CENTRAL ELECTRICITY REGULATORY COMMISSION
NEW DELHI

Petition No. 420/MP/2014

Coram:
Shri Gireesh B. Pradhan, Chairperson
Shri A.K. Singhal, Member
Shri A.S. Bakshi, Member
Dr. M.K.Iyer, Member

Date of Hearing: 18.08.2015
Date of Order: 05.01.2016

In the matter of

Endangering grid security due to non-implementation of contingency demand disconnection scheme for sudden loss of wind generation as per CERC order 120/MP/2011 dated 22.2.2014, non-availability of LVRT protection, non-scheduling of wind generation as per Central Electricity Regulatory Commission (Indian Electricity Grid Code) Regulations, 2010 (IEGC) 6.5.23 (i), lack of necessary demand estimation as per IEGC Regulation 5.3 and not providing real time SCADA data to LDC.

And
In the matter of

Southern Regional Load Despatch Centre
29, Race Course Cross Road,
Bangalore-560 009 **....Petitioner**

Vs.

1. Tamil Nadu State Load Despatch Centre
Load Despatch and Grid Operation
144, Anna Salai, Chennai-600 002

2. Karnataka State Load Despatch Centre
Kaveri Bhawan. K.G.Road,
Bangalore-560 009.

3. AP State Load Despatch Centre
Vidyut Soudh, Hyderabad-500 082

4. Telangana State Load Despatch Centre
Vidyut Soudh, Hyderabad-500 082

5. Kerala State Load Despatch Centre
Vaidyuthi Bhavanam, Pottam,
Trivandrum-695 009, Kerala

6. Indian Wind Power Association
1st Floor, A-Wing, AMDA Building, 716, Siri Fort Institutional Area, August Kranti Marg, New Delhi-110 049

7. Solar Energy Association
1/694, Chandrapuram,
Dharapuram Road,
Tirupur-641608 Tamil Nadu,
India

Respondents

1. Central Transmission Utility
Saudamini, Plot No. 2,
Sector-29, Gurgaon-122 001 (Haryana)

2. Central Electricity Authority
Sewa Bhawan, R.K.Puram,
New Delhi-110 022

3. Member Secretary,
Southern Regional Power Committee
29, Race Course Cross Road,
Bangalore-560 009

Proforma Respondents

The following were present:

Shri V. Suresh, SRLDC
Ms. Jayantika Singh, SRLDC
Ms. Pragya Singh, WRLDC
Shri Anand K Ganesan, Advocate, IWPA
Shri Dharmendra Gupta, IWTMA
Shri C.V. Vetriselvan, PWPL
Shri K. Ramu, PWPL
Shri M. Pradeep Sankar, PWPL
Shri S. Vallinayagam, Advocate, TANGEDCO

ORDER

The petitioner, Southern Regional Load Despatch, has filed the present petition *inter-alia* seeking direction to SLDCs to ensure that LVRT setting of the available wind turbines is installed in terms of the Central Electricity Authority (Technical Standards for Grid Connectivity) Regulations, 2007. The petitioner has made the following

prayers:

(a) Direct SLDC to expedite implementation of contingency demand disconnection scheme for mitigating impact of sudden loss of wind generation in line with order dated 22.2.2014 in 120/MP/2011.

(b) Direct the SLDC to ensure Data Acquisition System/Real Time data availability of their SCADA system as envisaged in the IEGC and extended geographically consolidated data to SRLDC.

(c) Direct the SLDC to ensure that LVRT setting of the available wind turbines as prescribed in CEA (Technical Standards for Grid Connectivity) Regulations, 2007 amendment dated 15.10.2013.

(d) Issue suitable guidelines for protection to be provided by the existing machines not having LVRT feature to mitigate the cascading effect on the grid during sudden loss of wind generation.

(e) Direct proper forecasting and scheduling by Renewable Energy generators and demand estimation by SLDC in compliance with IEGC.

(f) Direct SLDC to study line loading in the STU) network and ensure strict N-1 compliance by expediting works under progress, particularly wind evacuation system.

(g) Direct CTU/STU/SLDC to ensure that the new units being commissioned and getting connected to the grid are fully complying with CEA (Technical Standards for Grid Connectivity) Amendment Regulations, 2013.

2. Gist of the submission of the petitioner is as under:

(a) Wind generation in India has been systematically growing every year. As per the Centre for Wind Energy Technology. Ministry of New Renewable Energy (MNRE), the overall installed capacity up to 31.1.2014 is 20,226 MW out of which Tamil Nadu has highest installed capacity of 7,251 MW followed by Gujarat (3,384 MW) and Maharashtra (3427 MW).

(b) In the Southern Region, there is Talcher Kolar HVDC as well as the upcoming Raigarh Pugalur HVDC in close proximity to the wind generators. The existing Raichur-Sholapur 765 kV inter-connector has high sensitivity to sudden change in Southern Region generation/load. In case the faults in the system are

not cleared on time, it would result in an adverse impact on HVDC systems, inter-connectors and wind generators. This would result in cascading failures impacting the All India Grid.

(c) During the meeting of the Forum of Regulators held on 27.6.2014, it was discussed that Variability and Intermittent Generation, Frequency fluctuations due to generation or load loss/ poor Frequency Response Characteristics (FRC) of individual sub-systems, absence of Fault Ride Through (FRT) capabilities, low voltage situation and heavy wind injection are the challenges which are grappling the grid.

(d) As per CEA report on *'Large Scale Grid Integration of Renewable Energy Sources-Way Forward'* dated November, 2013, the basic technical challenge comes from the variability of wind and solar power affects the load generation balance and varying demand for reactive power, and has an impact on voltage stability. However, the burgeoning problem lies in the sudden loss of wind generation, which has a much more cascading effect as opposed to the gradual variability. In the Southern Region, due to the Grid Incidents (GI)/Grid Disturbances (GD) in the recent past, there has been loss of wind generation by more than 800 MW as under:

S. No.	Date and Time	Details of Incident	Loss of Wind Generation
1	28.5.2013 at 17.00 hrs	Low voltage in Udumalpet area and fault at 110 kV Othakalmandapam	860 MW
2	7.6.2013 at 10:47 hrs	Bus fault at 230/110 kV Kayathar substation. Delayed clearance of fault due to absence of 110 kV bus bar protection	1340 MW

3	2.6.2014 at 15:54 hrs	Bus fault at 230/110 kV Kayathar substation. Delayed clearance of fault due to absence of 110 kV bus bar protection	1135MW
4	5.6.2014 at 19:10 hrs	Multiple tripping at Neyveli TS-2. Delayed clearance of fault	920 MW
5	1.7.2014 at 17:52 hrs	Delayed clearance of fault in 230 kV Kayathar-Tuticorin TPS line	920MW

(e) During the above incidents, the loss of wind generation were primarily due to cascade tripping of wind mills which do not have Low Voltage Ride Through (LVRT) protection during momentary low voltage. This delayed clearance of fault by more than 450 m/s. In the absence of LVRT protection as well as contingency load disconnection scheme for loss of wind generation, the impact has been passed on to the grid within rush of power flow in the inter-regional links, operation of SPS on such links as well as drop in system frequency. Such instances poses threat to grid security since it involved compounding tripping, with severe oscillation on 765 kV Sholapur-Raichur link, thereby impacting the line loading across S1-S2 and causing multiple SPS/UFR operations. On 5.6.2014, one of the instances led to tripping of 765 kV Sholapur- Raichur transmission line.

(f) LVRT mechanism boosts the terminal voltage of the point of connection of the wind machine when there is a fault at the remote location to provide transient stability support. LVRT is the capability of the electrical device to operate through periods of lower grid voltage.

(g) The Central Electricity Authority (Technical Standards for Connectivity to the Grid) (Amendment) Regulations, 2013 provides that wind generating station connected at voltage level of 66 kV and above shall remain connected

to the grid when voltage at inter-connection point on any or all phases dips up to 0.15 Pu. However, no LVRT protection has been provided by the wind energy generators so far. As per the said regulations, the new generators connected with effect from the date of the Regulations i.e. 15.4.2014 are required to meet technical requirement by taking care of the impact of future addition. Moreover, it is silent on the way out required to mitigate the impact of the existing wind generators.

(h) In the present scenario, major portion of wind generators operating without LVRT protection creates the risk of making any temporary faults in the transmission system in the situation of grid disturbance near wind energy areas. The level of risk is maximum in the State of Tamil Nadu followed by Karnataka and other States in Southern Region. On 5.6.2014, multiple trippings occurred at NLC TPS-II, which is a typical example to visualize such situations. Due to fault at Neyveli, the wind generators at Udumalpet area also responded with cascade tripping, thereby creating simultaneous crisis at more than one geographical location of the grid. Since 2009, SRLDC has been emphasizing the issue of Automatic Demand Management Scheme (ADMS) to mitigate the contingency of sudden loss of wind generation and the issue of LVRT requirement has been taken up for more than three years.

(i) SRLDC filed Petition No. 120/MP/2011 seeking direction to Tamil Nadu Electricity Board (TNEB) to maintain grid security of the Southern Regional Grid by curbing overdrawal and to effect proper load management by TNEB. One of the primary reasons submitted by TNEB was sudden change in huge quantum of wind generation. In response, SRLDC explained that lack of

contingency demand disconnection scheme matching the loss of wind generation is the root cause. After considering the submission of the parties, the Commission vide order dated 22.2.2014 in Petition No. 120/MP/2011 had directed TNEB to take necessary steps to implement ADMS to deal with the emergency situations such as sudden variation/loss of wind generation or forced outages, etc. and submit the monthly progress report to SRLDC and SRPC in this regard. SRPC convened special meetings in the regard and matter was taken up in all OCC meetings of SRPC and TCC. However, no tangible measures have been taken in this regard by TNEB.

(j) The issue needs to be taken up by STUs/DISCOMs/SLDCs with the concerned State Electricity Regulatory Commissions. The lines in wind intensive areas were often getting over loaded contributing to low voltages and fault was causing the pulling out of the generators. The State of Tamil Nadu needs to monitor the line loading /voltages in the critical areas and back down generation/curtail load as per the requirement. The evacuation issues also need to be addressed at the earliest.

(k) The non-availability of real time data of wind generation to SLDCs is another important issue compounding the problem, particularly in Tamil Nadu. The real time data integration of wind generation to SLDC SCADA is far below 100%. Typical evidence is the cascade tripping of wind generation during NLC TPS - II instance, during which Tamil Nadu SLDC itself was not aware about the loss of wind generation for more than an hour. The availability of real time wind generation data in the State of Karnataka is better than other States having similar status as of Tamil Nadu.

(l) Another prolonging issue, which has not been implemented since 2010, is the “Forecasting and Scheduling" of wind generation. Despite variation in the renewable energy sources, forecasting with fair accuracy can be done similar to other countries. As a system operator, the forecast error or deviation shall be as minimum as possible. However, the wind energy generators are encouraged for commencement of scheduling and getting expertise in forecasting and scheduling as the Central Electricity Regulatory Commission (Indian Electricity Grid Code) Regulations, 2010 as amended from time to time (Grid Code) permits flexibility upto 30% deviation.

(m) Forecasting the power output of wind farms in the next hours or days is of prime importance for the management of a power system with high wind penetration. In the case for wind energy, the generation depends on weather conditions. Wind power forecasts are useful for power system scheduling, congestion management, storage management, reserves allocation and other functions. Wind farm operators also need forecasts to participate in a day-ahead electricity market or to plan maintenance of wind farms. However, it is observed that most of the wind generators are yet to commence the forecasting and scheduling practices. Moreover, the wind generators had filed appeals before various High Courts regarding technical limitations and commercial implication. In absence of proper forecasting and scheduling by renewable energy sources, SLDCs are not complying with the provisions of Regulation 5.3 of the Grid Code.

(n) The growth of renewable energy sources in India is important, realizing the paramount need for a grid security. Anything hampering the secured

operation of the grid would also impede the full growth of green energy. Therefore, the provisions with respect to scheduling, forecasting, demand estimation, contingency plans and protection system needs to be ensured. At present, in India renewable generation penetration is being done without ensuring essential features for integration with very large grid. The bird's eye view of present scenario is as under:

(i) In Southern Region, about 10000 MW plus generation operates like infirm power injection.

