

Inspection Division
N/REF: Bey/15.468
Project Ref.: PI15.088a

Onyx Energy
To the attention of Mr. Abbas Kassem

Subject: Ferox Fuel additive pilot test on EDZ generators.

Dear Sir,

Upon the request of Onyx Energy Lebanon, Apave Liban performed stack emissions analysis on generators exhausts, as part of the pilot test done in order to check the performances of Ferox fuel additive at the new EDZ power plant.

The test was performed on diesel electrical generators owned by Aggreko, at the newly implemented EDZ power plant in Zahlé. Three similar generators were considered during the test: two new generators (with less than 1,000 running hours) and one old generator (with about 13,000 running hours).

All three generators are of the same model: Cummins QSK50G4 with a rated capacity of 1,030 kW (continuous). The generators are running on diesel (green fuel).

An initial measurement was performed on the three generators before adding the fuel additive to the old generator (referred to as the pilot generator). Then a final measurement was performed after having the pilot generator running for **500 hours** on Ferox.

All three generators are located in the same location, connected to the same electrical grid (with load sharing), subject to the same maintenance works and supplied with the same type of fuel (except for the pilot generator where Ferox is added); thus their working conditions are similar.

Below are the container references for the concerned generators:

- Pilot Generator (old genset with fuel additive): XBNT041
- Generator 2 (new genset without fuel additive): 151150-0
- Generator 3 (new genset without fuel additive): 292150-0



generator, compared to other similar generators in the plant. However, these readings were not witnessed or approved by Apave Liban.

Finally, it is to be noted that no damage or dysfunction was reported on the pilot generator during the test.

This letter was given at the request of Onyx Energy Lebanon. However, Apave Liban does not guarantee any performances on other installations, nor relief Onyx Energy from its liability for any future damages on treated engines.

Best Regards,

Marc Daoud

apave s.a.r.l.
Liban Marc

To be noted also that no emissions treatment systems are installed on the exhausts of the generators.

For each measurement done, the electrical load was stabilized (with a +/- 30kW fluctuation) for a minimum of 30min before taking the reading. The flue gas analysis was performed with a portable combustion analyzer type Kane 900 plus; latest date of calibration 19/12/2014. The same measurement point was considered for all 3 generators.

Below are the results for both tests done. CO, NO, NOx and SO₂ readings are reported as measured values (first value) and normalized values at 5% O₂ (second value).

	Initial Measurement (baseline)			Final Measurement		
Date	11/05/2015			13/08/2015		
Outdoor Temperature	22°C			33°C		
Generator	Pilot Generator	Generator 1	Generator 2	Pilot Generator	Generator 1	Generator 2
Load (kW)	860	900	850	860	885	870
Flue Temperature (°C)	482	452	459	492	483	491
O ₂ (%)	11.6	12.1	12.1	12.0	11.8	11.7
CO ₂ (%)	6.9	6.5	6.5	6.6	6.8	6.8
CO (mg/m ³)	357/610	362/657	358/650	486/869	466/814	476/824
NO (mg/m ³)	541/924	495/887	446/791	517/923	522/911	511/883
NOx (mg/m ³)	582/994	523/955	471/850	556/993	561/980	550/950
SO ₂ (mg/m ³)	0/0	0/0	0/0	0/0	0/0	0/0

The increase in CO and NO values between the two tests is due to the increase in the outdoor temperature. However, **a reduction in NO values can be seen on the pilot generator**, when compared to the new generators which are now at the same levels.

It was also noticed that the amount of black smoke emitted at engine startup has reduced after the use of Ferox on the pilot generator.

In addition to the stack emissions monitoring, fuel consumption measurements were also performed during the pilot test by EDZ. We were informed that these measurements show an average reduction of 15% in fuel consumption on the pilot