EUTurbines comments to
ENTSO-E consultation on Guidance for Connection Code Implementation related to Frequency Stability Parameters

(Overview of EUTurbines comments)
2017–12-21

EUTurbines is the European association of gas and steam turbines manufacturers employing more than 70,000 people across Europe with a turnover of around 25 billion Euros. Our members are Ansaldo Energia, Doosan Skoda Power, GE Power, MAN Diesel and Turbo, Mitsubishi Hitachi Power Systems Europe, Siemens and Solar Turbines.

General Context – relevant for all IGDs

EUTurbines welcomes the preparation of the IGDs and agrees that they can be helpful for national implementation. However, we believe that the IGDs should not be considered the only relevant support document – especially since not all relevant technical matters are covered. In this sense, the IGDs should be considered living documents and further updates should be conducted in the future as well.

Frequency Sensitive Mode

General comments:

Please indicate tables and figures with numbers. It is hard to reference without them.

Can ENTSO-E also lead a benchmark of Frequency Sensitive Mode settings, as currently practiced in Europe? It seems that several countries have already selected various frequency related settings and are keen on keeping those going forward. This can create distortion of competition between the two sides of a border in a same synchronous grid. Indeed, the price to provide frequency controls would not be the same depending on those settings.

It is once more recommended to analyse thoroughly the current practices and direction taken in each country. It is a necessary step to understand how the grids currently operate, define cost effective frequency controls and equity of treatment between plant owners.

Technical comments:

page 5, droop calculation

There is a mismatch between the interdependency of minimum reserve for FSM, the droop range and the frequency deviation for full activation. Example: with 200 mHz and with the (maximum) droop of 12%, the resulting reserve would be 3,3%. This is higher than the minimum reserve of 2% in Germany

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and higher than the minimum reserve in RfG of 1,5%. It needs to be clarified. whether the droop is fixed by the TSO (resulting in a fair reserve activation among all FSM generators but a full reserve release at a df different from 200 mHz) or whether the droop needs to be variable, dependant on the current amount of reserve, but deployed at a df of 200 mHz.

Page 6-7 active dead-band
"Active dead-band" needs to be further explained. A recommendation is missing if and under which circumstances it shall be applied (only for modelling or intentional floating dead-band?) and, if yes, which parameters need to be applied. Application of this functionality requires consideration of a fair distribution of FSM among the contributing generators, as well as discussion about inherent time delay created by the filtering between true grid frequency change and change in processed frequency signal.

Page 8, frequency response dead-band
A "step-function dead-band" needs to be further explained. It is understood to have a sudden increase/decrease of output at the borders of the dead-band. Such functionality would not only cause stress but also would be a possible reason for instability in the system frequency.
Suggestion: clearly exclude a step function dead-band. It also needs to be made clear that there should be no change in the droop within the applicable frequency range, in order to make the FSM functionality not too complicated.

Figures 2 and 3: it is not clear what "100% insensitivity and "100% dead-band" means (missing reference value)
Frequency measurement accuracy shall be defined and accounted in all those studies and results. In a real situation, for the same (true) grid frequency, a frequency measurement device may not perceive the same frequency. This question is obviously upstream of consideration of insensitivity ("inherent dead-band") and (deliberate) dead-band. As frequency measurement accuracy devices, especially of existing units, may typically range between 3 mHz and 20 mHz, it can induce a large spread onto the distribution of results, consequence of accuracy, insensitivity, and dead-band.
Has the frequency measurement accuracy been considered here?
What would be the results of figure 3 with, for instance, 5 mHz standard deviation (of measurement accuracy) on the European fleet? We do suspect that the inner "bath tub" shape may not look the same at all.

Other points to consider.

- When we plot today's frequency density of probability on several grids (available from manufacturers, for instance), we typically do not see the bath tub, although many units are with static frequency dead-band. Shall we conclude here that facts defeat simulation, and study supporting frequency dead-band setting has just not the right assumptions in?
- Logic prioritisation shall be addressed in the IGD. In particular, it shall be stated how to deal with other logics that can affect / control the active power output of the generating unit. Specifically, the setpoint coming from DSO, industrial process, market related logics shall be addressed in terms of priority or how to deal with such signals in light of the discussion carried out at the GC ESC. As an example, please refer to the prioritisation proposal indicated in EN 50549-1/2.
- Lowering the dead-band to control the number of small deviation of frequency shall be assessed on cost versus benefit. Zero dead-band might lead to unwanted effect with a multi-machine and meshed network model; the model used for in the IGD might not cover all effects of small frequency deviation.

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Limited Frequency Sensitive Mode

<u>Technical Comments:</u>
System characteristics: in page 5, it is said that system inertia would be lower for small synchronous areas. In our view, system inertia and the transient frequency behaviour is not a function of the size of the synchronous area but only of the share of non-synchronous generation in that area.