(ii) More than 80% of current capacity of wind generation operates without LVRT/FRT feature thereby adversely responding at low voltage either due to high load condition at wind pockets or any fault condition in different parts of the grid and becomes a source for grid incident. At present, 20% current installed capacity have LVRT. However, their settings are not uniformly matching with the provisions of the Central Electricity Authority (Technical standards for connectivity to the Grid) Regulation, 2007 as amended from time to time (CEA Technical Standards for Connectivity Regulations).

(iii) Real time renewable energy data availability to the Load Despatch Centre SCADA system is partial. Major portion of Tamil Nadu wind data is manually entered/updated from SLDC Tamil Nadu periodically.

(iv) None of the States has implemented contingency demand disconnection schemes to mitigate the sudden loss of wind generation.

(v) Forecasting and Scheduling of renewable generation is still at the incubation stage.

(vi) There is no evidence to the effect that demand forecasting is being done by SLDCs with the due consideration of weather forecast and its impact on renewable energy generation.

(o) There is a need for contingency plan for sudden loss of wind generation. In order to reduce the delay in response and to ensure instantaneous load shedding, ADMS has to be in place to deal with contingencies. The contingency scheme to be implemented shall be different from the ADMS which is meant for regular load - generation balance in a time block interval.

3. The petition was admitted on 26.2.2015. Notices were issued to the respondents to file their replies. The Commission directed the petitioner to implead Wind Energy Association and Solar Power Association of Southern Region as party to the petition. During the course of hearing, the representative of Southern Regional Load Despatch Centre (SRLDC) submitted as under:

(a) Regulation B2.(3) of the CEA Technical Standards for Connectivity Regulations provides that Low Voltage Ride Through (LVRT) is compulsory for machines installed after 15.4.2014, but for existing wind power generating stations, LVRT should be mutually discussed. It does not exempt any station from installing LVRT.

(b) The issue of installing LVRT has been discussed from the time when the installed capacity of wind in Southern Region was 3000 MW. Presently, the installed capacity is around 13,000 MW. Out of this, 9000 MW wind capacity does

not have LVRT.

(c) No tangible action has been taken with regard to installation of LVRT. The responsibility of monitoring installation of LVRT has not been fixed under any Regulation.

4. The representative of CEA submitted as under:

(a) At the time of framing of CEA Technical Standards for Connectivity Regulations, it was thought that installation of LVRT on existing machines would have an implication on tariff. Since, ADMS, scheme has not been implemented by the States, the grid becomes vulnerable due to emergency situations such as sudden variation of load/loss of wind generation. Therefore, availability of LVRT is very important.

(b) STUs/SLDCs should be responsible to monitor installation of LVRT. LVRT should fall under the Connectivity Regulations of respective States.

5. The representative of POSOCO submitted that installation of LVRT needs to be ensured at the time of "connection" of the wind generators. The strictness of LVRT is necessary. The Commission directed the respondents to submit status of LVRTs on wind generators in their respective States.

6. SLDC, Tamil Nadu Transmission Corporation Ltd (SLDC, TAMIL NADU), vide affidavit its dated 25.3.2015, has submitted the status of LVRTs on wind generators in the State of Tamil Nadu as under:

S. No.	Description	No. of wind generators
1	Total no. of wind generators	11,701
2	LVRTs available	1,850
3	LVRTs not available	9,851

7. During the next hearing on 12.5.2015, the representative of the petitioner submitted that in the months of August and September, maximum wind generation has been reported. Approximately 125 MU (i.e. 5400 MW) is generated in a day by the wind generators. He further submitted that wind is not a stable source of energy. However, almost 40% of Tamil Nadu demand is met by power generated from wind. There is 13000 MW of installed wind generation but data has not been ascertained by SLDCs. SLDCs should provide concurrence to wind generators only after ascertaining necessary requirements. The Commission directed SLDCs of Southern Region to file their replies with reasons of non-availability of real time data of wind generation to SRLDC.

8. Andhra Pradesh SLDC, vide affidavit its dated 9.5.2015, has submitted as under:

(a) The demand disconnection scheme for mitigating impact of sudden loss of wind generation/any other generation is carried out by the AP DISCOMs/AP SLDC. SCADA data is available for 600 MW of wind generation. For the balance 276.39 MW, generators are being pursued to install SCADA. N-1 contingency is followed by APTRANSCO in case of Wind Evacuation System.

(b) All the wind generators have been required to install LVRT in terms of provisions of CEA Technical Standards for Connectivity Regulations as amended on 15.10.2013. Wind Mills to the extent of 200 MW have confirmed the availability of LVRT out of 876.39 MW. APTRANSCO would endeavor to impress upon the old wind generators not having LVRT feature to install the same to mitigate the cascading effect on the grid during sudden loss of wind generation.

(c) APSLDC is carrying out its own demand estimation from the historical data and weather forecast data from time to time. Demand estimation is being carried out on a daily/weekly/monthly basis for daily operational use. The monthly estimated demand is being provided by AP SLDC to RLDC and RPC for better operational planning. At present, AP SLDC is considering power availability given by 322.7 MW of wind mills in load generation balance.

(d) Clause 4.1 of Regulation 2 of Andhra Pradesh Electricity Regulatory Commission (Interim Balancing and Settlement Code) Regulations,2006 provides that the wind base or mini-hydel open access generators shall not be required to provide a day ahead wheeling schedule and actual electricity injected by them shall be deemed to be the scheduled energy. The total installed capacity of the wind generation in the State of AP is 876.39 MW. As per Regulation 6.5.23(i) of the Grid Code, about 659 MW of wind generation would fall under the purview of scheduling and 217.39 MW of wind generators does not falls under the purview of the scheduling. Presently, schedules for 322.7 MW are being received from the generators. The remaining generators of 336.3 MW are being pursued to submit their forecasting and day-ahead schedules.

(e) Regulation 6.5.23 of the Grid Code provides for scheduling of wind power generation plants. However, Wind generators commissioned before 3.5.2010 are not willing to provide day-ahead schedules.

(f) The Commission's orders would be complied with new units which are being commissioned and getting connected to the grid in terms of the Central

Electricity Authority (Technical Standards to the Connectivity to the Grid) (Amendment) Regulation, 2013. AP SLDC has requested to issue directions to all wind generator connected to the grid to submit forecast and provide day-ahead schedule of their generation to SLDC.

9. SLDC Tamil Nadu in its reply dated 6.6.2015 has submitted as under:

(a) All the new wind generators commissioned after 15.4.2014 are LVRT compliant. Wind turbine manufactures were already addressed to enable the LVRT provisions for their Wind Energy Generators (WEGs).

(b) TANGEDCO vide letter dated 23.5.2015 requested all the Wing Energy Generators (WEGs) to install LVRT before 15.4.2015. In this regard, an exclusive meeting was convened on 15.5.2015 with members of IWPA, SIMA, TASMA and IWTMA to discuss the provisions of LVRT in the WEGs installed before 15.4.2014. In the said meeting, Wind Association informed that LVRT feature for the WEGs installed before 15.4.2014 is not technically feasible and not viable for the old stall regulated machines and they would submit a separate affidavit to the Commission requesting exemption in this regard.

(c) The following action has been initiated by TANGEDCO/TANTRANSCO to provide real time data of wind generation to SLDC/SRLDC:

(i) Ministry of New Renewable Energy (MNRE) has entrusted the National Institute of Wind Energy (NIWE) for a study of wind forecasting in Tamil Nadu in collaboration with Spanish weather monitoring company. With the wind speed, wind direction, humidity air density and other relevant particulars, the historical data of wind generation in that particular area including the special software is correlated to predict the

wind speed, to arrive at the forecast of the wind generation in MW in such area. The said wind forecasting and scheduling was successfully launched on 13.5.2015 at NIWE.

(ii) Under an Indo-Spanish Joint Programme for Technical Co-operation in Renewable energy, NIWE has jointly worked with M/s Vortex Factoria de Calculs, S.L., Spain for capacity building to forecast wind and wind power in India as the ultimate deliverable to support the scheduling and dispatching process of grid connected electricity. NIWE has reached the final milestone of launching of forecasting services after rigorous trial and training of scientist.

(iii) The launch of wind power forecasting services by NIWE jointly with Vortex, Spain showcases the forecasting capacity built in India in a highly wind penetrated State of Tamil Nadu (7390 MW installed capacity) to enable the wind farm operators, SLDC Tamil Nadu and TANGEDCO to effectively evacuate maximum wind power by the scientific forecasting provided by NIWE and to schedule power and manage the utility grid. Forecasting by NIWE is proposed for all 117 sub-stations and forecasting has already commenced in 4 stations. Web interface is also under customization for TANGEDCO.

(iv) TANGEDC0/TANTRANSCO permitted the IWPA to install ABT meters at EHV end of all wind pooling sub-station. IWPA and the other Associations are in the process of fixing ABT meters in 117 sub-stations towards wind power data collection and forecasting. IWPA has agreed to pay the charges to NIWE for the forecasting works. However, with

regard to provision of ABT meters by TANGEDCO/ TANTRANSCO, tender activities are under progress for procurement of ABT meters.

(v) Action has already been initiated byTANGEDCO/TANTRANSCO for wind forecast during the ensuing wind season itself.

10. During the next hearing on 9.7.2015, the representative of SRLDC submitted that on 26.6.2015, there was a grid incident whereby a bus fault led to pulling out of 1000 MW of wind generation. This fault caused increase of flow in Raichur-Solapur transmission line by 1000 MW and dynamic variation during power swing was around 2000 MW leading to SPS operation and backing down of some generators in Western Region. He further submitted that there was around 1000 MW sudden variation in Tamil Nadu drawal i.e. Tamil Nadu's Ul increased from -150 MWto +840 MW. The representative of SRLDC submitted that as per data available from Tamil Nadu, only 71 machines having LVRT responded out of 151 machines having LVRT feature and the following issues are to be considered in the present petition:

(a) It should be concluded whether LVRT is necessary on older wind turbines.

(b) There should be an implementing agency to monitor the implementation, operation and performance of LVRT. Even for generators which claimed to have LVRT, it should be monitored whether they are providing desired performance or not.

(c) There should be an agency to ensure availability of data on wind generation and LVRT status to SLDC.

11. The Commission directed Member Secretary, Southern Regional Power Committee to convene a meeting with SRLDC, Wind Power Associations, Wind Turbine Manufacturers Association and TANGEDCO. The Commission also directed SRPC to request MNRE and CEA to participate in the said meeting. The Commission further directed SLDCs of Southern Region to submit data in the prescribed format.

12. Indian Wind Power Association (IWPA), vide its affidavit dated 9.7.2015, has submitted as under:

(a) In terms of the Clause B of Part-ll of the Schedule of the Central Electricity Regulatory Commission (Technical Standards for Connectivity to the Grid) Regulations, 2007 (CEA Connectivity Regulations), the requirement of compliance with the connectivity conditions given in Part-I of the Schedule is for wind generating stations and for the generating stations using inverters. The petitioner is seeking to read the requirement of using inverters for non-wind generating stations, which is not correct. There is no rationale to apply the requirements to generating stations with inverters but for wind generators even without inverters.

(b) In terms of sub-clause (3) of Clause B2 of the CEA Connectivity Regulations, the requirement for LVRT protection is only for wind energy stations connected at voltage level of 66 kV and above. However, the petitioner is seeking to apply the regulations to the generating units connected below 66 kV which is contrary to the regulations.

(c) At present, total installed capacity of wind generators in the country is about 23,500 MW. Out of this, about 5000 MW are in the sub MW category. Such wind turbines are "stall-regulated". For such turbines, it is technically not

possible to install LVRT devices. "Stall-regulated" WEGs are being manufactured and such stall-regulated WEGs should be exempted from the purview of installing LVRT devices in view of its technical non-feasibility.

(d) There are no "stall-regulated" turbines with inverters anywhere in the world. To install an inverter in "stall-regulated" turbines would require to have control over the power and speed. The same requires fresh designing, simulations and testing which would change the nature of the units from "stall regulated" to "pitch regulated" turbines. It would mean redesigning the entire turbine design for each model and further certification/re-certification of each model. The process of designing and certifications itself takes about 3 years. Further, stall regulated turbines are stopped altogether. It would also have an adverse effect on the existing generators who would not have access to spare parts and repair facility and the manufacturing units would close down. The sub-MW stall regulated turbines are being installed even in European countries and are, as on date, without LVRT.

