International Association of Oil & Gas Producers

Brussels, 9 June 2014

OGP's contribution to the review of Best Available Techniques Reference Document (BREF) for Large Combustion Plants (LCP)

Executive Summary

The International Association of Oil and Gas Producers (OGP) recognises the good work carried out by the European IPPC Bureau to review the LCP BREF and its efforts in handling information provided by the Technical Working Group members. It is critical that the key differences between offshore operations and conventional industries are well understood. Specifically, these are related to:

- Space and weight limitations;
- Physical location of facilities many kilometres from shore;
- Isolated from grid supply (power) so need to be self-sufficient and reliable, hence spinning reserve and dual fuel turbines;
- Use of self-produced fuel gas which is of inherently variable quality;
- Significant production profile changes over life-of-field i.e. will impact loading;
- Logistics and access for materials and personnel – much more complicated.

Bearing the above in mind, the main areas of OGP concerns with the draft BREF centre around:

i. Need for flexibility to use any of the established methodologies for stack emissions reporting i.e. manual testing, PEMS or CEMS.
ii. Most post combustion treatment techniques are less applicable to an offshore environment given space, weight and logistical constraints.
iii. LoNOx burners, particularly as retrofits but also for new build, need consideration of various factors before being deemed fully applicable for offshore facilities: single or dual fuel operation, fuel gas variability, space and weight as well as turbine loading.
iv. Impact of gas turbine loading on NOx and CO emission levels, particularly relevant below 70% loading.
v. Variability of performance over life-of-field with significant changes in the production profile.

Introductory remarks

OGP believes that to assess and respond to comments provided to the first draft (D1), additional information is needed on a number of sectors, including our own. For instance, there is a need for further exchange of views on the offshore industry gas turbines. It should be noted that there is a significant number (> 270) of turbines larger than 50 MW_{th} input operating on offshore platforms of the petroleum and natural gas producing companies across the European Union and Norway. Therefore, it is essential that the chapter 7.4 and the BAT conclusions (both general and specific) to be put forward in the background paper are coherent and the final BAT conclusions are appropriate for the existing offshore installations as well as for the new ones.

1. Monitoring/Measurement of emissions (PEMS/CEMS)

The monitoring of emissions from offshore platforms is not explicitly discussed in the BREF (D1) as a separate item. Predictive emissions monitoring (PEMS) and continuous emission monitoring system (CEMS) are described in section 7.4.1.2, but the specific benefits of a predictive approach are not outlined.

Manual stack sampling is a valid and accurate technique – proven across multiple industries over many years. Extensive work has been carried out in the UK that has demonstrated repeatability and accuracy of the methodology when clear guidance is followed.[1]

For **existing** offshore facilities, PEMS, CEMS and manual sampling should all be considered as viable options based on the uniqueness of offshore operations:

- Location of the offshore facilities in relation to sensitive receptors (many kilometres away),
- Access to equipment / port can be difficult e.g. lack of work platforms, access ladders,
- Logistics (to get to and from facility for maintenance, calibration, repairs),
- Safety considerations (working at heights, working overboard),
- Calibration requirements for CEMS are very significant (with the need for competency of staff, housing of calibration gases an issue Offshore i.e. not easy to just bring specialists in).

PEMS has significant advantages over CEMS in a number of areas for an equivalent accuracy. These include lower cost, no hardware requirements, resilient to failure and little or no maintenance and calibration requirements.

For new facilities, both PEMS and CEMS should be considered and no single methodology should be mandated because of the significantly design variability between different assets.

2. Available technologies

a) General remarks

Section 7.4.1.2 presents several options for reducing NOx emissions from Gas Turbines and in Section 7.4.4.3 these are presented as techniques generally considered as BAT for offshore turbines without addressing the applicability constraints. What is written in section 7.4.4.3 needs to underpin the BAT conclusions drawn in 10.4.3.

