EUROPEAN
TURBINE
NETWORK

Brussels
13 February 2013

Dear Mr. Verheye and and Mr. Roudier,

The European Turbine Network (ETN) appreciates the opportunity to submit further comments to the LCD BREF Review Team of the Joint Research Center of the European Commission, regarding Directive 2010/75/EU. The focus of this comment will be related to the requirement that gas turbines permitted after 2012 meet a NO_x limit of 50 mg/Nm^3 when operating on liquid fuel.

ETN requests that this rule be stayed and held in abeyance, for a period of ten years, for gas turbines operating on liquid fuel. This would allow gas turbine manufacturers time to do the very challenging research and development needed to make commercially available products that can achieve 50 mg/Nm^3 while operating on liquid fuel. The technical reasons and the important role of liquid fuel firing are described below.

ETN further requests that the NO_x limit multiplier of efficiency divided by 35 that applies to simple cycle gas turbines operating on natural gas also apply to simple cycle gas turbines when operating on liquid fuel. The rationale for creating an efficiency incentive for liquid fuel is the same as that for natural gas.

With only one minor exception, there are no gas turbines commercially available, either simple cycle or combined cycle, either water injected or Dry Low NO_X, that offer NO_X emissions less than approximately **86 mg/Nm^3** when operating on liquid fuel. While ETN is aware of one recently upgraded E-class engine for which it is claimed capability to meet 50 mg/Nm^3 NO_X above 70% load on liquid fuel, we note that this engine has only one liquid fuel-capable installation with very low hours of liquid fueled service to date. In light of the lessons learned from the deployment of early Dry Low NO_X systems, validation for such a configuration would normally consist of multiple installations, at widely varying sites, running to completion of at least tens of thousands of hours of liquid fueled operation. Thus, it must be concluded that validation of this single engine model running on liquid fuel is yet in its *very* early stages. Further, there are no engines higher than E-class that can meet this NO_X level on liquid fuel and no aeroderivative engines (with ultra fast start and load capability) that can meet the limit either. Thus, with the exception of a single E-class engine in the very early stages of validation, there are no gas turbines commercially available, either simple cycle or combined cycle, either water injected or Dry Low NO_x combustion systems, that offer NO_x emissions less than approximately **86 mg/Nm^3** when operating on liquid fuel.

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The reason for the current state of the art in gas turbine liquid fuel operation is that, after massive investment in research and development over the past two decades, gas turbine manufacturers have been unable to reach lower emission levels on liquid fuel without encountering thermo-acoustic combustion dynamics in the gas turbine combustion chamber. Gas turbines, if allowed to operate in the presence of combustion dynamics, which produce large and rapid internal pressure oscillations, will experience premature failure often with serious consequences. This phenomenon is very similar to the combustion dynamics encountered in Dry Low NOx (DLN) combustion systems firing natural gas which took manufacturers two decades to solve. The problem has not yet been solved for the more complex problem of liquid fuels due to their much greater propensity to ignite in premixing passages and the necessity to vaporize the fuel prior to mixing with air and then burning.

ETN are also aware that the IED has a provision for simple cycle gas turbines, operating on natural gas, to raise the 50 mg/Nm^3 NO_x limit to a higher level based on the efficiency of the gas turbine (using a limit-multiplier of efficiency divided by 35). We note that this will result in a very small increase in the limit for simple cycle gas turbines. For example this provision would allow the limit to be raised to approximately 55 to 60 mg/Nm^3, well short of the current 86 mg/Nm^3 liquid fueled capability of commercially available units, as noted on the web sites of the gas turbine OEM's. Despite this fact, ETN strongly requests that this action also be taken for liquid fuel operation as well. This action would create the same incentive for efficient operation as currently exists for natural gas operation, and it would likely reduce the developmental burden required given that the final "kilometer to the goal" is often the most difficult and expensive. We also note that this limit-multiplier would, if applied to combined cycle gas turbines, enable most large combined cycle gas power plants to meet the rule with little modification based on the current state of the art in liquid fuel fired combustion. However, the NO_x limit multiplier currently does not apply to combined cycle gas turbines.

Operation on liquid fuel is important for two major reasons. For large portions of Europe, gas supplies are interruptible (particularly during periods of extended weather extremes or geo-political tension). For these regions, the ability to operate on a liquid backup fuel is crucial. Other areas of Europe simply do not have a natural gas supply, reliable or otherwise. Operation of gas turbines on liquid fuels is very important in these areas.

We would also like to address the suggestion from some quarters that installation of exhaust treatment such as selective non-catalytic reduction (SNCR) or selective catalytic reduction (SCR) is a viable means to meet the proposed NO_x regulation. We first note that in the case of SNCR that this technical approach is primarily suited to boiler applications and is not suited to gas turbine exhausts because of low operating temperatures in the gas turbine exhaust duct and the low NO_X concentrations found there. According to the USEPA *[EPA-452/F03-031]*, SNCR is "Not applicable to sources with low NO_X concentrations such as gas turbines".

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Regarding SCR, we also have significant concerns regarding both the physics of the method and undesirable economic consequences. For flexibly operated plants, the emission of unreacted ammonia slip creates an additional environmental impact – the extent of which will depend on a number of highly specific technical and location issues. Additionally, in some combined cycle applications, ammonia slip can also result in the fouling of heat transfer surfaces which in turn reduces plant efficiency (through added gas turbine back pressure and reduced heat exchange), damage plant hardware through corrosion, and perhaps even generate particulate emissions from the stack.

Secondly, the added back pressure of SCR on the gas turbine will reduce the output and efficiency of the plant and thus also increase specific emission of CO_2. This is true even of a new and clean HRSG gas path, and worsens through the operating cycle.

Finally, the cost of SCR very significantly increases plant capital cost. With ammonia reagent consumption and balance of plant impacts, SCR will also increase the operating costs for the asset. Increasing both CAPEX and OPEX will significantly drive up the Levelised Cost of Electricity (LCoE) at a time where European gas turbine fleets are struggling to be economic with plant closures and mothballing becoming definite possibilities. Therefore the need to apply SCR compromises electricity generation diversity and ongoing security of supply.

Given these three factors we do not consider SCR to represent BAT for any Gas Turbine plant and specifically for those with dual fuel capability.

In conclusion, ETN requests that this rule be held in abeyance for a period of ten years for gas turbines operating on liquid fuels to allow manufacturers the time to complete the critical research and development needed. We also request that the limit multiplier be applied to liquid fueled operation as well as for natural gas operation.

On behalf of ETN

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