(e) With regard to Pitch Regulated Machines, while it is technically possible to install LVRT devices, such installation can be done based on the commercial feasibility and viability. For the existing pitch regulated machines already in operation and the tariff and other terms and conditions are based without considering the installation of LVRT devices, the installation of LVRT device would be commercially unviable on account of the exorbitant cost.

(f) While future wind energy generators being established are in position to take into account the installation of LVRT devices and plan their affairs including the tariff terms and conditions, taking into account the financial

implication of LVRT installation to require installation of LVRT devices for existing pitch regulated machines without addressing the issues of commercial and viability, cannot be done. IWPA has requested to relax LVRT requirement for wind farms where the sub-stations are completed prior to coming into force of these regulations and where one or few turbines are being installed ought not to be insisted upon with LVRT protection. IWPA has also requested to clarify the applicability of the LVRT system on wind farms where the sub-stations are already commissioned with some installations.

(g) While the installation of LVRT protection would resolve the cascading tripping of wind mills on account of low voltage conditions, the primary focus ought to be on the prevention of low voltage conditions and immediate clearance of faults. The primary issue which needs to be resolved is prevention of low voltage conditions which may have a cascading effect on the system resulting in generation loss and other consequences. CEA Grid Standards Regulations provides for Voltage Standards. However, STU in the State is not complying with the same. Consequently, the wind generators are being adversely affected on account of the non-maintenance of voltage standards by STU across the State. In the circumstances, the primary issue which needs to be dealt with is the adherence to the voltage standards.

(h) The Commission should incorporate provisions under Section 79(1)(h) and 79(1)(i) of the Act on the Standards of Performance for power quality and particularly with regard to voltage quality and also ensure adherence by STU of the grid and voltage standards. The voltage quality affects the operations of wind energy. If standards of performance and grid operations are specified, it

would greatly facilitate the development and operations of wind energy generators in the country. The Commission may consider forming a technical group like NIWE to study the issues arise.

(i) 'Scheduling' is beneficial for the system as a whole, including the generators as well as the distribution licensee for scheduling of wind energy. The primary requirement to implement scheduling provisions is availability of wind energy forecasting data for the State. NIWE has undertaken the task of wind forecasting for the entire State of Tamil Nadu as an industry sponsored project of IWPA and the same is expected to be in place during the wind season.

(j) In India, 85% of wind farms are less than 10 MW size in total capacity. For such small wind farms, it is not possible to afford and get the accuracy as specified by the Commission.

(k) Under the RRF Mechanism, wind farms of capacity higher than 10 MW had been forecasting and scheduling. In the MNRE meeting held on 17.4.2015, wind farms had summarized their performances. During 50% of the times, they were within +/- 30% limits. Only 7% of the time, they had been within +/- 12%. Therefore, most of the time, they had been liquidating penalties. Better scheduling capability could not be achieved even by larger wind farms.

(l) State-wise forecasting for all 7500 MW wind mills installed in Tamil Nadu is being attempted in 2015. Such forecasting is said to have less percentage of error and is also said to be less expensive. It is essential to examine the result of the efforts being made for scheduling of wind generators in the State of Tamil

Nadu and based on the results, the Commission should decide on the enforcement of scheduling for wind mills in the country.

13. SRPC, vide its letter dated 27.7.2015, has submitted that as per the Commission's direction, a meeting on the issue of LVRT was convened on 20.7.2015 with IWPA, IWTMA, NIWE, CEA, SRLDC, TANGEDCO, TANTRANSCO and SRPC. During the said meeting, the following was submitted:

(a) The representative of CEA submitted that since the quantum of renewable generators was significant, the availability of LVRT features for the machines commissioned prior to 15.4.2014 is also necessary. The issue withregard to getting compensation for additional capitalization on account of installing LVRT should be made "pass through".

(b) The representative of IWTMA stated that 'Stall' generators which had been installed during initial stages of RE penetration did not have facility to provide LVRT mechanism, even throughretrofitting as "Stall" type machines neither have convertor/inverter circuits nor pitch features. He further informed that the capacity of "Stall" type generators presently is about 11% of total WTGs in the country which was also coming down day by day since manufacture of this type of machine is quite limited. Details of WTG installation in India as on 31.3.2015 are as under:

WTG installation in India as on 31.3.2015							**(in** MW)		
Type of WTGs	Up to 31.3.2008	2008-09	2009-10	2010-00	2011-12	2012-12	2013-14	2014-15	Total
Stall WTGs	1976	60	79	118	80	14	29	23	2378
Pitch WTGs	5875	1677	1259	2021	2940	2901	2236	2157	21066
Total Installation	7860	1737	1338	2139	3020	2915	2265	2180	23444
%of Stall WTGs	25.15%	3.46%	6.90%	5.62%	2.65%	0.48%	1.28%	1.06%	10.14%
%of Pitch WTGs	74.84%	96.55%	94.10%	94.48%	97.35%	99.52%	98.72%	98.94%	89.86%

% Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

(c) IWTMA stated that it would be unfeasible to create same effect of LVRT by placing STATCOM or any other device at the level of pooling station. However, it would make efforts to explore alternate means to achieve LVRT features at pooling stations by carrying out suitable studies at grid level. IWTMA confirmed that Doubly Fed Induction Generator (DFIG) and Fully Convertible Turbines (FCT) could be retrofitted with suitable mechanism/enable for LVRT feature as per requirement specified in the CEA Grid Standard Regulations**.** IWTMA further stated as under:

(i) OEM of various old model of WTG is not in the business presently.

(ii) Financial implications for LVRT implementation/enabling depend on the Technology/model/Type/manufactures, etc.

(iii) Some of the wind owners are also carrying out AMC though third party agencies (instead of OEM). However, IWTMA is not sure about any modifications carried out in the control circuit by the third party agency. Under such circumstances, it would be required to have detailed discussion amongst existing manufactures to finalize a road map or action plan, considerinig both commercial and technical aspects.

(iv) There were several owners of wind turbines connected to a pooling station and each would have to contacted for upfront payment of capital for incorporatin of LVRT feature.

(v) Most of the winid mills in the early days were of captive nature. Additional investment on such machines is also to be compensated through some appropriate manner. Accordingly, tariff / PPA needs to be re-looked to take care of additional CAPEX on LVRT feature. Commercial issues are one of the primary requirements which would facilitate proper implementation of LVRT.

(vi) DG, NIWE on behalf of MNRE projected difficulties involved in implementation of LVRT and submitted that out of 55 WT models available in the country, 34 models had informed LVRT compliance based on the self-declaration of manufactures. Manufactures of 11 models had categorically reported non-compliance. Response in respect of 8 models was yet awaited. Two WT models had reported compliance based on certification of type certification body.

(vii) The representative of PWPL expressed that “stall” generators were designed to discononect from the grid during any voltage sag. As per their input, provision of LVRT feature on such machines or at pooling station grid level was not technically feasible. Design rating of any STATCOM would be quite enormous compared to size of the machines and it would also not meet other technical requirements of CEA Grid Standard Regulations which provide for active power support up to the retained voltage, etc.

(viii) Member of IWPA enquired as to whether implementation is applicable to machines connected at 11 kV, 22 kV and 33 kV side of State

transmission or distribution utility, since as per the CEA Technical Standards for Connectivity Regulations it is applicable only for wind generating stations connected at 66 kV or above. In response, Chief Engineer (RA), CEA clarified that the intent of CEA Technical Standards for Connectivity Regulations was to ensure that all wind generators commissioned after a specified date get covered under these Regulations. Regulations were prepared considering that wind generator owns assets up to HV side of grid connecting transformer, which is the case in Gujarat. Also, based on similar considerations only, the renewable energy tariff is fixed. However, to avert any ambiguity, action had already been initiated by CEA to issue necessary clarifications on this aspect. Subsequently, as per the provisions, necessary amendment to the CEA Technical Standards for Connectivity Regulations would be carried out to dispel any doubt, if required.

(ix) After deliberation, IWTMA confirmed that it would be furnish required data along with the road map of action plan. SLDC Tamil Nadu requested all stakeholders to furnish the required data as per the Commission's direction. SRLDC stated that the issues being a critical system security, cooperation of all stakeholders for implementation of LVRT feature in wind turbines within the shortest possible period and suitable alternative scheme for “Stall” type of generators were required.

(x) With regard to query of Chief Engineer (RA), CEA regarding status of implementation of communication system for wind farms, the representative of IWPA informed that real time SCADA data would be

ensured from 102 sub-stations/distribution feeders and from 18 sub-stations developed by the manufacturers to NIWE for wind forecasting, etc. The implementation was expected to be completed by end of August, 2015. TANGEDCO informed that real time data from generators would be available to SLDC as a separate scheme from the Energy Meters through AMR and it would ensure 100% real time data availability from about 13000 energy meters and could take another 4 months to commission.

(xi) Joint Secretary, MNRE expressed that LVRT must be implemented for every wind turbine on the grid. However, the cost needs to be passed through as per the standard arrangements made by the regulators for such additional post-PPA cost.

(xii) SRPC Secretariat expressed the following views:

(a) As per IWTMA, around 11% of WTGs are "Stall" type in which retrofitting with LVRT is not commercially viable. "Stall" type WTGs are still being commissioned which amount to 2-3% of total annual additional of WTGs in which too, putting LVRT is not technically/commercially viable.

(b) In the remaining commissioned WTGs (around 89%), there are some models where manufactures may not support retrofitting.

(c) Barring above WTGs, all other WTGs can be retrofitted with LVRT. LVRT can be provided for more than 97% of annual additional WTGs.

(d) Provision of STATCOMS at pooling sub-station level in place of LVRT at WTGs does not seem to be a commercially viable solution especially and it may increase the cost.

(e) IWPA requested to explore suitable mechanism to meet the incurred expenditure instead of either loading the expenditure on wind farm owners or reworking PPA as number of agreements are third party sales arrangement or wheeling and banking arrangements.

14. KSEBL, vide its affidavit dated 5.8.2015, has submitted that the total wind generation capacity in the State of Kerala is only 34.875 MW which has been commissioned before 2011 and LVRT facility is not available for wind generators. The details for submitting the format as directed by the Commission was taken up with generators. However, they have not submitted the details so far. KSEBL has further submitted that since the penetration of wind in Kerala system is only 1.2% of installed capacity, SLDC Kerala has not faced any adverse impact in the transmission system. KSEBL has submitted that the forecasting and scheduling are not being done and it is operated as must run.

15. SLDC Telangana, vide its affidavit dated 4.8.2015, has submitted that as on today, there is no wind generation in Telangana State. Therefore, installation of LVRT, scheduling of wind generation, demand estimation and providing real time SCADA data to SLDC at this junction may not be applicable. For coming wind power station, directions of the Commission would be complied with.

16. During the hearing on 25.8.2015, the representative of SRLDC submitted that as per the Commission's direction, a special meeting was convened on 20.7.2015

with all the WTG manufacturers, developers, utilities and institutions. In the said meeting, the following was discussed to implement LVRT:

(i) About 11% of present installed capacity is of 'Stall' type. Since these machines have neither 'pitch control' nor inverter/convertor circuit in turbine side, LVRT is not feasible at machine level even through retrofitting. For remaining 89%, LVRT feature is possible. The implementation requirement and cost varies with the type of machine. Some of the machines already have this feature which needs to be enabled and tested. Some of the machines require logic/setting modification in the inverter/convertor circuit while some of the machines require separate/independent retrofitting mechanism.

(ii) Considering number of machines and their owners, implementation of LVRT should be done in phased manner.

(iii) It is not possible to have LVRT demonstration as part of 'Type Test' report or WTG technical specification of existing models with immediate effect though the machines are having inbuilt LVRT feature. This is because inclusion of any additional information in the 'type certification' has significant commercial/procedural implication on Technology Transfer Agreement'.

(iv) NIWE confirmed that out of 35 existing models, only two models confirmed LVRT compliance in type certification. For others, the manufacturers confirmed the LVRT compliance through declaration/ confirmation. Accordingly, WTG manufacturers would issue a separate certificate clearly indicating enabling and effective functioning of LVRT feature from the day of commissioning of the machine which needs to be endorsed by the generators/developers for all the existing models of old/new machines. For all

new models, it shall be part of type certification.

(vi) The developers/applicants shall ensure availability of data to SCADA system of appropriate Load Despatch centre (LDC) and only after ensuring the same, COD of the machine should commence. Certification of SLDC in this regard has to be mandated. Appropriate LDC shall monitor the availability and performance of LVRT feature continuously with analysis on every instance of GD-1 and above and specific instances as communicated by RLDC. LDC shall submit a monthly report of analysis (including 'Nil' report) for discussion in the Protection Co-ordination meeting of RPC and shall take up the matter with Appropriate Commission on any lapses. Accordingly, the appropriate LDC shall be responsible for ensuring effective performance of LVRT mechanism.

