GRID CONNECTION REQUIREMENT FOR WIND POWER PLANTS – ADDENDUM TO THE CEB GUIDE FOR GRID INTERCONNECTION OF EMBEDDED GENERATORS, DECEMBER 2000

1.0 DATA PROVISION

This is in addition to the information requested under Exchange of Information about the Interconnection as stipulated in CEB GUIDE FOR GRID INTERCONNECTRION OF EMBEDDED GENERATORS; December 2000 hereinafter refers as CEB guide.

1.1 Data requirement for grid impact studies

The interconnection request for a prospective wind farm shall accompany following data which requires for conducting grid interconnections studies.

(a) Single line diagram of the wind farm power collector system up to the main installation circuit breaker. This shall include, listed in a separate sheet if necessary, all the technical parameters related to the conductors, and step up transformers of the power collector system.
(b) Details of voltage support facilities such as switched capacitors, static var compensators and, dynamic var compensators including the intended power factors for full MW range. (Curve depicting power factor Vs wind turbine out put power)
(c) Wind turbine model data from the manufacturer, format acceptable to PSS/E software, and general plant characteristics including power curve to conduct simulation studies at 33 kV and 132 kV level.
(d) Wind turbine layout, as per micro siting, on a 1:10,000 map.

2.0 PLANT MONITORING

This is a new requirement introduce for embedded wind power plants whose installed capacities less than or equal to 10MW**.**

2.1 On line Data Provision

The generating company should build the necessary data transmission facility to provide on line data delivery to the System Control Centre of the Ceylon Electricity Board (CEB) for following parameters.

(a) Status of the main circuit breaker of the wind farm
(b) Active power export from the wind farm.
(c) Active power import by the wind farm. (or instead of (b), (c) net active power flow indicating direction)
(d) Reactive power import by the wind farm
(e) Reactive power export from the wind farm. (or instead of (d), (e) net reactive power flow indicating direction)
(f) Wind farm voltage at the main circuit breaker of the wind farm
(g) Wind speed from the site wind mast
(h) Wind direction from the site wind mast

2.2 Applicability of On Line Data Provision

The online monitoring facility of aforesaid parameters shall be updated on each 10 minute interval during 18.00 hrs – 21.00 hrs and 02.00 hrs – 05.00hrs and during rest of the day generating company have the option of providing on line data either half hourly basis or 10 minute basis. However, any major breakdown such as sudden tripping of entire wind farm or synchronizing the wind farm during high wind situations where wind speeds are near rated wind speed of the turbine etc, shall be immediately brought to the notice of the system control center through the direct communication link as specified in section 3.3 of this document.

2.2.1 The above on line facility shall be provided by all wind farms, except plant capacities below 5 MW

2.2.2 The minimum on line data provision requirement for wind farms having installed capacities between 5 MW to 10 MW shall be equal or not less than the parameters stipulated in item (a), (c) and (g).

2.2.3 If the cumulative installed capacity of wind farms connected to particular grid substation equal or exceed 20 MW, the developers shall provide on line data facility as depicted in 2.2.2 either as an individual generating companies or as a group.

2.2.4 If on line data provision is undertaken as a group where number of wind farms having installed capacities less than 5 MW, the group may have the option of providing equivalent out puts pertaining to (c), (e) and (g).

2.3 Data Provision on a Monthly Basis

The monthly summary report on plant performances shall be provided within first week of each month and shall include the following

(a) Project location, no. of turbines, turbine model, total installed capacity, total machine hours
(b) Total monthly generation, plant factor, availability factor, cumulative generation since commissioning and generation in the same month in the previous year.
(c) Daily generation, Generator hours, Composition of down time hours such as due to inadequate wind speed, machine fault, machine shut down for maintenance, grid fault, grid shut down for maintenance etc.
(d) Individual turbine performances

3.0 CONTROLS

This is a new requirement introduce for embedded wind power plants whose installed capacities less than or equal to 10MW

3.1 Out put Control

The wind farm shall provide the necessary controlling facility to limit the out put variation of the wind farm by incorporating necessary controls to individual wind turbines. The ramp rate will be defined for the grid substation and shall not exceed 10 MW/minute. The ramp rates applicable for individual wind farms will be distributed in terms of their installed capacity. The ramp rate shall be applicable to wind farms connected to a particular grid substation as depicted below.