[1] Offshore PPC (Combustion Plant) Emissions Monitoring Guide, DECC, UK. Source: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/128711/offshore_monitoring_guidance_sept09.pdf

There are several techniques for deNOx available for onshore gas turbines and these are well known:

- Diluent injection (steam or water)
- Selective Catalytic Reduction (SCR)
- Low NOx Burner design.

There are specific reasons why some of these established post combustion techniques are less suitable for offshore applications:

a) **Selective Non-Catalytic Reduction (SNCR)** is not suitable for treating gas turbines exhaust because the temperature and residence time windows are not favourable to the reaction. [BREF D1 section **3.3.3.3.12].** The reference to the NOxRED-GT in section 7.4.1.3 seems to be a proprietary SNCR technique developed for the onshore use of General Electric SAC Series of gas turbines. As such, it is not relevant to the offshore sector and should be deleted from the text and also as a technique in Table 7.29.

b) **Diluent injection** is described as a technique in 7.4.1.2 – this is also described in 3.3.3.3.10 and in 3.3.3.4 for the particular case of the Cheng Steam Cycle. Offshore, these techniques need high grade water and (as indicated in 3.3.3.4) a desalination plant would be needed to supply sufficient water of acceptable quality to avoid corrosion and fouling problems. Section 3.3.3.3.10 also points out the problems of reliability using diluent injection and the overall superiority of burner modifications for NOx reduction. On this basis diluent injection is to be considered generally not applicable to offshore turbines and Table 7.29 should be amended replacing "Generally Applicable for New plants" to "May be applicable in certain cases depending on availability of boiler grade water and heat" and amending the text for existing plants to "Not Applicable". The Cheng Steam cycle is not seen as a separate reduction technique. Any specific advantages it would have viz-a-viz power to weight ratio would be a consideration in the choice of new equipment. Therefore, it should be removed as a separate technique.

c) **Selective Catalytic Reduction** requires the addition of a reactor between the turbine and the exhaust. Its operation requires a supply of anhydrous ammonia. On existing platforms the space requirements to engineer a reaction section of sufficient size to achieve meaningful reductions in NOx are not going to be met. The optimisation of design for space and weight, which is carried out in designing a platform, eliminates the possibility to add such structure. The addition of a necessary inventory of anhydrous ammonia, a toxic and flammable gas, is a serious safety concern on a platform where evacuation is a serious undertaking. Alternatives to anhydrous ammonia like aqueous ammonia or urea could be considered, but these alternatives will require more equipment and more material needs to be stored and handled. The extra weight and space requirements related to aqueous ammonia and urea will also be challenging offshore. In Table 7.29 therefore, the correct applicability is given (not applicable) for existing installations. For new installations, it would have to be established that the SCR system could be safely incorporated into the platform design and that accidental risks from NH_3 releases from storage and handling managed. The applicability should be changed to "Applicable in certain cases subject to assurance of safe design and operation".

Table 7.29 includes an entry "lean burn concept". This is not fully appropriate, therefore for the aforementioned reasons, OGP recommends including in a general category "Low NOx Burners" covering the DLN and DLE designs.

b) Low NOx Burners

The use of LoNox burners as either a retrofit or as an alternative to standard combustors is a proven and well-established technology. That said, there are specific issues related to the use of such technology that are particularly relevant for the offshore industry.

Offshore turbines used for power generation are generally and should be dual fuelled so that they can function on liquid fuel and maintain the platform in the case of an interruption in gas supply. As described in the BREF section 3.3.3.3.7 the performance of low NOx burners is optimum on gas fuelled turbines because establishing stable and low temperature premixed combustion with liquid fuel injection is significantly more difficult to design.

BREF 6.1.5.3 refers to the NOx reduction benefit being apparent only at full load. Offshore gas turbines will typically operate below 70%, especially on power turbines. There may be minimal emission difference between a low NOx turbine and its traditional variant at low load (where majority of Offshore Gas Turbines might be operating for majority of life). This aspect of performance needs to be addressed in the applicability comments.

Gas turbine manufacturers offer refurbishment packages for many of their turbines, which typically involve the replacement of the internals of the gas turbine and often significant engineering to the “skid” on which the engine is mounted to allow clearance for new fuel line staging. Offshore, space and weight are often very constrained and therefore retrofit is not always a practical option.

