked SLDC Telangana for hosting the fifth meeting of the sub-group. He made the following remarks:
  - Presence of SLDC Chiefs, representative from SERC, Director TSTRANSCO, CMD POSOCO demonstrates the commitment for institution building and strengthening of the Load Despatch Centres
  - Telangana is leading in deployment of RE and SCADA systems
  - Visit to each SLDC has been a learning experience. There is huge diversity in the infrastructure and capabilities at Load Depatch Centres. The objective of the sub-group to suggest an enabling framework to raise the LDCs like Jharkhand.
  - Physical visit to all SLDCs is desirable as there is no substitute for bonding. However due to paucity of time it would be difficult to cover all of them.
  - The report has to be submitted by the end of October so that it could be put up before the Forum of Regulators' meeting in November.
  - Each visit has given new insight. Study of international ISOs/TSOs indicates the need to strengthen the Information Technology and compliance oversight in LDCs in India. From International literature it was learned that the grid operator has to be prepared for Area Control Error, Security Constrained Economic Despatch and Optimization. It would require

modelling capabilities, data archiving and analytics. Decisions taken by Operators must be mathematically proven.

- Wide consultations have been done and the draft report should be circulated amongst members for their comments. The data collected by surveys must be validated by the Forum of Load Despatcher. He requested CMD POSOCO to take up this Agenda in next FOLD meeting.
5. CMD, POSOCO expressed pleasure on being invited to the meeting of the sub-group. He made the following remarks:
- System Operation is a vital link between the system and the policy makers and regulators. Load Despatch Centres are not a part of consumer or utility or market participant. Hence the System Operator must be non-discriminatory. It must be equipped with right capability, right bent of mind, technology and infrastructure.
  - The faculties required in System Operation are expanding. Besides System Operation, Market Operation, Logistics, the System Operators require knowledge of regulations, laws economics as well as art of report writing.
  - LDCs may tie up with institutes for load and RE forecasting
  - FOLD is helping in bridging the gap between the extremes. In the last FOLD meeting, 26 SLDCs including the 7 SLDCs of the North-east States were connected through Video Conference.
  - Website are the face of any Load Despatch Centre. Websites should be rich in content. It should facilitate information dissemination. Sub-group could suggest measures to harmonize the contents on the websites of Load Despatch Centres.
6. Representative of SERC Telangana said that TSSLDC was very strong in implementation of IT solutions. She added that TSSLDC provides feedback on various regulations brought about by the SERC. She suggested that the TSSLDCs needs help in implementing the intra State ABT in the State.
7. CE (LD), TSSLDC gave a presentation on the activities of TSSLDC. The presentation is enclosed as Annex-II. Key highlights of his presentation were as under:
- Telangana State load Despatch Centre is functioning under the control of STU (TSTRANSCO) and Accounts are separated. A separate ARR is being filed every year.
  - SLDC is located in the Headquarters of TSTRANSCO and it is distributed in various floors of the building.
  - Construction of Back-up SLDC at 220/132 kV Warangal substation is envisaged.
  - Apart from the regular activities of an SLDC, TSSLDC advises the State discom in procurement and portfolio management. It does the energy accounting and Billing for the inter discoms energy transactions. SLDC also verifies injection of RE for certification of REC.
  - RE data integration at SLDC is 92.9%. Real-time control of Solar PV at Inverter level is envisaged from SLDC.
  - Intra State ABT is yet to be implemented.
  - Physical and Cyber Security Policy has been implemented at SLDC. Fire safety system is in place. Communication is monitored with the help of Network Management System functional round the clock.
  - Data exchange with Pumping Station Monitoring Centre and REMC
  - There are four persons in each shift. There are total 73 persons in the engineering cadre and 18 number of supporting staff in TSSLDC
  - SLDC is coordinating the operation of Srisailam in generation as well as pumping mode. SLDC is also coordinating with the concerned department for Lift Irrigation pumping load
  - One time cash incentive of Rs. 10000 was being given to those who acquire the Basic or Specialist level Certificates
  - Intranet has a web-based solution for accessing and visualizing archived data
  - Scroll display in the control room video wall

- SLDC has developed many user friendly mobile applications like Line clearance app, Vid�ut Shakti App
- Surplus funds of the SLDC were being passed on to the consumers
- One time connection fee of LTA was considered in the SLDC fee and charges

Mr. Suresh Babu, SE TSSLDC suggested that there should be a template for model website and it should clearly identified as to what would be in public domain and what not. A list of all SLDCs website may be listed in Report.

8. Members deliberated on the issues being faced by TSSLDC. Following decisions were taken
  - There should be five groups in the shift with one group as a backup to enable the shift personnel to attend training
  - Infrastructure and HR requirement in an LDC has a non-linear relation with the peak demand met and energy consumption. Coordination effort by LDCs increases with the number of generating stations, transmission lines, substations and other users. Management of bigger systems requires automation and special tools at LDCs. Complex systems require advanced technologies and mechanisms for congestion management, decision support and analytics.
  - Certification should be voluntary. It should come as a culture rather than a mandate.
  - LDCs need to build in-house capabilities for modeling (network & market), simulation studies and optimization. Over-reliance on external consultants may not be desirable.
  - The States rich in hydro resources would have to coordinate with water resource and irrigation department. Pumping load of Lift irrigation projects and Pumped Storage hydro stations could be used in a versatile manner. The LDCs require people with capabilities who could design mechanisms to exploit the inherent potential of hydro resources.
  - After unbundling the LDC need to coordinate between different entities in a non-discriminatory manner.
  - For fail-safe operation of LDCs even in case of a disaster, the back-up LDC should be planned and maintained as Main-I / Main-II rather than Main and Back-up. The LDC functions shall be carried out from Main I and Main II at periodic intervals.
  - NPTI should maintain database of all certified Operators and Validity of Certificates. LDCs also should maintain database of certified employees and keep track of number of employees with valid certificates after retirement and transfers. A template for monitoring shall be enclosed in the Report. A minimum percentage may be decided by SLDCs say 75 % as percentage of employees which are certified.
  - TSSLDC would suggest the structure of model website, intranet system and apps.
  - Whether DoT certified vendors shouldonly be allowed to supply communication equipment shall be discussed in next meeting. CERC Communication systems Regulations be complied with and each State may come out with similar Regulations for State.
9. NLDC gave a presentation on the compiled responses of Survey-II. The presentation and the survey responses in excel sheet is attached as Annex-III.
  - All members would validate the survey data
  - The results would be shared with FOLD members for validation
10. SLDC Gujarat gave presentation on best practices of PJM, NYISO and CAISO. Key takeaways from the presentation were as under:
  - Every SLDC should compile operating manuals
  - Suitable mechanisms should be in place for compliance oversight. Peer review could be organized for obtaining suggestions for improvement.
11. WRLDC gave presentation on the compilation of LDC fees and charges. Following suggestions were given by members
  - Data to be re-validated

- Following numbers to be flagged separately
    - Number of States where fees and charge regulations are yet to be notified
    - Number of States where regulations have been notified but the petition for SLDC F&C is to be filed
    - Number of States where regulations have been notified, petition for SLDC F&C has been filed but order is pending
    - Number of States where regulations have been notified, petition for SLDC F&C has been filed, order is published but billing is not done
    - Number of SLDCs where billing is done under SLDC fees and charges but SLDC has to depend on STU for expenditure
12. Members deliberated on the Model Fees and Charge Regulations. Following consensus emerged
- LDC Users shall be clearly defined in the report. Generation, Transmission and Distribution licensees to be essentially be treated as Users
  - Users of LDC shall be explicitly share the LDC fees and charges
  - Whether fees and charges should be bifurcated into SOC and MOC needs to be decided keeping in view rationale of the same in CERC Regulations for simplicity.
  - Proportion of transmission licensees in SOC could be increased
  - Transmission Utilities having contracted capacity for auxiliary consumption could also share some proportion of MOC
  - Load Despatch Centre Development Fund should be created in every LDC for parking the surplus funds and other income
  - The LCDDF fund shall be leveraged for creating infrastructure in LDCs and for HR capability building. Utilization of fund from LCDDF shall be treated as equity and depreciation shall be allowed. The LCDDF fund could be utilized for CAPEX, pilot projects and HR capacity building
  - A separate head of HRD expenditure shall be maintained. HRD expenditure could be considered as a CAPEX in line with the principles of Human Resource Accounting
  - Expense on contract employees should not be a part of HR expense. Outsourcing expense to be booked under A&G
  - The KPIs for LDCs could be organized under four heads: Financial Prudence, Stakeholder value, Internal Processes and Learning & Growth. The SERCs in consultation with SLDC could select the desired KPIs from the basket of KPIs in the report
  - 75 % of employees to have Basic Certification. 10-15 % of employees to have Specialist Certification. This shall be decided based on category of SLDC.
  - All members to suggest further for deliberation in the next meeting on following points:
    - What should be the proportion of SOC and MOC ?
    - Whether the LDC ARR shall be offset with surplus income ?
    - Who should administer LCDDF ?
    - Should LCDDF be considered in the books of accounts of LDC?
    - Should LDC seek permission from ERC for expenditure from LCDDF ?
    - Whether the funds released from LCDDF should be treated as grant ?
    - Should RoE and Depreciation be allowed on CAPEX from LCDDF or not ?
13. WRLDC shared the strawman draft of the report. Following decisions were taken
- Presentation of the draft report may be made for discussion and feedback with SERC by respective SLDC and CERC before submission to FOR.
  - Ergonomics should be covered as a separate section. There shall be a separate chapter for SCADA and another chapter for IT sectionalized.
  - SLDCs shall be grouped in four categories depending upon the system size handled to decide complexity required, fees and charges etc.
  - All the references to be compiled as Annex-II of the report

- Draft report to be shared in the FOLD meeting in 1<sup>st</sup> week of October
- Action points with timeline for monitoring to be included in Report.
- Members of sub-group to give presentation of the recommendations in other SLDCs preferably in cross regions.
- List of Apps which can be useful for SLDCs shall be included in Report.
- TSSLDC shall give a write up on line clearance through SAP done by them.
- ATM / Bank should be located in SLDC building for ease of employees.
- SLDCs are suggested to write papers on critical events handled for collective learning.
- Gujarat will provide list of operating manuals to be published by SLDC.
- Maharashtra SLDC suggested that bills of SLDC fees and charges may be uploaded on website. And need of paper billing may be done away with. They also intimated that they have kept a corpus to pay RLDC fees and charges.
- View shall be taken on treatment of condition of non meeting of planned HRD expenses.

14. Member convener confirmed that the next meeting of the sub-group was scheduled on 11<sup>th</sup> September 2018 in SLDC Lucknow. It was decided that a visit to SLDC Assam and SLDC Meghalaya would be organized after the visit to SLDC Lucknow.

15. Sub-group members visited the control room, Communication room, UPS, Library, DTS room of TSSLDC

16. Chairman thanked the members for a fruitful discussion.

## **6<sup>th</sup> meeting (11.09.2018 at SLDC Lucknow): Agenda**

1. Introduction and Opening remarks
2. Presentation by SLDC Lucknow
  - a. Civil and IT infrastructure facilities at SLDC Lucknow
  - b. HR Resources at SLDC - Approved vs actual vs envisaged
  - c. HR practices in SLDC regarding Induction/training/career growth
  - d. Certification linked incentive schemes in SLDC
  - e. SLDC Fees and Charge regulations by UPERC- Strengths and challenges
  - f. Interface of SLDC with ERC / STU / Genco / Discom / other stakeholders
3. Measures for institutional capacity building of LDCs
  - a. How to encourage further inter-LDC engagement
  - b. How to enhance international exposure of LDCs ?
  - c. How to encourage participation of LDCs in collaborative activities in CIGRE /GO15/IEEE?
  - d. How to encourage participation of LDCs in ICPS/NPSC/other national conferences
  - e. How to inculcate the culture of peer review ?
  - f. How to encourage interaction between ERCs and LDCs ?
  - g. How to encourage engagement of LDCs with stakeholders ?
  - h. How to encourage, facilitate HR capacity building in SLDCs ?
  - i. How to achieve targets for certification of operators?
4. Principles for “Model Fees and Charge Regulation”
  - a. Who should be defined as “Users” of LDCs ?
  - b. Should SOC and MOC be merged into one ? What is the rationale?
  - c. If SOC and MOC is to be segregated then what should be the proportion of SOC and MOC in the Annual F&C?
  - d. What should be proportion for apportioning SOC / MOC between Users ?
  - e. Should transmission licensees share MOC ? If yes, what should be the proportion?
  - f. How to ensure financial prudence of LDCs ?
  - g. What should be the frequency of truing up ?
  - h. How to encourage realistic and practical CAPEX plan ?
  - i. What should be the framework to monitor CAPEX utilization ?
  - j. What should be the HR strength of typical Large/Medium/Small LDC ?
5. Utilization of LDC Development Fund
  - a. Whether the LDC ARR shall be offset with surplus income or considered as Reserves?
  - b. What should be the heads for which LDCDF could be utilized by LDC ?
  - c. How could LDCDF be utilized for LDC institution building and strengthening ?
  - d. Should LDCs take loan for CAPEX or should they use LDCDF ?
  - e. Whether the funds released from LDCDF should be treated as grant ?
  - f. Should RoE be allowed on CAPEX from LDCDF or not ? What is the rationale ?
  - g. Should depreciation be allowed on CAPEX from LDCDF ? What is the rationale ?
6. Roadmap for monitoring implementation of the sub-group recommendations
  - a. What are the key milestones ?
  - b. What should be the timeline for implementation?
  - c. Who would monitor implementation of the roadmap?
  - d. What would be the periodicity of review?
7. Data validation and progress update for sub-group report

- a. Validation of Survey data
  - b. Validation of compiled data on LDC Fees and Charges
  - c. Feedback on the strawman draft by sub-group members
  - d. Feedback on LDC KPIs by sub-group members
  - e. Model LDC Organization Structure
  - f. Model LDC civil infrastructure - by SLDC Maharashtra
  - g. List of Operation Manuals to be maintained by LDCs - by SLDC Gujarat
  - h. Write up on model LDC website and IntraNet- by SLDC Telangana
  - i. Write up on Apps for MIS – by SLDC Telangana
8. Future meetings and visits of the sub-group
- a. Date for VC with SLDC West Bengal
  - b. Date for visit to SLDC Assam and Meghalaya
  - c. Discussion of sub-group draft recommendations in FOLD
9. Any other item
10. Visit of SLDC Lucknow premises

#### **6<sup>th</sup> meeting (11.09.2018 at SLDC Lucknow): Minutes**

1. The 6<sup>th</sup> meeting of the FOR Technical Committee Sub-Group was held on 11<sup>th</sup> September 2019 in SLDC Lucknow. List of participants is enclosed as Annex
2. Shri A.K. Singh, Chief Engineer, UPSLDC welcomed the participants of the sub-group meeting and said that UPSLDC was honoured to host the sub-group. He said that independent functioning of SLDCs and strengthening of its infrastructure and Human Resources is the need of the hour.
3. Shri Ram Swarath, Director, UPSLDC thanked Forum of regulators for constituting the sub-group under the chairmanship of an eminent person as Shri Soonee. He stated as under
  - a. The LDC operations are complex
  - b. System Operators are like peacock- multifaceted and always on vigil
  - c. It requires a team of talented, dedicated personnel
  - d. Role of Shift Engineers is very important
  - e. Working environment in the control centre should be such that the personnel are motivated to work
  - f. Total sanctioned strength of Officers and Staff is 277, which includes the officers and staff for 4 Sub-SLDCs also. Against the total sanctioned strength of 277, presently 247 officers and staff are working in the UPSLDC. Most of the non-executive functions are out sourced.
  - g. The policies and practices related to recruitment, promotion, salary structure etc. of UPPTCL accordingly apply on UPSLDC also. Recently only UPPTCL management on the request of SLDC has increased the Special Pay for officers and staff of SLDC and made it at par with other technical units of UPPTCL i.e. T&C and Microwave etc.
4. Chairman of the sub-group thanked UPSLDC for agreeing to host the 6<sup>th</sup> sub-group meeting. He opined that UPSLDC is of international standard and it is a must visit for every Load Despatcher. He mentioned that the power system of Uttar Pradesh is large and could include several countries of Europe UPSLDC. He stated that UPSLDC staff must take pride in operating such a large system
5. Chairman appreciated the active participation and generous contribution of all sub-group members. He urged the members to highlight the issues to be discussed in the meeting. He acknowledged that acquisition of talent and retaining them is a major challenge for all Load

Despatch Centres, hence the LDCs must strive to create a decent working environment and good work culture.

6. ED, NLDC expressed pleasure on the excellent infrastructure of UPLDC. He recalled that UPLDC had a legacy of innovations such as revolving telephone desk. He said that the best practices of UPLDC should be shared with others.
7. Shri Vivek Dishit SE, UPLDC gave a presentation on the UP power system and SLDC infrastructure. The highlights are as under:
  - i. Erstwhile UPSEB has been unbundled into UP Rajya Vidyut Nigam Ltd., UP Jal Vidyut Nigam Limited, UP Power Transmission Corporation Limited. UPPTCL is one among the three transmission licensees. UPLDC functions under UPPTCL as one of its Directorate
  - ii. There are three State owned distribution licensees and two private distribution licensees
  - iii. There are four sub-LDCs (Meerut, Moradabad, Kanpur and Varanasi). Back Control centre is located in one of the Sub-LDCs (Modipuram in Meerut)
  - iv. There are 9 no. of 765 substations, 35 no. of 400 kV substations, 122 no. of 220 kV substations and 399 no. of 132 kV substations in UP system. UPLDC coordinates operations of 1730 ckt km of 765 kV lines, 6612 ckt. Km of 400 kV lines, 10599 ckt. Km of 220 kV lines and 18857 ckt. Km of 132 kV lines. Total demand is more than 19 GW, out of which 26% is rural, 34 % is town, 16% is district, 8% tehsil, and 16% industrial load
  - v. Maximum demand met was 20 GW and 438.7 MU in a day
  - vi. UPLDC, Lucknow is spread over an area of 4090 Sqm, which includes Control Room Block and Administrative Block. Separate space is available for State Power Committee in the building. A new building of UPERC and UPPTCL is also located nearby. In addition to physical security, building is equipped with CCTV surveillance and public address system. Building is equipped with complete 'Fire Protection System'. It is being developed as Green building. Installation of Solar PV on the rooftop is planned.
  - vii. UPLDC Control Room area with an area of 550 Sqm is one of the biggest amongst SLDCs in the country. It has very Large 8x4 VPS Display Screen which allows display of multiple windows for better visualisation. There is a separate screen for weather data. Conference room is spacious and has a Video Conferencing Facility.
  - viii. It has twin electricity supply sources with separate 11/0.4 kV sub-station with DG backup. It has separate UPS backup for SCADA and Electronic Equipment & Emergency Lights.
  - ix. Separate Servers for SCADA and Non SCADA IT Systems with backup (Disaster Recovery) at Sub-SLDC, Modipuram. SCADA Intra as well as inter (web based) network is protected by separate firewalls. Penetration testing as well as Cyber Audit is routinely done for both these systems. There are two lease lines (POWERTEL & BSNL both 20 MBPS) for reliable and un-interrupted data/information transmission on internet. Upgradation 40 MBPS is planned. Complete building is Wi-Fi enabled.
  - x. Most of the 220 kV and above sub-stations are connected through Optical Fibre for secured data and information transmission. Facility for remote tripping of some of the 132 kV feeders for load management is also available.
  - xi. UPLDC has a dynamic & interactive website. It also provides access to web based Energy Accounting and Settlement System application. Information on the web-site and the EASS application can also be accessed through UPLDC Android App. EASS application provides the facility of sending E-Mails and SMS to concerned stake holders. To look after the account related functions a Zonal Accounts Unit has been created under the UPLDC.
  - xii. For capacity building there is heavy dependence on training programmes organized by NRPC, POSOCO etc. Officers also participate in System Operator Certification programmes conducted by NPTI. Around 45 officers from SLDC have completed Basic

Level System Operators Course. Meeting/ sessions are also conducted to discuss important technical and commercial matter in which all stakeholders participate

8. The challenges envisaged by UPSLDC are as under
  - a. Need for implementation of robust energy metering, AMR system and scheduling
  - b. Peaking and ramping challenge with high penetration of Solar PV and limited hydro capacity
  - c. Tools for Forecasting of renewable generation (Solar and wind)
  - d. Changes in the existing software due to introduction of 5-minute metering and scheduling
  - e. Adaptation of PMU (WAMS) based applications.
  - f. Utilization of EMS System.
  - g. Cyber Security
  - h. Use of Operator Training Simulator by user groups.
  - i. Application of GST on fee and charges of SLDC
9. The issue of headcounts and skill sets required in a typical LDCs was deliberated in detail. Following consensus emerged
  - a. LDCs shall be executive oriented centre with limited support staff. The manual work associated with data collection needs to be automated and certain mundane work may be outsourced. Computer literacy is essential for an LDC personnel. There is a need for clear definition of executive, non-executive and workman in the context of LDC functions. Certification of LDC personnel is essential
  - b. The number of personnel in real-time needs to be enhanced to ensure adequate strength in the control room round-the-clock after taking into account entitled leaves, public holidays, festivals, business travel, training, special assignments. There is a need for five groups to factor leave reserves and training of real-time personnel
  - c. There is a need for strengthening of HR in the emerging areas such as
    - i. REMC, Forecast,
    - ii. Simulations, Optimization, Knowledge Management, Data Repository & Analytics
    - iii. Decision Support System, WAMS, Information technology, Information Security
    - iv. Market oversight, Market Analysis, Legal, Regulatory Affairs, Compliance monitoring
    - v. Training, HRD, Scrap Disposal, Energy Efficiency
  - d. LDCs could be grouped into three categories – Small, Medium and Large. The number of personnel could be typically in the following range
    - i. Small LDC : 25 – 50; Medium LDC : 50- 100; Large LDC : 80 – 125
    - ii. Proportion of personnel in SO: MO: SL: Others could be 35:30:20:15
  - e. In addition to the engineering knowledge, the following new hard skill sets are required
    - i. Hard skills: MS Office applications, Forecasting, Network Simulation, Market Simulation, Software Development, Optimization Economics, Law, Meteorology, Communication, Research Methodology, Statistics, Data Science, Analytics
    - ii. Soft skills : Cognitive, Interpersonal Communication, Public Speaking, Emotional Intelligence, Report Writing, Analytical, Aesthetics, Public Relations
  - f. Applied research on the practical problems faced in Indian power system/electricity market needs to be encouraged. The LDC staff needs to be facilitated to take up higher studies. Collaboration with local colleges/NIT/IIT needs to be encouraged.
10. The principles of Model Fees and Charge Regulations for LDCs were deliberated in detail. Following consensus emerged:
  - a. The Users of LDC shall be clearly defined and charged explicitly. Following entities may be considered as Users
    - i. Generating Companies, Sellers
    - ii. Distribution Licensees, Railways, Buyers Bulk consumers (SEZ)

- iii. Transmission Licensees
    - iv. Licensed Traders, Power Exchange, Aggregators/QCA
    - v. Demand Response Consumers, EV Charging Stations
    - vi. Grid Reliability Service Users like NHPTL
  - b. LDCs are ‘Profit-neutral’ but that does not imply ‘for-loss’. Hence financial prudence and efficiency to be taken care and Depletion of Net worth to be guarded
  - c. Billing, recovery and reconciliation should be simple. Sharing of Charges to be simplified for ease of billing and collection
  - d. LDCs provide numerous services to the transmission licensees hence the proportion of recovery from Transmission needs to be increased. New Users should also share Fees and Charges
  - e. HRD expenses to be booked separately instead of within A&G
  - f. Regulatory Pool fund shall be separate from the LDC balance sheet
  - g. Load Despatch Centre Development Fund is essential for financial autonomy of LDC. Other Income / revenue to be deposited in LDCDF. Expenditure from LDCDF to be replenished to avoid depletion.
  - h. Holding charge on surplus income/LDCDF to be addressed in the amendment to regulations
  - i. Utilization of Funds from LDCDF may be pre-approved by ERC for following heads
  - j. CAPEX / REPEX
    - i. Human Resource Development
    - ii. Unforeseen expenditure such as engaging consultants for new technology, Exploratory Studies, Pilot projects
  - k. Funds from LDCDF shall not be considered as grant. Depreciation and Nominal RoE shall be allowed for CAPEX from LDCDF. LDCDF may be reviewed from time to time by ERC
  - l. Since the liability of SOC and MOC is shared in the proportion of installed capacity/contracted capacity amongst the eligible Users, the methodology of splitting the ARR into SOC and MOC for the purpose of recovery may be reconsidered.
  - m. Alternatively ARR could be recovered as Grid Management Charge from the Generators/Sellers; Distribution Licensees/Buyers and Transmission Licensees in the proportion of (1/3):(1/3):(1/3)
  - n. The incentive for LDC could be linked to achieving the target KPI set by the ERCs. The Performance Related Pay of individuals could also be linked achieving KPI targets.
  - o. Certification linked incentives in the lines of SLDC Maharashtra needs to be notified
  - p. Reconciliation of fees and charges could be done annually while truing up could be done every five years with an option for mid-year review petition in case ERC approval is required for unforeseen expenses or in case major deviations from approved F&C.
11. Measures for institutional capacity building were discussed. Members opined that the sharing of best practices under the aegis of FOLD could continue.
12. CE SLDC, Gujarat shared the list of documents to be maintained by LDCs as under:
- List of Important Grid Elements
  - Transmission Outage Coordination Procedure
  - Operation guidelines
  - Standard Operating Procedure
    - Demand Forecasting, RE Forecasting
    - Scheduling, STOA Processing
    - ERP software
    - Cyber Security, Information Security
  - System Recovery Procedure
  - System Protection Schemes, Islanding Schemes
  - Soft and Hard copy of all Relevant Regulations

- Disaster Recovery Manual
13. CE, SLDC Maharashtra shared the civil infrastructure requirement of a typical LDC. Chairman advised to examine the civil infrastructure details of UPSLDC and consider including it in the report suitably.
14. Dr. Anoop Singh agreed to share a framework for facilitating industry academia collaboration.
15. CE, SLDC Telangana agreed to share the site map of Telangana SLDC website and IntraNet. He also agreed to provide a brief write up on the Apps developed for MIS purpose.
16. The sub-group also interacted with the intra State generating companies, transmission licensees, open access customers and distribution licensees. They opined that SLDC should consider their concerns in their submissions to the regulators. It was agreed that there is an emerging need for flexibility services and explicit compensation for such services. There was a consensus on mutual efforts to enhance transparency in the system, implementing security constrained economic dispatch and improved coordination amongst stakeholders.
17. Roadmap for implementation was deliberated. All members agreed to conduct sessions in SLDCs to disseminate the recommendations of the sub-group. It was also agreed that the discussions with SERCs may also be held to explain the rationale of recommendations. A tentative roadmap was agreed by the members.