Page 7: we have the following remarks:

- Default droop settings are given only for LFSM-O. What about LFSM-U?
- Equation for the droop should be generalised to be applicable for FSM and LFSM.
- Clarify the time at which the change in active power ΔP is to be measured for LFSM-U and LFSM-O.
- Tsr is measured when the MW reaches the tolerance range. The range and the minimum duration to hold the set value is not defined in the IGD or RfG.

Page 8: The first paragraph discusses the response time and refer to different technologies for provision of inertia. It is understood that those response parameters are not related to inertia response performance. If so, it will benefit the common understanding to state this.

Page 9: The response time of max 8 s for a power decrease of 45% is and will not be feasible for all synchronous generator technologies. Therefore, the following needs to be added: "Technologies which inherently are not able to perform a power decrease of 45% within 8 s shall indicate the power decrease which is technically feasible within this timeframe." Indeed, those 8 s are referring to best available technologies.

To which Δf, Δf1 and droop assumption, is the 45% referring to?
Moreover, defining conditions for detection of events (such as rate of change of frequency, or any other signals from the grid operator) are necessary for many unit to define optimal strategy (balance reliability and speed of response). We kindly request to also include the following statement: "methodology for detection of a grid split event shall be clearly agreed between plant owner and grid operator".

In case a plant is operated at low load and LFSM-O would result in zero load under high frequency conditions, is the plant then allowed to disconnect in order to support system stability or does it have to remain on a stable low load? In other words: is the requirement to remain connected under certain frequency conditions prevailing over the requirement of LFSM-O?
IGD shall provide indication whether the generating unit shall disconnect from the grid when LFSM-O drops below its minimum operating load or whether the generating unit shall remain connected to the grid at its minimum operating load.

Frequency Ranges

<u>Technical comments:</u>
The frequency ranges as defined in the RfG have been developed in coordination with stakeholders, taking into account many aspects, one of them the technical capabilities of generators. The table on page 5, however, now requires extended frequency ranges for the synchronous area of IE and NI. The exhaustive values given in the NC RfG do not match with the extended ranges in this IGD. Please, correct the values in the IGD according to the binding provisions of the NC RfG.

The IGD shall highlight in its content that high and low frequency operations have an impact on the generating unit lifecycle, maintenance and associated operational costs. As a consequence, the system operator shall define appropriate strategy and defence plan to limit rather than enlarging the over-frequency and under-frequency operative conditions. Please, refer to the comments provided by EUTurbines during the public consultation also at the beginning of the year.

Maximum Admissible Active Power Reduction at Low Frequencies – *NEW*

Technical comments:

Transient / steady state behaviour - relation to ambient conditions

The IGD clearly states that the transient behaviour of the generators during the decline of frequency is of much higher importance for system stability than the steady-state behaviour. Under steady-state conditions (after the decline), power and demand are balanced and, therefore, the need for a certain level of output is not relevant anymore.

Only the inherent (physical) behaviour of a generating unit is relevant for system stability. Any control actions during a frequency transient, to compensate for the inherent power loss, will be too late or even might further disturb the system e.g. when frequency is stabilised. Any requirement which does not consider the inherent behaviour would therefore exclude this technology from access to the system, disregarding all other benefits of this technology.

For SPGMs, it has to be taken into account that during a frequency drop (i.e. when the requirement is important) the inertia power response compensates the inherent power reduction to a certain amount (depending on the RoCoF).

On the other hand, the NC RfG clearly states that each Member State has to define a requirement on Admissible Active Power Reduction at Low Frequencies. The IGD combines this need with the a.m. physical facts in the recommendation to define a very stringent transient behaviour (upper limit of the allowed range in Art 13 (4) & (5)) and a relaxed steady state behaviour (lower limit of allowed range).

Compliance with this requirement is for certain technologies (in particular for Gas Turbines) only possible under certain ambient conditions – due to the fact that they show a strong relation between inherent power loss and ambient temperature. Hence, it does not make sense to link the requirement to a fixed ambient temperature.

A real test of compliance is not possible. Therefore, only a manufacturer statement based on calculations and simulations can be used as a prove of compliance. EUTurbines therefore proposes the following clear and simple approach:

- Keep the recommended required values of the table (p. 8) in the IGD for transient and steady state domain as they are, in order to comply with the RfG need to state a requirement.

- Require from SPGMs on a project-specific basis the inherent power vs. frequency characteristics (without any power compensation control measures) with ambient temperature as a variable parameter, to be used for system stability studies and design. This calculation can be done e.g. for a defined frequency over time curve.

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Only such approach allows a simultaneous compliance with NC RfG and a feasible compliance process based on clear requirements with minimum complexity.

EUTurbines is available to provide support to find an adequate wording to present the information in the IGD. We would welcome a request to propose and agree on a dedicated wording.

Automatic (re-)connection and Rate of Change of Active Power

General comments:
There is sometimes a mismatch between the typical times provided in the IGD page 5 and technical capabilities.

In the definition, it is indicated that automatic reconnection is related to connecting the generating unit after an incident (disconnection due to perturbation on the grid) or at start-up. The last one (at start-up) collides a bit with the definition of Normal connection after stand still. We recommend deleting "at start-up" or improve / clarify the definition.