17. The representative of SRLDC requested the Commission to issue the following directions for:

(i) early implementation of LVRT in all the wind turbines (except Stall Type) in phased manner.

(ii) implementation of LVRT for all solar generators also from the initial stage itself. The responsibility to ensure implementation and performance monitoring may be emphasized to respective LDC similar to that of WTG.

(iii) to furnish detailed action plan for implementation in a phased manner by IWPA/IWTMA through respective Load Despatch Centre facilitating monitoring the progress by respective RPCs.

18. Learned counsel for IWTMA submitted that during the meeting held on

20.7.2015, details of WTG installation in India has already been submitted as on 31.3.2015. He further submitted that (a) approximately 11% of total installation is of Stall type WTGs, (b) The percentage of installation year-wise is also declining and was at mere 1.08% of total installation during the year 2014-15, (c) Phasing-out of existing Stall type WTGs would take at least 3 to 4 years and manufacturers need to provide service to the existing customers. Learned counsel for IWTMA submitted that for implementation of LVRT on existing WTGs commissioned before 15.4.2014, the economic aspects need to be seen.

19. Learned counsel for Pioneer Wincon, a WTG manufacturer submitted that the existing Stall type WTGs need to be serviced. He further submitted that since phasing-out of stall type WTGs would take at least 3 to 4 years, the Commission should issue direction in this regard.

20. The representative of CEA submitted that CEA has initiated the process of amendment to CEA Technical Standards for Connectivity Regulations to remove ambiguity about the clause mandating provision of LVRT in existing WTGs which were in operation before Connectivity Regulations on LVRT came in force and to include solar generators except roof-top solar generators. With regard to provision of LVRT in large roof-top solar, the representative of CEA submitted that for medium voltage level of 33 kV and above, LVRT is required. However, for 11 kV and below voltage level, LVRT may not be required.

21. Indian Wind Turbine Manufacturers Association (IWTMA), vide its affidavit dated 31.8.2015, has submitted that with regard to legal aspect, the Central Electricity Authority notified the Central Electricity Authority (Technical Standards for

Connectivity to the Grid) (Amendment) Regulations, 2012 on 15.10.2013 which specified certain conditions for connectivity for wind generating plants. The technical standards related to LVRT specified in the above regulations is applicable on wind generating stations connected with the grid on or after 15.4.2014. IWTMA has further submitted that for the wind generating stations connected prior to 15.4.2014, the regulation specifically provides that for the generating stations which were connected prior to and also up to six months of the CEA Technical Standards for Connectivity Regulations coming into force, the measures which can be taken to meet the standards are to be mutually discussed between the generating company and the licensee to which the generating unit is connected. The standards were to be met subject to technical feasibility. Therefore, a special dispensation was consciously provided in the CEA Technical Standards for Connectivity Regulations for such generating units. With regard to technical aspect, IWTMA has submitted as under:

(a) At the outset, LVRT function would definitely help the wind generation to be available in the event of transient faults when the recovery of voltage starts after 300 milli sec. An attempt is made to analyze some of the reasons for the loss of wind generation during those incidents with the limited information available on the official websites of the central sector.

(b) During the Southern Region Power System Planning Committee meeting held on 22.1.2007, a comprehensive power evacuation scheme for the wind power with 400 kV sub-stations and lines in Tamil Nadu was proposed by TNEB and the same was approved. However, the process of implementation was actually started after 5 years. As a result, the wind power installations were connected mostly at 110 kV and 220 kV levels. As the 400 kV sub-stations catering to the evacuation of wind power have not come up, while the growth of

wind power installations has increased considerably, lot of tapping on 110 kV systems were permitted to accommodate the addition of wind power. Despite adequate support of reactive power from the wind turbines, there were issues of low voltage during high wind generation due to these arrangements. As the voltages were generally low during the high wind generation period, the un-cleared bus faults, or other system faults were cleared by several EHV lines from far end/ back up protection. Therefore, the faults might have cleared after zone-2 time of distance relays on the EHV lines or beyond, which could be beyond 300 milliseconds. In such events, the substantial loss of generation from wind, connected/nearer to those buses (where fault has occurred) was not preventable even if LVRT was provided in those wind turbines.

(c) Grid incidents occurred on 7.6.2013 and 2.6.2014 were very similar. Since 110 kV bus fault at Kayathar sub-station could not be cleared due to non--availability of bus bar protection at Kayathar 110 kV bus, all the incoming 230 kV feeders tripped. Therefore, there was no supply to 110 kV bus. Since about 440 MW of wind generators are connected at Kayathar 110 kV bus, the wind generation at Kayathar 110 kV is destined to be disconnected, irrespective of the fact that LVRT is provided or not on all of the wind turbine generators.

(d) Grid incidents of 28.5.2013, 5.6.2014 and 1.7.2014: In all these incidents, the common factor is that the triggering point is a voltage dip in the system due to a fault in an adjacent corridor and mostly delayed clearance of faults. The voltages at number of places in 110 kV system of Tamil Nadu are near 0.9 PU) due to lack of reactive compensation at the various grid substations, during high wind season, mainly because of not having the 400kV system in

place, which was planned and approved exclusively for wind power evacuation in 2007. As the voltages were generally low, in the vicinity of 0.9 PU, during high wind generation, due to a fault on any of the transmission lines in the other corridor, the overall system voltages would go down and cause trips of all the turbines, whose trip setting is set at 0.85PU. These trips alone can be attributed due to lack of LVRT protection, albeit with a caution.

(e) It should be appreciated that in the above incidents, the clearance of the fault was delayed, which indicates that the faults persisted for longer time. If faults have persisted beyond 0.3 sec and the voltage has remained less than 0.15 PU for more than-0.3 sec, at the wind generating unit, even if LVRT has been installed, it would not have saved the wind generation from tripping. Since the outputs of disturbance recorder or the detailed occurrence reports were not available in public domain for these incidents, specific comments could not be given. The slope of recovery of voltage at the wind turbines (as per the characteristics at 82 (3) of the CEA Technical Standards for Connectivity Regulations) determines whether they could hold on to the grid or pull out, even with LVRT features. Disturbance recorders at the pooling sub-stations are essential to capture these excursions of voltage.

(f) In developed, well operated and maintained grids like Gujarat, the loss of wind generation due to un-cleared faults in EHV sub-station are not experienced. By 2012, TANTRANSCO has undertaken the setting up of the 400 kV network for power evacuation schemes at Kayathar, Thappagundu, Annaikadavu and Rasiyapalayam in a serious manner. When these are commissioned, better voltage profile and constraint-free power evacuation for wind generation is

expected in the coming years. Out of these, Kayathar sub-station was commissioned in September and October 2014. Therefore, there is no denying the fact that LVRT is a desirable feature subject to:

a) Efficacy of primary protection;

b) Grid operational discipline viz

(i) automatic load shedding

(ii) proper reactive compensation

(iii) control of voltage profile to be in acceptable limits

c) Augmentation of the power evacuation system as per planning,

d) Adhering to time schedules in transmission project completion

(g) The petitioner has contended that the lack of automatic load disconnection scheme commensurate with the loss of wind generation has also contributed to the sudden rush of power flow in the inter-regional link viz. 765 kV Raichur-Sholapur line causing power oscillations.

(h) In the minutes of meeting of 25th SRPC meeting held on 26.7.2014, it was recognized that the underlying transmission systems which were to be commissioned (delayed due to ROW issues) along with the above 765 kV lines were not commissioned and as and when they are commissioned, issues like oscillations and operational constraints would be resolved.

(i) With regard to submission of data, wind developers through their combined letter dated 12.12.2008 approached Tamil Nadu authorities to allow them to connect ABT meters at various sub-stations to understand the voltage profile and the power flow pattern and as a precursor to engage in the activity of forecast. In the said letter dated 23.12.2008, the wind developers had requested for provision

of Disturbance Recorders in EHV pooling sub-stations. However, both of the above requests were not entertained by TNEB.

(j) It is imperative that the focus should be on to establish 400 kV system and its underlying EHV and HV systems for wind power evacuation as soon as possible, reactive power compensation and voltage profile need to be made optimal at all nodes of the power system. Protection system should ensure line faults and bus faults are cleared in instantaneous time. Free governor mode of operation has been mandated since 1999-2000. However, it is yet to be implemented. In case of sudden variations in generation/load, FGMO would help to ensure frequency. Since, this feature is already covered under fixed cost of the generator, the generators have to be disciplined if they are not participating in FGMO by way of appropriate penalty.

(k) With regard to technical constraints, IWTMA has submitted as under:

(i) Some of the old wind turbines of up to 700 kW and with stall regulation, the provision of putting add on LVRT is technically not possible. In India, about 11,510 such turbines were installed till April, 2014. The Central Electricity Authority may undertake a study on this aspect and give its suggestions in this regard.

(ii) For more than 700 kW turbines and with pitch regulation, the provision of LVRT as retrofit is possible. However, it is not possible to purchase such turbine type/model and then it can be mass produced and retrofitted on these turbines. Further, in some turbine models, the retrofitting of LVRT would also require modifications in the turbine structure for additional strength to absorb the mechanical stress of the LVRT, which would cause in the fault situation.

For old turbines, which were not originally designed for LVRT, adding the LVRT feature by way of retro-fitting would result in increased loads on the turbine especially in its drive train and related components. The present drive train and related components can only take this additional load, if there was a higher margin considered while designing.

(iii) Turbines manufactured as per the existing regulations does not have LVRT,therefore, the certificate also does not include the LVRT. For turbines in which the design margins permit for adding the LVRT by way of retrofit, the Type Certification of turbines would no longer remain valid which could potentially affect the insurance of the turbine in case of major damage occurring to the turbine for any reason. In case of retrofitting of LVRT, if utilities insist on the wind turbine type certification of the entire type certification process which is time consuming and involves substantial cost approximately Rs. 3.00 crore per certification. Therefore, provision of LVRT should be certified from the competent authority and inclusion of the same in turbine test certification should not be insisted upon and sufficient time would need to be provided for implementation of LVRT on old turbines.

(I) The implementation of LVRT on turbines connected before April, 2014 would pose a challenge of scales as there are about 25807 wind turbines connected prior to April, 2014. Out of these, there would be about 14,346 turbines of more than 750 kW on which LVRT needs to be implemented. These turbines have been manufactured by about 48 different manufacturers. Out of these, there are about 28 manufacturers who have manufactured the turbines of capacity of more than 750 kW. Out of these 28 manufacturers, only 14 are still in the business of

manufacturing of wind turbine. There are about 2000 owners of such turbines who will have to invest and provide LVRT. As per the information available, at present, there are no suppliers of LVRT, which is understandable as the LVRT needs to be designed, in case of retrofitting, for each model/type of turbine. In case of new turbines, which are LVRT compliant, the LVRT feature is part of turbine design. Therefore, it is not procured from suppliers and added to the turbines. This limitation of designing and suppliers of LVRT required to be considered while considering time frame to implement LVRT on existing turbines.

(m) With regard to commercial implications, IWTMA has submitted that the retrofitting of LVRT would require additional investment by the wind generators. As per the estimates, the cost of LVRT would be in the range of 25-50 lakh/turbine, irrespective of turbine capacity which would put a lot of financial burden on the generators.

(n) It is imperative that a financing mechanism would definitely require for retrofitting of LVRT on existing turbines for successful implementation. Even after financing of LVRT, the generators needs to be required compensated for the additional capital expenditure. In case of wind power projects, there are following three models for off-take of power:

(i) Sale to Discom: Tariffs are levelised tariffs based on capital cost assumed at the beginning of the tariff period and fixed for the tariff period. For recovery of capital expenditure, the tariff would need to be increased by respective State Commissions. Only after such tariff revision, retrofitting of LVRT on old turbines can be successfully implemented.

(ii) Sale of power though Open Access: The additional cost incurred due to retrospective implementation of regulation would result in loss to the generator as the purchaser of power may or may not agree to pay the additional cost. A solution for such scenario is essential as such projects may prove to be impediment to the implementation.