List of participants:

| S N. | Name (Mr./Ms.)    | Organization   | S N | Name (Mr./Ms.)    | Organization |
|------|-------------------|----------------|-----|-------------------|--------------|
| 1    | S.K. Soonee       | POSOCO         | 24  | Ram Sharan Singh  | UPSLDC       |
| 2    | S.R. Narasimhan   | NLDC           | 25  | Chandra Prakash   | UPSLDC       |
| 3    | Shilpa Agrawal    | CERC           | 26  | Avinash Rai       | UPSLDC       |
| 4    | B.B. Mehta        | SLDC Gujarat   | 27  | Mithilesh Gupta   | UPSLDC       |
| 5    | Anil Kolap        | SLDC Maha.     | 28  | A Sudhakar        | UPSLDC       |
| 6    | Vasan Pande       | SLDC Maha.     | 29  | Mohd. Irfan Alam  | UPSLDC       |
| 7    | N. Bhaskar        | SLDC Telangana | 30  | Anurag Agarwal    | UPSLDC       |
| 8    | Dr. Anoop Singh   | IIT-Kanpur     | 31  | Vivek Dishit      | UPSLDC       |
| 9    | A.K. Arya         | SLDC Rajasthan | 32  | M.S. Ansari       | UPSLDC       |
| 10   | Manoj Kumar Verma | SLDC Rajasthan | 33  | Sangeeta          | UPSLDC       |
| 11   | Vivek Pandey      | WRLDC          | 34  | Ashotosh Kumar    | UPPCL        |
| 12   | Ram Swarath       | UPSLDC         | 35  | Mahesh Prasad     | UPJVNL       |
| 13   | A.K. Singh        | UPSLDC         | 36  | H.R. Singh        | UPJVNL       |
| 14   | C.K. Shukla       | UPSLDC         | 37  | Brajesh Singh     | UPRVUNL      |
| 15   | A.J. Siddiqui     | UPSLDC         | 38  | Pankaj Saxena     | UPPTCL       |
| 16   | Zubeir Ahmad      | UPSLDC         | 39  | H.C Harchandani   | NTPC         |
| 17   | S.P. Gupta        | UPSLDC         | 40  | Vikas Saxena      | NTPC         |
| 18   | Rajeev Mohan      | UPSLDC         | 41  | Surendra Singh    | Rosa power   |
| 19   | P. Shukla         | UPSLDC         | 42  | Ambuj Shukla      | Rosa Power   |
| 20   | Vikrant Kumar     | UPSLDC         | 43  | Kiran Kumar       | Lalitpur     |
| 21   | Suvi Gupta        | UPSLDC         | 44  | Vikas Kumar Singh | Lanco-Anpara |
| 22   | Ashok Kumar       | UPSLDC         | 45  | Narendra Wadhwa   | Bajaj Energy |
| 23   | Sanjay Jaiswal    | UPSLDC         |     |                   |              |

**7<sup>th</sup>, 8<sup>th</sup> and 9<sup>th</sup> meetings (21-22nd September, SLDC Meghalaya, NERLDC, SLDC Assam):**

**Agenda**

Day-1: 21<sup>st</sup> September 2018

- 1000 -1200 hrs : Visit to SLDC Meghalaya control room
- 1500- 1800 hrs : Meeting at NERLDC
  - 1. Welcome by ED, NERLDC
  - 2. Opening remarks by Chairman of sub-group
  - 3. Remarks by STU Representatives of NER States
  - 4. Progress update of the sub-group work
  - 5. Remarks by representatives from NER SLDCs
  - 6. Presentation by SLDC Meghalaya
  - 7. Presentation by SLDC West Bengal through VC
  - 8. Presentation by SLDC Tamil Nadu through VC
  - 9. Incentive Scheme for Load Despatch Centres

Day-2: 22<sup>nd</sup> September 2018

- 1100-1300 hrs : Visit to SLDC Assam
  - o Brief Overview of the work done by sub-group by Chairman
  - o Progress update of the sub-group work
  - o Remarks by Representative of SERC and STU Assam
  - o Presentation by SLDC Assam on best practices, issues and concerns pertaining to SLDC infrastructure and Human Resources
  - o Views of stakeholders

**7<sup>th</sup> Meeting (21.09.2018 (Morning at SLDC Meghalaya) Minutes:**

1. The 7<sup>th</sup> meeting of the FOR Technical Committee was held on 21<sup>st</sup> September 2018 at SLDC Meghalaya in Shillong. The list of participants is enclosed.
2. Mr. Frederick, Meghalaya SLDC Incharge welcomed the members of the sub-group and NERLDC officials. He said that
  - a. SLDC Meghalaya was established in 2004.
  - b. New control Centre was built last year
  - c. SLDC Meghalaya is computing the deviation charges for Open Access Customers in the State
  - d. Implementation of SAMAST is being taken up
  - e. Meghalaya State Electricity Regulatory Commission (Levy and Collection of Fee and Charges by State Load Despatch Centre) Regulations-2009.
  - f. SLDC files separate petition for ARR in accordance with the provisions of MSERC regulations.
  - g. Commission approved the SLDC Charges Rs. 2.42 Crore, Rs. 2.54 Crore and Rs. 2.66 Crore for the Control Period 2018-19, 2019-20 & 2020-21 respectively.
3. Chairman of the sub-group thanked SLDC Meghalaya for organizing the meeting. He said that
  - a. One member from NER was coopted by the sub-group to get first-hand information on the issues and challenges
  - b. All States have some or the other constraints. We need to gracefully approach all those who matter to evolve solutions
  - c. Building institutions takes time. Large SLDCs could hand-hold smaller SLDCs
  - d. SLDCs need to be fully equipped to handle the upcoming challenges

- e. FOLD appreciates the presentation made by SLDC Meghalaya in the FOLD meeting
  - f. HR inadequacy is a common problem in all LDCs.
  - g. Indian grid is third largest in the world and is unique in many respects
  - h. Youngsters need to be provided with adequate resources and infrastructure to perform
4. Following challenges were highlighted by SLDC Meghalaya team
- a. Reliability of Communication and telemetry is a major challenge
  - b. Demand forecast is a challenge due to frequent changes weather change in Meghalaya
  - c. The nearest Doppler is in Agartala. There is a need for weather station in Shillong
  - d. HR staff is inadequate to discharge all the statutory functions in System Operation, Market Operation and System Logistics
  - e. 12 SLDC personnel had been certified for Basic level. However 7 personnel have been transferred out of SLDC. There is one person certified for Specialist level.
  - f. There is only one person in Market Operation department.
  - g. In the absence of official accommodation nearby, the SLDC staff ha to make their own arrangement which is far from the SLDC. There are nine female staff. They also works in night shift. Self-driving and commuting during odd hours is a risky in the absence of official transport facility or public transport. SE, UPSLDC ALSO narrated the casualty of their staff who was driving after night shift.
  - h. Availability of telemetry is only 70-80 %. Inadequate visibility of the network in real-time is a cause of anxiety to control room personnel as there are frequent tripping of transmission elements and pressure to restore supply quickly.
  - i. Need training on PSS/E software for simulation studies and grid event analysis
  - j. Inadequate opportunities to interact with other stakeholders
  - k. Inadequate opportunities to participate in training programmes to insufficient staff
  - l. Very few personnel want to work in SLDC
  - m. Physical Security and Cyber Security
5. Following suggestions emerged during deliberations
- a. The challenges highlighted by SLDC Meghalaya are being faced at other LDCs also. Hence all these have to be suitably covered in the sub-group report
  - b. Reliable speech and data communication is essential for grid management
  - c. Latest VSAT technology could be explored for communication.
  - d. Twining of LDCs could be explored for mentoring
  - e. Control room to be equipped with Television for News update
  - f. Geographical displays could be used in control room for better visualization
  - g. The IMD nowcast could be displayed in one of the screens in control room. The requirement of weather forecast to be highlighted to the nearest IMD Centre in Northeast
6. Sub-group members visited the control room, server room, refreshment area at the terrace. All members appreciated the well maintained control centre despite adversities and challenges.
7. AE, SLDC Meghalaya proposed the vote of thanks

Chairman thanked all the participants for their contribution.

## **Minutes of 8<sup>th</sup> meeting [NERLDC Shillong, 21.09.18 (afternoon)]**

1. The 8<sup>th</sup> meeting of the FOR Technical Committee was held on 21<sup>st</sup> September 2018 at NERLDC in Shillong. Representatives of all SLDCs of NER and NERLDC attended the meeting. SLDC Tamil Nadu and Member Convener participated in the meeting from NLDC Delhi through Video Conference. The list of participants is enclosed.
2. ED, NERLDC welcomed all the participants and advised the representatives from SLDC NER to take full advantage of the opportunity to share their views on the various aspects of the sub-group terms of reference without hesitation.
3. Chairman of the sub-group thanked Forum of Regulators for giving an opportunity to bring work and bring all the LDCs on a common platform. He also thanked all the members of the sub-group for taking pains to travel, attending all the meetings and contributing enthusiastically. He appreciated the resources made available by the NLDC, RLDCs and SLDCs towards accomplishment of the sub-group work.
4. He shared the highlights of the discussions with SLDC Meghalaya in the first half and requested all participants to share their views in free and fair manner. He stated that-
  - a. The work of the sub-group would not have been complete without visit to NER and interaction with all LDCs of NER.
  - b. The binder circulated along with the agenda contains a compilations of the discussions and decisions of the sub-group in the earlier meetings
  - c. The draft report of the sub-group would be discussed in the upcoming FOLD meeting on 01<sup>st</sup> October 2018 and would be subsequently put up to the Technical Committee of the Forum of Regulators.
  - d. The System Operators have to be knowledgeable and should have courage to operate the system without fear or favour.
5. Representatives from SLDC Arunachal Pradesh stated that-
  - a. Arunanchal Pradesh is geographically large but thinly populated
  - b. SLDC Arunachal Pradesh and Transmission Division II is a unit under Transmission Planning and Monitoring Zone of Department of Power, Arunachal Pradesh vide notification dated 18th March 2015
  - c. New SCADA systems was commissioned in July 2018. VC facility is also available
  - d. There are 2 executives, 3 supervisors, 4 skilled workmen and 5 unskilled workmen
  - e. The regular staff is inadequate to operate the control centre round the clock. They were managing with casual staff.
  - f. There are only three personnel to run the SLDC out of which one is on long leave.
  - g. The peak demand is around 600 MW. The discoms were participating in the electricity market. Metering and settlement was an issue.
6. Representative of SLDC Assam stated that
  - a. SLDC, Assam is presently being operated by the STU of Assam i.e. Assam Electricity Grid Corporation Ltd. (AEGCL).
  - b. No Separate Fees and Charges Regulation notified by AERC.
  - c. The annual SLDC Charges are approved by AERC in Tariff order of AEGCL (Dated 19/03/2018)
  - d. Part of ARR of AEGCL, payable by APDCL
  - e. There are 12 executives, 7 supervisors, 2 workmen, 4 skilled workmen
  - f. 17 no. of employees obtained Basic Level Training; 13 nos. are Certified Basic Level Operators.
  - g. New SCADA system was installed in July 2015.
  - h. System Operation, SCADA, LD & Commercial, Accounts and Establishment departments

- i. Peak demand met of Assam is 1809 MW
- j. They were grateful to the FOR sub-group for visiting NER to take their inputs
- k. SLDC-Assam was operating under STU
- l. Separate fees and charge regulations were yet to be notified
- m. Staff is inadequate. The training opportunities were not be utilized for want of leave reserves. Career growth opportunities were also getting limited due to non-availability of sanctioned posts for senior personnel at SLDC

7. Representative of SLDC Manipur stated that

- a. SLDC, Manipur is presently being operated by the STU of Manipur i.e. Manipur State Power Company Limited (MSPCL)
- b. The Joint Electricity Regulatory Commission for Manipur and Mizoram notified Procedure, Terms & Conditions for payment of Fees and Charges to SLDC and other related provisions Regulations, 2010.
- c. 6 no. of employees obtained Basic Level Training; 5 nos are Certified Basic Level Operators.
- d. New SCADA system has been in operation in SLDC since September, 2017.
- e. There are three departments-System Operation, Real time and Commercial
- f. There are 3 executives, 3 supervisors, 15 skilled workmen and 11 unskilled skilled workmen. Thus there are 26 workmen out of a total staff of 32.
- g. Five operators were certified.
- h. A society has been formed for independence of SLDC
- i. Commercial operation and grid event analysis was being conducted

8. Representative of SLDC Meghalaya stated that

- a. SLDC Meghalaya is a Strategic Business Unit under STU i.e. MePTCL vide notification dated 18th June 2015
- b. Fees & Charges are governed by Meghalaya State Electricity Regulatory Commission (Levy and Collection of Fee and Charges by State Load Despatch Centre) Regulations-2009
- c. 16 no. of employees obtained Basic Level Training; At present 5 out of 11 are Certified Basic Level Operators. 1 no. has Specialist level certification.
- d. New SCADA system was commissioned in 2016
- e. There are 4 executives, 16 supervisors, 7 skilled workmen and 3 unskilled workmen
- f. The visit of the FOR sub-group had given them a feeling of oneness
- g. They were grateful to the sub-group for visiting SLDC Shillong and providing them the opportunity to share their achievements and challenges
- h. They were managing the SLDC operations despite the shortcomings
- i. SLDC Meghalaya participates in all the regional forums in NER. They were organizing regular meetings with intra-state entities
- j. They had spent around Rs. 1 crore on HRD
- k. HR in MIS, MO, SL and offline support functions was inadequate

9. Representative of SLDC Mizoram stated that

- a. SLDC Mizoram is a unit under Power and Electricity Department, Government of Mizoram
- b. The Joint Electricity Regulatory Commission for Manipur and Mizoram (Procedure, Terms & Conditions for payment of Fees and Charges to SLDC and other related provisions) Regulations, 2010
- c. No Certified Basic Level Operators.
- d. New SCADA system has been installed in April, 2017.
- e. Technical and Establishment Departments only
- f. RTUs are required at five locations but only one had been installed
- g. There are 4 executives, 9 supervisors, 7 skilled workmen and 6 unskilled workmen.

- h. There were no certified operators
- i. The hotline communication between NERLDC and SLDC is functional

10. Representative of SLDC Nagaland stated that

- a. SLDC Nagaland is a unit under STU of Nagaland i.e. Department of Power, Government of Nagaland.
- b. Nagaland Electricity Regulatory Commission (Levy And Collection of Fees and Charges by State Load Despatch Centre) Regulations, 2012
- c. No Certified Basic Level Operators.
- d. New SCADA system was installed in April 2018.
- e. Only Real-time department
- f. There is 1 executive, 12 supervisors, 10 skilled workmen and 6 unskilled workmen.
- g. Telemetry is not available

11. Representative from SLDC Tripura stated that

- a. SLDC Tripura is a unit under STU of Tripura i.e. Tripura State Electricity Corporation Ltd (TSECL).
- b. Tripura State Electricity Corporation was formed in 2004
- c. Fees and Charges Regulation yet to be notified by Tripura State Electricity Regulatory Commission.
- d. No Certified Basic Level Operators.
- e. New SCADA system was installed in operation since April, 2016
- f. Real Time, Market Operation and System Logistics departments
- g. Interconnection with Bangladesh was established in 2016
- h. The staff working in SLDC is on deputation from the erstwhile Electricity Department.
- i. There are 16 executives, and Nil supervisors/workmen
- j. There were no certified operators. The staff was ill equipped to handle in challenges associated with evolving reforms, regulations and market products
- k. Night Shift allowance was only Rs. 12.
- l. Fees and Charges regulations are yet to be notified

12. The summary of manpower in NER SLDCs is tabulated below:

| Name of State     | Executive | Supervisor | Workmen |           | Total |
|-------------------|-----------|------------|---------|-----------|-------|
|                   |           |            | Skilled | Unskilled |       |
| Arunachal Pradesh | 2         | 3          | 4       | 5         | 14    |
| Assam             | 12        | 7          | 2       | 4         | 25    |
| Manipur           | 3         | 3          | 15      | 11        | 32    |
| Meghalaya         | 4         | 16         | 7       | 3         | 30    |
| Mizoram           | 4         | 9          | 7       | 6         | 26    |
| Nagaland          | 1         | 12         | 10      | 6         | 29    |
| Tripura           | 16        | 0          | 0       | 0         | 16    |

13. SLDC Tamil Nadu gave a presentation of the infrastructure and HR aspects through Video Conference. The highlights of their presentation were as under:

- a. A new six floor building was being constructed by TANTRANSCO. One floor would be for SLDC
  - b. Following application softwares for SLDC functioning were being developed in-house
    - i. IntraState Outage coordination
    - ii. Connectivity processing
    - iii. Website
  - c. Draft DSM regulations had been notified by SERC and comments have been submitted
  - d. Award for development of Infrastructure for implementation of intrastate ABT had been awarded to Kalkitech. It includes the following applications
    - i. Grid connectivity, Open Access
    - ii. Outage Coordination, Metering
    - iii. Deviation Settlement, Renewable Energy Certificate
    - iv. Renewable Purchase Obligation
  - e. 9500 meters had been installed for Wind and 183 meters had been installed for Solar RES
  - f. Automated Meter Reading System is in place
  - g. TANGEDCO is a single discom + generating company
  - h. All SLDC staff undergoes 3 months induction training. They are also nominated for training at SRLDC, NLDC or other organization. Nomination is from the HRD department of the parent organization. Few persons are nominated for international conferences
  - i. Presently there are 24 certified operators
14. The sub-group deliberated in the challenges faced by the SLDCs in North eastern Region. Following consensus emerged
- a. The report shall recommend the roadmap to strengthen the small and new LDCs
  - b. Need for adequacy of HR for a large, medium and small SLDC shall be explicitly mentioned
  - c. SLDC personnel should be involved during the commissioning of the SCADA system so that they could take over and run the system
  - d. Communication system needs to be given due importance
  - e. Strengthening of NER SLDC is essential for improving coordination among utilities and for reliable power supply.
  - f. Head of LDC should be of the rank of Chief Engineer with financial powers
  - g. Delegation of powers to the LDC head is required for quick decision making
15. The sub-group deliberated on the criteria for clustering Load Despatch Centres, estimated number of personnel required for different LDCs. Following consensus emerged:
- a. LDCs shall be grouped into three categories – Small, Medium, Large depending upon the Installed Capacity handled, RES capacity handled, Peak demand met, Daily Energy Consumption and size of the transmission system handled. An estimated Annual Revenue Requirement of a typical LDC in each category would be worked out.
  - b. LDCs to be executive oriented. Ratio of (Executive + Supervisors) to Non-executive in a typical LDC would be **95:5**
  - c. Automation may be introduced for improving process efficiency. Mundane and routine activities may be outsourced. Productivity of the mainstream staff to be improved through skill enhancement in e-technologies.
  - d. The number of persons in rotating shift for control room operation would be 3 - 8 per shift with five shift groups to have provision for leave reserves and :
  - e. Staff in general shift to support
  - f. Total number of executives (including Supervisors) in a SLDC/RLDC/NLDC
    - i. Group-A : Large LDCs : **100 - 150**
    - ii. Group-B : Medium LDCs: **70 - 100**
    - iii. Group-C : Small LDCs : **30 - 50**
    - iv. The above number excludes the staff at Sub-LDC and staff for security guards.

- g. Proportion of executive Staff in various functional divisions would be
    - i. SO:MO:SL:Others = (35 – 45) % : (20 – 30) % : (15 – 20) % : (10 – 15) %
  - h. Support staff (HR, F&A, Contracts etc) = 10 - 15 % of the total HR of an LDC
  - i. Post upgradation for succession planning and career growth
  - j. HRD expenses to be a separate head in HR expenses instead of Administrative and General Expenses. Minimum 5 % of total HR expenses to be in HRD
  - k. Pick-up and drop shall be provided for personnel attending shift duty in control room
16. The sub-group deliberated on institutional capacity building of LDCs. Following consensus emerged
- a. FOLD has been taking a lead role in institutional capacity building and harmonization of practices at different LDCs. The collaborative activities among LDCs could be enhanced through FOLD. Twining, Peer Reviews, Joint Working Groups, Short deputation could also be explored
  - b. The Incentive for LDCs shall be linked to achieving the KPI targets provided by respective SERCs
  - c. The LDC incentives shall be de-linked to profits.
  - d. The aggregate incentive of the LDC could be a certain percentage of the ARR.
  - e. Incentive shall be pass through.
  - f. Incentive for the LDC personnel shall be drawn from incentive approved by the ERC and shall be linked to achieving individual KPI targets derived from the LDC KPIs.
  - g. LDC personnel shall also be given a certain amount as ‘certificate retainership’ for qualifying operator certification exams and maintaining the validity of the certificate.
17. Chairman, thanked all the participants for their contribution. He also thanked NERLDC team and SLDC Meghalaya team for hosting the meeting.

#### **9<sup>th</sup> meeting (22.09.18 at SLDC Assam): Minutes:**

1. The 9<sup>th</sup> meeting of the FOR Technical Committee subgroup was held in SLDC Assam, Guwahati on 22<sup>nd</sup> September 2018. Chairman as well as Member (T) AERC along with senior officials of NERLDC were also present. The list of participants is enclosed.
2. Chairman of the subgroup thanked SLDC Assam for hosting the meeting. He shared the experience of visit to other SLDCs and the interim back-up NERLDC control centre set up in Guwahati. He also apprised the participants about the terms of reference of the sub-group and sought inputs from SLDC Assam and AERC members.
3. SLDC Assam gave a presentation on subjects under the terms of reference of the sub-group. The highlights of the presentation are as under.
  - a. System Operation, SCADA, LD & Commercial, Accounts and establishment departments. SLDC Assam is functioning on its old structure which needs to be restructured under single umbrella for effective and efficient utilization manpower and available resources.
  - b. Officials posted in SLDC at the working level are frequently transferred after they are trained. This is resulting in wastage of trained manpower and hampering smooth operation of SLDC. Hence ring fencing of SLDC is desirable.
  - c. There is a lack of skilled manpower.
  - d. Though most of the SLDC personnel have completed their certificate course in System Operation, there has been no incentive/increment or financial benefit for them.
  - e. Basic amenities like canteen, rest room, pick & drop facilities are not available.
  - f. For enhancing collaboration between LDCs, the SLDCs of a Region and RLDC should meet physically or through VC to have discussion at micro-level with wider participation. Frequent interaction between RLDC and SLDC is required to address operational,

- commercial issues periodically. Best practices sharing. FOLD should discuss issues at macro-level
- g. The major challenges envisaged in Assam are - Integration of Renewable Energy in to the Grid and implementation of various procedures associated with renewable energy generation, Facilitating of open Access, Standardization and Harmonization of state power sector, Energy Accounting Etc.
  - h. Implementation of SAMAST is being undertaken for all NER States on the ULDC model
    - i. To derive mutual benefits, AEGCL provided required land to POSOCO for NERLDC back up control centre.
4. ED, NLDC apprised Chairman AERC regarding the progress of the sub-group work. He also shared the summary of deliberations and key findings of the sub-group.
5. Chairman, AERC appreciated the progress made by the sub-group and stated that-
- a. The independence and financial autonomy of SLDCs is still an issue. A timeline for implementation is desirable
  - b. The existing organization structure in SLDCs needs to be reviewed. SLDCs need to have a separate cadre. The sanctioned posts in an SLDC needs to be upgraded to facilitate career progression of SLDC personnel within SLDC.
  - c. The LDC personnel must be provided with ample opportunities to upgrade their capabilities. The policy of paid Study Leave could be adopted and implemented with appropriate riders
  - d. Without adequate staff several LDCs are unable to nominate personnel for training. Hence adequacy of staff is essential from this perspective also
  - e. Regulatory commissions are ready to support the LDCs. LDC personnel need to express their problems before the Commission for appropriate redressal
  - f. Synergy between grid operator and regulator is needed to implement the regulations.
  - g. The sub-group may suggest a template for ARR to assist the SLDCs in filing their petitions
6. Member AERC stated that
- a. Incentives of LDCs could be linked to achieving Quantitative KPI targets
  - b. Individual KPIs should be linked to the Organizational KPIs
  - c. The LDCs being HR centric, the incentive scheme of LDCs would have to be different from the commercial organizations
7. Chairman of the sub-group thanked all the participants for their contributions.