Low NOx turbines can also be highly sensitive to variations in the fuel quality. Offshore turbines are principally fired on self-produced gas, the fuel composition of which can be variable. The main concern is to avoid acoustic disturbances due to feedback in the combustion chamber caused by variations in flame speed (can lead to resonance and damage to the turbine). Assessing the suitability of specific turbines for retrofit has to take the likelihood of fuel quality variation into account.

The applicability of Low NOx burners in new turbines (i.e. complete replacement of a turbine) may be limited by operational constraints on the expected loading, fuel operation (dual fuel or single fuel), and consistency of the fuel gas.

Reliability of combustion plant is critical in an Offshore environment, where access to technical support, vendors etc. will incur an immediate delay due to logistics of travel. In that sense reliability (i.e. use of proven, less complex technology) can carry a greater weighting over absolute environmental performance.

For existing installations the applicability must be judged by several criteria other than the availability of a retrofit package. OGP proposes: Applicability should be judged on a case-by-case basis taking account of: the requirement for dual fuel service, the availability of a retrofit package, the engineering possibility of refitting the modified turbine, the potential of the turbine to perform as a low NOx emitter under its required duty schedule, the robustness of the retrofit under fluctuating fuel conditions.

OGP therefore supports the entry in Table 7.29 that “Low NOx Burners” for new installations should be generally applicable. An AEL range is only relevant where it is certain that a retrofit can be installed and will function and therefore the BAT conclusion must be framed to those cases.

3. Limits for existing and new plants

Offshore plants need specific considerations based on their unique operating conditions and limitations – e.g. offshore machines need, often, to be dual fuel to ensure power supply and will often run at low loads, where NOx emissions can rise.

The current data used in order to populate the tables (gathered from Questionnaire collection phase) do not seem to reflect real operational experience. For instance, it should be underlined that plants in fig. 7.29 with codes number 330-331-332-333 have NOx and CO concentrations which are very low and so not representative of the category and not comparable with the ranges reported in table 10.37.

Existing plants: the current range for ELVs do not reflect current operating experience. It needs to be made clear that the limits as shown can only apply above 70% loading. Since DLN on duel fuel is not fully proven for offshore there needs to be a condition that the range as shown (all table 10.37) only apply on single fuel GTs and > 70% loading. [2]

New Plants: Current limits for new gas turbines do not reflect existing operating experience – especially in the offshore industry. It is suggested to change the NOx upper limit of the daily and yearly range (table 10.37). Some of the most efficient gas turbine assures 25 ppm NOx, and BAT should be in accordance with the limit that all vendors guarantee. DLE Gas Turbines are not proven for dual fuel turbines or where there is a large variation in fuel gas composition. Recommend changing the limit for CO from "<50" to "< 75" mg/Nm3 and add the following footnote to relevant table as per the Directive: *Limits only apply when loading is greater than 70%.*

4. Economic Impact

OGP agrees with the conclusion of 3.3.3.3.7 which states that for new gas turbines the cost of a Low NOx unit compared to a conventional burner design is not substantial. The retrofit costs of a DLN burner to an existing turbine are significant. The operational costs of installing equipment and maintaining equipment offshore are at least an order of magnitude higher than onshore and logistically difficult. The capital cost of a low NOx retrofit based on equipment can be in the range of €10 to €20 million euro per turbine, depending on the specific unit. If however engineering work is needed on the platform the ancillary work costs can increase substantially. For instance, Danish offshore gas turbines are not equipped with DLN - the costs of establishing DLN for existing gas turbines on the Danish offshore installations (establishing DLN ensuring NOx emission concentrations of 50 mg/Nm3) has by Oil Gas Denmark been estimated to between €6 and €27 million per turbine, excluding costs of accommodation rigs, structural reconstructions and production losses.

[2] Please see figures and observations in Appendix.