(a) If the wind farm capacity is equal or greater than 5 MW.
(b) If the cumulative installed capacity of wind farms connected to a particular grid substation equal or exceeds 20 MW. (Wind farms having installed capacities less than 1 MW will be exempted though the capacities of such wind farms will be considered for calculation of cumulative installed capacity)

3.2 Remote Control Facility

Remote controlling facility from System Control Centre shall be provided for the main circuit breaker of the wind farm if the cumulative installed capacity of wind farms connected to a particular grid substation exceeds or equal 20 MW. The wind farms having installed capacities less than 1 MW will be exempted though the capacities of such wind farms will be considered for calculation of cumulative installed capacity.

This requirement will be waive off for first 40 MW of wind farms. However, CEB reserve the right to control out puts of those plants, during an emergency situation such as restoration of power supply after an Island-wide supply failure, during very volatile wind situation and situations where wind farm out puts are not responsive to the ramp rates stipulated in section 3.1.

3.3 Direct Communication Facility

Direct communication facility shall be provided at the wind farm control desk on a 24 hour basis for plant having installed capacities 5 MW or more.

4.0 PROTECTION REQUIREMENT

Protection relays shall be of suitable quality to provide reliable and consistent operation. The performance levels of the relays shall be declared by the manufacturer.

It is preferable to use proven protection equipment supplied by a reputable manufacturer with a track record in this type of application. The performance of all protection relays shall be within the scope of IEC protection product family Standard IEC 60255 (formerly IEC 255).

It is recommended that control and protection panels are soak tested (i.e. the protection relay panels are energized for several hours or days) prior to being put into operation. During the soak test the operation of the protection relays should be checked periodically.

Protection relays and the associated sensing circuits must be designed to maintain accuracy and operation in fault conditions. Particular consideration should be made of the requirements for current transformers to sustain operation when fault currents occur. Current and voltage transformers should be appropriately selected and comply with product standards IEC 60185 (formerly IEC185) and IEC 60186 (formerly IEC 186) respectively.

All protection relays to have indication of operation.

It is useful if the relay system can indicate which relay or function operated first to disconnect a generator during a fault condition. The indication may be reset at next breaker or contactor closure. This indication is not a requirement.

Secondary injection test points should be provided where practical to facilitate commissioning and later testing of relay settings and operation.

4.1 Frequency Requirement

As per section 7.2.3 of CEB guide (PART 2). The embedded wind plant shall operate through out the full range of frequencies depicted below. (i.e 47 HZ to 52 HZ)

Over Frequency:	1.04 PU	-	Continuously
Under Frequency:	0.94 PU	-	Continuously

4.2 Voltage Requirement

As per section 7.2.2 of CEB guide (PART 2). The embedded wind plant shall operate though out the full range of voltages (+/- 10%) with time base capabilities depicted below.

Over Voltage:	1.10 PU	- Continuously
	> 1.10 PU, 1sec	- Should remain connected to the grid for 1 second and trip.
Under Voltage:	< 0.90 PU, 3 sec	- If LVRT capability applicable. Should remain connected to the grid for 3 seconds and trip.
Otherwise;	<0.90 PU, 1sec	- Should remain connected for 1 second and trip

4.3 Power Factor and Reactive Power Support

The recommended range for reactive power support by a wind farm is 0.80 lagging to 0.95 leading. The exact level of reactive power support required from a wind farm will depend on the out come of grid interconnection studies. Therefore, unless specific reactive power support is requested in the grid interconnection proposal the wind farm shall operate in the range of 0.98 leading to unity power factor. Failure to operate below 0.98 leading power factor (i.e. less than 0.98 leading) shall result in imposition of a penalty which shall be decided by CEB.