#### **10<sup>th</sup> meeting (28.09.2018 through VC) - Discussion Summary:**

1. The 10<sup>th</sup> meeting of the FOR Technical Committee Sub-group was organized through video conference on 28<sup>th</sup> September 2018. All other members participated through Video Conference.
2. Chairman of the sub-group apprised the members regarding the deliberations of the 7<sup>th</sup>, 8<sup>th</sup> and the 9<sup>th</sup> meeting of the sub-group held in Shillong / Guwahati. He stated that the sub-group had the privilege to interact with fifteen SLDCs and looked forward to have inputs from SLDC West Bengal.
3. SLDC West Bengal gave shared the salient features of the power system of West Bengal and the HR / infrastructure available in SLDC Howrah. The highlights of the presentation were as under:
  - i. Started functioning from 24.04.2006 under sub-section (1) of section 31 of Electricity Act 2003. Previously it was known as CLD (Central Load Despatch -WBSEB).
  - ii. Main SLDC is at Danesh Sk. Lane, Howrah.
  - iii. New Back-up is at SLDC at Abhikshan Bhavan, Saltlake
  - iv. SLDC coordinates with four distribution licensees, five intra State generating stations, two ISGS (100 % allocation to WB) and five IPPs/CPPs

- v. WBSEDCL is the largest distribution licensee with peak demand met of 6677 MW
  - vi. Apart from the regular functions, the SLDC Howrah carries out State level Energy Accounting , Organizes SLCF and other meetings for better operation of intra-state power system, Administers the UI pool fund, computes and collects Transmission charges, SLDC charges, Meter charges etc. as Nodal agency for Intra-State STOA
  - vii. SLDC Howrah has a dedicated team for compiling and providing daily statistical report to CEA, ERPC, ERLDC and other State authorities. It keeps records of daily, monthly and yearly power system report. It provides statistical data for future system planning
  - viii. Intra-State ABT Mechanism was implemented in January, 2008 while ADMS scheme is in place since 28.11.2016
  - ix. Scheduling is being done in MS Excel
  - x. SLDC oversees the islanding Scheme for two generating stations and one more is under process
  - xi. The Purulia pumped storage station is operated by WBSEDCL (Discom)
  - xii. Real-time monitoring is through 75 nos. RTUs. Installation and commissioning of 46 nos. more RTUs are under process.
  - xiii. PMUs have been installed at seven locations KTPP, BkTPP, PPSP, DURGAPUR, JEERAT, ARAMBAG, KASBA
  - xiv. The HR at SLDC is as under
  - xv. Different applications are being used for Scheduling, Actual meter data processing, Energy Accounting, open Access, Data Management, shutdown and outage management module. SLDC has planned to adopt a comprehensive solution package to combine all the modules in process. For Implementation of ‘SAMAST’ framework at the State Level in West Bengal, proposal has been submitted to PSDF Secretariat for funding from PSDF fund.
4. Chairman thanked the entire team of SLDC Howrah for excellent presentation. He stated that all the LDCs were facing similar challenges.
5. Continuing the deliberations on model regulations on LDC fees and charges, ED NLDC suggested that the sub-group could examine the Terms and Conditions for Determination of Tariff for Airport Operators) Guidelines, 2011. He shared the following links with the members:
- i. <http://aera.gov.in/upload/uploadfiles/files/AERAACCT.pdf> functions of AERA.
  - ii. <http://aera.gov.in/upload/uploadfiles/files/gazette%20rule.pdf> only one regulation related to transaction of business
  - iii. <http://aera.gov.in/upload/uploadfiles/files/guidelines/188.pdf>. Terms and conditions of tariff for airport operators guidelines 2011
  - iv. <http://aera.gov.in/upload/order/54421d422c3cd243.pdf> Aeronautical tariff order for Delhi airport
  - v. <http://aera.gov.in/upload/cp/5b9bac949ac69KannurFinalCP14092018.pdf>. Recent consultation paper on tariff for kannur airport for 2018-23 tariff period
6. Chairman suggested that the members may study the resource material and borrow the best practices from other cybernetics. He said that the report of the sub-group had to be filed within the limited time available.
7. After deliberations it was decided that
- i. The key findings and recommendations of the sub-group could be shared in the upcoming meeting of the Forum of Load Despatchers' scheduled on 01<sup>st</sup> October 2018.
  - ii. The draft report and the model regulations on LDC fees and charges may be put up for discussion in the next meeting of the FOR Technical Committee scheduled on 08<sup>th</sup> October 2018
8. Chairman thanked all the members for participation and their contributions.

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## **Annexure-16: Extracts from CERC Order of 07.05.08 in 58/SM/2008**

Extracts from “*Control Area Concepts and Obligations*” issued by the North American Electricity Reliability Council (NERC) in July 1992 are given in the ensuing paragraphs. This was also endorsed by the CERC in its suo motu order No. 58/2008 in the matter of ‘Clarity regarding control areas and demarcation of scheduling responsibility between RLDCs and SLDCs’ in 7th May 2008

“A control area is obligated to:

- (a) *carefully select and train its system operating personnel. The operation of increasingly sophisticated control centers, which is supported by control equipment, instrumentation, and data presentation systems, and the closer integration of power systems through stronger interconnections, require highly-skilled and extensively-trained personnel. Proper action during a system emergency as well as minute-to-minute operation depends upon prompt, correct human performance.*
- (b) *empower system operators with sufficient authority to take any action necessary to assure that the system or control area for which the operator is responsible is operated in a stable, accurate, and reliable manner. Each control area shall provide its operators with a clear definition of their responsibilities and authority. Each control area shall make other system personnel aware of the authority of the system operators.*
- (c) *select system operators with skills that include directing other personnel and contributing to a positive working environment. Ability to perform under pressure in high-stress situations is of utmost importance. In addition, system operators should possess aptitude for logical problem solving, strong reasoning, and mechanical, electrical, mathematical analysis, communication, supervisory, and decision-making skills. Successful performance in lower-level positions is desirable.*
- (d) *provide each system operator with guidelines for solving problems that can be caused by realistic contingencies and known facility limitations. They shall be thoroughly indoctrinated in the basic principles and procedures of interconnected systems operation.*
- (e) *implement a training program for its operating personnel. This should include both classroom and on-the-job training. Emergencies should periodically be simulated using a simulation training program when possible.”*

## **Annexure-17: FOLD - Charter and Code of Ethics**

### **A. Forum of Load Despatchers - Charter**

#### **1)Vision**

“Forum of Load Despatchers envisions being a catalyst in reliable, efficient and economic operation of the Indian bulk electric power supply system.”

#### **2)Mission**

“Forum of Load Despatchers of India shall strive to achieve its vision through technical cooperation, knowledge sharing, regular interaction, active collaboration, mutual respect, cooperation, consensus building, international benchmarking and promoting ethical, non-discriminatory and fair practices.”

#### **3)Functions**

The functions of the FOLD are outlined as under:

##### **i. Promoting technological excellence**

- a. Helping Load Despatch Centres in Management of Technology (such as forecasting, assessment, adoption, absorption etc.) required for Load Despatch, Communication and Market Operation;
- b. Facilitate better utilization and exploitation of available technologies and tools in System/Market Operation and Logistics;
- c. Conducting research, exploration and trial of promising new technology in the area of System Operation and control in collaboration with educational institutes and vendors.

##### **ii. Promoting harmonization of practices**

- a. Documentation and sharing of best practices in Load Despatch Centres;
- b. Facilitating harmonization of the Grid Codes of power systems connected to the Indian National Grid;
- c. Suggesting Standard Operating Procedures and guidelines for Power System/Market Operation and Logistics;
- d. Facilitating International benchmarking and developing best practices.

##### **iii. Promoting compliance to Reliability Standards**

- a. Developing consensus among Load Despatch Centres on issues relating to reliability of Indian bulk electric power system;
- b. Objective analysis of grid operation related data, near misses/ grid incidents / disturbances and disseminating lessons learned from them with regards to tools, human performance factors, equipment performance etc;
- c. Providing feedback to stakeholders on issues related to resource adequacy, system security and market operation in long-term, medium term and short time horizons;
- d. Developing proposals for reliability standards;
- e. Facilitating compliance to Reliability Standards and Grid Code.

##### **iv. Facilitating development of Ancillary Services in power system**

- a. Suggesting principles, philosophies and proposals for reliable, efficient and transparent delivery of ancillary services in power system;
- b. Helping Load Despatch Centres in streamlining their internal processes for delivery of ancillary services.

##### **v. Promoting capacity building in Power System/Market Operation**

- a. Identification of focus areas for capacity building of human resource in Load Despatch Centres;
- b. Creating opportunities for development of human resource employed at Load Despatch Centres through training, workshops conferences, seminars, visits, expert talks, certification and other activities as deemed fit;
- c. Assimilate and develop electronic resources for learning and knowledge dissemination;

- d. Facilitate the development of faculty of Power System/Market Operation and System Logistics in India.
- e. Evolving a mechanism for rewarding excellence in Load despatching.

**vi. Facilitating information sharing with stakeholders**

- a. Compilation and sharing of information among Forum Members for comparison of performance in all relevant aspects of power system operations and electricity market operations in India and other countries;
- b. Convening public and other information-sharing sessions from time to time that may involve the participation of all stakeholders;
- c. Facilitating information sharing with academic institutions for research in Indian power system.

**vii. Developing Code of Ethics for Load Despatchers in India**

**viii. Development and review of suitable Performance indicators** for assessment of Load Despatch Centres and Load Despatchers in India as well as recognition (by peers) of exemplary contributions by individuals in load despatching.

ix. Deliberating any other issues referred to it by the Forum of Regulators and other stakeholders.

**4)Members**

All the State Load Despatch Centres, Regional Load Despatch Centres and National Load Despatch Centre in India would be members of this forum. FOLD could be invited members from industry and academic institutions.

**5)General Body, Steering Committee and Working Groups**

All the executives working in SLDCs, RLDCs, NLDC would be members of the General Body of Forum of Load Despatchers (FOLD). A Steering Committee comprising of the Head of State/Regional/National Load Despatch Centres or its authorized representative would be constituted to steer the activities of FOLD. Besides these the Steering Committee would constitute Working Groups to advise the Steering Committee on matters related to power system and electricity market operation. The Working Groups would have volunteers/nominated members from the General Body and invited experts.

The Steering Committee subsequent to its constitution may develop Conduct of Business Rules for governance of FOLD in conformity with this charter. The steering committee may also develop a suitable logo for FOLD.

**6) Secretariat**

The secretarial assistance to the FOLD would be provided by the National Load Despatch Centre located in New Delhi.

**7) Regular Reports to Forum of Regulators**

FOLD would submit a detailed report of its activities to Forum of Regulators on half yearly basis in addition to recommendations on various issues.

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**B) Code of Ethics of the Forum of Load Despatchers (FOLD), INDIA**  
**As adopted in the 15th Meeting of FOLD on 3<sup>rd</sup> Aug 2015**

We, the members of the FOLD, in recognition of the importance of our functions in ensuring a secure and economic operation of the electricity grids in India and thereby making an improvement towards humanity, do hereby commit ourselves to the highest ethical and professional conduct and agree:

- 1) To maintain and improve our technical competence and our understanding of appropriate technology/processes, its advantages and limitations and also help colleagues in knowledge management and dissemination of knowledge.
- 2) To strive and evolve a shared vision among all stakeholders
- 3) To accept responsibility in making decisions consistent with the safety, health, and welfare of the public; to recognize that public safety comes first followed by equipment safety and then the safety of the electricity grid.
- 4) To be honest and realistic in stating claims or estimates based on available data; ensure the highest standards of objectivity in both oral and written communication in any form.
- 5) To seek, accept, and offer honest observation of technical work and an healthy respect for others' ideas, to acknowledge and correct errors, and to credit properly the contributions of others;
- 6) To maintain the highest standards of transparency in our day to day functioning
- 7) To be fair and neutral in all interactions without favouring any entity, irrespective of ownership, either through selective disclosure of information or in any other manner.
- 8) To disclose the interest, if any, in any market player either through holding of shares or employment of near members of the family or any other aspect which has the potential to influence decision making.
- 9) To maintain the highest standards of public conduct, never seek favours from any entity in any form including free or reduced fee for any industry sponsored event; observe the member organization's policies strictly in the matter of acceptance of gifts etc.
- 10) Not to discriminate against any person including a fellow worker on the basis of age, sex, caste, religion, position or any other basis; to provide equal opportunity to all sections within the organization.
- 11) To encourage fellow workers, seniors and juniors to observe this Code of Ethics.

## **Annexure-18: Institutional Capacity Building – Literature review**

**The questions that are addressed in this section are as under:**

1. What is capacity?
2. What are the dimensions of capacity at the system level?
3. What are the dimensions of capacity at the entity level?
4. What are the dimensions of capacity at the individual level?
5. What is institutional capacity building?
6. What is capacity development?
7. What are the objectives of capacity development?
8. What is the conceptual framework of capacity development?
9. How to identify the stakeholders in the capacity development programme?
10. Factors that makes a capacity initiative successful?
11. What is governance and how is it related with capacity development?
12. What are capacity development indicators?

**Extracts from Joe Bolger, ‘Capacity Development: Why What and How’, Canadian International Development Agency, Policy Branch, Occasional Series, Vol. 1, No.1, May 2000, [http://www.hiproweb.org/fileadmin/cdroms/Biblio\\_Renforcement/documents/Chapter-1/Chap1Doc1.pdf](http://www.hiproweb.org/fileadmin/cdroms/Biblio_Renforcement/documents/Chapter-1/Chap1Doc1.pdf)**

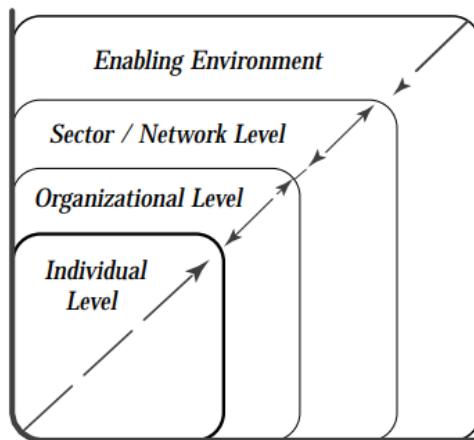
### **Quote**

*Capacity is defined as the : ‘abilities, skills, understandings, attitudes, values, relationships, behaviours, motivations, resources and conditions that enable individuals, organizations, networks/sectors and broader social systems to carry out functions and achieve their development objectives over time’*

*Capacity development refers to the approaches, strategies and methodologies used by developing country, and/or external stakeholders, to improve performance at the individual, organizational, network/sector or broader system level.*

*The objective of capacity development is to: enhance, or more effectively utilize, skills, abilities and resources; strengthen understandings and relationships; and address issues of values, attitudes, motivations and conditions in order to support sustainable development.*

### **Capacity Development: Conceptual Framework**



Unquote

**Extracts from Richard Flaman ‘CAPACITY ASSESSMENT AND DEVELOPMENT In a Systems and Strategic Management Context’ Technical Advisory Paper No. 3 Management Development and Governance Division Bureau for Development Policy, United Nations Development Programme, January 1998**

Quote

*Capacity is defined as the ability of individuals and organisations or organisational units to perform functions effectively, efficiently and sustainably. This implies that capacity is not a passive state but part of a continuing process and that human resources are central to capacity development. The overall context within which organisations undertake their functions are also key considerations in capacity development. Capacity is the power of something (a system, an organisation, a person) to perform or to produce. Capacity development is a concept which is broader than organisational development since it includes an emphasis on the overall system, environment or context within which individuals, organisations and societies operate and interact (and not simply a single organisation).*

*Dimensions of Capacity at the Systems Level*

- Policy Dimension
- Legal/Regulatory Dimension
- Management or Accountability Dimension
- Resources Dimension: (human, financial, information)
- Process Dimension

*Dimensions of Capacity at the Entity Level*

- Mission and strategy
- Culture/Structure and Competencies
- Processes : (internal and external to the entity)
- Human resources
- Financial resources
- Information resources
- Infrastructure

*Often, capacity assessments of individuals are based on an established “job description” or some other format which lays out the performance/ skills requirements of the position and the individual filling that position. This is combined with a skills assessment of the individual. The assessment will demonstrate any “capacity gaps.” Subsequent training and development plans can then be prepared to address these gaps. Increasingly, the dimensions of accountability, performance, values and ethics, incentives and security are becoming ever more important in individual level capacity assessments and technical assistance development programmes. Strategies that stress continuous learning are also important.*

*Factors that makes a capacity initiative successful*

- Visible Leadership
- Organisation - Wide and Participatory
- Open and Transparent
- Awareness and Understanding
- General Buy-in and Acceptance
- Appropriate Methodologies
- Clear Set of Objectives and Priorities
- Clear Management Accountabilities
- Sufficient Time and Resources

*Questions to Help Identify Stakeholders*

- Who makes/influences policy and decisions?
- Who would “champion” the capacity initiative?
- Who could provide financial and technical resources?
- Who would be impacted?
- Who are the direct / indirect beneficiaries?
- Who with no “voice” needs special attention?
- Who are the representatives of those impacted?
- Who is likely to support or oppose the initiative?
- Who is responsible for implementation?
- What political forces are there?

**Extracts from Govindan G. Nair, ‘Nurturing capacity in developing countries From consensus to practice’, Capacity Enhancement Briefs, The World Bank Institute, Nov, 2003, <http://siteresources.worldbank.org/INTCDRC/Resources/CDBrief01.pdf>**

Quote

*There is an emerging consensus that capacity building in developing countries must shift from supplyside, donor-driven to demand-led approaches. Three areas in which this is critical are evaluation capacity, the availability of skilled individuals, and aid management. An effective demand-led approach requires fostering a transparent evaluation culture, focused on poverty impacts and involving participatory approaches. The approach to skilled resources must move from skills acquisition to the retention and use of skills, using the resources of the diaspora, tackling incentives and addressing issues that discourage retention of skills. Recipient countries need to be placed in the “driver’s seat” to manage and coordinate external assistance. There is no single clear path to achievement of these goals. With vigorous political commitment and conducive recipient country circumstances it can take time, and even significant institutional capacity will wither if the governance environment is weak.*

Unquote

**Extracts from M.R. Bhagavan and I. Virgin ‘Generic Aspects of Institutional Capacity Development in Developing Countries,’ Stockholm environment Institute, 2004, <https://pdfs.semanticscholar.org/ecd7/3f3b451762ff60123ce6e801ffd80cac6559.pdf>**

Quote

*Our definition of “institutional capacity” thus encompasses, on the one hand, the functions (tasks) that institutions should have the competence (ability) to perform, and, on the other, the resources (human, technical and financial) and structures they need to that end. For ease of analysis, we subsume relations, rules, values, behaviour, etc. within the concept of “structure”. It will become apparent as we proceed that these defining “capacity components” contain a number of elements that belong to “traditional institutional development”, “governance” and “microeconomics of institutions”. We regard the “development of institutional capacity” as the securing of the resources and structures that are appropriate and essential for satisfactorily performing the functions (tasks) that the institution is mandated to. Since “competence (ability)” refers to the knowledge and skills embodied in individuals, it is subsumed under “resources” as “human resources”. We will use the term “institutional capacity development” to mean not only the building of fresh capacity, but also the strengthening, mobilising and changing of existing capacity.*

Unquote

Quote

*An institution’s capacity can be regarded as being sustainable if, within a longish timeframe, internal and external conditions persist that make it possible for the institution to carry out its critical functions reasonably well. Among the internal conditions that would apply to most institutions are the functional appropriateness of internal structures, tangible and intangible incentives and rewards to employees that ensure involvement and commitment, and penalties for non-performance that are seen as being transparent, fair, impartial and consistent.*

*The creation and maintenance of these internal conditions depend on the structure and character of the institution’s management and its actions. External conditions relate principally to the accessibility of financial and technical resources, which in turn means maintaining one’s relevance and importance for key stakeholders in state and civil society. Conducive external conditions are contingent on the institution’s capability to deliver the expected “outputs” to specified requirements, as well as to identify and meet the demand for “new outputs” that it has the capacity to generate. Some overarching issues that will decisively affect sustainability are an institution’s legal foundation, internal governance, social legitimacy, financial and social accountability, stability and degree of dependence on foreign donors and organisations. Of particular importance will be the proven ability of the institution’s leadership to secure substantial resources (financial and technical) from within the country and the region. An institution or programme that remains almost entirely dependent on foreign donors for a long period of time is very unlikely to become sustainable. Equally crucial would be the leadership’s drive to systematically follow-up and monitor the capacity development efforts.*

Unquote

**Extracts from M. D. Langaas, J. Odeck and K. Bjørvig, ‘The concept of institutional capacity building and review of road sector projects’, Norwegian Public Roads Administration, Norway, [https://www.vegvesen.no/ attachment/112627](https://www.vegvesen.no/attachment/112627)**

Quote

*Institutional Capacity Building (ICB) encompasses three main activities: (i) skill upgrading, (ii) procedural improvements, and organizational strengthening.*

*Institutional Capacity Building refers to investment in people, institutions and practices that will enable developing countries and transition countries to achieve their road sector development objectives.*

*ICB occurs by acquiring resources (human, financial, networks, knowledge, systems and culture) and integrating them in a way that leads to change in individual behaviour and ultimately to more efficient and effective operations of institutions and organizations.*

*However, ICB also has to do with two types of that are emphasized; tangibles and non-tangibles. The tangibles include physical assets such as infrastructure, machinery, natural resources, health of the population and education. Organizational structure and systems, legal frameworks and policies are also included in this category. The tangibles can be referred to as hard capabilities. These are factors that generally are amenable in either physical terms or in terms of indices.*

*The intangibles on the other hand, have to do with social skills, experience, creativity, social cohesion, social capital, values, motivation, habits, traditions, institutional culture etc., and hence can be referred to as soft capabilities. These are normally difficult to quantify. Others may term these capabilities as core capabilities as they refer to the creativity, resourcefulness and capacity to learn and adapt of individuals and social entities. In ICB, the intangibles are as important as the tangibles because they determine how well a given society uses the other resources at its disposal. They are what allow them to realize their human and social potential to the highest possible level.*

*Institutional development is more likely to succeed if it promotes both the tangibles (technical competencies and organizational framework) and intangibles (social arrangements).*

*ICB within the road sector has had success problems primarily because only one of the axes and not both have been emphasized.*

*The ICB concept pursues the same objective, and should thus be seen as a way of promoting and developing good governance and integrity.*

Quote

*“Governance can be defined as a set of traditions and institutions through which authority is exercised with the objective of achieving common good. Good governance and integrity is characterized by transparency, accountability, predictability and credibility..... The ICB concept pursues the same objective, and should thus be seen as a way of promoting and developing good governance and integrity.”*

*Strategies for capacity building*

- *Financial assistance and supply of physical resources*
- *Improving the organizational and technical capabilities of institutions*
- *Setting strategic goals for an institution*
- *Strengthening the larger system, networks and organizational framework*

Unquote

**Extracts from Generic Aspects of Institutional Capacity Development in Developing Countries M.R. Bhagavan and I. Virgin Stockholm Environment Institute  
<https://pdfs.semanticscholar.org/ecd7/3f3b451762ff60123ce6e801ffd80cac6559.pdf>**

Quote

*As Morgan and Qualman (1996) point out in detail, the donors’ journey along the capacity building route has taken them through the three stations of “traditional institutional development”, “governance”, and the Capacity Building of Indian Load Despatch Centres*

Forum of Regulators

*“micro-economics of institutions”*. As conceptualised and practised currently, “capacity building” encompasses the principal features of these three stages, but goes beyond them to a wider perspective that enables involvement based on a deeper systemic “cause and effect” analysis rather than being content with tackling the proximate reasons for poor performance.

In contrast to the “supply” nature of traditional institutional development, the intention of the governance approach is to respond to the “demand” by the above-mentioned stakeholders. Its aim is to promote and strengthen accountability, transparency, legitimacy, pluralism and participation. This in turn compels one to address the question of the “enabling environment” in which these values can take root and flourish, i.e. the political, economic, social and cultural contexts in which the “governance” initiatives are attempted.

Organisational performance is regarded as being strongly influenced by how well the institutional arrangements of ownership and operation are matched with institutional “outputs” in the context in which the institutions are embedded. The intention of the micro-economic approach is to bring market forces and competition to bear on donor programmes and projects, which are seen as “contracts and agreements linking principals and agents, i.e. owners, contractors, consultants, participants and beneficiaries” (Morgan and Qualman, *op cit*).

According to Morgan and Qualman (*op cit*), “traditional institutional development” focuses on what an organisation has in terms of resources and structure, and on how it performs its various functions. It has the character of “organisational engineering” that concentrates on improving administrative procedures through the “supply” of training, technical assistance and some “systems development”.

“The “sustainability” of institutions and their capacities depends upon a host of dynamic factors, not all of which can be foreseen, let alone “managed”. Those who actually implement the process (in particular, the “hands-on” rank and file) would be the best judges of the more decisive factors to concentrate on and the strategies for tackling them.”

Our definition of “institutional capacity” thus encompasses, on the one hand, the functions (tasks) that institutions should have the competence (ability) to perform, and, on the other, the resources (human, technical and financial) and structures they need to that end. For ease of analysis, we subsume relations, rules, values, behaviour, etc. within the concept of “structure”.

#### Generic “Capacity Areas”

- Information and knowledge
- Competence and ability (so-called “human resources development”)
- Governance, institutional economy and institutional finance
  - Efficiency, Solvency and vulnerability, Transparency and accountability, Sustainability
- Technical and infrastructural resources
- Policy arena
- Policy instruments

#### Generic “Capacity Development Indicators”

- Intra- and inter-institutional consensus achieved on matters at hand
- Policies, strategies and regulatory regimes developed and implemented
- Decisions taken and implemented to achieve specific aims, objectives and targets
- Decisions made and implemented in a “participatory” manner
- Actions coordinated involving relevant institutions, actors and stakeholders
- Actions and results monitored, and infringement of agreements dealt with
- Lessons learnt from past efforts and experience, and learned lessons implemented
- Institutions’ personnel motivated and mobilised to perform tasks to agreed standards
- Resources mobilised (internal and external to the institution)
- Audits conducted to given deadlines (audits can be on a variety of things, e.g. levels of outputs or outcomes or impacts, efficiency, performance, costs, benefits, inventories, finance, etc.)
- Surveys, studies and research carried out
- Reports produced, disseminated and published, including articles in peer reviewed professional journals
- Channels of communication established and utilised between relevant institutions, actors and stakeholders

Unquote

# **Annexure-19: Model Fees & Charges Regulations for the LDCs**

## **[.....] Electricity Regulatory Commission**

[Location]

No. ERC /

Dated: ..... /...../20....

