

## Stack Emission

### Test Report No.:

**R-343-H-4-26-0220t**

Plant: **Noble Energy Mediterranean Ltd.**

Location: **Aba Even 12 Street, Herzliya-Pituach, 46725. Israel.**  
**"LEVIATHAN" Sea Platform Site.**

Person on Charge: **Gali Miron**

Stack ID: **Heater-4**    **Stack (H-4).**

Stack ID No.:

Test No.: **343-H-4-26**

Test Format: **Technology Test**

Test Date: **14/02/2020**

Report Printing Date: **16/02/2020**

Testers Team: **Michael Melnichenko**

**Yevgeny Tieliehin**

Report was Written by: **Nadezhda Grinberg**

Report was Checked by: **Alexey Ratner**



## **Test Procedure.**

**Plant:** Noble Energy Mediterranean Ltd.

**City:** "LEVIATHAN" Sea Platform Site.

**Sampling Date:** 14/02/2020

**Stack Location:** Heater-4

**Hazard Tested:**

| Hazard               | Sampling<br>Method | Analytical<br>Method | Analytical<br>Lab | Remarks |
|----------------------|--------------------|----------------------|-------------------|---------|
| <b>TOC as Carbon</b> | EPA-25a            | FID                  | Ecolab            |         |
| <b>Burnt Gases</b>   | EPA-3a             | Analyser             | Ecolab            |         |
| <b>Gas Flowrate</b>  | EPA-1, 2, 4        | -----                | Ecolab            |         |

**Sampling Site:**

- Two Sampling Ports (4", 90 degrees).
- About 2 Dst DownStream up to the Last Turbulence.
- More than 2 Dst UpStream up to the Next Turbulence.

**SamplingTrain:**

- TOC Analyser (FID, EPA-25a Flexible Configuration).
- Sampling Probe: Teflon, Flexible, Heated.