About OGP: *Our membership spans the globe and accounts for more than half of the world's oil output and about one third of global gas production. From our London office, we foster cooperation in the area of health, safety and the environment, operations and engineering, and represent the industry before international organisations, such as the UN, IMO and the World Bank, as well as regional seas conventions, such as OSPAR, where we have observer status. OGP Europe in Brussels represents OGP members who are active in Europe at EU level.*

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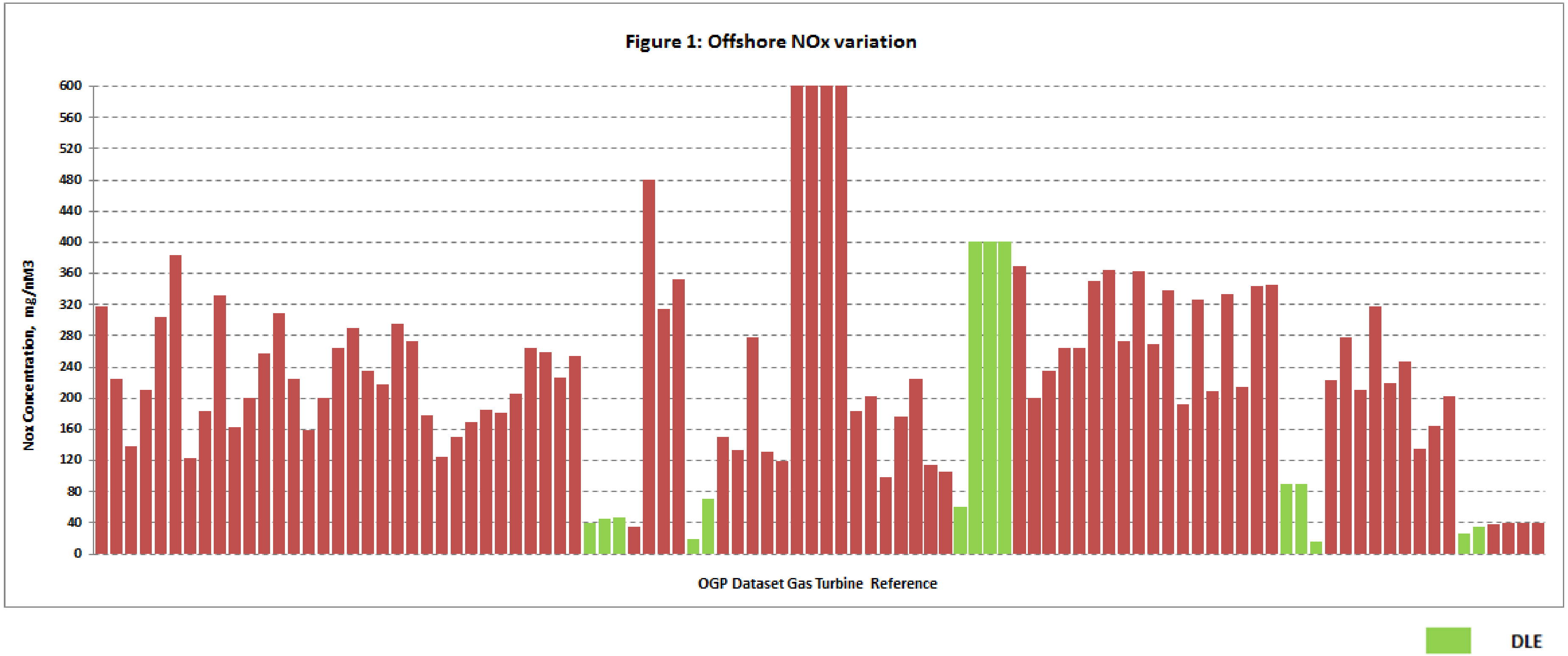
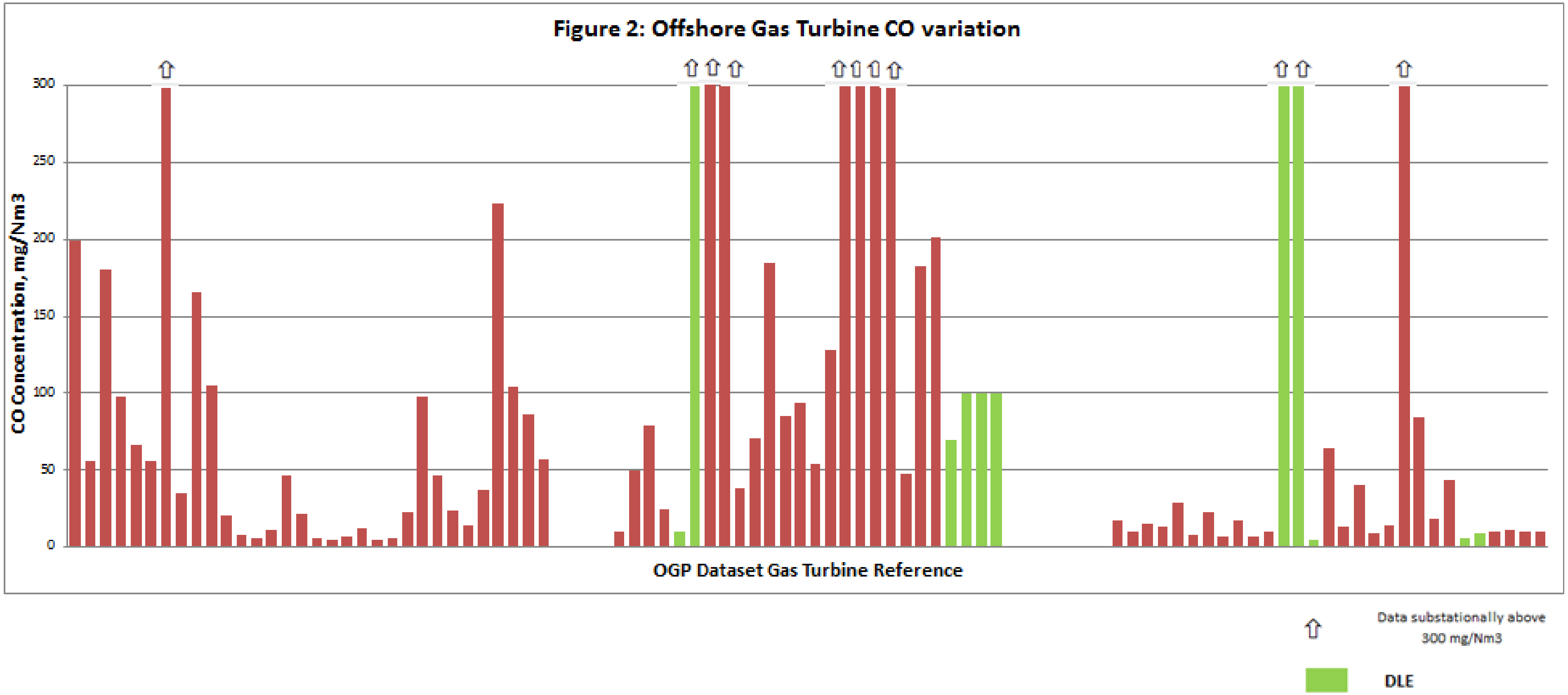
Appendix



From the OGP dataset provided, consisting of 98 Gas Turbines, the following conclusions can be drawn:

- Only 14 (15%) of these Gas Turbines are DLE
- Vast majority, 79 (80%), are dual fuel (gas and diesel)
- Majority, 71 (72%), are on Power duty (as opposed to Compression)
- Majority of Gas Turbines at low / Medium loading, especially for power duties
- Loading a significant issue with regards NOx concentration i.e. much higher at lower loads



From the OGP dataset provided, consisting of 98 Gas Turbines, the following conclusions can be drawn:

- Very significant variation in CO performance across the dataset (several tested gas turbines > 1,000 mg/Nm3)
- Orders of magnitude rise in CO concentrations at partial (low) loads

Note: Some of the dataset as provided did not include CO data, so shown as blank columns to ensure consistency of full turbine dataset