### **NOTIFICATION**

In exercise of powers conferred under Section [178/181] of the Electricity Act, 2003 (36 of 2003) read with sub section [4 of section 28/sub section 3 of section 32] thereof and all other powers enabling it in this behalf, and after previous publication, the [.....] Electricity Regulatory Commission hereby makes the following regulations, namely:

### **CHAPTER-1**

#### **PRELIMINARY**

##### **1. Short title and commencement**

- (1) These regulations may be called the [.....] Electricity Regulatory Commission (Fees and Charges of [.....] Load Despatch Centre and other related matters) Regulations, 2019.
- (2) These regulations shall come into effect from the date of their publication in the Official Gazette, and unless reviewed earlier or extended by the Commission, shall be applicable during the control period from 1.4.2019 to 31.3.2024.

##### **2. Scope and extent of application**

These regulations shall be applicable for determination of fees and charges to be collected by the [.....] Load Despatch Centre(s) from the generating companies, distribution licensees, [inter/intra]-State transmission licensees, buyers, sellers and [inter/intra]-State trading licensees and any other users of the respective load despatch centre defined from time to time.

##### **3. Definitions:** In these regulations, unless the context otherwise requires:

- (1) '**Act**' means the Electricity Act, 2003 ;
- (2) '**Additional Capitalization**' means the capital expenditure incurred or projected to be incurred, after the date of commercial operation of the project and admitted by the Commission after prudence check;
- (3) '**Annual LDC Charges (ALC)**': The Annual LDC charges (ALC) shall comprise the aggregate revenue requirement (ARR) for meeting the annual expenditure to be incurred by the [.....] Load Despatch Centre as approved by the Appropriate Commission.
- (4) '**Auditor**' means an auditor appointed by the Load Despatch Centre, qualified for appointment as an auditor in accordance with the provisions of sections 224, 233B and 619 of the Companies Act, 1956 (1 of 1956), as amended from time to time or Chapter X of the Companies Act, 2013 (18 of 2013), or any other law for the time being in force;
- (5) '**Bank Rate**' means the base rate of interest as specified by the State Bank of India from time to time (or any replacement thereof) plus 350 basis points;
- (6) '**Buyer**' means a person buying power through medium term open access or long term access and whose scheduling, metering and energy accounting is coordinated by the [.....] Load Despatch Centre;

- (7) ‘**Capital Cost**’ means the capital cost as defined in Regulation 9 of these regulations;
- (8) ‘**Capital Expenditure**’ or ‘**CAPEX**’ means the expenditure of capital nature planned to be incurred during the control period for creation of assets of the [.....] Load Despatch Centres;
- (9) ‘**Charges**’ means recurring payments on monthly basis to be collected by the [.....] Load Despatch Centres for the services rendered by Load Despatch Centre;
- (10) ‘**Commission**’ means Central Electricity Regulatory Commission referred to in sub-section (1) of section 76 or the State Electricity Regulatory Commission referred to in section 82 or the Joint Commission referred to in section 83 of the Act as the case may be;
- (11) ‘**Contingency Reserve**’ is the reserve to be created and maintained by LDCs from other incomes (other than registration fees and approved annual LDC charges) viz. short term open access application fees and operating charges, REC and PAT charges etc.
- (12) ‘**Contracted Capacity**’ means the capacity arranged through long term access or medium term open access;
- (13) ‘**Control Period**’ means a period of five years starting from 1.4.2019;
- (14) ‘**Day**’ means the 24 hour period starting at 0000 hour;
- (15) ‘**Effective tax rate**’ for tax on return on equity is the rate (in %) calculated on the basis of actual tax paid by the concerned Load Despatch Centre in the respect of the financial year in line with the provisions of the relevant Finance Acts & this shall be in line with the norms defined in terms and conditions of tariff regulations notified by the appropriate commission.
- (16) ‘**Expenditure Incurred**’ means the fund, whether equity or debt or both, actually deployed and paid in cash or cash equivalent, for creation or acquisition of a useful asset and does not include commitments and the liabilities for which no payment has been made;
- (17) ‘**Ergonomics**’ means the science of refining the design of products/Office equipment to optimize them for human use. Human characteristics, such as height, weight, as well as information about human hearing, sight, temperature preferences and so on are considered while choosing the workplace equipment/furniture. Ergonomics is sometimes known as human factors engineering.
- (18) ‘**Fees**’ means the non-refundable one-time or fixed payments collected by the [.....] Load Despatch Centres, or in a defined periodicity, for the services rendered for commencement of grid access and scheduling ,and on account of registration, membership or any other purpose as specified by the Commission from time to time;
- (19) **Forum of Load Despatchers (FOLD)** means the association of load despatchers having NLDC, RLDCs, SLDCs as its members with secretariat office at NLDC and which was constituted by the Forum of Regulators (FOR).
- (20) ‘**Grid Access**’ means the permission granted by the [.....] LDC concerned for integration of the generating station including a stage or unit of the generating station, or licensees, buyers and sellers with the grid on meeting the technical requirements;
- (21) ‘**LDC Empowerment Reserve**’ is the reserve to be created and maintained by the [ ]LDC for administering capital expenditure & other expenses as approved by the [ ] Commission
- (22) ‘**Licensee**’ means a person granted a license under Section 14 of the Act;
- (23) ‘**Logistics Function**’ means support functions for Load Despatchers including but not limited to the

following:

- (a) Engineering of new SCADA/EMS/WAMS/REMC upgrades
  - (b) Maintenance of SCADA/EMS/WAMS/REMC infrastructure
  - (c) Synchro-phasor technologies
  - (d) Real time software applications
  - (e) Off-line software applications
  - (f) Big Data Analytics tools
  - (g) Decision Support Systems
  - (h) IT, Networking and Communication systems including websites, Wi-Fi access systems, cyber security & other related systems
  - (i) Conference & meeting related facilities including audio-visual equipment such as video conference equipment etc.,
  - (j) Power supply system
  - (k) Fire fighting
  - (l) Ergonomics
  - (m) Public Address System
- (24) '**Market Operation Function**' includes but not limited to the following functions:
- (a) Facilitating Grid Access to new entities including but not limited to first time charging of elements
  - (b) Feedback in respect of Market Design, for complementing reliability and causing economy
  - (c) Open Access Administration,
  - (d) Finalization of Inter-change schedules for energy accounting
  - (e) Day Ahead Market,
  - (f) Real Time Market,
  - (g) Ancillary Services Market,
  - (h) Interface Energy Metering,
  - (i) Registry Function under REC / PAT and similar other functions as directed by the Commission
  - (j) Information dissemination.
  - (k) Any other functions assigned to the [...] LDCs under the Act and/or National Load Despatch Centre Rules, 2005 ('NLDC Rules') or the regulations and orders issued by the Commission from time to time;
- (25) '**National Load Despatch Centre**' or '**NLDC**' means the Centre at the national level established by the Central Government under sub-section (1) of section 26 of the Act;
- (26) '**Other Support Functions**' of the [...] Load Despatch Centre including but not limited to taxation and TDS Reconciliation, Accounting, Settlement, Billing & Collection, Contracts, human resource administration, management information system, legal & regulatory affairs, policy advocacy, etc.
- (27) '**Power System Operation Corporation Limited**' or '**POSOCO**' means a company entrusted with the operation of the National Load Despatch Centre in accordance with Section 26 of the Act and Regional Load Despatch Centres in accordance with Section 27 of the Act or any other related function assigned by the Govt./ Commission from time to time;
- (28) '**Region**' means any one of the regions demarcated by the Central Government under Section 25 of the

Act;

- (29) '**Regional entity**' means an entity whose scheduling, metering and energy accounting is done at the regional level by the concerned Regional Load Despatch Centre;
- (30) '**Regional Load Despatch Centre**' or '**RLDC**' means the Centre for each region established by the Central Government under sub-section (1) of section 27 of the Act;
- (31) '**Replacement Expenditure**' or '**REPEX**' means the expenditure incurred or projected to be incurred for replacement of capital assets on completion of their useful life but are not covered under the Repairs and Maintenance expenses;
- (32) '**Regulatory Pool Account**' means the account operated by the [...] LDC under the relevant regulations or orders by the Commission for handling Deviation Settlement Charges, Reactive Energy Charges, Ancillary Services Operation, Congestion Charges and Congestion Revenue amount due to market splitting or any other pool account / market product which may be operated by the [...] LDC from time to time as per the Regulations or directions of the Commission.
- (33) '**Scheme**' means the facilities and equipment associated with and installed at the [...] Load Despatch Centre and Corporate office of Load Despatch Centre (if applicable), as the case may be, and shall include but shall not be limited to the following, namely: -
  - i) Supervisory control and data acquisition (SCADA) System, Wide Area Measurement System (WAMS), Renewable Energy Management Centre (REMC), Weather Portal and other such related information systems
  - ii) Computer systems, hardware and software, Cyber Security Systems, Multiple Video conferencing facilities, Voice Recording Systems
  - iii) Ergonomically designed office furniture/equipment
  - iv) Auxiliary power supply system comprising Uninterrupted Power Supply, Diesel Generating Set and DC power system,
  - v) Communication system including redundant communication infrastructure – Satellite communication in addition to conventional systems,
  - vi) Other infrastructure facilities, such as air-conditioning, fire-fighting and construction and renovation of buildings, roof-top solar units for energy efficiency etc.
  - vii) Any innovative schemes R & D projects and pilot projects for better system operation, such as Synchro-phasors, System Protection Scheme,
  - viii) Disaster Recovery (Main-I & Main-II) control centres for the [...] LDCs,
  - ix) Surveillance System,
  - x) Dual redundant internet connectivity for Web Servers of LDCs
  - xi) NMS (Network Management System) & Asset management tool for Network & IT Asset Monitoring
  - xii) Cyber Security System infrastructure facilities such as Anti-APT (advanced Persistent Threat) monitoring, Vulnerability Assessment for Persistent Threat (VAPT) & control Device, Local Area Network (LAN) Zone & Layer, Secure Sockets Layer (SSL) Certificate , SSL Virtual Private Network (VPN) and Security Information & Event Management (SIEM)
  - xiii) Infrastructure to ensure high availability of the Information Technology (IT) and Operational

Technology (OT) applications:

- a) Redundant communication links / distribution path for IT / OT equipment
  - b) Redundant site infrastructure – DR
  - c) Multiple independent distribution path serving the equipment
  - d) Dual powered and fully compatible with the site topology
  - e) Cooling equipment dual powered including air-conditioning system
  - f) Fault tolerant site infrastructure with electrical power storage, standby power supply, distribution facility
  - g) Physical access security needs to be ensured for IT – OT infrastructure with biometric access, CCTV surveillance, fire alarm and firefighting system.
- xiv) Additional infrastructure facilities like ‘Digital Signature’, ‘Instant Messaging for Business’, ‘Centralized Patch Management and Antivirus server’, ‘Syslog Server’ and ‘Enterprise class Backup and replication software’ etc.
- xv) Future Technologies like Cloud Computing (e.g. PaaS (Platform as a Service), SaaS (Software as a Service), DaaS (Desktop as a Service) and are available on Public Cloud, Private Cloud and Hybrid Cloud), Big Data Analytics tools and Advanced data visualization tool (with GIS interfacing) etc.
- xvi) Ergonomically designed office equipment
- (34) ‘Seller’ means a person other than a generating company supplying power through medium term open access or long term access and whose scheduling, metering and energy accounting is coordinated by [.....] Load Despatch Centre;
- (35) ‘State Entity’ means an entity whose scheduling, metering and energy accounting is done at the intra-state level by the concerned State Load Despatch Centre
- (36) ‘State Load Despatch Centre (SLDC)’ means the center established under subsection (1) of section 31 of the Electricity Act, 2003;
- (37) ‘System Operation Function’ includes but not limited to the following;
- a) **Operational Planning**
    - i) Load Forecasting
    - ii) RE forecasting
    - iii) Fuel security assessment
    - iv) Production cost optimization studies
    - v) Generating outage planning
    - vi) Transmission outage planning
    - vii) Assessment of Transfer Capability
    - viii) Reactive Power studies
    - ix) Short circuit and transient stability studies
    - x) small signal stability studies
    - xi) Electromagnetic transient studies
    - xii) Mock black start drills
    - xiii) Activation of back up control centre

- xiv) Preparations for special events like festivals, natural calamities like cyclone, floods etc.
- xv) Documentation of procedures (operating, restoration)

**b) Scheduling & Despatch on day-ahead & real time basis**

- i) Day ahead security studies factoring all outages
- ii) Unit commitment
- iii) Day ahead optimization and scheduling
- iv) Shift Crew Resource Management
- v) Anticipating and mitigating congestion
- vi) Preparation for special events
- vii) Handling requests for emergency/urgent outages unforeseen in operational planning horizon

**c) Real Time Operation**

- h) Frequency Control
- ii) Voltage control
- iii) Tie line loading control
- iv) Congestion management
- v) Ensuring security at all times
- vi) Ancillary Services
- vii) Balancing Services, Automatic Generation Control
- viii) Real Time Contingency Analysis
- ix) Dynamic Security Assessment
- x) Monitoring weather updates
- xi) Handling emergency outage requests
- xii) Restoration of network after tripping
- xiii) Rescheduling of generation
- xiv) Reporting of a grid disturbance (GD)/grid incident (GI)
- xv) Periodic communication with stakeholders and sensitizing in case of emergency
- xvi) De-briefing after an extreme event

**d) After the Fact or Post Despatch Analysis:**

- i) Analysis of frequency and voltage
  - ii) Analysis of Grid Code violations and follow up with agencies
  - iii) Analysis of Grid Events (GD/GI)
  - iv) Evaluating primary response viz.computation of Frequency Response Characteristics (FRC) of individual control areas
  - v) Low Frequency Oscillations (LFO) monitoring and analysis
  - vi) Detailed reports of Grid Disturbances/Grid Events
  - vii) Simulation of events and learnings thereof
  - viii) Event replay, lessons learnt and dissemination of same
  - ix) Taking up shortcomings with stakeholders
- e) Submission of Operational feedback to CEA/CTU/STU/CERC/SERC
- f) Information dissemination and any other function(s) assigned to the [...] LDC, as the case may

be, under the Act or [...] LDC Rules or regulations and/or orders issued by the Appropriate Commission from time to time;

- (38) ‘User’ means the generating companies, distribution licensees, buyers, Bulk consumers (SEZ), sellers and [inter/intra]-State transmission licensees, Demand Response Consumers, Qualified Coordinating Agency (QCA), Electric Vehicle (EV) Charging Stations, Grid Reliability Service users like the National High Power Test Laboratory (NHPTL) or any other such existing (or envisaged in future) entity who use the [inter/intra]-state transmission network or the associated facilities and services of [...] Load Despatch Centre:

**Note:**

- (1) A generating station or unit whose scheduling, metering and energy accounting is carried out separately for each stage or unit, such generating station or stage or unit shall be considered as a user for the purpose of sharing of Annual LDC Charges (ALC) in accordance with Regulation 25 of these Regulations and for payment of registration fees in accordance with Regulation 23 of these Regulations;
  - (2) In case of [inter/intra]-State transmission licensees, each [Region/State] where the licensee has the operation shall be considered as a user for the purpose of these Regulations;
  - (3) Where the inter-State Transmission System is having cross-border international connections, the agency designated by Government of India for coordinating the scheduling, metering and energy accounting for the transaction carried out for import and export of power through the said transmission system shall be considered as a user for the purpose of these Regulations;
  - (4) Where any international/cross border generating station is connected to the inter-state transmission system of the Indian National Grid and injecting power through medium and/or long term PPA, the agency designated by Government of India for coordinating the scheduling, metering and energy accounting for the transaction carried out for import and/or export of power through the said transmission system shall be considered as a user for the purpose of these Regulations;
  - (5) The Sardar Sarovar Project (SSP) and Bhakra Beas Management Board (BBMB), whose scheduling, metering and energy accounting is carried out by the concerned RLDCs, shall be considered as users of the respective Load Despatch Centres for the purpose of this Regulation;
  - (6) Distribution licensee selling power through LTA/MTOA and using transmission system shall be considered as a user under the category “Seller” for the purpose of these Regulations;
  - (7) Any other entity which may use services of the [...] Load Despatch Centres from time to time;
- (39) ‘Year’ means a financial year;
- (40) The words and expressions used in these regulations and not defined herein but defined in the Act shall have the meaning assigned to them under the Act or the CERC (Indian Electricity Grid Code) Regulations 2010 as amended from time to time.

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## **CHAPTER-2**

### **GENERAL**

#### **4. Registration**

(1) The users shall register with the respective [.....] load Despatch Centre (LDC) for commencement of Grid Access for availing system operation services of [.....] LDC as under:

(a) All generating stations, distribution licensees and [inter/intra]-State transmission licensees or any other user defined under clause 3(38) of these regulations intending to avail the Grid Access shall register themselves with concerned [.....] Load Despatch Centre responsible for scheduling, metering, energy accounting and switching operations, not less than 30 days prior to intended date of commencement of Grid access, by filing an application in the format prescribed as **Appendix-IV** to these regulations:

Provided that when a unit is added to a generating station, the generating company, as the case may be, shall send an intimation to the concerned [.....] LDC by 20<sup>th</sup> day of every month for updating its records;

Provided that when an element is added to a transmission system, transmission licensee shall send intimation to the concerned [.....] LDC for updating its records by 20<sup>th</sup> day of every month.

(b) The buyers and sellers who intend to avail grid access shall register themselves with the concerned [.....] Load Despatch Centre not less than 30 days prior to intended date of commencement of grid access by filing an application in the format prescribed as **Appendix-IV** to these regulations;

(c) The Power exchanges and traders who intend to avail the services of [...] LDCs shall register themselves with the National Load Despatch Centre and [...] Load Despatch Centre by filing an application in the format prescribed as Appendix-IV to these regulations.

(2) The [.....] Load Despatch Centre, as the case may be, after scrutinizing applications for registration and on being satisfied with correctness of the information furnished in the application shall register the applicant and send a written intimation to the applicant:

(3) The generating companies, distribution licensees, [inter/intra]-State transmission licensees, power exchanges, traders, sellers and buyers and any other user as specified in Regulation 3(38) shall pay the registration fees as specified in these Regulations.

(4) [.....] Load Despatch Centre shall maintain a list of registered users on their website along with their date of registration.

#### **5. Capital Expenditure (CAPEX) and Replacement Expenditure (REPEX) Plan:**

- (1) The [.....] Load Despatch Centre shall formulate the scheme for Capital Expenditure (CAPEX) and Replacement Expenditure (REPEX) for the control period duly approved by the Board of Directors / Appropriate Approving Authority of the Load Despatch Centre. The CAPEX and REPEX plan shall also include future costs to be incurred for the up-gradation, modernization, automation and expansion of infrastructure in addition to existing capital assets.
- (2) The concerned [.....] Load Despatch Centre shall submit the following along with the petition for determination of fees and charges:

- (a) the CAPEX for the control period along with details of estimated expenses, financing plan and estimated completion period of each scheme ;
  - (b) the REPEX plan for capital expenditure of existing asset, completion of life of existing asset, cumulative depreciation recovered, date of replacement, cumulative repayment of loan up to date of replacement, writing off of the gross value of the original assets from the original fixed assets along with estimated expenses and estimated completion period of each scheme.
- (3) In relation to any consolidated schemes of CAPEX and REPEX involving one or more LDCs the capital expenditure chargeable to each LDC shall be segregated and considered as a part of capital expenditure of the LDC concerned as the case may be (Applicable only to RLDCs and NLDC or in cases of multiple LDCs in one State).

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## **CHAPTER-3**

### **APPLICATION FOR FEES AND CHARGES DETERMINATION**

#### **6. Application for determination of fees and charges**

- (1) The [.....] LDC shall make application in the formats annexed as **Appendix-I** to these regulations within 180 days from the date of notification of these Regulations, for determination of fees and charges for the control period, based on the capital expenditure incurred and duly certified by the auditor as on 1.4.2019 and projected to be incurred during the control period based on the CAPEX and the REPEX; other approved expenditures viz. Human Resource expense, Operation & Maintenance, Interest on working capital etc.
- (2) The application shall contain particulars such as source of funds, equipment(s) proposed to be replaced, details of assets written off, and details of assets to be capitalized etc.
- (3) Before making the application, the concerned [.....] LDC, as the case may be, shall serve a copy of the application on the users and submit proof of service along with the application. The concerned [.....]LDC shall also keep the complete application posted on its website till the disposal of its petition.
- (4) The concerned [....] LDC, as the case may be, shall within 7 days after making the application, publish a notice of the application in at least two daily newspapers, one in English language and one in Indian modern language, having circulation in each of the States or Union Territories where the users are situated, in the same language as of the daily newspaper in which the notice of the application is published, in the formats given in **Appendix-II** to these regulations. The [....] LDC will recover such expenditure on publication of notice of the application from the Users, on pro rata basis, as one-time expenditure.
- (5) The concerned [.....]LDC, as the case may be, shall be allowed the fees and charges by the Commission based on the capital expenditure incurred as on 1.4.2019 and projected to be incurred during control period on the basis of CAPEX and REPEX duly certified by the auditor in accordance with these Regulations:

Provided that the application shall contain details of underlying assumptions and justification for the capital expenditure incurred and the expenditure proposed to be incurred in accordance with

the CAPEX and REPEX.

- (6) If the application is inadequate in any respect as required under **Appendix-I** of these regulations, the application shall be reverted back to the concerned [.....] LDC for resubmission of the petition after rectifying the deficiencies as may be pointed out by the Commission.
- (7) The Commission shall consider the suggestions and objections, if any, received from the respondents and any other person including the consumers or consumer associations. The Commission shall issue order determining the fees and charges order after hearing the petitioner, the respondents and any other person permitted by the Commission.
- (8) During pendency of the application, the applicant shall continue to bill the users on the basis of fees and charges approved by the Commission during previous control period and applicable as on 31.3.2019, for the period starting from 1.4.2019 till approval of the Fees and Charges by the Commission, in accordance with these Regulations. This shall be subject to true up as approved by the Commission for the Control Period 2019-2024.
- (9) After expiry of the control period, the applicant shall continue to bill the users on the basis of fees and charges approved by the Commission and applicable as on 31.3.2024 for the period starting from 1.4.2024 till approval of fees and charges under the applicable regulations.

## **7. Determination of Fees and Charges**

- (1) The Fees and Charges shall be determined separately for the [.....] Load Despatch Centres; Provided that the annual charges of NLDC including corporate office expenses for the control period shall be apportioned among Regional Load Despatch Centre on the basis of the peak demand served (in MW) in the respective region as indicated on CEA's website for the preceding year (applicable only to NLDC & RLDCs).

## **8. Truing up of Annual Charges**

- (1) The [.....] LDCs shall make an application, in the formats annexed as Appendix-I to these regulations by 31.10.2024, for carrying out truing up exercise after end of the control period.
- (2) The [.....]LDCs shall submit, along with the application for truing up, details of capital expenditure including additional capital expenditure, sources of financing, human resource expenditure, operation and maintenance expenditure etc. incurred for the period from 1.4.2019 to 31.3.2024, duly audited and certified by the auditor.
- (3) The Commission shall carry out truing up exercise along with the application for determination of fees and charges for the next control period based on the capital expenditure including additional capital expenditure incurred up to 31.3.2024 and as admitted by the Commission after prudence check at the time of truing up:

Provided that the [.....]Load Despatch Centre, as the case may be, shall carry out annual reconciliation and provisional truing up of expenditure based on the capital expenditure including additional capital expenditure up to 31<sup>st</sup> March of each financial year of the control period and refund the additional recovery of fees and charges to the users by 30<sup>th</sup> September of the following year.

Provided that the [.....] Load dispatch centre, as the case may be shall carry out mid-term review of its expenses at any point of time within the control period, if the same is felt necessary in view of the

emergent situation such as pay revision, significant deviation w.r.t. approved CAPEX/REPEX or any other unforeseen requirement etc., and may suitably file the Mid Term Review Petition before the appropriate commission.

- (4) The amount under-recovered or over-recovered by the [....] Load Despatch Centres, along with simple interest at the rate equal to the bank rate as on 1<sup>st</sup> April of the respective year, shall be recovered or refunded by the respective [....] LDC within three months from the date of the order issued by the Commission after the truing up exercise.

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## **CHAPTER-4**

### **COMPUTATION OF CAPITAL COST AND ADDITIONAL CAPITALISATION**

#### **9. Computation of Capital Cost**

- (1) The capital cost as admitted by the Commission after prudence check, for the [....] Load Despatch Centre, shall form the basis for determination of annual charges.
- (2) The capital cost shall be computed by considering the following:
- i) The Capital cost as admitted by the Commission as on 01.04.2019 duly trued up by excluding liability, if any;
  - ii) Expenditure on account of additional capitalization and de-capitalization determined in accordance with the Regulation 10;
  - iii) The original capital cost of the fixed assets which has been replaced during control period shall be de-capitalized from the admitted capital cost from the respective date duly adjusting cumulative depreciation and cumulative loan repayment, if any;
  - iv) Interest during construction and incidental expenditure during construction;
  - v) Any grant received from the Central or State Government or any statutory body or authority for execution of the project which does not carry any liability of repayment shall be excluded from the Capital Cost for the purpose of computation of interest on loan, return on equity and depreciation;
- (3) The Capital cost shall be admitted after prudence check which may include scrutiny of the reasonableness of the capital expenditure, financing plan, Interest During Construction (IDC), Incidental Expenditure During Construction (IEDC), financing charges, any gain or loss on account of Foreign Exchange Rate Variation (FERV), and such other matters as may be considered appropriate by the Commission:

Provided further that interest during construction shall be computed corresponding to the loan from the date of infusion of debt fund, and after taking into account the prudent phasing of funds duly adjusting IDC on account of time over run if any;

Provided further that incidental expenditure during construction shall be computed after prudence check duly adjusting the IEDC on account of time over run if any, interest on deposits or advances, or any other receipts and liquidated damages recovered or recoverable corresponding to the delay.