(iii) Captive consumption of power: Since the additional retrofitting cost would result in effective loss and needs to be addressed as under:

a. Providing LVRT on wind turbines would help in grid management, however it alone cannot guarantee it. There are other measures, which should be implemented simultaneously.

b. In case of implementation of LVRT on turbines connected prior to 15.4.2014, the same needs to undertaken with mutual agreement. The implementation plan for such turbines must be devised based on the (i) technical constraints, (ii) implementation limitations due to high number of turbines, and (iii) compensation to generators for retrofitting of LVRT on old turbines

In view of the above, a time frame of 3 years would be required with adequate funding arrangement along with cost recovery to implement LVRT on wind turbines.

Analysis and decisions:

22. We have heard the learned counsels and representatives of the parties. We have considered the submission of the parties and perused documents available on

record. The following issues arise for our consideration:

(a) Whether LVRT is required in all wind generating stations commissioned even before 15.4.2014 and connected at voltage level of below 66 kV?

(b) Whether LVRT compliance should be made mandatory for Solar Generating Stations?

(c) What should be the commercial mechanism for offsetting cost of LVRT installation if it is technically viable? What should be the time frame for such installations?

(d) Whether Type Certification should be made part of Turbine Test Certification in case of retrofitting?

(e) Whether SLDC has ensured implementation of Data Acquisition System/ Real Time Data Availability of SCADA system as envisaged in the IEGC?

(f) What is the status of implementation of contingency demand disconnection scheme for mitigating impact of sudden loss of wind generation in line with order dated 22.2.2014 in 120/MP/2011?

(g) Whether Renewable Energy Generators are required to do proper forecasting & scheduling and demand estimation by SLDC in compliance with Grid Code?

(h) Other issues:

(i) Study of line loading in the STU network and strict N-1 compliance by expediting works under progress, particularly wind evacuation system.
(ii) Compliance of CEA (Technical Standards for Grid Connectivity) (Amendment) Regulations, 2013.

The above issues have been dealt with as under:

Issue No. (1): Whether LVRT is required in all wind generating stations commissioned before 15.4.2014 and connected at voltage level of below 66 kV?

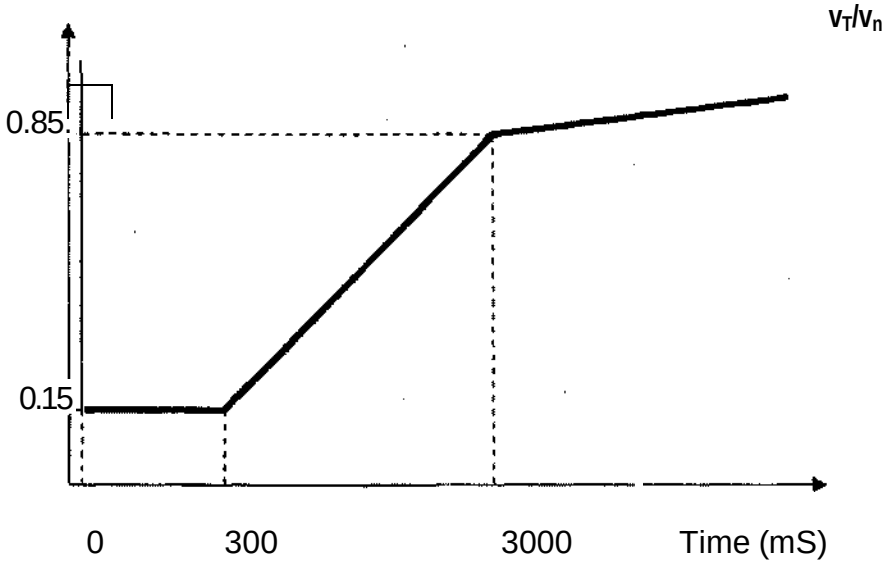
23. Clause-B of Part-ll of CEA Technical Standards for Connectivity Regulations, extracted below provides that Connectivity Standards shall be applicable to the wind generating stations and generating stations using inverters. Clause B of Part-ll is extractedas under:

"B. Connectivity Standards applicable to the Wind generating stations and generating stations using inverters

These generating stations shall comply with the following requirements besides the general connectivity conditions given in the said regulations and Part I of the Schedule."

24. Sub-clause (3) Clause B (2) of Part-ll of the Central Electricity Authority (Technical Standards for Connectivity to the Grid) (Amendment) Regulations, 2012 provides that LVRT is compulsory for wind turbine generators installed after 15.4.2014.

"B2. For generating station getting connected on or after completion of 6 months from date of publication of these Regulations in the Official Gazette
(1) and (2)...
(3) Wind generating stations connected at voltage level of 66 kV and above shall remain connected to the grid when voltage at the interconnection point on any or all phases dips up to the levels depicted by the thick lines in the following curve:



Where

V /V„ is the ratio of the actual voltage to the nominal system voltage at the interconnection point

25. The petitioner has submitted that around 50% of the country's wind generation concentration lies in the Southern Region which is around 20% of the total installed capacity of the Southern Region. According to the petitioner, Southern Region has Talcher-Kolar HVDC as well as the upcoming Raigarh-Pugalur HVDC in close proximity to the wind generators and the existing Raichur - Sholapur 765 kV inter-connector has high sensitivity to sudden changes in Southern Region generation/ load. The impact of any faults in the system which are not cleared in time would have an adverse impact on HVDC systems, inter-connectors and wind generators which can result in cascading failures impacting the All India Grid. The petitioner has submitted that the issues regarding variable and intermittent generation, frequency fluctuations due to generation or load loss, poor Frequency Response Characteristics (FRC) of individual sub-systems, absence of Fault Ride Through (FRT) capabilities and low voltage situation with heavy wind injection were discussed in the Forum of Regulators (FoR) meeting held on 27.6.2014. The petitioner has submitted that certain recent grid disturbances occurred in the Southern Region due to sudden loss of wind generation in the range of 860-1340 MW and loss of wind generation during these incident were primarily due to cascade tripping of wind mills which do not have LVRT protection during momentary low voltage situation caused by delayed clearance of fault by more than 450 msec. The petitioner has stated that in absence of LVRT protection as well as contingency load disconnection scheme for loss of wind generation, the impact has been passed on to the grid within rush of power flow in the inter-regional links, operation of SPS on such links as well as drop in system frequency. The petitioner has submitted that the CEA Technical Standards for Connectivity Regulations provide that new generators connected after six months from the date of the Regulations i.e. after 15.4.2014 need to meet the technical requirement

stipulated in the CEA Technical Standards for Connectivity Regulations. However, it is silent on the way out required to mitigate the impact of the existing wind generators. The petitioner has submitted that in the present scenario, major portion of wind generators operating without LVRT protection creates the risk of making any temporary faults in the transmission system in the situation of grid incident/grid disturbance near wind energy areas, through cascade tripping in huge quantum. The level of maximum risk is in Tamil Nadu followed by Karnataka and other States in Southern Region.

26. The Indian Wind Power Association (IWPA) has submitted that clause-B of Part-ll of CEA Technical Standards for Connectivity Regulations provide requirement of compliance for wind generating stations and generating station using inverters. There is no rationale to apply the requirements to generating stations with inverters but for wind generators even without inverters. As per sub-clause (3) of Clause B2, the requirement for LVRT protection is only for wind energy stations connected at voltage level of 66 kV and above. However, the petitioner is seeking to apply the Regulations to the generating units connected below 66 kV.

27. In the meeting held on 20.7.2015, one of the members of IWPA queried as to whether LVRT implementation is also applicable to machines connected at 11 kV, 22 kV and 33 kV side of State transmission or distribution utility, since CEA Technical Standards for Connectivity Regulations provides that it is applicable only for wind generating stations connected at 66 kV or above. In this regard, the representative of CEA clarified that the intent of regulations was to ensure that all wind generators commissioned after a specified date get covered under this regulations. The representative of CEA further clarified that the regulations had been prepared

considering that wind generator owns assets up to HV side of grid connecting transformer, which is the case in Gujarat and based on similar considerations only, the renewable energy tariff is fixed. However, to avert any ambiguity, action has already been initiated by CEA to issue necessary clarifications on this aspect. Subsequently, as per the provisions, necessary amendment to the CEA Technical Standards for Connectivity Regulations would be carried out to dispel any doubt, if required. In the said meeting dated 20.7.2015, SRPC Secretariat concluded as under:

(i) As per IWTMA, around 11% of WTGs are "Stall" type in which retrofitting with LVRT is not commercially viable. "Stall" type WTGs are still being commissioned which amount to 2-3% of total annual additional of WTGs in which too, putting LVRT is not technically/commercially viable.

(ii) In the remaining commissioned WTGs (around 89%), there are some models where manufactures may not support retrofitting.

(iii) Barring above WTGs, all other WTGs can be retrofitted with LVRT. For more than 97% of annual additional WTGs, LVRT can be provided.

(iv) Provision of STATCOMS at pooling sub-station level in place of LVRT at WTGs does not seem to be a commercially viable solution especially since this may increase the cost.

(v) IWPA requested to explore a suitable mechanism to meet the incurred expenditure instead of either loading the expenditure on wind farm owners or reworking PPA since many agreements are third Party sales arrangement or wheeling and banking arrangements.

28. In the said meeting dated 20.7.2015, Joint Secretary, MNRE opined that LVRT must be implemented for every WTGs and the cost incurred in this regard should be passed through as per the standard arrangement made by the regulators for such additional post-PPA cost. View of Joint Secretary, MNRE is extracted as under:

> "In my opinion (which would be probably in the minutes of the meeting with MoS on wind issues held on 19th June) LVRT must be implemented for every wind turbine on the grid; however, the cost needs to be passed through as per the standard arrangements made by the regulators for such additional post-PPA cost."

IWTMA has submitted that till April, 2014, there are about 11,510 Stall Type turbines installed in India up to 700 kW and with Stall Type, adding LVRT even as a retrofit is technically not possible. In this regard, CEA should undertake a study and come out with suggestions. IWTMA has submitted that for the other turbines with capacity more than 700 kW and with pitch regulation, the provision of LVRT as retrofit is possible. Further, in some turbine models, the retrofitting of LVRT would also require modifications in the turbine structure for additional strength to absorb the mechanical stress of LVRT, which would cause in the fault situation. For old turbines, which were not originally designed for LVRT, adding the LVRT feature by way of retro-fitting would result in increased loads on the turbine especially in its drive train and related components. The present drive train and related components can only take this additional load, if there was a higher margin considered while designing.

29. We have considered the submissions of the petitioner and the respondents. The petitioner has submitted that some of the recent grid disturbances occurred in the

Southern Region due to sudden loss of wind generation in the range of 860-1340 MW and loss of wind generation during these incidence were primarily due to cascade tripping of wind mills which do not have LVRT protection during momentary low voltage situation caused by delayed clearance of fault by more than 450 msec. The petitioner has further submitted that in absence of LVRT protection as well as contingency load disconnection scheme for loss of wind generation, the impact has been passed on to the grid within rush of power flow in the inter-regional links, operation of SPS on such links as well as drop in system frequency. Perusal of the minutes of the meeting of SRPC dated 20.7.2015 reveals that MNRE, CEA and the petitioner were of the opinion that LVRT must be implemented for every wind turbine on the grid. We are of the view that LVRT should be implemented for all wind turbines commissioned before 15.4.2014 and connected to voltage level of 66 kV and above except for Stall Type WTGs, which are not technically feasible to be retrofitted with LVRT. However, keeping in view the suggestions of IWTMA, we are of the view that presently LVRT should be implemented for all wind turbines (except Stall Types) commissioned before 15.04.2014 having installed capacity equal to or more than 500 KW. In case of wind turbines of less than 500 kW and installed before 15.04.2014 (except stall types), CEA is directed to conduct a study regarding technical feasibility of installation of LVRT in these turbines and submit a report to the Commission within 6 months of issue of this order. Representative of CEA submitted during the hearing that CEA was in the process of issuing clarification in regad to the voltage level above which LVRT provision would be mandatory. After the issue of necessary regulations/clarification by CEA with regard to the voltage level above which LVRT would be mandatory, the same requirement shall be applicable even in case of WTGs installed prior to 15.4.2014 keeping in view the safety and security of the grid. It is however clarified that WGTs whose useful

life is going to expire in the next 5 years, shall be exempted from installation of LVRT.

Issue No. (2): Whether LVRT compliance should be made mandatory for Solar Generating Stations?