4.4 Neutral Voltage Displacement Relay

The provision of NVD facility shall be in accordance with the CEB guide.

4.5 Inter-Tripping

Refer CEB guide for detail explanations on Inter-tripping

4.6 Low Voltage Ride Through (LVRT) Capability

The wind power plant shall be connected to the grid during voltage disturbances (Under voltage conditions) of the power system for a short period of time. The low voltage margin required in the LVRT capability is beyond the low voltage margin stipulated under '***'4.2 Voltage Requirement***'. If the grid voltage at the point of interconnection reduces to 40% of the nominal voltage and remain at 40% of nominal voltage for a period less than 100 ms and then recover to a voltage level of 90% or higher within 3 seconds, the wind farm shall remain connected to the grid. If the voltage during the disturbance reduces below the aforesaid voltage profile, the wind farm shall trip.

4.6.1 Applicability of LVRT capability

The LVRT capability shall be applicable for any one of the cases described below.

(a) Wind farm having installed capacities 5 MW or above.

(b) If the cumulative installed capacity of wind farms connected to particular grid substation exceeds or equal to 20 MW, all the generating companies, except wind farms having installed capacities below 1 MW, shall together or individually provide the LVRT facility either at point of common coupling or at 33 kV bus bar of the grid substation.

4.6.2. Exemptions from LVRT capability

The LVRT capability is waived off for following cases.

(a) The first wind farm developers will be exempted form LVRT capability whose total installed capacity is 40 MW.

(b) The wind farm having installed capacities less tan 1 MW

5.0 POWER QUALITY

The power quality depends on the interaction between the grid and wind turbine. Thus the grid connected wind turbines do affect the power quality. Hence, power quality in terms of voltage and frequency should be maintained as per given IEC standards.

5.1 Harmonics

The harmonics and inter harmonics are as defined in IEC 61000-4-7 and amendment 1. For wind turbines using power electronic converter, the emission of inter harmonic current during continuous operation should be specified. These are to be specified for frequencies up to 50 times the fundamental grid frequency, as well as the total harmonic distortion and emission of the individual harmonics. The relevant emission limits as per IEC 61800-3 are given below. Further the total harmonic distortion (THD) to be less than 5% of the fundamental rated current.

Harmonic order	Odd harmonic Current (% of I_{rated})	Even harmonic current (% of I_{rated})
n<11	4.0	1.0
11≤ n < 17	2.0	0.5
17≤ n < 23	1.5	0.4
23≤ n < 35	0.6	0.2
35≤ n ≤ 50	0.3	0.1
THD ≤ 5% (for n=40)		

5.2 Flicker

Flicker emission for continuous operation and switching operation should be within the limits given in the relevant IEC standards. The applicable IEC Standard are IEC 60868, IEC 61400-21 and IEC 61000-3-7.

Summary of Minimum Protection Requirements for Wind Farm Interconnection

	Type A	**Type B**	**Type C**	**Type D**	**Type E**
Cumulative installed capacity of the GSS (CICGS)		**CIGS<20 MW**	**CIGS≥20 MW**	**CIGS<20 MW**	**CIGS≥20 MW**
Wind farm capacity (WFC)	**WFC≤ 1MW**	**WFC > IMW WFC < 5MW**	**WFC>1MW WFC < 5MW**	**WFC≥ 5 MW WFC ≤10MW**	**WFC≥ 5 MW**
Voltage requirement	●	●	●	●	●
Frequency requirement	●	●	●	●	●
Reactive power support	●	●	●	●	●
Vector shift protection		●			
ROCOF protection					
"True" ROCOF protection					
NVD protection		●	●	●	●
Inter-tripping				●	●
Loss of Phase	●	●	●	●	●
On line Data Provision			●		●
Remote Over Riding Facility			●		●
Direct Communication link				●	●
Out put Control (Ramp Rate)			●	●	●
Low voltage ride through (LVRT)					●
Harmonics as per IEEE 519 1992	●	●	●	●	●
Flicker as per IEC 61000-3-7	●	●	●	●	●