#### **10. Additional Capitalization and De-Capitalization**

- (1) The capital expenditure incurred or projected to be incurred for the assets already in service and the

additional assets projected to be procured during tariff period may be admitted, in its discretion, by the Commission, subject to prudence check.

- (2) In case of de-capitalization of assets under the REPEX or otherwise, the original cost of such asset as on the date of de-capitalization shall be deducted from the value of gross fixed asset along with corresponding adjustment in equity, outstanding loan, cumulative repayment of loan and depreciation in the year such de-capitalization takes place.

## **11. Debt-Equity Ratio**

- (1) The actual debt - equity ratio as admitted by the Commission for the period ending 31.3.2019 shall be considered for the opening capital cost of the [...] Load Despatch Centre for the next control period:

Provided that, if on the date of notification of these regulations, the accounts of the LDC(s) are not separated from the parent organization(s), the actual debt: equity ratio appearing in the books of accounts as on the date of transfer shall be considered for the opening capital cost of the Load Despatch Centre.

- (2) The capital expenditure incurred prior to 1.4.2019, where debt - equity ratio has not been determined by the commission for determination of annual charges of the [...] LDC for the period ending 31.3.2019, the commission shall determine the debt: equity ratio in accordance with the *previous control period LDC fees & charges regulations of the Commission* i.e. Regulation [...] of the [...] Electricity Regulatory Commission (Fees and Charges for [...] Load Despatch Centres and other related matters) Regulations:

Provided that if no previous period regulation on LDC fees & charges is available, the commission shall determine the debt:equity ratio as per the existing tariff determination norms for the parent organization.

- (3) For the capital expenditure incurred or projected to be incurred on or after 1.4.2019, the debt-equity ratio shall be considered as 70:30. If the equity actually deployed is more than 30% of the capital cost, equity in excess of 30% shall be treated as normative loan:

Provided that:

- i. where equity actually deployed is less than 30% of the capital cost, actual equity shall be considered for determination of Return on Equity;
- ii. the equity invested in foreign currency shall be designated in Indian rupees the date of each investment;
- iii. any grant obtained for the execution of the project shall not be considered as a part of capital structure for the purpose of debt - equity ratio.

**Explanation:** The premium, if any, raised by the [...] Load Despatch Centre while issuing share capital and investment of internal resources created out of its free reserve, for the funding of the project, shall be reckoned as paid up capital for the purpose of computing return on equity, only if such premium amount and internal resources are actually utilized for meeting the capital expenditure of the [...] LDC.

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## **CHAPTER-5**

### **[...] LDC FEES AND CHARGES STRUCTURE**

- 12. Components of [...] LDC Fees and Charges:** The [...] LDC Fees and Charges shall comprise [...] Load Despatch Centre Fees to be recoverable by the [...] Load Despatch Centre towards registration for commencement of grid access and scheduling and annual charges to be collected in the form of Annual LDC Charges from users.
- 13. Annual LDC Charges (ALC):** The annual LDC charges shall correspond to the expenditure proposed to be incurred by the [...] LDC and as approved by the appropriate Commission. The annual LDC charges (ALC) as approved by the Appropriate Commission shall be recovered on monthly basis. The annual charges shall consist of the following components, namely:
  - (a) Return on equity;
  - (b) Interest on loan capital;
  - (c) Depreciation;
  - (d) Operation and maintenance (excluding human resource) expenses including:
    - Administrative and General Expenses (excluding HRD expenses);
    - Repair and Maintenance Expenses;
  - (e) Human resource (HR) expenses including Human Resource Development (HRD) expenses;
  - (f) NLDC & Corporate office expenses [applicable only for RLDCs] or RLDC Charges (applicable only for SLDCs) and
  - (g) Interest on working capital;
  - (h) Statutory Taxes & Duties
  - (i) Any other incidental expenses incurred for discharging any responsibility assigned by statutory bodies

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## **CHAPTER-6**

### **COMPUTATION OF ANNUAL LDC CHARGES (ALC)**

- 14. Return on Equity**
  - (1) Return on equity shall be computed in Rupee terms on the equity base determined in accordance with Regulation 11 of these regulations.
  - (2) Return on equity shall be computed on pre-tax base rate of [...] % to be grossed up as per the sub-clause (3) of this regulation.
  - (3) The rate of return on equity shall be computed by grossing up the base rate with the effective tax rate of the financial year 2019-20 applicable to the [...] Load Despatch Centre:  
Provided that the return on equity with respect to the actual tax rate applicable to the [...] Load Despatch Centre in line with the provisions of the relevant Finance Acts of the respective year during control period shall be true up at the end of the control period.
  - (4) Rate of return on equity shall be rounded off to three decimal points and be computed as per the following formula:

$$\text{Rate of pre-tax return on equity} = \text{Base rate} / (1-t)$$

Where ‘t’ is the effective tax rate in accordance with sub-clause (3) and regulation 3(15).

## **15. Interest on Loan Capital**

- (1) The loan determined in accordance with Regulation 11 shall be considered as gross normative loan for calculation of interest on loan.
- (2) The normative loan outstanding as on 01.04.2019 shall be worked out by deducting the cumulative repayment as admitted by the Commission up to 31.03. 2019 from the gross normative loan.
- (3) The repayment for respective year of the control period shall be deemed to be equal to the depreciation allowed for that year. In case of de-capitalization of assets, the repayment shall be adjusted by taking into account cumulative repayment on a pro-rata basis and the adjustment should not exceed cumulative depreciation recovered up to the date of de-capitalization of such asset.
- (4) The rate of interest shall be the weighted average rate of interest calculated on the basis of the actual loan portfolio at the beginning of each year applicable to the respective [...] Load Despatch Centre:

Provided that if there is no actual loan for a particular year but normative loan is still outstanding, the last available weighted average rate of interest shall be considered;

Provided further that if any of the [...] Load Despatch Centre does not have actual loan, then the weighted average rate of interest on the loan of [...] Load Despatch Centre as a whole shall be considered.
- (5) The interest on loan shall be calculated on the normative average loan of the year by applying the weighted average rate of interest.
- (6) The [...] Load Despatch Centre shall make every effort to re-finance the loan as long as it results in net savings on interest and in that event the costs associated with such re-financing shall be borne by the users and the net savings shall be shared between the users and the [...] Load Despatch Centre in the ratio of 2:1. The changes to the terms and conditions of the loans shall be reflected from the date of such re-financing.
- (7) In case of dispute, any of the parties may make an application in accordance with the [...] Electricity Regulatory Commission (Conduct of Business) Regulations, [Year], as amended from time to time, including statutory re- enactment thereof, for settlement of the dispute:

Provided that the users shall not withhold any payment on account of the interest claimed by the users and the [...] Load Despatch Centre] during the pendency of any dispute arising out of re-financing of loan.

## **16. Depreciation**

- (1) The value base for the purpose of depreciation shall be the capital cost of the assets admitted by the Commission.
- (2) The salvage value of the asset (excluding IT equipment and Software) shall be considered as 10% and depreciation shall be allowed up to maximum of 90% of the capital cost of the asset. The salvage value for IT equipment and software shall be considered as NIL and 100% value of the assets shall be considered as depreciable.
- (3) Land shall not be a depreciable asset and its cost shall be excluded from the capital cost while computing depreciable value of the capital cost of the asset.

- (4) Depreciation shall be calculated annually based on Straight Line Method and at rates specified in Appendix-III to these regulations for the assets of the [...] Load Despatch Centre.
- (5) Assets fully depreciated shall be shown separately.
- (6) Value of the assets not in use or declared obsolete shall be taken out from the capital cost for the purpose of calculation of depreciation.
- (7) The balance depreciable value as on 1.4.2019 shall be worked out by deducting the cumulative depreciation from the gross depreciable value of the assets appearing in the books of accounts of the [...] Load Despatch Centre for the respective [...] Load Despatch Centre.
- (8) In case of de-capitalization of assets in respect of concerned [...] LDC, the cumulative depreciation shall be adjusted by taking into account the depreciation recovered in tariff by the de-capitalized asset during its useful services.

## **17. Operation and Maintenance Expenses**

- (1) Operation and maintenance (O&M) expenses (excluding human resource expenses) shall be derived on the basis of actual operation and maintenance expenses for the years 2014-15 to 2018-19, based on the audited balance sheets. The O&M expenses shall be normalized by excluding abnormal operation and maintenance expenses, donation, loss-in-inventory, prior-period adjustments, claims and advances written-off, provisions, etc., if any, after prudence check by the Commission
- (2) The normalized operation and maintenance expenses, after prudence check, for the years 2014-15 to 2018-19, shall be escalated at the rate of [.....%] to arrive at the normalized operation and maintenance expenses at the 2018-19 price level respectively and then averaged to arrive at normalized average operation and maintenance expenses for the 2014-15 to 2018-19 at 2018-19 price level. The average normalized operation and maintenance expenses of 2018-19 price level shall be escalated at the escalation rate as worked out in accordance with clause (4) of this Regulation to arrive the operation and maintenance expenses for the year 2019-20.
- (3) The operation and maintenance expenses for the year 2019-20 shall be escalated further at the annual escalation rate as worked out in accordance with clause (4) this Regulation to arrive at permissible operation and maintenance expenses for the subsequent years of the control period.
- (4) The escalation rate shall be worked out by considering the compounded annual growth rate, inflation rate, rationalization of O&M expenses and other factors, if any.
- (5) The actual expenditure towards Annual Maintenance Contract (AMC) of SCADA system, after prudence check, shall be considered for arriving at the Operation and Maintenance Expenses during 2019-20 to 2023-24.

## **18. Human Resource Expenses**

- (1) Human resource expenses shall be derived on the basis of actual human resource expenses for the years 2014-15 to 2018-19 based on the audited balance sheets. The human resource expenses shall be normalized by excluding abnormal Human resource expenses, ex-gratia, VRS expenses, prior-period adjustments, claims and advances written-off, provisions, etc., if any, after prudence check by the Commission:
- Provided that the expenses towards payment of Certificate Retainer-ship amount would be a part of the Human Resource Expenses.

Provided that performance related pay computed in accordance with DPE /other applicable guidelines shall be met from the incentive allowed in accordance with Regulation 27 of these Regulations.

- (2) The normalized human resource expenses, after prudence check, for the year 2014-15 to 2018-19, shall be escalated at the rate of [.....% ]to arrive at the normalized human resource expenses at the 2018-19 price level respectively and then averaged to arrive at normalized average human resource expenses for the 2014-15 to 2018-19 at 2018-19 price level.
- (3) The manpower approved during the year 2018-19 shall be the basis for computation of the HR expenses for 2019-20. Thereafter, for the subsequent years, the HR expenses shall be escalated at the annual escalation rate.
- (4) The average normalized human resource expenses of 2018-19 price level shall be escalated at the escalation rate as worked out in accordance with clause (6) this Regulation to arrive the operation and maintenance expenses for the year 2019-20.
- (5) The human resource expenses for the year 2019-20 shall be escalated further at the annual escalation rate as worked out in accordance with clause (6) this Regulation to arrive at permissible human resource expenses for the subsequent years of the control period:
- (6) The escalation rate shall be worked out by considering the compound annual growth rate, inflation rate, rationalization of human resource and other factors, if any.
- (7) The cost of anticipated increase in the manpower of each year of the control period shall also be considered after prudence check. The strength of manpower required for effective functioning of [...] LDC will be as approved by the Appropriate Commission while specifying the fees and charges.
- (8) Human Resource Development (HRD) expenses, incurred by the [...] LDC will be a part of HR Expenses from FY 2019-20 onwards. In addition to the capacity building of the employees of LDC, capacity building workshops / training programs organized for other stakeholders will also form part of the HRD expenses. Projected annual HRD expenses will be at least 5% of the HR expenses arrived based on the methodology defined above. However, if the actual utilization towards HRD expenditure exceeds the 5% of HR expenses of any year, it shall be allowed at the time of truing up by the Commission after prudence check. In case of less than 5% utilization, it shall be refunded at the time of annual truing up. All efforts shall be made to ensure minimum seven days training per employee per annum is imparted as per the National Training Policy.

## **19. Interest on Working Capital**

- (1) The working capital shall cover:
  - (i) Operation and maintenance expenses (excluding human resource expenses) for one month;
  - (ii) Human resource expenses including Human Resource Development Expenses for one month;
  - (iii) NLDC charges for one month (applicable to RLDCs only); and/or
  - (iv) RLDC charges for one month (applicable to SLDCs only); and
  - (v) Receivables equivalent to two months of annual charges as approved by the Commission.
- (2) Rate of interest on working capital shall be on normative basis and shall be considered as the bank rate as on 1.4.2019.
- (3) Interest on working capital shall be payable on normative basis notwithstanding that the [...] Load Despatch Centre] has not taken any loan for working capital from any outside agency.

**20. NLDC Charges and Corporate Office Expenses [only for RLDCs] / RLDC Charges [only for SLDCs]**

- (1) To the extent applicable, NLDC charges shall be computed by following the methodology specified for computing annual charges of Regional Load Despatch Centres except interest on working capital.
- (2) The Corporate Office Expenses, computed in accordance with the actual expenses incurred, shall be allowed by the Commission, after prudence check.
- (3) The expenditure towards running the FOLD Secretariat computed in accordance with the actual expenses incurred, shall be allowed by the Commission, after prudence check.
- (4) All expenses of NLDC and Corporate Office expenses approved by the Commission shall be apportioned to the Regional Load Despatch Centre on the basis of the peak demand served (in MW) in the respective region as indicated in CEA's website for the preceding year.
- (5) RLDC Charges may be paid directly by the concerned users and/or the SLDCs / STU (on behalf of the RLDC users in the state) shall be approved by the Appropriate Commission while allowing the Annual Fees & Charges of the respective State Load Despatch Centre.

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**CHAPTER-7**  
**LDC EMPOWERMENT RESERVE**

**21. LDC Empowerment Reserve**

- (1) The Load Despatch Centre shall create and maintain a separate fund called 'Load Despatch Centre Empowerment Reserve' ('LDCE Reserve') for administering capital expenditure.
- (2) The charges on account of return on equity, interest on loan, depreciation of the [.....] Load Despatch Centre including the registration fees, shall be deposited into the LDCE Reserve after meeting the statutory tax requirements:  
Provided that short term open access charges and other income of the [.....] LDCs, if any, shall not form part of the LDCE Reserve and will be deposited to a separate account namely Contingency Reserve as per regulation -23 of these regulations.
- (3) The [.....]LDC shall be entitled to utilize the money deposited in the LDCE Reserve for creation of new assets, loan repayment, servicing the capital raised in the form of interest and dividend payment restricted to ----% percentage [as allowed in proviso 14(2) of these Regulations] of Paid up Capital, meeting stipulated equity portion in asset creation, margin money for raising loan from the financial institutions, Corporate Social Responsibility and Sustainability Activities in compliance of the applicable provisions of the Companies Act and Dept. of Public Enterprises (DPE) / other applicable Government Guidelines issued and amended from time to time, Capacity Building of [.....] LDC and sub-LDC personnel and other users / stake holders, including but not limited to using the platform of Forum of Load Despatchers (FOLD) and/or through Institutes of national/international repute like NPTI/PSTI/NITs/ IITs/IIMs etc., funding participation in national/international conferences viz. NPSC, IEEE, CIGRE etc. and publication of technical papers there-in, facilitating higher education, availing institutional membership with national/international bodies such as the IEEE, CIGRE etc., and funding of Research & Development (R & D) projects, hiring consultancy service for learning & implementation of new technology & market products etc. subject to approval of the Commission.

- (4) To ensure betterment of Power System, it is imperative that LDC promotes interaction among stakeholders, shares and learns the best practices, quickly adopts technologies through using the platforms such as the FOLD. LDCs will ensure timely payment of any fees like membership fees or any other recurring or non-recurring expenditure related to the participation in the activities of the FOLD from its LDCE Reserve. NLDC, as the secretariat of FOLD, has to deposit such fees to its LDCE Reserve after meeting the expenses on FOLD activities, if any.
- (5) The LDCE Reserve shall not be utilized for any other revenue expenditure. However, in case of shortfall in meeting the revenue expenditure including human resource expenses, Load Despatch Centre shall be entitled to take interest free advance from LDCE Reserve which shall be recouped from the expenditure allowed by the Commission under the respective heads at the time of truing up to be carried out after the expiry of the control period.
- (6) Any asset created by the [...] LDC out of the money deposited into the LDCE Reserve shall be considered for computation of return on equity, and depreciation as per the rates specified in these Regulations. This will be treated as a normative loan with NIL Interest on Loan for this funding. Load Despatch Centre shall submit details of such assets in the CAPEX plan.
- (7) Load Despatch Centre shall submit the amount accumulated in LDCE Reserve along with the break-up of sources from where the fund is received. The [...] LDC shall submit at the end of every financial year (FY), a report on utilization of LDCE Reserve during last FY to the Commission. The Commission may (if necessary) issue directives to the [...] LDC for effective utilization of LDCE Reserve.

## **22. Contingency Reserve**

- (1) The [...] Load Despatch Centre shall maintain a separate account namely Contingency Reserve for depositing other income like short term open access charges, REC charges, PAT Charges and any other income (if any) etc.
- (2) The [...] Load Despatch Centre shall use such income to meet the short fall, if any, in the annual charges allowed by the Commission or to meet the contingency expenses which were not foreseen at the time of making the application for fees and charges and are considered necessary for the efficient power system operation. Recovery of Contingency expenses incurred for works assigned by the Commission will be allowed after prudence check.
- (3) The balance amount shall be deposited into the LDCE Reserve after meeting the statutory tax requirements.
- (4) There may be some requirements for which funds available under the contingency expenses are not enough to meet the unforeseen requirements. Such short fall may be met from the LDCE Reserve.

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## CHAPTER-8

### **COMPUTATION AND RECOVERY OF [...] LDC FEES AND CHARGES**

- 23. Registration Fees:** The fees shall be payable by the users including power exchanges and electricity traders before commencement of grid access and scheduling. The fees payable are as under:
- (1) The distribution licensees and [inter/intra]-State transmission licensees shall pay non-refundable one-time registration fees of Rs. 10 Lakh along with application for commencement of grid access: Provided that the LDC concerned shall be intimated by 20<sup>th</sup> of every month by the [inter/intra]-State transmission licensees about the existing as well as additions of transmission elements synchronized with the grid and by the distribution licensees about the additional capacity tied up for the purpose of updating the record by concerned [...] LDC; Provided that all other users having NIL contracted capacity shall be charged on the basis of a minimum capacity of (\_\_\_\_) MW which is the least MW load for which an entity is eligible for grant of connectivity to Inter/Intra state transmission system as per the Connectivity (to Inter/Intrastate transmission system) Regulations (*Year*) of the Commission.
- (2) The generating companies shall pay registration fees as under:
- a) For generating station up to 10 MW installed capacity: Rs. 0.50 Lakh;
  - b) Generating stations having installed capacity of not less than 10 MW and up to 100 MW: Rs. 1.0 Lakh;
  - c) Generating stations having installed capacity of not less than 100 MW and up to 2000 MW : Rs. 5.0 Lakh;
  - d) Generating stations having capacity of 2000 MW and above : Rs.10.0 Lakh, and;
  - e) Provided that the entire capacity of the generating station or stage thereof whose scheduling, metering and energy accounting is done separately shall be considered for the purpose of registration fees at the time of the initial registration;
  - f) Provided further that the generating companies shall intimate the [...] LDC concerned about the additional capacity commissioned by the generating station or a stage thereof in the previous month by 20<sup>th</sup> day of each month.
- (3) The [inter/intra]-State trading licensees, sellers and buyers shall pay one time registration fees of Rs. 10,000.00 (Rupees Ten Thousands only) along with application for commencement of scheduling for market operation.
- (4) The Power exchanges shall pay Rs. 20.0 Lakh (Rupees Twenty Lakh only)as one time registration fees to NLDC and shall pay [.....] as one time registration fees to [...] LDC.
- (5) All other users as defined in 3(38) of these regulations shall be liable to pay one time registration fees of Rs. 10,000 (Rupees Ten Thousand only) along with the application (ref. Appendix-IV) for commencement of grid access.
- 24. Monthly LDC Charges:** The monthly LDC charges shall be calculated for the [inter/intra]-State transmission licensees, generating stations and sellers, distribution licensees and buyers as under:
- (a) The LDC Charges for [inter/intra]-state transmission licensees shall be determined on the basis of 33.34% of approved annual charges and shall be worked out on the basis of the circuit kilometers (ckt-

km) of the lines owned by [inter/intra]-state transmission licensees;

- (b) The LDC Charges for the [inter/intra]-state Generating station and sellers shall be determined on the basis of 33.33% of annual LDC charges and shall be worked out on the basis of installed capacity in case of the generating station and long term and/or medium term contracted capacity in case of sellers;
- (c) The LDC Charges for the distribution licensees and buyers shall be determined on the basis of 33.33% of annual charges and shall be worked out on the basis of sum of aggregate allocated capacity and/or contracted capacities in case of distribution licensee including deemed distribution licensees and sum of long term and/or medium term contracted capacity in case of buyer.

## **25. Computation and Payment of LDC Charges:**

- (1) The rates of LDC charges for [inter/intra]-state transmission licensee shall be computed on annual basis and recovered on monthly basis in accordance with following formula;

Monthly LDC Charge rate (for Transmission Licensee) =

$$(33.34\%) [ALC/ (Ckt\_Km)]/12 \text{ in Rs./Kilometer}$$

Where,

ALC = Approved Annual LDC Charges in accordance with Chapters 5 & 6;

Ckt\_Km = Length of aggregate [inter/intra]-state transmission lines as on last day of the month prior to the month of billing (rounded off to the nearest two decimals);

Provided that the monthly LDC charges for individual transmission licensee shall be computed on the basis of rates determined above and the length (in Ckt\_Km) of transmission lines owned and operated by the respective transmission licensee(s).

- (2) The rates of LDC charges for generating companies and sellers shall be computed on annual basis and recovered on monthly basis in accordance with following formula:

Monthly LDC Charge rate (for Generation or seller) =

$$(33.33\%) (ALC/(Capacity))/12 \text{ in Rs./ MW}$$

Where,

ALC = Approved Annual LDC Charges in accordance with Chapters 5 & 6;

Capacity = Aggregate Installed capacity (in MW) of generating stations and contracted capacity (in MW) of the sellers (rounded off to the nearest two decimals) whose scheduling and energy accounting is covered under concerned [...] LDC as on last day of the month prior to the month of billing;

Provided that the monthly LDC charges for generating companies or sellers shall be computed on the basis of rates determined above and respective 'capacity' (MW) of the generating station or seller.

- (3) The rates of LDC charges for distribution licensee and buyers shall be computed on annual basis and recovered monthly after taking into account aggregate contracted capacity in accordance with following formula:

Monthly LDC Charge rate (for Distribution Licensee or buyer) =

$$(33.33\%) (ALC/ (Capacity))/12 \text{ in Rs./ MW}$$

Where,

ALC = Approved Annual LDC Charges in accordance with Chapters 5 & 6;

Capacity = Aggregate long term or medium term contracted capacity by distribution licensees and buyers (rounded off to the nearest two decimal) whose scheduling and accounting is covered under concern [...] LDC

as on last day of the month prior to the month of billing;

Provided that the monthly LDC charges from distribution licensees and buyers shall be collected in proportion to the sum of their allocations and contracted capacities, as the case may be, as on the last day of the month prior to billing of the month.

- (4) The respective State Load Despatch Centre (SLDC) shall be the nodal agency for collection of monthly LDC charges payable to the concerned Regional Load Despatch Centre (RLDC), from the distribution licensees and other RLDC users in the State. After collecting the monthly LDC charge the concerned SLDC shall deposit the same into the account of the concerned RLDC. The RLDC users in the state shall have to option to make direct payment of monthly RLDC Charges into the account of concerned RLDCs or they may choose to pay the same through the respective SLDCs.

- 26. National Load Despatch Centre charges and corporate office expenses:** All the expenses of National Load Despatch Centre and Corporate Office, as approved by the Commission, shall be apportioned to the Regional Load Despatch Centres on the basis of the demand served in the respective regions. The expenditure incurred for activities envisaged for the Forum of Load Despatchers (FOLD) shall be booked under NLDC charges & corporate office expenses.

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## **CHAPTER-9**

### **PERFORMANCE LINKED INCENTIVE**

- 27. Performance linked incentive to [...] LDC**

- (1) Recovery of incentive by the [...] Load Despatch Centre shall be based on the achievement of the Key Performance Indicators (KPIs) as specified in **Appendix-V** or such other parameters as may be prescribed by the Commission.
- (2) Each [...] Load Despatch Centre shall submit its actual performance against each of the key performance indicators to the Commission on annual basis as per the format specified in **Appendix-V**.
- (3) The [...] LDC shall submit the details in regards to each Key Performance Indicator in the format specified in **Appendix-V** along with the methodology for approval of the Commission.
- (4) The Commission shall evaluate the overall performance of the [...] LDC, on the basis of KPIs and weightage specified in **Appendix-V**. The Commission, if required, may seek advice of the Central Electricity Authority for evaluation of the performance of system operator.
- (5) The [...] LDC as the case may be, shall be allowed to recover incentive of 10% of gross turnover / gross sales of the LDC for aggregate performance level of 85%. The incentive shall increase by 1% on pro-rata basis for every 5% increase of performance level above 85%:  
Provided that incentive shall be reduced by 1% on pro-rata basis for the every 3% decrease in performance level below 85%.
- (6) The [...] LDC, as the case may be, shall compute the Key Performance Indicators on annual basis for the previous year ending on 31<sup>st</sup> March and submit to the Commission along with petitions for approval of the Commission as per **Appendix-V and Appendix-VI** of these Regulations:  
Provided that the key performance indicators of previous year ending on 31st March shall be considered

to recover incentive on each year and shall be trued up at the end of the control period.