30. The representative of CEA argued that CEA is in the process of amendment to the CEA Technical Standards for Connectivity Regulations to include solar generators except roof-top solar generators in the clause. It is noticed that CEA has taken note of the requirement of LVRT in case of solar generators in view of large scale addition of solar generation into the grid in coming years and CEA is taking necessary action to include provision of LVRT in case of solar generators through amendment to CEA Technical Standards for Connectivity Regulations. We have purused the guidelines for implementation of grid connected rooftop and small solar power plant programme of MNRE issued vide order dated 26.06.2014 and guidelines under JNNSM scheme of MNRE. While JNNSM scheme provides that all grid connected solar plants be connected at 33kV and above, the scheme of grid connected rooftop and small solar power palnt programme provides for feeding the grid at 11kV/33kV or 440/220 volts. In our view, there is a requirement to make the provision of LVRT mandatory for all solar generators connected at the voltage level of 11 kV and above. It is noted that solar capacity getting installed as on date is not huge but large capacity addition in solar power is envisaged in near future. Therefore, we direct that the solar generators whose bidding process has not yet commenced i.e. NIT has not yet been issued on date of this order shall take necessary stps to implement LVRT in their generating stations. CEA is requested to consider issuing necessary amendment to the CEA Technical Standards for Connectivity Regulations to make LVRT mandatory for all types of solar plants including roof top as early as possible.

Issue No. (3): What should be the commercial mechanism for offsetting cost of LVRT installation if it is technically viable? What should be the time frame for such installations?

31. SLDC, Andhra Pradesh has submitted that out of 876.39 MW wind generation, 200 MW have confirmed the availability of LVRT. For other wind generators, APTRANSCO would endeavour to impress upon these generators to install LVRT feature. SLDC, Tamil Nadu has submitted that all wind turbines after 15.4.2014 are equipped with LVRT. However, a meeting was held on 15.5.2015 with IWPA, SIMA, TASMA and IWTMA to discuss the provision of LVRT with regard to wind turbines installed before 15.4.2014. In the meeting, it was informed by the Wind Power Association that LVRT feature for WTGs installed before 15.4.2014 is not technically feasible. SLDC, Tamil Nadu submitted that out of 11,701 wind generators in Tamil Nadu, only 1,850 wind generators have installed LVRT so far.

32. KSEBL has submitted that total wind generation capacity in the State is only 34.875 MW which has been commissioned before 2011 in which LVRT facility is not available for wind generators. The penetration of wind power in Kerala's system is only 1.2% of installed capacity and SLDC, Kerala has not faced any adverse impact in the transmission system. The forecasting and scheduling is not being done and is operated as must run. SLDC, Telangana has submitted that since, there is no wind generation in Telangana as on date, installation of LVRT, scheduling of wind generation, demand estimation and providing real time data is not applicable to Telangana presently.

33. IWPA has submitted that out of total 23,500 MW of installed energy in India, about 5000 MW are in the sub-MW category which are "stall-regulated" and for such turbines, it is technically not possible to install LVRT devices. Therefore, these turbines

should be exempted from the purview of installing LVRT devices. Further, for "Pitch Regulated" machines, it is technically feasible to install LVRT devices. However, for existing machines, installation of LVRT devices would be commercially unviable on account of exorbitant cost. IWPA has submitted that installation of LVRT protection would resolve the cascading tripping of wind mills on account of low voltage conditions. IWPA has further submitted that the primary focus ought to be on the prevention of low voltage conditions and immediate clearance of faults. IWPA has emphasised that though the CEA Grid Standards Regulations provides the voltage standards, the same is not being complied with by STUs of the respective States.

34. SRPC during the course of hearing was directed to convene a meeting with SRLDC, Wind Power Associations, Wind Turbine Manufacturers Association and TANGEDCO to discuss the issue of LVRT by WTGs. MNRE and CEA were also requested to participate in the said meeting. SRPC, vide letter dated 27.7.2015, has submitted that a meeting in this regard was convened on 20.7.2015 to discuss LVRT issues in which the following were concluded:

(a) Around 11% of WTGs are "Stall" type in which retrofitting LVRT is not commercially/technically viable. Stall type WTGs are still being installed which amounts to 2-3% of total annual addition of WTGs.

(b) In the remaining commissioned WTGs (around 89%), there are some models where manufactures may not support retrofitting. Barring these WTGs, for more than 97% of annual additional WTGs, LVRT can be provided all other WTGs.

(c) Provision of STATCOM at pooling sub-station in place of LVRT at WTGs

does not seem to be a commercially viable solution since this may increase cost.

(d) Suitable mechanisms for meeting the incurred expenditure by reworking PPA or making it "pass through".

35. IWTMA has submitted that till April, 2014, there are about 11,510 Stall Type turbines installed in India up to 700 kW and with Stall Type, adding LVRT even as a retrofit is technically not possible. In this regard, CEA should undertake a study and come out with suggestions. IWTMA has submitted that for the other turbines with capacity more than 700 kW and with pitch regulation, the provision of LVRT as retrofit is possible. Further, in some turbine models, the retrofitting of LVRT would also require modifications in the turbine structure for additional strength to absorb the mechanical stress of LVRT, which would cause in the fault situation. For old turbines, which were not originally designed for LVRT, adding the LVRT feature by way of retro-fitting would result in increased loads on the turbine especially in its drive train and related components. The present drive train and related components can only take this additional load, if there was a higher margin considered while designing.

36. IWTMA has submitted that implementation of LVRT on turbines connected before April, 2014 will pose a challenge. These turbines have been manufactured by about 48 different manufacturers. Out of these, only 14 manufacturers are still in the business of wind turbine manufacturing. There are about 2000 owners (Approximately) of such turbines who have to invest and provide LVRT. As per information available, there are no suppliers of LVRT, which is understandable as the LVRT needs to be designed, in case of retrofitting, for each model/type of turbine. In case of new turbines which are LVRT compliant, the LVRT feature is part of turbine design. Therefore, it is not procured from

suppliers and added to the turbines.

37. With regard to commercial implication, IWTMA has submitted that financial institutions would not finance to install LVRT on turbines. IWTMA has submitted information regarding estimated cost and time for implementation of LVRT in WTGs commissioned prior to 15.4.2014. The data submitted by IWTMA is attached at **Annexure-I** to this order.

38. We have considered the submissions of the petitioner and the respondents. SRPC and IWTMA have stated that it is technically not feasible to install LVRT feature on "Stall Type" WTGs. As per data submitted by IWTMA, "Stall Type" WTGs constitute only 11% of WTGs installed in India and year after year, the percentage of installation of Stall Type WTGs are decreasing. Further, Wind Turbine manufacturers have stated that although, "Stall Type" is outdated model but is being manufactured at very small level to service the existing Stall Type WTGs. With regard to time for phasing out of all Stall Type WTGs, IWTMA has stated that at least 3 to 4 years would be required to phase-out existing Stall Type WTGs. We direct that the Stall Type WTGs existing prior to 15.4.2014 shall be allowed to operate in the Grid till their useful life. The time line submitted by IWTMA for implementation of LVRT in different make turbines of 225 kW to 750 kW and 800 kW and above is 2 to 3 years and 1 to 3 years respectively. Since in the meshed network, any load generation imbalance even in the State network affects the ISTS, therefore, there is a requirement that all types of WTGs within the State network are provided with LVRT. Therefore, we request all the State Electricity Regulatory Commissions to make suitable provisions in their relevant regulations or through orders to provide for mandatory installation of LVRT in WTGs which fall within their jurisdiction.

39. According to SRPC and IWTMA, there are other types WTG where retrofitting of LVRT is technically feasible. However, the Commission needs to devise a suitable commercial mechanism keeping in view the fact that huge amount of investment is involved in retrofitting. Perusal of the submission of IWTMA (filed during the hearing on 25.8.2015) reveals that retrofitting of WTGs with LVRT would cost in the range of Rs. 25-50 lakh/turbine which include WTGs which are selling power at levelised tariffs to the distribution companies based on the capital cost assumed at the beginning of tariff period and are fixed for the tariff period, WTGs which are selling power through open access and WTGs used for captive usage. In all of the above cases, tariff need to be revised to make retrofitting with LVRT commercially viable. We are of the view that LVRT is a technical requirement from the point of view of safety and security of the grid and its usefulness cannot be overlooked in view of the cost involved in retrofitting of LVRT. We direct all WTGs of capacity equal to or more than 500 KW except 'Stall Type WTGs' to comply with LVRT within two years in terms of our directions in para 29 of this order.

40. Retrofitting WTGs with LVRT feature is a new requirement which did not exist at the time of bidding and may be considered under 'Change in Law'. State Electricity Regulatory Commissions are requested to consider to allow the cost of rettofitting WTGs wth LVRT under the provision of 'Change in Law' in the respective PPAs. We direct wind mill owners, which are selling power through open access/banking, to factor the capital expenditure incurred by them for retrofitting WTGs with LVRT feature while quoting price of electricity for sale through open access/banking. In case the estimated cost of installing LVRT is substiantially higher as compared to the capital investment in the turbine, RPCs may make a proposal for arrangement of funding from PSDF/NCEF/Green Fund for retrofitting

WTGs with LVRT. In respect of WTGs, which have completed their useful life as on date of this order and those which are likely to complete their useful life in next two years should not be retrofitted with LVRT under PSDF/NCEF and should be taken out of service.

41. With regard to monitoring of the installation and performance of LVRT installed on existing WTGs, we direct SLDCs to prepare quarterly reports and submit it to RPCs. RPCs are directed to validate the reports submitted by SLDCs in consultation with RLDCs and report any deficiency and non-compliance to the Commission in accordance with law.

Issue (4): Whether Type Certification should be made part of Turbine Test Certification in case of retrofitting?

42. IWTMA has submitted that since number of turbines have been manufactured as per existing regulations, they do not have LVRT and therefore, the certificate also does not include the LVRT. IWTMA has further submitted that for turbines in which the design margins permit for adding the LVRT by way of retrofit, the type certification would no longer remain valid. WTMA has further submitted that in case of retrofitting of LVRT, if utilities insist on the wind turbine type certification of the entire type certification process, it is time consuming and involves substantial cost approximately Rs. 3.00 crore per certification. IWTMA has submitted that the provision of LVRT may be certified from a competent authority and inclusion of the same in turbine test certification may not be insisted upon.

43. We have considered the submissions of the petitioner and the respondents. We are of the view that Type Test Certification for all WTGs as per applicable Standards should be made mandatory. The modalities for carrying out Type Test Certifications including

timeline for completing the process for certification, cost sharing, etc., shall be finalized by the respective RPC in consultation with CEA.

Issue (5): Whether SLDC has ensured implementation of Data Acquisition System/ Real Time Data Availability of SCADA system as envisaged in the IEGC?

44. The petitioner has submitted that another important issue compounding the problem is the non-availability of real time data of wind generation to SLDC. Particularly, in Tamil Nadu, the real time data integration of wind generation to the SCADA system of SLDC is far below 100%. During the cascade tripping of wind generation in NLC TPS-II instance, Tamil Nadu SLDC was not aware about the loss of wind generation for more than an hour. The petitioner has further submitted that though the situation of real time wind generation data availability in the State of Karnataka is better, while the status in other States is similar to Tamil Nadu.

45. IWTMA has submitted that in the context of submissions made on data availability, it may not be out of context that in 2008, there were instances in which the wind developers approached Tamil Nadu Electricity Board to allow them to connect ABT meters at various sub-stations to understand the voltage profile, power flow pattern and as a precursor to engage in the activity of forecast. Wind developers also requested Tamil Nadu Electricity Board to make provisions for Disturbance Recorders in EHV pooling sub-stations. However, the said request was not considered by the Tamil Nadu Electricity Board.

46. We have considered the submissions of the petitioner and the respondent. Regulation 5.2 (u) of the Grid Code provides as under:

"5.2 (u) Special requirements for Solar/ wind generators

System operator (SLDC/ RLDC) shall make all efforts to evacuate the available solar and wind power and treat as a must-run station. However, System operator may instruct the solar /wind generator to back down generation on consideration of grid security or safety of any equipment or personnel is endangered and Solar/ wind generator shall comply with the same. For this, Data Acquisition System facility shall be provided for transfer of information to concerned SLDC and RLDC."