In addition, there had been cases for which the frequency, even if stable, continued to stay out of the permitted band (especially in countries where the frequency upper limit is 50.05 Hz) for a long period even if in stable condition. The IGD shall clarify that in such cases, the operator is allowed to manually initiate the synchronisation process – eventually in agreement with the system operator – and that such a solution is an option.

Rate of Change of Frequency Withstand Capability (RoCoF)

General comments:
The IGD is lacking on recommendations about the compliance test procedure. Limitations on the possibility of testing interact strongly with the minimum requirements to be applied.

Technical Comments:
SPGMs are not generally capable of withstanding a RoCoF of 2,5 Hz/s as stated in the IGD. Manufacturers are not aware of having given this value.

The SPD report , among others, refers to 2 Hz/s - but we would be cautious and question some of its assumptions. We indeed understand there are means available to the Grid Operators to ensure that the rate of change of frequency remain below acceptable values.

- Inertia seems overly low in some regions, assuming that synchronous technology (including hydro) may not be connected anymore. We would challenge this assumption.
- The highest rate of change of frequency only happens for largest load imbalances (40%?). Certainly, System Operating Guidelines could make sure acceptable level load imbalance are not infringed in order not to endanger the grid stability.
- This does not consider any inertial support from non-synchronous generators, although it is a potential opportunity/requirement in the future.

We felt the indication of 2.5 Hz/s misleading during our discussion in many national codes, where such value had been assumed as a self-standing value, not associated, for example, to a time-rolling window.

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Page 6: There is an explicit inconsistency in RoCoF requirement between two studies given in the supporting documents on page 3.

This comment seeks to request the reasons why this IGD is not fully considering the finding of the Kema-DNV study reference [13]. Additionally to the importance of window size, the Kema-DNV study shows that out of 8 different SPGM technologies, a 2 Hz/s RoCoF value over 500 ms is not achievable with most of generation sets, apart from the small OCGT and the salient multiple-pole Hydro machine as exceptions (see executive summary). Despite this result, the ENTSO-E WG SPD reference [7] recommends RoCoF profile withstand capability to 2 Hz/sec over 500ms as a minimum.

There is an apparent inconsistency in defining such capability, with the SPD study focusing on the transmission network performance during large power imbalance and disregarding the outcome of the Kema-DNV study and subsequent discussion in Ireland and GB. The requirement and studies should focus on the capability at the generator unit level; not only at the performance of the transmission network. A detailed investigation is required with a full network representation focusing on the generating units considering the operating range, excitation system performance, benefit of fast frequency response from non-synchronous generation, the difference between islanded network in a power deficit situation versus an island in surplus of generation. We believe that the proposed values are not in line with studies on RoCof performed by O&Ms and Kema.

We also believe that the use of transmission infrastructural investment and better protection coordination as a means of improving RoCoF at a location weakly interconnected should be more effective and should not lead to such wider requirement than those proposed in GB or Ireland.
We would recommend the use of a lower value (1Hz/s) associated to a longer rolling window (500 ms) as proposed in IE.

While we understand the IGD drives requirements for generators and comes from different studies, we consider that the IGD shall point out to System Operators that high RoCoF values are, in any case, dangerous for the system and counter-measures, defence plan and any other means to limit RoCoF value at reasonable value for existing generating units need to be considered. The studies carried out should evolve taking into account such counter-measures and the RoCoF limit shall be set as a target for both generating unit technologies and System Operators.

RoCoF withstand capability and compliance through testing:
It is very difficult, if not impossible, to predict and simulate the stability and the limitations of a complex technology such as a gas turbine under the extreme conditions of a high RoCoF due to the complexity of, for instance, the combustion process. Additionally, there is almost no operational experience with high RoCoF due to the very limited occurrence of such extreme events and the impossibility of testing it under real conditions.

For generating units above 1 MW, it is not possible to test RoCoF requirements; in fact, there is the need for a virtual grid capable of changing its frequency to which the generating unit shall be connected.
The proposed frequency profiles, therefore, can only be applied to a simulation of the controller behaviour in an adequate simulation model. Acceptance of compliance, hence, must be limited to stability of the model (e.g. no disconnection) during such simulation. As a consequence, the SPGM cannot be made liable for any unpredictable effects under such severe conditions.

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Taking the frequency profile as a boundary profile in a real event (like for FRT) might cause conflicts with the requirements for frequency ranges. Therefore, it needs to be made clear that such profile is just the input for the simulation compliance test to confirm capability of the generating unit.

RoCoF withstand capability and RoCoF Protection:
In the IGD, there is reference to Loss of Mains RoCoF protection. We consider LOM RoCoF could need a dedicated small chapter. In particular it shall be clearly stated that RoCoF withstand capability and LOM RoCoF protection function are two separate concepts with different definitions, measurement criteria etc. We specifically appreciated the reference to the need of collaboration in defining the appropriate settings for the LOM RoCoF. We recommend adding some complementary information including the reasoning related to the settings of the RoCoF protection and the parties to be involved.

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