**28. Certification Retainer-ship Amount to the employees of [...] LDC**

- (1) The employees of [...] Load Despatch Centre who acquire the certificate of basic level, specialist level and management level in their respective areas of specialization shall be allowed a fixed retainer-ship amount during the validity of such certificate period as per the following parameters:

| <b>SI. No.</b> | <b>Certification Level</b> | <b>Retainer-ship amount (in Rs. Per Month)</b> |
|----------------|----------------------------|--|
| 1              | Basic                      | 7500   |
| 2              | Specialist                 | 10000  |
| 3              | Management                 | 12000  |

Provided that a person acquiring one basic level and more than one Specialist and/or Management level certificate shall be entitled for maximum retainer ship amount capped at the higher applicable slab. For e.g. a person having both basic & specialist certificates shall be entitled for a maximum retainer-ship amount of Rs. 10,000/- per month. Similarly, a person having all three levels of certificates shall be entitled for a maximum retainer-ship amount of Rs. 12,000/- per month.

Provided that, funding will be done from the LDCE Reserves for (i) payment of registration and/or application fees for appearing in basic, specialist and management level examinations, (ii) payment towards training expenses for these examinations, (iii) payment of certification retainer-ship amount to the certified LDC personnel.

- (2) Certificate Retainer-ship Amount shall be in addition to the performance linked incentive specified in Regulation 27.

**CHAPTER-10**  
**BILLING AND OTHER MISCELLANEOUS PROVISIONS**

**29. Billing and Payment of charges**

- (1) Bills shall be raised for the [...] LDC charge on monthly basis by the [...] Load Despatch Centre in accordance with these regulations, and payments shall be made by the users directly to the concerned [...] Load Despatch Centre.
- (2) Persistent default in payment of [...] LDC fees and charges shall be brought to the notice of the Commission.

**30. Late payment surcharge:** In case the payment of any bill for charges payable under these regulations is delayed by a user beyond a period of 30 days from the date of billing, a late payment surcharge at the rate of **1.5%** per month shall be levied from the users.

**31. Recovery of cost of hedging or Foreign Exchange Rate Variation:** Recovery of cost of hedging or foreign exchange rate variation shall be made directly by the [...] LDC from the users without making any application before the Commission:

Provided that in case of any objections by users regarding the cost of hedging or foreign exchange rate variation, the [...] LDC may make an appropriate application before the Commission for decision.

**32. Rebate**

- (1) A rebate of 2% shall be allowed by the [...] LDC on gross bill amount settled through RTGS, NEFT, Letter of Credit or cheque up to seventh day (i.e. T+6 day) from the date of issuance of the bills, where T is the date of issuance of the bill by the [...] LDC.
- (2) The rebate of 1% shall be allowed when payment is made from T+7 to T+15 days from issuance of the bill.
- (3) No rebate shall be allowed for payment made after T+15 days where T is the date of issuance of bill by the [...] LDC

**33. Power to Relax:** The Commission, for reasons to be recorded in writing, may relax any of the provisions of these regulations on its own motion or on an application made before it by the [...] LDC / Users after giving reasonable opportunity to those likely to be affected by such relaxation.

**34. Removal of Difficulty:** The Commission, for reasons to be recorded in writing, may relax any of the provisions of these regulations on its own motion or on an application made before it by the [...] LDC / Users after giving reasonable opportunity to those likely to be affected by such relaxation.

\*\*\*

## **APPENDIX**

**TARIFF FILING FORMS FOR [...] LDC**

**INDEX****Checklist of Forms and other information/ documents for tariff filing for [...]LDCs**

| <b>Form No.</b> | <b>Tariff Filing Formats ( [...] LDC)</b>                                      | <b>Tick</b> |
|-----------------|--|-------------|
| <b>FORM-1</b>   | Summary Sheet  |             |
| <b>FORM-2</b>   | Normative Parameters considered for calculations                               |             |
| <b>FORM-3A</b>  | Financial Package up to COD  |             |
| <b>FORM-3B</b>  | Statement of Capital cost  |             |
| <b>FORM-3C</b>  | Financing of Additional Capitalization   |             |
| <b>FORM-4A</b>  | Calculation of Interest on Normative Loan                                      |             |
| <b>FORM-4B</b>  | Calculation of Weighted Average Rate of Interest on Actual Loans               |             |
| <b>FORM-4C</b>  | Details of Foreign Loans   |             |
| <b>FORM-5A</b>  | Statement of Depreciation  |             |
| <b>FORM-5B</b>  | Calculation of Depreciation Rate   |             |
| <b>FORM-6A</b>  | Details of Operation and Maintenance Expense excluding Human Resource Expenses |             |
| <b>FORM-6B</b>  | Details of Human Resource Expenses   |             |
| <b>FORM-6C</b>  | Details of Repairs and Maintenance Expenses                                    |             |
| <b>FORM-6D</b>  | Details of Administrative and General expenses                                 |             |
| <b>FORM-7</b>   | Calculation of Interest on Working Capital                                     |             |
| <b>FORM-8</b>   | Year wise statement of LDC Empowerment Reserve (projected)                     |             |
| <b>FORM-9</b>   | Other Income   |             |

| <b>Other Information/ Documents</b> |   |             |
|-------------------------------------|---|-------------|
| <b>Sl. No.</b>                      | <b>Information/Document</b>   | <b>Tick</b> |
| 1                                   | Audited Balance Sheet and Profit & Loss Accounts with all the Schedules &<br>Annexure for [...] LDC and [...]LDC/Corporate office.  |             |
| 2                                   | Copies of relevant loan Agreements  |             |
| 3                                   | a) Copies of the approval of Competent Authority for the Capital Cost and Financial package.<br>b) CAPEX and REPEX plan along with Board approval, estimated capital cost and justification |             |
| 4                                   | a) Copies of the Equity participation agreements and necessary approval for the foreign equity, if any.<br>b) Equity contribution from LDC Empowerment Reserve along with Board Approval    |             |
| 5                                   | Any other relevant information, (Please specify)  |             |

**Note 1.** Electronic copy of the petition (in words format) and detailed calculation as per these formats (in excel format) and any other information submitted shall also be furnished in the electronic form.

**FORM-1****Summary Sheet**

Name of the LDC: \_\_\_\_\_

(Rs. in lacs)

| S.N. | Particulars   | Form No. | Existing 2018-19 | 2019-20 | 2020-21 | 2021-22 | 2022-23 | 2023-24 |
|------|---|----------|------------------|---------|---------|---------|---------|---------|
| 1    | 2   |          | 3                | 4       | 5       | 6       | 7       | 8       |
| 1    | Return on Equity <sup>1</sup>   |          |                  |         |         |         |         |         |
| 2    | Interest on<br>Loan Capital   |          |                  |         |         |         |         |         |
| 3    | Depreciation  |          |                  |         |         |         |         |         |
| 4    | O&M Expenses<br>excluding human<br>resource expenses                                      |          |                  |         |         |         |         |         |
| 5    | Human<br>resource<br>expenses<br>including<br>HRD   |          |                  |         |         |         |         |         |
| 6    | NLDC*/RLDC <sup>2</sup><br>charges and<br>Corporate office<br>expenses (as<br>applicable) |          |                  |         |         |         |         |         |
| 7    | Interest on<br>Working<br>Capital   |          |                  |         |         |         |         |         |
|      | <b>Total</b>  |          |                  |         |         |         |         |         |

<sup>1</sup> Details of calculations, considering equity as per regulation, to be furnished.

\*NLDC charge &amp; corporate office expense applicable for RLDCs

<sup>2</sup>RLDC charge applicable for SLDCs where SLDC/STU is paying the RLDC charge on behalf of RLDC users in the State**Petitioner**

**Normative Parameters considered for calculations of annual charges****Name of the LDC:**

| <b>Particulars</b>                                     | <b>Unit</b> | <b>As Existing</b>      | <b>Control Period</b> |                |                |                |                |
|--|-------------|-------------------------|-----------------------|----------------|----------------|----------------|----------------|
|  |             | <b>Existing 2018-19</b> | <b>2019-20</b>        | <b>2020-21</b> | <b>2021-22</b> | <b>2022-23</b> | <b>2023-24</b> |
| <b>1</b>   | <b>2</b>    | <b>3</b>                | <b>4</b>              | <b>5</b>       | <b>6</b>       | <b>7</b>       | <b>8</b>       |
| Base Rate of Return on Equity                          | %           |                         |                       |                |                |                |                |
| Tax Rate   | %           |                         |                       |                |                |                |                |
| Receivables in Months for WC                           | months      |                         |                       |                |                |                |                |
| O&M excluding human resource expenses in Months for WC | months      |                         |                       |                |                |                |                |
| Human resource expenses in Months for WC               | months      |                         |                       |                |                |                |                |
| *NLDC / #RLDC charges in Months for WC                 | months      |                         |                       |                |                |                |                |
| Base Rate of SBI as on (date)                          | %           |                         |                       |                |                |                |                |

\*Applicable only for RLDCs

#Applicable only for SLDCs

**Petitioner**

**Financial Package up to COD**

Name of the LDC: \_\_\_\_\_

Project Cost as on 1.4.2019: \_\_\_\_\_

Date of Commercial Operation: \_\_\_\_\_

(Amount in lacs)

|                     | Financial Package as Approved    |   | Financial Package as on 1.4.2019 |   | As Admitted on 1.4.2019          |   |
|---------------------|----------------------------------|---|----------------------------------|---|----------------------------------|---|
|                     | Currency and Amount <sup>3</sup> |   | Currency and Amount <sup>3</sup> |   | Currency and Amount <sup>3</sup> |   |
| 1                   | 2                                | 3 | 4                                | 5 | 6                                | 7 |
| Loan-I              |                                  |   |                                  |   |                                  |   |
| Loan-II             |                                  |   |                                  |   |                                  |   |
| Loan-III            |                                  |   |                                  |   |                                  |   |
| and so on           |                                  |   |                                  |   |                                  |   |
|                     |                                  |   |                                  |   |                                  |   |
| Equity-             |                                  |   |                                  |   |                                  |   |
| Foreign             |                                  |   |                                  |   |                                  |   |
| Domestic            |                                  |   |                                  |   |                                  |   |
| Total Equity        |                                  |   |                                  |   |                                  |   |
| Debt : Equity Ratio |                                  |   |                                  |   |                                  |   |

**Petitioner**

**Statement of Capital cost****Name of the LDC:**

|   |  | As on relevant date. <sup>1</sup> |
|---|--|-----------------------------------|
| A | a) Opening Gross Block Amount as per books   |                                   |
|   | b) Amount of capital liabilities in A(a) above                                       |                                   |
|   | c) Amount of IDC, FC, FERV & Hedging cost included in A(a) above                     |                                   |
|   | d) Amount of IEDC (excluding IDC, FC, FERV & Hedging cost)<br>included in A(a) above |                                   |
|   |  |                                   |
| B | a) Addition in Gross Block Amount during the period                                  |                                   |
|   | b) Amount of capital liabilities in B(a) above                                       |                                   |
|   | c) Amount of IDC, FC, FERV & Hedging cost included in B(a) above                     |                                   |
|   | d) Amount of IEDC (excluding IDC, FC, FERV & Hedging cost)<br>included in B(a) above |                                   |
|   |  |                                   |
| C | a) Closing Gross Block Amount as per books   |                                   |
|   | b) Amount of capital liabilities in C(a) above                                       |                                   |
|   | c) Amount of IDC, FC, FERV & Hedging cost included in C(a) above                     |                                   |
|   | d) Amount of IEDC (excluding IDC, FC, FERV & Hedging cost)<br>included in C(a) above |                                   |

<sup>1</sup> Relevant date/s means date of COD and financial year start date and end date

**Petitioner**

**Financing of Additional Capitalization****Name of the LDC:**

(Amount in Rs. lakh)

|  | Projected/Actual |        |        |        |                | Admitted |        |        |        |                |
|--|------------------|--------|--------|--------|----------------|----------|--------|--------|--------|----------------|
|  | Year 1           | Year 2 | Year 3 | Year 4 | Year 5 & So on | Year 1   | Year 2 | Year 3 | Year 4 | Year 5 & So on |
| <b>Financial Year<br/>(Starting from 1.4.2019)</b>   | 2                | 3      | 4      | 5      | 6              | 7        | 8      | 9      | 10     | 11             |
| 1  |                  |        |        |        |                |          |        |        |        |                |
| <b>Amount capitalized in<br/>Work/<br/>Equipment</b> |                  |        |        |        |                |          |        |        |        |                |
|  |                  |        |        |        |                |          |        |        |        |                |
| <b>Financing<br/>Details</b>                         |                  |        |        |        |                |          |        |        |        |                |
| <b>Loan-1</b>  |                  |        |        |        |                |          |        |        |        |                |
| <b>Loan-2</b>  |                  |        |        |        |                |          |        |        |        |                |
| <b>Loan-3 and so on</b>                              |                  |        |        |        |                |          |        |        |        |                |
| <b>Total Loan<sup>2</sup></b>                        |                  |        |        |        |                |          |        |        |        |                |
|  |                  |        |        |        |                |          |        |        |        |                |
| <b>Equity</b>  |                  |        |        |        |                |          |        |        |        |                |
| <b>Internal<br/>Resources</b>                        |                  |        |        |        |                |          |        |        |        |                |
| <b>Others</b>  |                  |        |        |        |                |          |        |        |        |                |
|  |                  |        |        |        |                |          |        |        |        |                |
| <b>Total</b>   |                  |        |        |        |                |          |        |        |        |                |

<sup>1</sup> Year 1 refers to Financial Year of COD and Year 2, Year 3 etc. are the subsequent financial years respectively.

**Petitioner**

**FORM-4A**

| <b>Calculation of interest on Normative Loan</b>              |                             |                     |                     |                     |                     |                     |
|---|-----------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| <b>Name of LDC:</b>   | <b>Amount in Rs. lakh</b>   |                     |                     |                     |                     |                     |
| <b>Particulars</b>  | <b>Existing<br/>2018-19</b> | <b>2019-<br/>20</b> | <b>2020-<br/>21</b> | <b>2021-<br/>22</b> | <b>2022-<br/>23</b> | <b>2023-<br/>24</b> |
| 1   | 2                           | 3                   | 4                   | 5                   | 6                   | 7                   |
| Gross Normative loan – Opening                                |                             |                     |                     |                     |                     |                     |
| Cumulative repayment of Normative<br>Loan up to previous year |                             |                     |                     |                     |                     |                     |
| Net Normative loan-Opening                                    |                             |                     |                     |                     |                     |                     |
| Increase/Decrease due to ACE during the<br>Year               |                             |                     |                     |                     |                     |                     |
| Repayments of Normative Loan<br>during the year               |                             |                     |                     |                     |                     |                     |
| Net Normative loan-Closing                                    |                             |                     |                     |                     |                     |                     |
| Average Normative Loan  |                             |                     |                     |                     |                     |                     |
| Weighted average Rate of Interest<br>on actual Loans          |                             |                     |                     |                     |                     |                     |
| Interest on Normative loan                                    |                             |                     |                     |                     |                     |                     |

(Amount in Rs. lakh)

**Petitioner**

**FORM-4B**

**Calculation of Weighted Average Rate of Interest on Actual Loans<sup>1</sup>**

Name of LDC : \_\_\_\_\_

(Amount in lacs)

| Sl.<br>no. | Particulars  | Existing<br>2018-19 | 2019-20 | 2020-21 | 2021-22 | 2022-23 | 2023-24 |
|------------|--|---------------------|---------|---------|---------|---------|---------|
| 1          | 2  | 3                   | 4       | 5       | 6       | 7       | 8       |
|            | <b>Loan-1</b>  |                     |         |         |         |         |         |
|            | Gross loan – Opening                                 |                     |         |         |         |         |         |
|            | Cumulative repayments of Loans upto previous year    |                     |         |         |         |         |         |
|            | Net loan – Opening                                   |                     |         |         |         |         |         |
|            | Add: Drawal(s) during the Year                       |                     |         |         |         |         |         |
|            | Less: Repayment (s) of Loans during the year         |                     |         |         |         |         |         |
|            | Net loan – Closing                                   |                     |         |         |         |         |         |
|            | Average Net Loan                                     |                     |         |         |         |         |         |
|            | Rate of Interest on Loan on annual basis             |                     |         |         |         |         |         |
|            | Interest on loan                                     |                     |         |         |         |         |         |
|            | Loan repayment effective from (date to be indicated) |                     |         |         |         |         |         |
|            |  |                     |         |         |         |         |         |
|            | <b>Loan-2 ...</b>                                    |                     |         |         |         |         |         |
|            | <b>Loan-3 and so on</b>                              |                     |         |         |         |         |         |
|            | <b>Total Loan</b>                                    |                     |         |         |         |         |         |
|            | Gross loan – Opening                                 |                     |         |         |         |         |         |
|            | Cumulative repayments of Loans upto previous year    |                     |         |         |         |         |         |
|            | Net loan – Opening                                   |                     |         |         |         |         |         |
|            | Add: Drawal(s) during the Year                       |                     |         |         |         |         |         |
|            | Less: Repayment (s) of Loans during the year         |                     |         |         |         |         |         |
|            | Net loan – Closing                                   |                     |         |         |         |         |         |
|            | Average Net Loan                                     |                     |         |         |         |         |         |
|            | Interest on loan                                     |                     |         |         |         |         |         |
|            | <b>Weighted average Rate of Interest on Loans</b>    |                     |         |         |         |         |         |

<sup>1</sup> In case of Foreign Loans, the calculations in Indian Rupees is to be furnished. However, the calculations in Original currency is also to be furnished separately in the same form.

**Petitioner**

**Form - 4C**

Name of the [ ] LDC: \_\_\_\_\_

Exchange Rate as on 01.04.2019: \_\_\_\_\_

**Details of Foreign Loans**

(Amount in Rs. lakh)

| <b>FY starting from 1.4.19</b> |                                       | <b>Year-1</b> |                                     |                   | <b>Year-2 – Year-3 and so on</b> |          |                             |                   |                   |           |
|--------------------------------|---------------------------------------|---------------|-------------------------------------|-------------------|----------------------------------|----------|-----------------------------|-------------------|-------------------|-----------|
| <b>S</b>                       | <b>1</b>                              | <b>2</b>      | <b>3</b>                            | <b>4</b>          | <b>5</b>                         | <b>6</b> | <b>7</b>                    | <b>8</b>          | <b>9</b>          | <b>10</b> |
|                                |                                       | Date          | Amount<br>(Foreign<br>Exchang<br>e) | Exchan<br>ge rate | Amount<br>(in Rs)                | Date     | Amount<br>(Foreign<br>Exc.) | Exchan<br>ge Rate | Amount<br>(in Rs) | ...       |
|                                | <b>Currency1 [1]</b>                  |               |                                     |                   |                                  |          |                             |                   |                   |           |
| A 1                            | At the date of Drawl                  |               |                                     |                   |                                  |          |                             |                   |                   |           |
| 2                              | Scheduled repayment date of principal |               |                                     |                   |                                  |          |                             |                   |                   |           |
| 3                              | Scheduled payment date of interest    |               |                                     |                   |                                  |          |                             |                   |                   |           |
| 4                              | At the end of Financial year          |               |                                     |                   |                                  |          |                             |                   |                   |           |
| B                              | In case of Hedging [3]                |               |                                     |                   |                                  |          |                             |                   |                   |           |
| 1                              | At the date of hedging                |               |                                     |                   |                                  |          |                             |                   |                   |           |
| 2                              | Period of hedging                     |               |                                     |                   |                                  |          |                             |                   |                   |           |
| 3                              | Cost of hedging                       |               |                                     |                   |                                  |          |                             |                   |                   |           |
|                                |                                       |               |                                     |                   |                                  |          |                             |                   |                   |           |
|                                | <b>Currency2 [1]</b>                  |               |                                     |                   |                                  |          |                             |                   |                   |           |
| A 1                            | At the date of Drawl                  |               |                                     |                   |                                  |          |                             |                   |                   |           |
| 2                              | Scheduled repayment date of principal |               |                                     |                   |                                  |          |                             |                   |                   |           |
| 3                              | Scheduled payment date of interest    |               |                                     |                   |                                  |          |                             |                   |                   |           |
| 4                              | At the end of Financial year          |               |                                     |                   |                                  |          |                             |                   |                   |           |
| B                              | In case of Hedging [3]                |               |                                     |                   |                                  |          |                             |                   |                   |           |
| 1                              | At the date of hedging                |               |                                     |                   |                                  |          |                             |                   |                   |           |
| 2                              | Period of hedging                     |               |                                     |                   |                                  |          |                             |                   |                   |           |
| 3                              | Cost of hedging                       |               |                                     |                   |                                  |          |                             |                   |                   |           |
|                                |                                       |               |                                     |                   |                                  |          |                             |                   |                   |           |

**Petitioner**

**Statement of Depreciation****Name of LDC:**

(Amount in Rs. lakh)

| <b>Financial Year</b>  | <b>Existing<br/>2018-19</b> | <b>2019-<br/>20</b> | <b>2020-<br/>21</b> | <b>2021-<br/>22</b> | <b>2022-<br/>23</b> | <b>2023-<br/>24</b> |
|--|-----------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| 1  | 2                           | 11                  | 12                  | 13                  | 14                  | 15                  |
| <b>Depreciation on Capital Cost</b>  |                             |                     |                     |                     |                     |                     |
| Depreciation recovered during the Year   |                             |                     |                     |                     |                     |                     |
| Cumulative depreciation deducted due to de-capitalization or write off of the assets etc.  |                             |                     |                     |                     |                     |                     |
| <b>Cumulative Depreciation &amp; Advance against Depreciation recovered up to the year</b> |                             |                     |                     |                     |                     |                     |

**Petitioner****Calculation of Depreciation Rate****Name of LDC:**

(Amount in Rs lakh)

| <b>Sl.<br/>no.</b> | <b>Name of the Assets<sup>1</sup></b>                | <b>gross Block as on<br/>31.03.2019, whichever<br/>is later and<br/>subsequently for each<br/>year thereafter<br/>up to 31.3.2024</b> | <b>Depreciation<br/>Rates as<br/>per CERC's<br/>Depreciation<br/>Rate Schedule</b> | <b>Depreciation Amount<br/>for each year up to<br/>31.03.2024</b> |
|--------------------|--|---|--|---|
|                    | 1  | 2   | 3  | 4= Col.2 X Col.3  |
| 1                  | Land (Freehold, Lease hold)                          |   |  |   |
| 2                  | Building and civil works                             |   |  |   |
| 3                  | Auxiliary power supply system                        |   |  |   |
| 4                  | Office furniture and furnishing                      |   |  |   |
| 5                  | Communication equipment                              |   |  |   |
| 6                  | SCADA hardware with test equipment and spares        |   |  |   |
| 7                  | ICT equipment  |   |  |   |
| 8                  | Software   |   |  |   |
| 9                  | <b>TOTAL</b>   |   |  |   |
|                    | <b>Weighted Average Rate of<br/>Depreciation (%)</b> |   |  |   |

**1** Name of the Assets should conform to the description of the assets mentioned in Depreciation Schedule appended to the Notification.