As per the above provisions, wind/solar generators are required to provide Data Acquisition System facility for transfer of information to concerned SLDC and RLDC considering grid security and safety of any equipment or personnel. With the increase in share of variable and intermittent wind and solar generation in total energy generated, the availability of real time data to system operator has become essential to manage the grid operation. Non-availability of real time data for longer duration leads to inefficient and insecure operation of the grid. We are of the view that the solar/wind generators are responsible to provide real time data to SLDCs. The State Electricity Regulatory Commissions are requested to make suitable provisions in their regulations and through orders to ensure that solar/wind generators provide real time data to SLDCs as per the provisions of Grid Code. SLDCs are directed to ensure availability of data in respect of real time data from their Data Acquisition Systems of solar/wind generators in SCADA systems to respective RLDCs as per the provisions of the Grid Code.

Issue (6): What is the status of implementation of contingency demand disconnection scheme for mitigating impact of sudden loss of wind generation in line with order dated 22.2.2014 in 120/MP/2011?

47. The petitioner had filed Petition No. 120/MP/2011 *inter-alia* seeking advise to Tamil Nadu Electricity Board to develop and implement a contingency plan for mitigating the loss of wind generation on priority basis. After considering the submissions of the parties,

the Commission vide order dated 22.2.2014 *inter-alia* observed as under:

> *"12. We have considered submissions of the petitioner and the respondent. The respondent has submitted that variation of wind generation is a prime reason for overdraw!. The respondent is expected to make arrangements for tackling such contingencies. The documents available on record bear testimony to the fact that several times in different forums, respondent was repeatedly requested and advised to formulate special schemes to deal with such situation but to no avail. Consequently, the grid security was jeopardized by overdrawing heavily and continuously from the grid to compensate for the variation of generation due to wind. At present, Tamil Nadu has a wind generation installed capacity of around 6,000 MW and maximum generation of wind is the range of 2500-3000 MW. On perusal of records submitted by SRLDC, it is a challenging and arduous task to contain the wind variability without having high ramp up generators, i.e. gas based generation of ample capacity for minimizing the ill effects of the variability of wind energy generation. However, in our opinion, evacuation of the generation in around Vemagiri area needs detailed study. The Commission in its order dated 2.2.2012 in Petition No. 67/2012 had directed CTU to carry out detailed study for the evacuation of the generation in around Vemagiri as under:*
>
> *"We also direct the CTU to take immediate steps to remove the constraints highlighted by TANTRANSCO for evacuation of Power in the Vemagiri area caused due to LILO arrangements of the existing transmission lines."*
>
> 18. *Under the Grid Code, SLDCs are responsible to formulate the automatic demand disconnection scheme to reduce overdraw! from the grid. We direct the respondent to take necessary steps to implement automatic demand management scheme to deal with the emergency situations such as sudden variation of wind generation or forced outages etc. and submit the monthly progress report to SRLDC and SRPC in this regard. SRPC shall inform the Commission about any deficiency in the action taken by the respondent and non-compliance with the directions of the Commission……*"

48. IWTMA has submitted that lack of Automatic Load Disconnection Scheme commensurate with the loss of wind generation has also contributed to the sudden rush of power flow in the inter-regional link viz. 765 kV Raichur-Sholapur transmission line causing power oscillations.

49. SRPC, vide letter dated 28.7.2015, has submitted that the Commission vide order dated 22.2.2014 in Petition No. 120/MP/2011 directed SLDC Tamil Nadu to take

necessary steps to implement ADMS to deal with emergency situations such as sudden variation in wind generation or forced outages, etc. SRPC has submitted that implementation of ADMS has continuously been followed up in OCC/TCC/SRPC meetings. SRPC has submitted that a special meeting was held on 20.7.2015 with TANTRANSCO and TANGEDCO in which they agreed to implement ADMS which would trigger instantaneously during sudden withdrawal of wind generation. TANTRANSCO and TANGEDCO also agreed to furnish the details of the finalized scheme in the 110th OCC meeting scheduled on 6.8.2015. It was also agreed that the scheme needs to be in place at the earliest. Till this scheme is commissioned, contingency plan for sudden withdrawal such as an additional logic (already agreed and noted in sub-committee Meeting of SRPC) be commissioned along with ADMS and once the scheme is commissioned, the additional logic in ADMS could be removed. SRPC has submitted that the issue has also been regularly followed up in the meeting of OCC/TCC/SRPC. In the meeting held on 20.7.2015, it was agreed that TANTRANSCO/TANGEDCO would implement ADMS by 31.8.2015.

50. We have considered the submissions of the petitioner and the respondents. As per Regulation 5.4.2(d) of the Grid Code, SLDCs are required to formulate the Automatic Demand Disconnection Scheme to reduce overdrawl from the grid. The relevant portion of the said Regulation 5.4.2(d) is extracted as under:

> ***"5.4.2 Demand Discussion***
> *(a)* .....
> *(b)* .....
> *(d) The SLDC through respective State Electricity Boards/Distribution Licensees shall also formulate and implement state-of-the-art demand management schemes for automatic demand management like rotational load shedding, demand response (which may include lower tariff for interruptible loads), etc., before 01.01.2011, to reduce overdrawl in order to comply para 5.4.2 (a) and (b). A Report detailing the scheme and periodic reports on progress of implementation of the schemes shall be sent to the*

Central Commission by the concerned SLDC."

51. The Commission vide order dated 22.2.2014 in Petition No. 120/MP/2011 directed the respondents to take necessary steps to implement Automatic Demand Management Scheme to deal with the emergency situations, such as sudden variation of wind generation or forced outages, etc., and submit monthly progress report to SRLDC and SRPC in this regard. SRPC was also directed to inform the Commission about deficiency in the action taken by the respondents and non-compliance with the directions of the Commission. In compliance with the Commission's directions dated 22.2.2014 in Petition No. 120/MP/2011, the petitioner has informed that TANTRANSCO and TANGEDCO have failed to comply with the direction of the Commission. SRPC has submitted that implementation of Automatic Demand Management Scheme has been continuously been followed up in OCC/TCC/SRPC meetings and in this regard, a special meeting was held on 20.7.2015 with TANTRANSCO and TANGEDCO in which they agreed to implement a scheme which would trigger instantaneously during sudden withdrawal of wind generation. In the said meeting, TANTRANSCO and TANGEDCO had agreed to furnish the details of the finalized scheme in the 110th OCC meeting scheduled on 6.8.2015.

52. We have perused the minutes of 110th and 111th OCC meetings of SRPC held on 6.8.2015 and 8.9.2015 respectively. The relevant portions of said meetings are extracted as under:

Extract of 110th OCC meeting

"6.10.2 It was noted that SRPC vide letter dated 28.07.2015 (Annexure - 6M) had furnished the status update on Instantaneous scheme for sudden withdrawal of wind and on ADMS (5.4.2 (d) oflEGC).

6.10.3 EE, TANTRANSCO informed that 500 MW of loads have been identified for

instantaneous tripping. The tripping signal would be initiated through RTU during bus dead condition at Udumalpet&Kayathar SS. On a query he informed that they were planning to extend this scheme to other wind sub-stations also which would be implemented in due course of time.

6.10.4 TANTRANSCO was requested to furnish schematic details of the scheme. It was pointed out that the scheme needed to be instantaneous and timing details (picking to tripping) are also required to be furnished."

Extract of 111th OCC meeting

*"6.10. **Wind generation withdrawal in Tamil Nadu system***

6.10.1. A Special Meeting was held at Chennai on 20th July, 2015 to discuss Wind Withdrawal and other pending issues pertaining to Tamil Nadu grid. Minutes of the Meeting are available at SRPC website.

6.10.2. In 110th OCC meeting, TANTRANSCO had informed that 500 MW of loads have been identified for instantaneous tripping. The tripping signal would be initiated through

RTU during dead bus condition at Udumalpet and Kayathar SS. They were planning to extend this scheme to other wind sub-stations also which would be implemented in due course of time. TANTRANSCO informed that the matter regarding reduction of Zone-II time settings to 200-250 msec would better be discussed in PCSC meeting. TANTRANSCO was requested to furnish schematic details of the scheme. It was pointed out that the scheme needed to be instantaneous and timing details (picking to tripping) are also required to be furnished.

6.10.3. In the meeting, EE, TANTRANSCO informed that their P & C wing was taking up the above scheme.

6.10.4. SRPC/SRLDC expressed serious concern that there was no noticeable progress in implementation of the instantaneous scheme though the scheme was to be in place by 31st August, 2015. The issue was being followed up by Hon'ble CERC and scheme was required to be implemented without any further delay. TANTRANSCO representatives were requested to appraise the Management and expedite the commissioning of the scheme."

Perusal of the said minutes of 110th and 111th OCC meetings reveals that SRPC and SRLDC have expressed their serious displeasure for poor progress in implementation of the instantaneous demand disconnection scheme though the scheme was to be

implemented by 31.8.2015 as per the commitment given by TANTRANSCO and TANGEDCO during the Special Meeting held on 20.7.2015. In our view TANTRANSCO has failed to comply with the Commission's direction given in order dated 22.2.2014 in Petition No. 120/MP/2011. Accordingly,we direct SLDC, Tamil Nadu to explain the reasons, on affidavit, by 29.1.2016 as to why action under Section 142 of the Act should not be initiated against it for non-compliance with the provisions of the Grid Code and order of the Commission.

Issue No. (7): Whether Renewable Energy generators are required to do proper forecasting and scheduling and demand estimation by SLDCs in compliance with Grid Code?

53. The petitioner has contended that forecasting and scheduling of wind generation is an important issue which is getting prolonged without implementation since 2010. Though renewable energy sources are of variable nature, it could be forecasted with fair accuracy as it is being done in number of countries. As a system operator, the forecast error or deviation shall be as minimum as possible. However, due to representations made by the wind energy generators and encourage them for commencement of scheduling and get expertise in forecasting and scheduling, flexibility to as much as 30% deviation was permitted in the Grid Code. Forecasting the power output of wind farms in the next hours or days is of primary importance for the management of a power system with high wind penetration. The petitioner has further submitted that the challenge comes when a large share of the generation depends on weather conditions, as is the case for wind energy. According to the petitioner, wind power forecasts are useful for power system scheduling, congestion management, storage management, reserves allocation and other functions. Wind farm operators also need forecasts to participate in a day-ahead electricity market or

to plan maintenance of wind farms.

54. The petitioner has further contented that the wind generators are yet to commence the forecasting and scheduling. However, the wind generators had taken up the matter before the various High Courts mentioning reasons such as technical limitations and commercial implication. In absence of proper forecasting and scheduling by renewable energy sources, SLDCs are not complying with the provisions of Regulation 5.3 of the Grid Code which provides as under:

"5.3 Demand Estimation for Operational Purposes

(a) This section describes the procedures/responsibilities of the SLDCs for demand estimation for both Active Power and Reactive Power.

(b) The demand estimation is to be done on daily/weekly/monthly /yearly basis for current year for load - generation balance planning. The SLDC shall carry out system studies for operational planning purposes using this demand estimate.

(c) Each SLDC shall develop methodologies/mechanisms for daily/ weekly/monthly/yearly demand estimation (MW, MVAr and MWh) for operational purposes. Based on this demand estimate and the estimated availability from different sources, SLDC shall plan demand management measures like load shedding, power cuts, etc. and shall ensure that the same is implemented by the SEB/distribution licensees. SLDCs. All SEBs/distribution licensees shall abide by the demand management measures of the SLDCs and shall also maintain historical database for demand estimation.

(d) Each SLDC shall carry out its own demand estimation from the historical data and weather forecast data from time to time. All distribution licensees and other concerned persons shall provide relevant data and other information as required by SLDC for demand estimate.

(e) While the demand estimation for operational purposes is to be done on a daily/weekly/monthly basis initially, mechanisms and facilities at SLDCs shall be created at the earliest but not later than 1.1.2011 to facilitate on-line estimation of demand for daily operational use for each 15 minutes block.

(f) The monthly estimated demand by the SLDC shall be provided to RLDC and

RPC for better operation planning.

(g) The SLDC shall take into account the Wind Energy forecasting to meet the active and reactive power requirement.

(h) In order to facilitate estimation of Total Transfer Capability /Available Transfer Capability on three month ahead basis, the SLDC shall furnish estimated demand and availability data to RLDCs."