**Petitioner**

**FORM-6A****Details of Operation and Maintenance Expenses excluding human resource expenses****Name of LDC:**

(Rs. in lacs)

|   | ITEMS   | 2019-20 | 2020-21 | 2021-22 | 2022-23 | 2023-24 |
|---|---|---------|---------|---------|---------|---------|
|   | 1   | 2       | 3       | 4       | 5       | 6       |
| 1 | <b>Repairs and maintenance expenses</b>         |         |         |         |         |         |
| 2 | <b>Administrative and general expenses etc.</b> |         |         |         |         |         |
| 3 | <b>Total</b>                                    |         |         |         |         |         |

**NOTE:**

1. Detail of these expenditure as per formats enclosed
2. To be furnished for the [...] LDC.

**Petitioner**

Name of LDC:

**Details of Human Resource Expenses**

|                |   |  |
|----------------|---|--|
| <b>Period-</b> | 1 | ACTUALS FOR PREVIOUS FIVE YEARS                  |
|                | 2 | ACTUALS FOR 1ST SIX MONTHS OF THE CURRENT YEAR   |
|                | 3 | EXPECTED FOR LAST SIX MONTHS OF THE CURRENT YEAR |
|                | 4 | EXPECTED FOR ENSUING YEAR                        |

| <b>Sr. No.</b> | <b>Account Code</b>                    | <b>Particulars</b> | <b>Executive</b> |           | <b>Non-Executive</b> |           | <b>Total</b> |
|----------------|--|--------------------|------------------|-----------|----------------------|-----------|--------------|
|                |  |                    | Technic al       | Non-Tech. | Technic al           | Non-Tech. |              |
| 1              | Number of Employees                    |                    |                  |           |                      |           |              |
| 2              | Salaries                               |                    |                  |           |                      |           |              |
| 3              | Over-time                              |                    |                  |           |                      |           |              |
| 4              | Dearness Allowance                     |                    |                  |           |                      |           |              |
| 5              | Other Allowance                        |                    |                  |           |                      |           |              |
| 6              | Bonus                                  |                    |                  |           |                      |           |              |
| 7              | Productivity Linked Incentive          |                    |                  |           |                      |           |              |
| <b>8</b>       | <b>Sub Total (1 to 6)</b>              |                    |                  |           |                      |           |              |
|                | <b>OTHER STAFF COST</b>                |                    |                  |           |                      |           |              |
| 8              | Reimbursement of Medical Expenses      |                    |                  |           |                      |           |              |
| 9              | Leave Travel Concession                |                    |                  |           |                      |           |              |
| 10             | Reimbursement of House Rent            |                    |                  |           |                      |           |              |
| 11             | Interim Relief to Staff                |                    |                  |           |                      |           |              |
| 12             | Encashment of Earned Leave             |                    |                  |           |                      |           |              |
| 13             | Honorarium                             |                    |                  |           |                      |           |              |
| 14             | Payment under Workmen compensation Act |                    |                  |           |                      |           |              |
| 15             | Ex-gratia                              |                    |                  |           |                      |           |              |
| 16             | Expenditure on VRS                     |                    |                  |           |                      |           |              |
| <b>17</b>      | <b>Sub Total (8 to 16)</b>             |                    |                  |           |                      |           |              |
| 18             | Staff Welfare Expenses                 |                    |                  |           |                      |           |              |

|           |   |  |  |  |  |  |  |
|-----------|---|--|--|--|--|--|--|
| 19        | Terminal Benefits                           |  |  |  |  |  |  |
| 20        | Provisions                                  |  |  |  |  |  |  |
| 21        | Others (Specify)                            |  |  |  |  |  |  |
| 22        | Human Resource Development                  |  |  |  |  |  |  |
| <b>23</b> | <b>Total<br/>(7+17+18+19+20+21+22<br/>)</b> |  |  |  |  |  |  |
| 24        | Revenue recovered, if any                   |  |  |  |  |  |  |
| <b>25</b> | <b>Net Total (23-24)</b>                    |  |  |  |  |  |  |

**Additional Information**

|   |                          |  |  |  |  |  |  |
|---|--------------------------|--|--|--|--|--|--|
| 1 | No. of Employees as on : |  |  |  |  |  |  |
|   | i) Executives            |  |  |  |  |  |  |
|   | ii) Non-Executives       |  |  |  |  |  |  |
|   | iii) Skilled             |  |  |  |  |  |  |
|   | iv) Non-Skilled          |  |  |  |  |  |  |
|   | <b>Total</b>             |  |  |  |  |  |  |
| 2 | No. of Employees per     |  |  |  |  |  |  |
|   | i) MW handled            |  |  |  |  |  |  |
|   | ii) MKwh handled         |  |  |  |  |  |  |

- |      |   |
|------|---|
| I)   | An annual increase in HR expenses under a given head in excess of 20 percent should be explained with proper justification. |
| II)  | The data should be based on audited balance sheets.   |
| III) | Details of arrears, if any pertaining to prior period should be mentioned separately.                                       |
| IV)  | No. of employees opting for VRS during each year should be indicated.   |
| V)   | Details of abnormal expenses, if any shall be furnished separately.   |

**Petitioner**

**Details of Repairs and Maintenance Expenses**

Name of LDC:

**A. Repairs and Maintenance Expenses (Actuals)**

| Sr.No. | Description                               | Actuals for previous Financial Year | Current Financial Year      |                                   |       | Estimates for ensuing year |
|--------|---|-------------------------------------|-----------------------------|-----------------------------------|-------|----------------------------|
|        |   |                                     | Actual For First Six Months | Projection For Balance Six Months | Total |                            |
| 1      | Consumption of stores and spares          |                                     |                             |                                   |       |                            |
| 2      | Loss of stores and spares                 |                                     |                             |                                   |       |                            |
| 3      | Plant & Machinery repairs and maintenance |                                     |                             |                                   |       |                            |
| 4      | Civil works repairs and maintenance       |                                     |                             |                                   |       |                            |
| 5      | Annual Maintenance Contract (4a+4b+4c)    |                                     |                             |                                   |       |                            |
| 5a     | -Plant & machineries                      |                                     |                             |                                   |       |                            |
| 5b     | -Civil repairs and maintenance            |                                     |                             |                                   |       |                            |
| 5c     | -Others                                   |                                     |                             |                                   |       |                            |
| 6      | Others (Specify)                          |                                     |                             |                                   |       |                            |
| 7      | <b>Total (1+2+3+4+5+6)</b>                |                                     |                             |                                   |       |                            |
| 8      | Revenue recoveries, if any                |                                     |                             |                                   |       |                            |
| 9      | <b>Net Total (7-8)</b>                    |                                     |                             |                                   |       |                            |

**B. Repairs And Maintenance Expenses (As per Regulation)**

| Particulars   | 2014-15 | 2015-16 | 2016-17 | 2017-18 | 2018-19 |
|---|---------|---------|---------|---------|---------|
| <b>Admitted Capital cost as on 1st April of the year</b>                |         |         |         |         |         |
| <b>Repairs and Maintenance expenses</b>                                 |         |         |         |         |         |
| <b>Repairs and Maintenance expenses as a percentage of Capital cost</b> |         |         |         |         |         |

**Petitioner**

**Details of Administrative and General Expenses Name of LDC/:**

| SI.<br>No. | Description                           | Actuals<br>for<br>previous<br>five<br>Financial<br>Year | (Current Financial Year)                                 |   |       | Estimates<br>for<br>ensuing<br>year |
|------------|---------------------------------------|---|--|---|-------|-------------------------------------|
|            |                                       |   | Actual<br>For<br>First Six<br>Months<br>(Rs. in<br>Crs.) | Projectio<br>n<br>For<br>Balance<br>Six<br>Months | Total |                                     |
|            | <b>Property Related Expenses</b>      |   |  |   |       |                                     |
| 1          | License Fees                          |   |  |   |       |                                     |
| 2          | Rent                                  |   |  |   |       |                                     |
| 3          | Rates & Taxes                         |   |  |   |       |                                     |
| 4          | Insurance                             |   |  |   |       |                                     |
| 5          | Contribution to accident reserve fund |   |  |   |       |                                     |
| <b>6</b>   | <b>Sub total :</b>                    |   |  |   |       |                                     |
|            | <b>Communication</b>                  |   |  |   |       |                                     |
| 7          | Telephone & Trunk Call                |   |  |   |       |                                     |
| 8          | Postage & Telegram                    |   |  |   |       |                                     |
| 9          | Telex, Teleprinter Charges, Telefax   |   |  |   |       |                                     |
| 10         | Courier Charges                       |   |  |   |       |                                     |
| 11         | Other                                 |   |  |   |       |                                     |
| <b>12</b>  | <b>Sub total :</b>                    |   |  |   |       |                                     |
|            | <b>Professional Charges</b>           |   |  |   |       |                                     |
| 13         | Legal expenses                        |   |  |   |       |                                     |
| 14         | Consultancy charges                   |   |  |   |       |                                     |
| 15         | Technical fees                        |   |  |   |       |                                     |
| 16         | Audit fees                            |   |  |   |       |                                     |
| 17         | Other charges                         |   |  |   |       |                                     |
| <b>18</b>  | <b>Sub total :</b>                    |   |  |   |       |                                     |

|           |                                      |  |  |  |  |  |
|-----------|--------------------------------------|--|--|--|--|--|
|           | <b>Conveyance &amp; Travelling</b>   |  |  |  |  |  |
| 19        | Conveyance expenses                  |  |  |  |  |  |
| 20        | Travelling expenses                  |  |  |  |  |  |
| 21        | Hire charges of vehicle              |  |  |  |  |  |
| 22        | Others                               |  |  |  |  |  |
| <b>23</b> | <b>Subtotal :</b>                    |  |  |  |  |  |
|           | <b>Other Expenses</b>                |  |  |  |  |  |
| 24        | Electricity charges                  |  |  |  |  |  |
| 25        | Fees & Subscription                  |  |  |  |  |  |
| 26        | Books & Periodicals                  |  |  |  |  |  |
| 27        | Printing & Stationery                |  |  |  |  |  |
| 28        | Advertisement                        |  |  |  |  |  |
| 29        | Entertainment                        |  |  |  |  |  |
| 30        | Watch & Ward                         |  |  |  |  |  |
| 31        | Miscellaneous                        |  |  |  |  |  |
| 32        | Organizational Development Expenses  |  |  |  |  |  |
| 33        | Donation                             |  |  |  |  |  |
| <b>34</b> | <b>Subtotal :</b>                    |  |  |  |  |  |
|           | <b>Material Related Expenses</b>     |  |  |  |  |  |
| 35        | Demurrage and Wharf age on materials |  |  |  |  |  |
| 36        | Clearing & forwarding charges        |  |  |  |  |  |
| 37        | Transit insurance                    |  |  |  |  |  |
| <b>38</b> | <b>Subtotal :</b>                    |  |  |  |  |  |
| 39        | Others (Specify)                     |  |  |  |  |  |
| <b>40</b> | <b>Total (6+12+18+23+34+38+39)</b>   |  |  |  |  |  |
| 41        | Revenue recoveries, if any           |  |  |  |  |  |
| <b>42</b> | <b>Net Total (40-41)</b>             |  |  |  |  |  |

**Petitioner**

**Calculation of Interest on Working Capital****Name of LDC/**

(Amount in lacs)

| <b>Sl.<br/>No.</b> | <b>Particulars</b>  | <b>Existi<br/>ng<br/>2018-<br/>19</b> | <b>2019-<br/>20</b> | <b>2020-<br/>21</b> | <b>2021-<br/>22</b> | <b>2022-<br/>23</b> | <b>2023-24</b> |
|--------------------|---|---------------------------------------|---------------------|---------------------|---------------------|---------------------|----------------|
| <b>1</b>           | <b>2</b>  | <b>3</b>                              | <b>4</b>            | <b>5</b>            | <b>6</b>            | <b>7</b>            | <b>8</b>       |
| 1                  | O & M expenses excl.<br>HR  |                                       |                     |                     |                     |                     |                |
| 2                  | Human resource<br>expenses  |                                       |                     |                     |                     |                     |                |
| 3                  | NLDC charges<br>(Applicable for RLDC<br>only) or RLDC<br>Charges (Applicable<br>only for SLDCs) |                                       |                     |                     |                     |                     |                |
| 4                  | Receivables   |                                       |                     |                     |                     |                     |                |
| 5                  | Total Working Capital   |                                       |                     |                     |                     |                     |                |
| 6                  | Rate of Interest  |                                       |                     |                     |                     |                     |                |
| 7                  | Interest on Working<br>Capital  |                                       |                     |                     |                     |                     |                |

**Petitioner**

**LDC Empowerment Reserve**

Name of LDC: \_\_\_\_\_

(Amount in lacs)

| <b>Particulars</b>   | <b>Existing<br/>2018-19</b> | <b>2019-<br/>20</b> | <b>2020-<br/>21</b> | <b>2021-<br/>22</b> | <b>2022-<br/>23</b> | <b>2023-<br/>24</b> |
|--|-----------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| <b>1</b>   | <b>2</b>                    | <b>3</b>            | <b>4</b>            | <b>5</b>            | <b>6</b>            | <b>7</b>            |
| Opening LDC Empowerment Reserve – Opening                            |                             |                     |                     |                     |                     |                     |
| Additions in LDC Empowerment Reserve during the year                 |                             |                     |                     |                     |                     |                     |
| Total LDC Empowerment Reserve  |                             |                     |                     |                     |                     |                     |
| Less : Utilization for capital expenses                              |                             |                     |                     |                     |                     |                     |
| Less : Utilization for revenue expenses                              |                             |                     |                     |                     |                     |                     |
| Net LDC Empowerment Reserve as on 31 <sup>st</sup> March of the year |                             |                     |                     |                     |                     |                     |
| Average fund accumulated during the year                             |                             |                     |                     |                     |                     |                     |

Note: Break-up of additions and utilization shall be provided in separate sheet for each year

**Petitioner**

**Other Income**

Name of LDC: \_\_\_\_\_

(Amount in lacs)

| <b>Particulars</b>                          | <b>As on<br/>31.3.2019</b> | <b>2019-<br/>20</b> | <b>2020-<br/>21</b> | <b>2021-<br/>22</b> | <b>2022-<br/>23</b> | <b>2023-<br/>24</b> |
|---|----------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| <b>1</b>                                    | <b>2</b>                   | <b>3</b>            | <b>4</b>            | <b>5</b>            | <b>6</b>            | <b>7</b>            |
| Other Income – Opening                      |                            |                     |                     |                     |                     |                     |
| Add : Short term open access charges        |                            |                     |                     |                     |                     |                     |
| Add : Allocation from REC income            |                            |                     |                     |                     |                     |                     |
| Add: ....                                   |                            |                     |                     |                     |                     |                     |
| Add: ....                                   |                            |                     |                     |                     |                     |                     |
| Gross Income during the year                |                            |                     |                     |                     |                     |                     |
| Less : Utilization to meet shortfall        |                            |                     |                     |                     |                     |                     |
| Less: Use for...                            |                            |                     |                     |                     |                     |                     |
| So on                                       |                            |                     |                     |                     |                     |                     |
| ...   |                            |                     |                     |                     |                     |                     |
| Net Income as on 31 <sup>st</sup> March.... |                            |                     |                     |                     |                     |                     |

**Petitioner**

[To be published in pursuance of Regulation 6]

**Name of the Applicant (in Bold Letters)**  
**(Registered Office Address)**

1. The applicant above-named has made an application before the (Central/Name of State] Electricity Regulatory Commission, [Location] for determination of fees and charges for [Give name of the applicant].
2. The users of the [...] LDC are:
  - a. ....
  - b. ....
3. Details of tariff (Publish only applicable portion):

(Rs. in lakh)

|       | <b>Tariff<br/>for the<br/>previous<br/>year</b> | <b>Year-wise tariff sought to be determined</b> |         |         |         |         |         |
|-------|---|---|---------|---------|---------|---------|---------|
|       |   | <b>Previous year</b>                            | 2019-20 | 2020-21 | 2021-22 | 2022-23 | 2023-24 |
| [...] | LDC   |   |         |         |         |         |         |

4. A copy of the application made for determination of tariff is posted on the website (indicate here the address of the website).
5. The suggestions and objections, if any, on the proposals for determination of tariff contained in the application be filed by any person, including the beneficiary before **the Secretary, [ ....] Electricity Regulatory Commission, [Address]** with a copy to the applicant within 30 days of publication of this notice.

Place\_\_\_\_\_

Name and Designation of the Authorized Signatory

Date \_\_\_\_\_

### Depreciation Schedule

| S. No.   | Asset Particulars  | Depreciation Rate |
|----------|--|-------------------|
| <b>A</b> | <b>Land under full ownership</b>   | 0.00%             |
| <b>B</b> | <b>Land under lease</b>  |                   |
| (a)      | for investment in the land   | 3.34%             |
| (b)      | For cost of clearing the site  | 3.34%             |
|          |  |                   |
| <b>C</b> | <b>Other Assets</b>  |                   |
|          |  |                   |
| <b>A</b> | Building & Civil Engineering works   |                   |
| (i)      | Offices and residential  | [3.34%]           |
| (ii)     | Containing plant and equipment   | 3.34%             |
| (iii)    | IT (Hardware Equipment and Software)   | [100%]            |
| (iv)     | Temporary erections such as wooden structures  | [100.00%]         |
| (v)      | Roads other than Kutch roads   | [3.34%]           |
| (vi)     | Others   | [3.34]%           |
| <b>B</b> | <b>Transformers, Kiosk, sub-station equipment &amp; other fixed apparatus (including plant foundation)</b> |                   |
| (i)      | Transformers including foundations having rating of 100 KVA and over                                       | 5.28%             |
| (ii)     | Others   | 5.28%             |
|          |  |                   |
| <b>C</b> | <b>Solar Panel/Wind Mill</b>   | 5.28%             |
|          |  |                   |
| <b>D</b> | <b>Lightning arrestor</b>  |                   |
| (i)      | Station type   | 5.28%             |
| (ii)     | Pole type  | 5.28%             |
| (iii)    | Synchronous condenser  | 5.28%             |
|          |  |                   |
| <b>E</b> | <b>Batteries</b>   | 15.00%            |
| (i)      | Underground cable including joint boxes and disconnected boxes   | 5.28%             |
| (ii)     | Cable duct system  | 3.34%             |
|          |  |                   |

|          |  |        |
|----------|--|--------|
| <b>F</b> | <b>Overhead lines including cable support systems</b>  |        |
| (i)      | Lines on fabricated steel operating at terminal voltages higher than 66 kV                         | 3.34%  |
| (ii)     | Lines on steel supports operating at terminal voltages higher than 13.2 kV but not exceeding 66 kV | 5.28%  |
| (iii)    | Lines on steel on reinforced concrete support  | 5.28%  |
| (iv)     | Lines on treated wood support  | 5.28%  |
|          |  |        |
| <b>G</b> | <b>Meters</b>  | 5.28%  |
|          |  |        |
| <b>H</b> | <b>Self-propelled Vehicles</b>   | 9.50%  |
|          |  |        |
| <b>I</b> | <b>Air Conditioning Plants</b>   |        |
| (i)      | Static   | 5.28%  |
| (ii)     | Portable   | 9.50%  |
|          |  |        |
| <b>J</b> | (i) Office furniture and furnishing  | 6.33%  |
|          | (ii) Office equipment  | 6.33%  |
|          | (iii) Internal wiring including fittings and apparatus   | 6.33%  |
|          | (iv) Street Light fittings   | 5.28%  |
| <b>K</b> | <b>Apparatus let on hire</b>   |        |
| (i)      | Other than motors  | 9.50%  |
| (ii)     | Motors   | 6.33%  |
| <b>L</b> | <b>Communication equipment</b>   |        |
| (i)      | Radio and high frequency carrier system  | 6.33%  |
| (ii)     | Telephone lines and telephones   | 6.33%  |
| <b>M</b> | <b>I. T equipment</b>  | 15.00% |
| <b>N</b> | <b>Software</b>  | 30.00% |
| <b>O</b> | <b>Any other assets not covered above</b>  | 5.28%  |

Petitioner

**(In Compliance of Regulation 4)**

- 1. Name of the entity** (in bold letters):
- 2. Registered office address:**
- 3. Region in which registration is sought:**
  - i. North-eastern
  - ii. North
  - iii. East
  - iv. West
  - v. South
- 4. User category:**
  - i. Generating Station
  - ii. Seller
  - iii. Buyer
  - iv. Transmission Licensee
  - v. Distribution Licensee
  - vi. Trading Licensee
  - vii. Power Exchange
  - viii. Battery Energy Storage system
  - ix. Electric Vehicle Charging Stations
  - x. QCA / Aggregators
  - xi. Others

**5. User details** (as on 31st March of last financial year):

- i. Category – generating Station**
  - i. Total Installed Capacity
  - ii. Maximum Contracted Capacity (MW) using ISTS
  - iii. Points of connection to the ISTS:

| <b>Sl. No.</b> | <b>Point of connection</b> | <b>Voltage level (kV)</b> | <b>Number of Special Energy Meters (Main) installed at this location</b> |
|----------------|----------------------------|---------------------------|--|
|                |                            |                           |  |

- ii. Category - Seller/Buyer/Distribution Licensee**
  - i. Maximum Contracted Capacity (MW) using ISTS
  - ii. Points of connection to the ISTS:

| <b>Sl. No.</b> | <b>Point of connection</b> | <b>Voltage level (kV)</b> | <b>Number of Special Energy Meters (Main) installed at this location</b> |
|----------------|----------------------------|---------------------------|--|
|                |                            |                           |  |

**iii. Category – Transmission Licensee (inter-State)**

- i. Sub-stations:

| <b>Sl. No.</b> | <b>Sub-station Name</b> | <b>Number of transformer</b> | <b>Total Transformation Capacity or Design MVA handling capacity if switching Station</b> |
|----------------|-------------------------|------------------------------|---|
|                |                         |                              |   |

ii. Transmission lines: (line wise details to be given)

| <b>Sl. No.</b> | <b>Voltage level (kV)</b> | <b>Number of transmission lines</b> | <b>Total Circuit-Kilometers</b> |
|----------------|---------------------------|-------------------------------------|---------------------------------|
|                |                           |                                     |                                 |

iv. Category (Others): Please specify details.

**6. Contact person(s) details for billing related to [...] LDC:**

- i. Name:
- ii. Designation:
- iii. Telephone No.:
- iv. E-mail address:
- v. Postal address:

**7. Other Details:**

- i. PAN No.:
- ii. GST No.:
- iii. Bank Account No.:
- iv. Bank Name and Address:
- v. MICR No:

The above information is true to the best of my knowledge and belief.

Signature of Authorized Representative

Place:

Name:

Date:

Designation:

Contact number:

**Assessment of Key Performance Indicators**

Name of LDC: \_\_\_\_\_

Performance Year: \_\_\_\_\_

| Category                             | No. | Key Performance Indicators | Weightage | Previous Year | Current Year |
|--------------------------------------|-----|----------------------------|-----------|---------------|--------------|
| <b>(A) Stake holder satisfaction</b> | 1   |                            |           |               |              |
|                                      | 2   |                            |           |               |              |
|                                      | 3   |                            |           |               |              |
|                                      | .   |                            |           |               |              |
| <b>(B) Financial Prudence</b>        | 1   |                            |           |               |              |
|                                      | 2   |                            |           |               |              |
|                                      | 3   |                            |           |               |              |
|                                      | .   |                            |           |               |              |
| <b>(C) Learning &amp; Growth</b>     | 1   |                            |           |               |              |
|                                      | 2   |                            |           |               |              |
|                                      | 3   |                            |           |               |              |
|                                      | .   |                            |           |               |              |
| <b>(D) Internal Process</b>          | 1   |                            |           |               |              |
|                                      | 2   |                            |           |               |              |
|                                      | 3   |                            |           |               |              |
|                                      | .   |                            |           |               |              |

(Calculations of specific key performance indicators above are to be detailed in a Procedure duly prepared by the LDC which shall be approved by the Commission)

**Human Resource Requirement - Projection for Control Period:****I. Number of regular employees posted in Load Despatch Centre**

| Grade        | Description   | Year-1 | Year-2 | Year-3 | Year-4 | Year-5 |
|--------------|---|--------|--------|--------|--------|--------|
| <b>Board</b> | Director  |        |        |        |        |        |
| <b>E9</b>    | Executive Director                                  |        |        |        |        |        |
| <b>E8</b>    | General Manager /Chief Engineer                     |        |        |        |        |        |
| <b>E7</b>    | Dy. General Manager / Jt. CE/Addl. Chief Engineer   |        |        |        |        |        |
| <b>E5-E6</b> | Manager/Chief Manager / Superintending Engineer     |        |        |        |        |        |
| <b>E3-E4</b> | Engineer to Dy. Manager/ Executive Engineer         |        |        |        |        |        |
| <b>E2</b>    | Assistant / Deputy Engineer                         |        |        |        |        |        |
| <b>E1</b>    | Supervisor / Junior Engineer                        |        |        |        |        |        |
| <b>NE</b>    | Non-Executives/Workmen                              |        |        |        |        |        |
| <b>TOT-E</b> | Total Executives                                    |        |        |        |        |        |
| <b>E/NE</b>  | Ratio of Executives to Non-Executive = (TOT-E)/(NE) |        |        |        |        |        |

**II. Adequacy of personnel in functional areas**

|                 | Description  | Year-1 | Year-2 | Year-3 | Year-4 | Year-5 |
|-----------------|--|--------|--------|--------|--------|--------|
| <b>E-RS</b>     | Executives working in rotating shifts                                    |        |        |        |        |        |
| <b>E-SO</b>     | Executives in System Operation functions (Off-line)                      |        |        |        |        |        |
| <b>E-MO</b>     | Executives in Market Operation functions (Off-line)                      |        |        |        |        |        |
| <b>E-SL</b>     | Executives in System Logistics functions (off-line)                      |        |        |        |        |        |
| <b>E-OTH</b>    | Executives in Other Support functions (Off-line)<br>(Law, HR, F&A, etc.) |        |        |        |        |        |
| <b>E-GS</b>     | Executives working in general shifts (E-SO+MO+SL+OTH)                    |        |        |        |        |        |
| <b>RS/GS</b>    | Ratio of Executives in Rotating Shift / General Shift                    |        |        |        |        |        |
| <b>SO/TOT</b>   | Ratio of Executives (SO/Total)   |        |        |        |        |        |
| <b>MO/TOT</b>   | Ratio of Executives (MO/Total)   |        |        |        |        |        |
| <b>SL/TOT</b>   | Ratio of Executives (SL/Total)   |        |        |        |        |        |
| <b>OTH/TO T</b> | Ratio of Executives (Oth/Total)  |        |        |        |        |        |

**III. Number of personnel in Load Despatch Centre having valid certificates** (as on 31<sup>st</sup> March of respective year)

| S No. | Particulars                                       | Year-1 | Year-2 | Year-3 | Year-4 | Year-5 |
|-------|---|--------|--------|--------|--------|--------|
| A     | Certified executives- Basic level                 |        |        |        |        |        |
| B     | Certified executives - Reliability Specialist     |        |        |        |        |        |
| C     | Certified executives - Market Specialist          |        |        |        |        |        |
| D     | Certified executives- System Logistics Specialist |        |        |        |        |        |
| E     | Certified executives - Specialist (Others)        |        |        |        |        |        |
| F     | Certified executives- Management level            |        |        |        |        |        |
| G     | Total number of certified executives              |        |        |        |        |        |
| H     | Total number of executives                        |        |        |        |        |        |
| I     | Ratio of Basic to Total (A/H)                     |        |        |        |        |        |
| J     | Ratio of Reliability Specialist to Total (B/H)    |        |        |        |        |        |
| K     | Ratio of Market Specialist to Total (C/H)         |        |        |        |        |        |
| L     | Ratio of Logistics Specialist to Total (D/H)      |        |        |        |        |        |
| M     | Ratio of Other Specialist to Total (E/H)          |        |        |        |        |        |
| N     | Ratio of Management Specialist to Total (F/H)     |        |        |        |        |        |

**IV. Qualification of personnel in Load Despatch Centre**

| S No. | Discipline<br>(at graduation level) | Year-1 | Year-2 | Year-3 | Year-4 | Year-5 |
|-------|-------------------------------------|--------|--------|--------|--------|--------|
| 1     | Power System                        |        |        |        |        |        |
| 2     | Electrical                          |        |        |        |        |        |
| 3     | Renewable                           |        |        |        |        |        |
| 4     | Communication                       |        |        |        |        |        |
| 5     | Computer Science                    |        |        |        |        |        |
| 6     | Public Policy                       |        |        |        |        |        |
| 7     | Economics                           |        |        |        |        |        |
| 8     | Commerce                            |        |        |        |        |        |
| 9     | Statistics                          |        |        |        |        |        |
| 10    | Law                                 |        |        |        |        |        |
| 11    | Human Resource                      |        |        |        |        |        |
| 12    | Finance                             |        |        |        |        |        |
| 13    | Management                          |        |        |        |        |        |
| 14    | Others-(Specify)                    |        |        |        |        |        |