55. SLDC, Tamil Nadu has submitted that MNRE has entrusted NIWE for a study of wind forecasting in the State of Tamil Nadu in collaboration with Spanish weather monitoring company which has successfully been launched on 13.5.2015. SLDC has further submitted that launch of wind power forecasting services by NIWE showcases the forecasting capacity built in India in a highly wind penetrated State of Tamil Nadu to enable the wind farm operators and SLDC to effectively evacuate maximum wind power by the scientific forecasting provided by NIWE and to schedule power and manage the utility grid. Forecasting by NIWE is proposed for all 117 sub-stations and forecasting has already commenced in four generating stations.

56. SLDC, Andhra Pradesh has submitted that it is carrying out its own demand estimation from the historical data and weather forecast data from time to time. Demand estimation is being carried out on a daily/weekly/monthly basis for daily operational use. SLDC Andhra Pradesh has further submitted that monthly estimated demand is being provided by SLDC AP to RLDC and RPC for satisfactory operational planning. According to SLDC AP, it is taking into account of power availability given by 322.7 MW of Wind Mills at present in load generation balance.

57. We have considered the submissions of the petitioner and the respondents.Part 6 of the Grid Code as amended through the third amendment provides as under:

"Part 6: Scheduling and Despatch Code: *This section deals with the procedure to be adopted for scheduling and despatch of generation of the Inter-State Generating Stations (ISGS) and scheduling for other transactions through long-term access, medium-term and short-term open access including complementary commercial mechanisms, on a day-ahead and intra-day basis with the process of the flow of information between the ISGS, National Load Despatch Centre (NLDC), Regional Load Despatch Centre (RLDC), Power Exchanges and the State Load Despatch Centres (SLDCs), and other concerned persons.*

Most of the wind and solar energy generators are presently connected to intra-State network and in future are likely to be connected to the inter-state transmission system (ISTS) as well. Keeping in view the variable nature of generation from such sources and the effect such variability has on the interstate grid, and in view of the large-scale integration of such sources into the grid envisaged in view of the Government of India's thrust on renewable sources of energy, scheduling of wind and solar generators which are regional entities, has been incorporated in this code."

Regulation 6.5 (23) ***of the Grid Code*** *further provides as under:*

" 6.5 (23) (i) Wind and Solar generators shall mandatorily provide to the concerned RLDC, in a format as prescribed by RLDC, the technical specifications at the beginning and whenever there is any change. The data relating to power system parameters and weather related data as applicable shall also be mandatorily provided by such generators to concerned RLDC in real time. The frequency and other details in this regard shall be provided in the Detailed Procedure to be prepared by NLDC and approved by the Commission.

(ii) Forecasting shall be done by wind and solar generators which are regional entities as well as the concerned RLDC. The concerned RLDC may engage forecasting agency(ies) and prepare a schedule for such generating stations. The forecast by the concerned RLDC shall be with the objective of ensuring secure grid operation. The forecast by the wind and solar generator shall be generator centric. The wind and solar generators which are regional entities will have the option of accepting the concerned RLDC's forecast for preparing its schedule or provide the concerned RLDC with a schedule based on its own forecast. Any commercial impact on account of deviation from schedule based on the forecast chosen by the wind and solar generator shall be borne by it."

The Commission in the Statement of Reasons to the Grid Code has observed as under:

"2.3.2 The Commission appreciates inputs on expanding the scope of IEGC regulations. Indeed, the Commission is committed to helping States implement a framework for forecasting, scheduling and deviation settlement for intrastate RE generating stations as well. However, the framework proposed by the Commission fits well for an ABT compliant payment, scheduling and balancing system. Currently all States do not have ABT mechanism in place. As such, it would not be advisable to prescribe a one-size-fits-all framework. After instituting an inter-state framework, the

Commission will also create an enabling framework and frame model regulations for the state level, which will be shared with the Forum of Regulators(FOR) for implementation/adaptation at the state level......"

As per the said provisions, wind and solar generators are required to mandatorily provide to the concerned RLDCs the technical specifications at the beginning and whenever there is any change. Wind and solar generators, which are regional entities, are also required forecast their generations and concerned RLDC is required to prepare schedule for such generating stations. Accordingly, we direct all solar/wind generators to forecast/schedule their power as per applicable regulations. For intra-State solar/wind generators, we request the State Commissions to issue appropriate regulations/orders to align with the provisions of the Grid Code as quoted in this para .

Other issues:

(a) Study of line loading in STU network and strict N-1 compliance by expediting works under progress, particularly wind evacuation system.

58. The petitioner has submitted that the Commission vide order dated 22.2.2014 directed the respondents to take necessary steps to implement ADMS to deal with the emergency situations, such as sudden variation/loss of wind generation or forced outages etc. and submit the monthly progress report to SRLDC and SRPC in this regard. The petitioner has submittied that the matter was discussed in various special meetings and in all OCC meetings of SRPC and in TCC meetings. However, no tangible measures have been taken by TNEB in this regard. The petitioner has submitted that the issue was taken up by STU/DISCOMs/SLDC with the concerned State Electricity Regulatory Commissions. The compounding problem is that the lines in wind intensive areas were often getting over loaded contributing to low voltages. The petitioner has submitted that

Tamil Nadu needs to monitor the line loading/voltages in the critical areas and back down generation/curtail load as per requirement. The petitioner has requested to address the evacuation issues at the earliest.

59. According to IWTMA, the petitioner has contended that there is a loss of wind generation during Grid Incidents (GI) and Grid Disturbances (GD) due to cascading tripping of wind mills which do not have the Low Voltage Ride Through (LVRT) protection and nature of instances poses threat to the gird security. IWTMA has submitted that LVRT function would definitely help the wind generation to be available in the event of transient faults when the recovery of voltage starts after 300 milli sec. IWTMA has submitted that it has analyzed some of the reasons for the loss of wind generation during incidents with the limited information available on the official websites of the central sector. IWTMA has submitted that during the Southern Region Power System Planning Committee meeting held on 22.1.2007, a comprehensive power evacuation scheme for the wind power with 400 kV sub-stations and transit lines in Tamil Nadu was proposed by TNEB and the same was approved. However, the process of implementation started after 5 years. As a result, the wind power installations were connected mostly at 110 kV and some at 220 kV levels. IWTMA has submitted that despite adequate support of reactive power from the wind turbines, there were issues of low voltage during high wind generation. As the voltages were generally low during the high wind generation period, the uncleared bus faults, or other system faults were cleared by several EHV lines from far end /back up protection. Therefore, the faults might have cleared after zone-2 time of distance relays on the EHV lines or beyond, which could be beyond 300 milliseconds. In such events, the substantial loss of generation from wind, connected/nearer to those buses (where fault has occurred)

was not preventable even if LVRT was provided in those wind turbines. According to IWTMA, in developed and well operated and maintained grids like Gujarat, the loss of wind generation due to un-cleared faults in EHV sub-station are not experienced. Therefore, bus bar protections should be installed and commissioned and ensured that it remain in operation all the time to clear the bus faults in "instantaneous time" and should not be allowed to be cleared by far end lines, which could entail loss of more wind generation, even with LVRT. IWTMA has submitted that by the year 2012, TANTRANSCO has undertaken the setting up of 400 kV network for power evacuation schemes at Kayathar, Thappagundu, Annaikadavu and Rasiyapalayam in a serious manner and when these are commissioned, better voltage profile and constraint-free power evacuation for wind generation is expected in the coming years (out of these, Kayathar sub-station was commissioned in September and October, 2014). Therefore, it cannot be denied that LVRT is a desirable feature subject to efficacy of primary protection, grid operational discipline viz. automatic load shedding, proper reactive compensation and control of voltage profile, augmentation of the power evacuation system as per planning and adhering to time schedules in transmission project completion.

60. We have considered the submissions of the petitioner and IWTMA. IWTMA has contended that non-availability of LVRT is not the reason for loss of wind generation during grid disturbances/grid incidents and cascade tripping of wind mills. The main reason for loss of wind generation during grid disturbances/ grid incidents and cascade tripping of wind mills is due to non-availability of wind evacuation system with 400 kV sub-stations and transit lines. In this regard, we have perused the June, 2015 report of CAC sub-Committee on Congestion in Transmission System which clearly highlights that the main reason of

constraint in the transmission system is inadequacy of State level transmission and sub-transmission system. The relevant portion of report of CAC sub-Committee on Congestion in Transmission System is extracted as under:

> *"One of the main reasons of the constraint is also the inadequacies of state level transmission and sub-transmission system".*

61. It is noticed that CTU has already planned green energy corridor based on anticipated additions in renewable capacity in various parts of the country. According to IWTMA, STUs of the renewable rich States are not geared up for evacuating large wind during high wind seasons which causes overloading of intra-State transmission lines during high wind seasons and make the system insecure. As per Section 39 of Electricity Act, 2003, STUs are responsible to ensure development of an efficient, co-ordinated and economical system of intra-State transmission lines for smooth flow of electricity from a generating station to the load centres. Therefore, STUs are required to plan and develop intra-State transmission system keeping in view the increase in capacity addition for generation of electricity from renewable energy sources.

62. As per Regulation 3.5 of the Grid Code and the CEA's Manual on Transmission Planning Criteria, transmission system should be (N-1) secured. Therefore, we direct STUs to study line loading in their systems to ensure N-1 compliance and submit reports in this regard to CEA by 10.3.2016. CEA is directed to discuss the same in the next Standing Committee Meeting (SCM) and suggest measures to strengthen the systems.

(b) Compliance of the Central Electricity Authority (Technical Standards for Grid Connectivity) (Amendment) Regulations, 2013 by new generating units being commissioned and getting connected to the grid.

63. As the Central Electricity Authority (Technical Standards for Grid Connectivity)

(Amendment) Regulations, 2013 is applicable for wind generating stations and generating stations using inverters and are connecting at voltage level 66 kV and above to the grid after 15.4.2014. Therefore, all the wind generating stations are directed to comply with the provisions of CEA Technical Standards for Connectivity Regulations. We further direct CTU and STUs to make provisions in this regard in their Connection Agreements to ensure that wind energy generators comply with the provisions of CEA Technical Standards for Connectivity Regulations for grid connectivity before granting connectivity to the grid.

64. The petition is disposed of in terms of the above.

Sd/-	sd/-	sd/-	sd/-
(Dr. M.K.Iyer)	**(A.S.Bakshi)**	**(A.K.Singhal)**	**(Gireesh B.Pradhan)**
Member	**Member**	**Member**	**Chairperson**

Annexure-I

Indian Wind Turbine Manufacturers Association

Prior to 16/04/2014 for 225-750kw Turbines (For states of AP, Karnataka, Tamil Nadu, Kerala)

Members	Sl No.	Size of Turbine (225-750kw)	Number of Turbines Under OEM Control	Cost / Turbine for LVRT fitting	Time For Implementation			
					2nd Half of 2015	1st Half of 2016	2nd Half of 2016	1st Half of 2017
GE	1	600KW	5	NA				
Pioneer	2	250KW and 750KW	754	NA	Not technically feasible			
RRB	3	225 kW	61	INR 25.0 Lakhs			Sep-16	
	4	500 kW	125	INR 30.0 Lakhs			Dec-16	
		600 kW	274	INR 30.0 Lakhs				Jun-17
Suzlon		350	912	25-30Lakhs	3 years			
		600	762	25-30Lakhs	3 years			
LSML		250	194		Not technically feasible			

Prior to 16/04/2014 (800kw & Above) (For states of AP, Karnataka, Tamil Nadu, Kerala)

	Sl No.	Size of Turbine (800kw & above)	Number of Turbines Under OEM Control	Estimated approximate Cost / Turbine for LVRT fitting	Time For Implementation			
					2nd Half of 2015	1st Half of 2016	2nd Half of 2016	1st Half of 2017
Gamesa	1	G58-850kW, 50Hz, IEC IIIB	1042	25-30L				
LSML	2	1.5 MW	75	Rs. 30 Lakhs	10	15	25	25
	3	1.8 MW	25	Rs .21 Lakhs	10	15		
	4	2.0 MW	1	Rs. 20 Lakhs	1			
Suzlon	7	1000	73	25-30 Lakh	3 years			
	8	1250	2360	25-30 Lakh	2-3 years			
	9	1500	1818	25-30 Lakh	2 years			
	10	2000	1	25-30 Lakh	2 years			
	11	2100	682	25-30 Lakh	1 year			
	12	2100	351	-	Compliant			
RRB	13	1800	1	-	Compliant			
Inox		2000	2	Rs. 30Lacks/WTG				Mar-17
GE		1.5S	6	~50Lakhs				6
Vestas								
Kenersys								
WWIL								