**V. Number of regular employees posted in Sub-Load Despatch Centre**

| Grade        | Description   | Year-1 | Year-2 | Year-3 | Year-4 | Year-5 |
|--------------|---|--------|--------|--------|--------|--------|
| <b>E3-E4</b> | Engineer to Dy. Manager/ Executive Engineer         |        |        |        |        |        |
| <b>E2</b>    | Assistant / Deputy Engineer                         |        |        |        |        |        |
| <b>E1</b>    | Supervisor / Junior Engineer                        |        |        |        |        |        |
| <b>NE</b>    | Non-Executives/Workmen                              |        |        |        |        |        |
| <b>TOT-E</b> | Total Executives                                    |        |        |        |        |        |
| <b>E/NE</b>  | Ratio of Executives to Non-Executive = (TOT-E)/(NE) |        |        |        |        |        |
|              | Number of certified personnel                       |        |        |        |        |        |

\*\*\*

# Report of the FOR Technical Committee Sub-group on LDCs

## - Institution Building and Strengthening

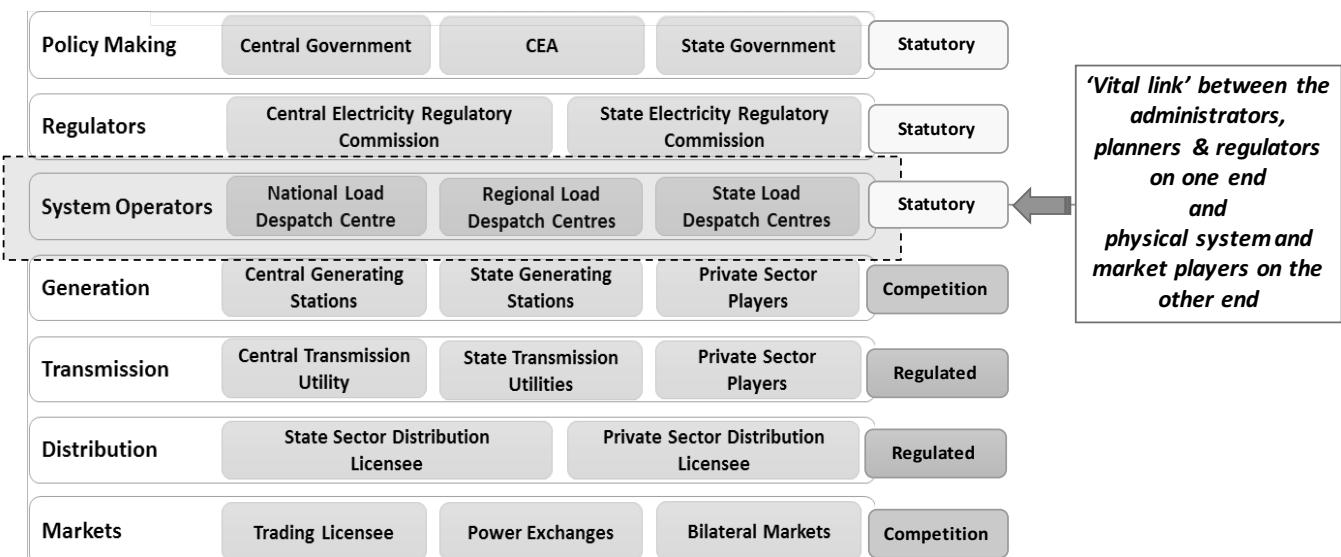
65<sup>th</sup> Meeting of the Forum of Regulators  
 Venue: Bhubaneswar; Date: 13<sup>th</sup> November, 2018

13-Nov-18

काबिला - CABEL (report of the technical committee sub-group)

1

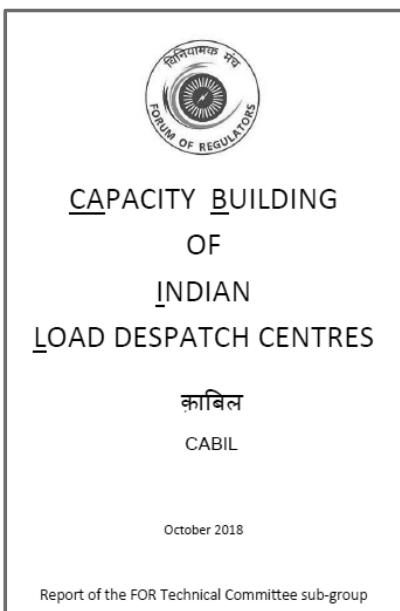
### Role of System Operators in Indian Power Sector



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काबिला - CABEL (report of the technical committee sub-group)

2



## SALIENT FEATURES

- 7 Terms of References**
- 12 Members**
- 42 Indian contributors**
- 2 International contributors**
- 16 SLDC visits**
- 11 Global ISO practices**
- 5 Surveys questionnaires**
- 24 Fee and charge regulations**
- 28 Fee and charges orders**
- 28 LDC websites**
- 71 Questions for deliberations**
- 11 Meetings**
- 2 FOLD meetings**
- 111 References**
- 8 Videos on control centres**
- ~ 40,000 man-hours**

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3

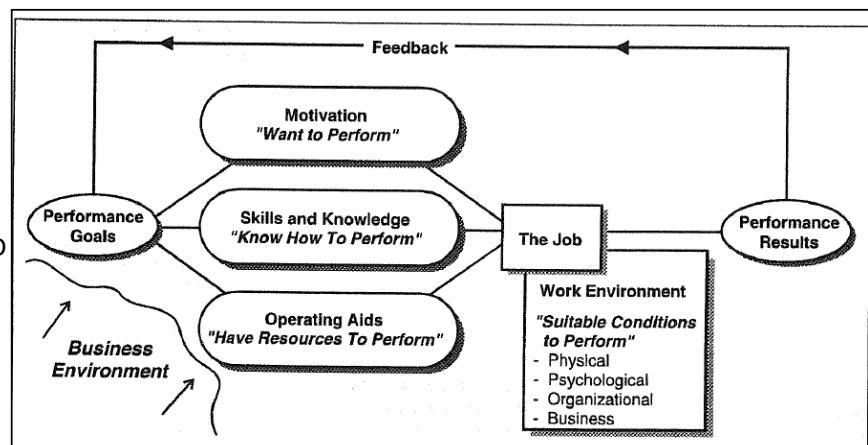
## 294 pages, 12 chapters

### Chapters

- Executive Summary
- 1. Introduction
- 2. Interface with stakeholders
- 3. Functional Activities
- 4. Human Resource
- 5. Infrastructure & Ergonomics
- 6. Decision Support System
- 7. Information & Communication Tech.
- 8. Governance Aspects of Data
- 9. Capacity Development through FOLD
- 10. Business Model
- 11. Key Performance Indicators
- 12. Recommendations (20)
  - 2 Road-maps
  - Bibliography (111)
  - Annexures (19)
  - 38 tables
  - 48 figures

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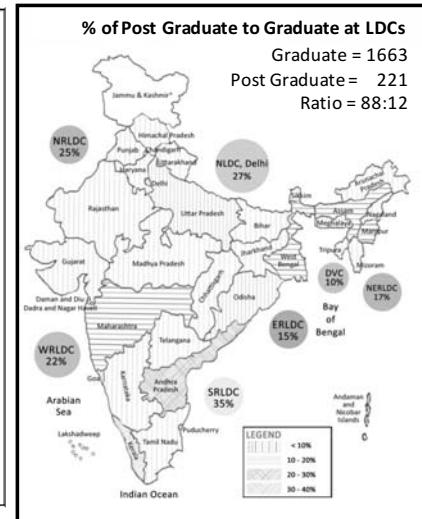
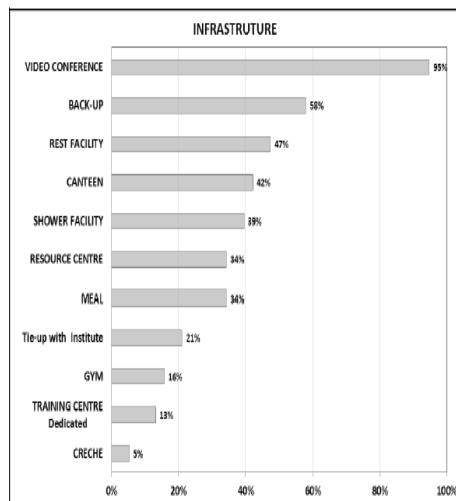
## Framework for Human Performance in Control Centers –



(Ref. CIGRE WG 39.03)

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4



**Sustainable institutional capacity building is required by suitable interventions in**

- **Tangible:** physical assets, resources, organization structure, systems, regulatory framework
- **Intangible:** skills, experience, creativity, tacit knowledge, values, motivation and culture

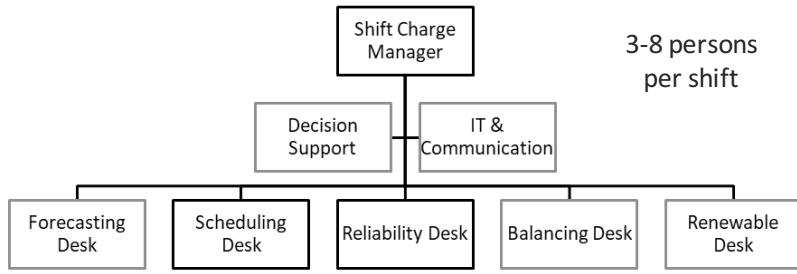
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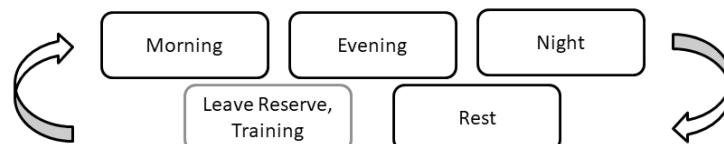
5



### Recommended Organization of the real-time team



### Typical Rotation of Groups



HR budgeting must factor training, business travel, official nominations, special assignments, leave entitlements, contingency leaves, leaves on extended weekends/Festivals

**Accommodation  
Rewards, recognition  
Job enrichment  
Professional engagement**

**Night shift pick-up / drop  
Compensatory off  
Study leave  
Social security benefits**

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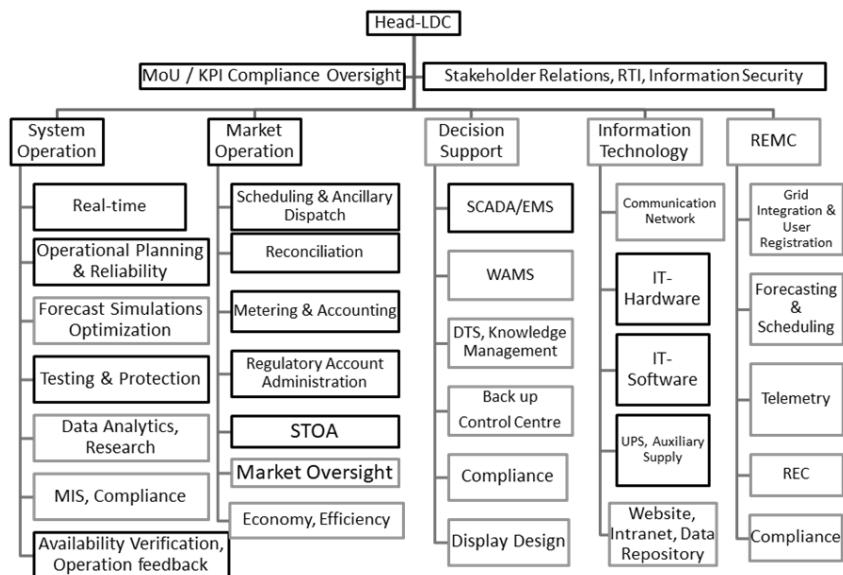
6

## Emerging challenges

- Automation Controls, Optimization
- Compliance Monitoring, Testing
- RE, DER, QCA, DSO, EV, BESS
- REC, PAT, Others
- Aggregators, Virtual Producers
- WAMS, Visualization
- Artificial Intelligence
- Cyber Security
- New Market Products
- Regulatory Changes, Reforms
- Data Analytics
- Data Sharing
- Collaborative Activities,
- Amendment of Electricity Act

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## Recommended Organogram (1/2)

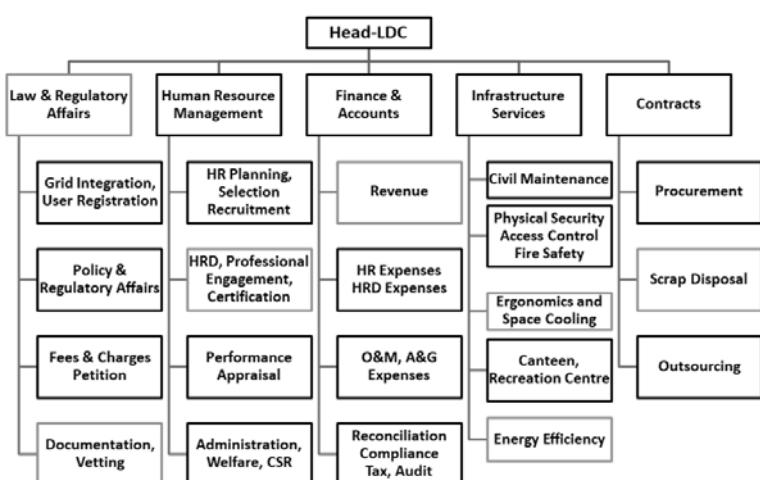


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## Recommended Organogram (2/2)

## HR Requirement



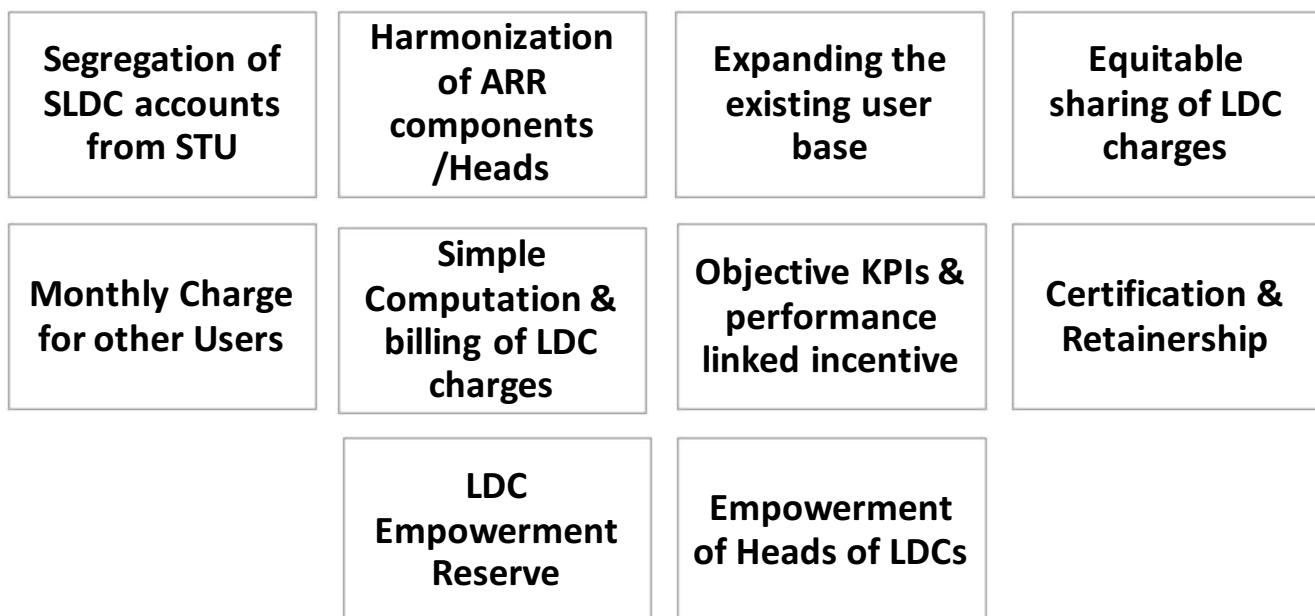
|                            |                          |                    |
|----------------------------|--------------------------|--------------------|
| 1                          | <b>Emerging LDC</b>      | <b>30 to 50</b>    |
| 2                          | <b>Medium LDC</b>        | <b>70 to 100</b>   |
| 3                          | <b>Large LDC</b>         | <b>100 to 150</b>  |
| 4                          | <b>Total All India</b>   | <b>3500 – 4000</b> |
| Less than 1% of the sector |                          |                    |
| 5                          | <b>REMC</b>              | <b>25 to 30</b>    |
| 6                          | <b>Sub-LDC</b>           | <b>15 to 25</b>    |
| 7                          | <b>Exec : Non-Exec</b>   | <b>95:5</b>        |
| 8                          | <b>SO : Total</b>        | <b>35 – 45 %</b>   |
| 9                          | <b>MO : Total</b>        | <b>20 – 30 %</b>   |
| 10                         | <b>SL : Total</b>        | <b>15 – 20 %</b>   |
| 11                         | <b>Real-time : Total</b> | <b>30 %</b>        |
| 12                         | <b>Support : Total</b>   | <b>10 - 15 %</b>   |

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# Principles for Model fee and charges regulation

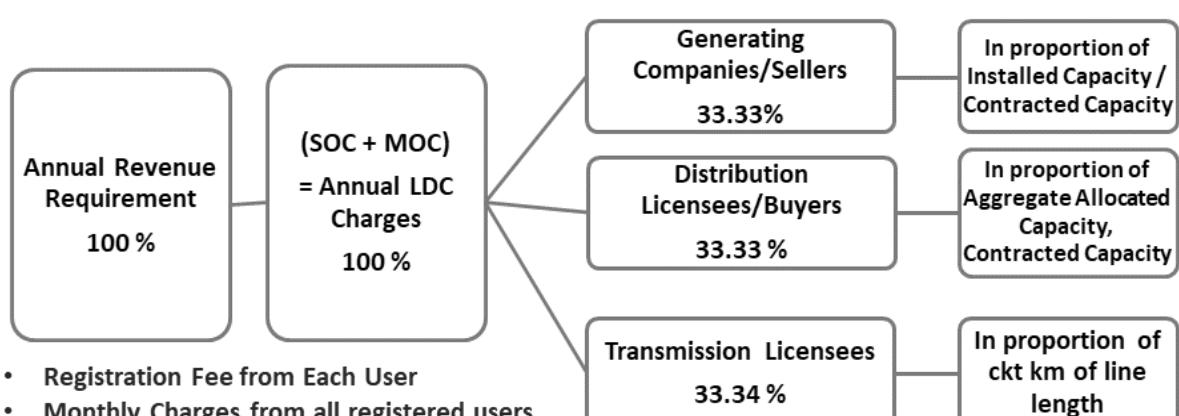


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## Proposed Model for Revenue Recovery

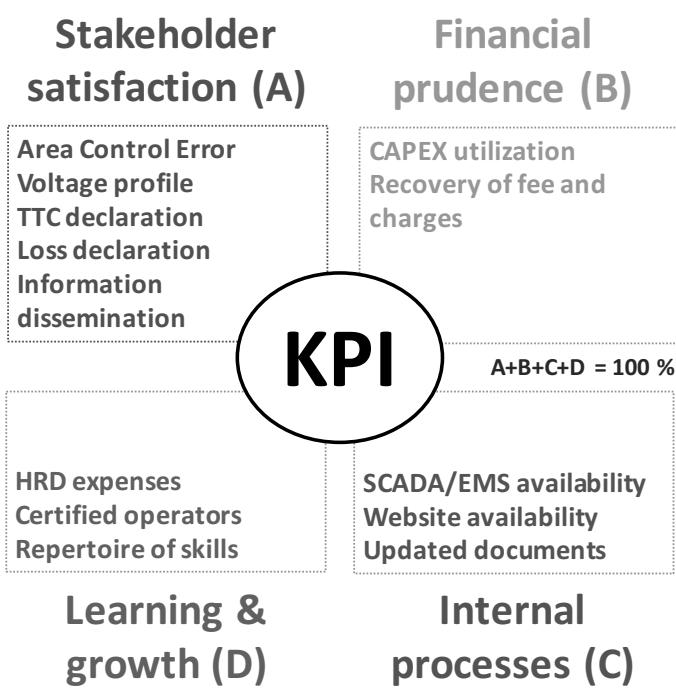


- Registration Fee from Each User
- Monthly Charges from all registered users
- Adhoc Monthly Charge for Grid Reliability Service Users
- Performance Linked Incentive on achieving KPI targets
- Fees & Charge Petition & Final True-up once in every 5 years control period
- Yearly Reconciliation with Users
- Option for Mid Term Review Petition

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|                                   | Expenses             | Typical fig.          |
|-----------------------------------|----------------------|-----------------------|
| 1                                 | HR : ARR             | 70-80 %               |
| 2                                 | CAPEX : ARR          | 20-30 %               |
| 3                                 | LDC ARR<br>All India | ₹. 900 – 1400 cr      |
| <b>Less than 1% of the sector</b> |                      |                       |
|                                   | Certification        | % of Total executives |
| 4                                 | Basic level          | 75 %                  |
| 5                                 | Specialist level     | 10-15 %               |
| 6                                 | Training (Min)       | 7 days /person        |
| 7                                 | Incentive kitty      | 10 % of turnover      |

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## Recommendations - LDC Institutional capacity building

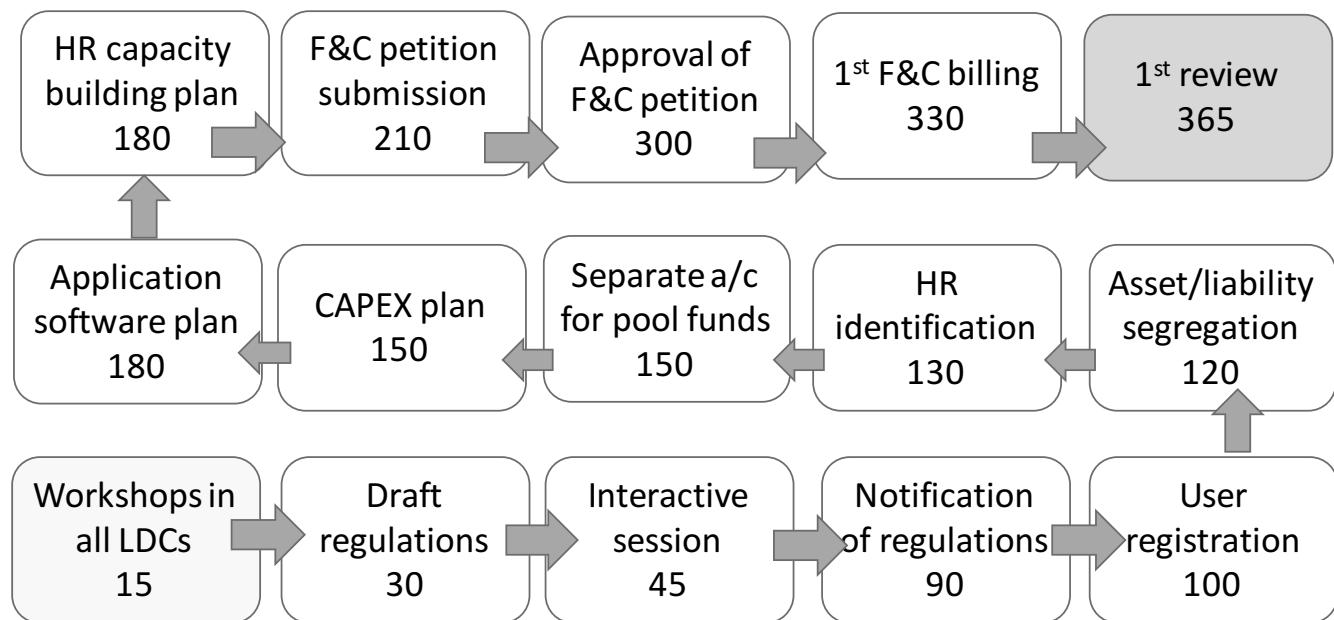
|                                      |                                 |                                      |   |   |
|--------------------------------------|---------------------------------|--------------------------------------|---|---|
| Human Resource Diversity, Adequacy   | 5 Real-time Operation desks     | Adequate Infrastructure, Ergonomics  | Robust Decision Support System, Thematic Maps | Reliable Communication Technology       |
| IT & Automation                      | HRD – Regular Skill Upgradation | Modelling & Simulation               | Certification                                 | HR Expense (incl. HRD) as separate head |
| Harmonization & hand-holding by FOLD | Governance of Data              | Model Regulations LDC Fees & Charges | Performance Evaluation - KPI                  | Benchmarking & Rewards                  |

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## ROAD MAP



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**Thank you for your kind attention !**



Uttar Pradesh SLDC



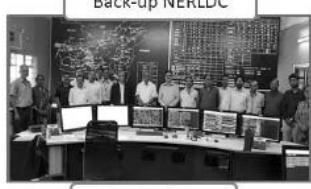
Back-up NERLDC



SLDC Meghalaya



Maharashtra SLDC



Guwahati



Shillong



Gujarat SLDC



SLDC

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## A few Load Despatch Centre premises (in India)



SLDC Maharashtra



SLDC Uttar Pradesh



SLDC Gujarat



Navi Mumbai



Lucknow



Vadodara



Back-up NERLDC



SLDC Meghalaya



Guwahati



Shillong

## Footprints of Load Despatch Centres in India



Capacity Building of Indian Load Despatch Centres

**Forum of Regulators**  
 C/o. Central Electricity Regulatory Commission (CERC)  
 3rd & 4th Floor, Chandralok Building, 36, Janpath, New Delhi 110 001