**Test No.:** **343-H-4-26**      **Technology**

**FUEL:**

**Filter No.:** **N.R.**

**Stack Diameter:** **73** cm      Measured

**Stack Cross Area:** **0.418** m<sup>2</sup>      =      **4.50** ft<sup>2</sup>      Calculated

**Nipple "A" Length:** **17** cm      Measured

**Nipple "A" Length:** **17** cm      Measured

## **STACK GAS VELOCITY PROFILE (according to EPA Methods 1 and 2).**

| Traverse Point<br>No.    | Fraction of Stack ID<br>%/100 | Traverse Point Location<br>cm | InStack Temperature<br>oC | Delta Pi (calculated)<br>mm H2O | Delta Pi (measured)<br>in. H2O | Square Root of Delta Pi<br>(in. H2O) <sup>1/2</sup> | Instack Static Pressure<br>mm H2O |
|--------------------------|-------------------------------|-------------------------------|---------------------------|---------------------------------|--------------------------------|-----------------------------------------------------|-----------------------------------|
| <b>Sampling Port "A"</b> |                               |                               |                           |                                 |                                |                                                     |                                   |
| 1                        | 0.979 *                       | <b>87.5</b>                   | 147                       | 22.86                           | 0.90                           | 0.949                                               |                                   |
| 2                        | 0.933                         | <b>85.1</b>                   | 149                       | 22.10                           | 0.87                           | 0.933                                               |                                   |
| 3                        | 0.882                         | <b>81.4</b>                   | 150                       | 25.40                           | 1.00                           | 1.000                                               |                                   |
| 4                        | 0.823                         | <b>77.1</b>                   | 150                       | 27.94                           | 1.10                           | 1.049                                               |                                   |
| 5                        | 0.750                         | <b>71.8</b>                   | 150                       | 25.40                           | 1.00                           | 1.000                                               |                                   |
| 6                        | 0.644                         | <b>64.0</b>                   | 150                       | 30.48                           | 1.20                           | 1.095                                               | 98                                |
| 7                        | 0.356                         | <b>43.0</b>                   | 150                       | 25.40                           | 1.00                           | 1.000                                               |                                   |
| 8                        | 0.250                         | <b>35.3</b>                   | 150                       | 23.88                           | 0.94                           | 0.970                                               |                                   |
| 9                        | 0.177                         | <b>29.9</b>                   | 150                       | 21.84                           | 0.86                           | 0.927                                               |                                   |
| 10                       | 0.118                         | <b>25.6</b>                   | 150                       | 23.62                           | 0.93                           | 0.964                                               |                                   |
| 11                       | 0.067                         | <b>21.9</b>                   | 149                       | 25.40                           | 1.00                           | 1.000                                               |                                   |
| 12                       | 0.021 *                       | <b>19.5</b>                   | 149                       | 30.48                           | 1.20                           | 1.095                                               |                                   |
| <b>Sampling Port "B"</b> |                               |                               |                           |                                 |                                |                                                     |                                   |
| 13                       | 0.979 *                       | <b>87.5</b>                   | 148                       | 25.15                           | 0.99                           | 0.995                                               |                                   |
| 14                       | 0.933                         | <b>85.1</b>                   | 149                       | 20.07                           | 0.79                           | 0.889                                               |                                   |
| 15                       | 0.882                         | <b>81.4</b>                   | 150                       | 21.34                           | 0.84                           | 0.917                                               |                                   |
| 16                       | 0.823                         | <b>77.1</b>                   | 150                       | 25.40                           | 1.00                           | 1.000                                               |                                   |
| 17                       | 0.750                         | <b>71.8</b>                   | 150                       | 30.48                           | 1.20                           | 1.095                                               |                                   |
| 18                       | 0.644                         | <b>64.0</b>                   | 150                       | 25.40                           | 1.00                           | 1.000                                               | 101                               |
| 19                       | 0.356                         | <b>43.0</b>                   | 150                       | 33.02                           | 1.30                           | 1.140                                               |                                   |
| 20                       | 0.250                         | <b>35.3</b>                   | 150                       | 27.94                           | 1.10                           | 1.049                                               |                                   |
| 21                       | 0.177                         | <b>29.9</b>                   | 150                       | 24.38                           | 0.96                           | 0.980                                               |                                   |
| 22                       | 0.118                         | <b>25.6</b>                   | 150                       | 23.37                           | 0.92                           | 0.959                                               |                                   |
| 23                       | 0.067                         | <b>21.9</b>                   | 150                       | 21.84                           | 0.86                           | 0.927                                               |                                   |
| 24                       | 0.021 *                       | <b>19.5</b>                   | 149                       | 25.40                           | 1.00                           | 1.000                                               |                                   |
| <b>Average</b>           | <b>-----</b>                  | <b>-----</b>                  | <b>149.6</b>              | <b>25.36</b>                    | <b>0.998</b>                   | <b>0.997</b>                                        | <b>99.5</b>                       |

**Remarks:**

1. Traverse Points Locations were Measured from the Nipples Ends.
2. Instack Static Pressure was Measured in 2 Traverse Points.
3. Traverse Points No. 1, 12, 13 and 24 Locations were moved to 1" Distances from the Stack Walls, according to EPA-1 Method Requirements.

# Combustion Gases Measurements Data Analyser (EPA-3 Method).

Test Time: **09:05**

| Time                         | O2<br>Conc-n | CO2<br>Conc-n |
|------------------------------|--------------|---------------|
| HH:mm                        | % v          | % v           |
| 09:05                        | 4.73         | 10.44         |
| <b>Average</b>               | <b>4.73</b>  | <b>10.44</b>  |
| 0 oC -                       |              |               |
| NORM. TO <b>3</b> % Oxygen   |              |               |
| <b>EMISSION RATE, g/Hour</b> |              |               |

Real Stack Gas Dry Molecular Weight, Calculated, According to EPA Method 3a:

|                |   |                     |
|----------------|---|---------------------|
| <b>Md real</b> | = | <b>29.86</b> g/Mole |
|----------------|---|---------------------|

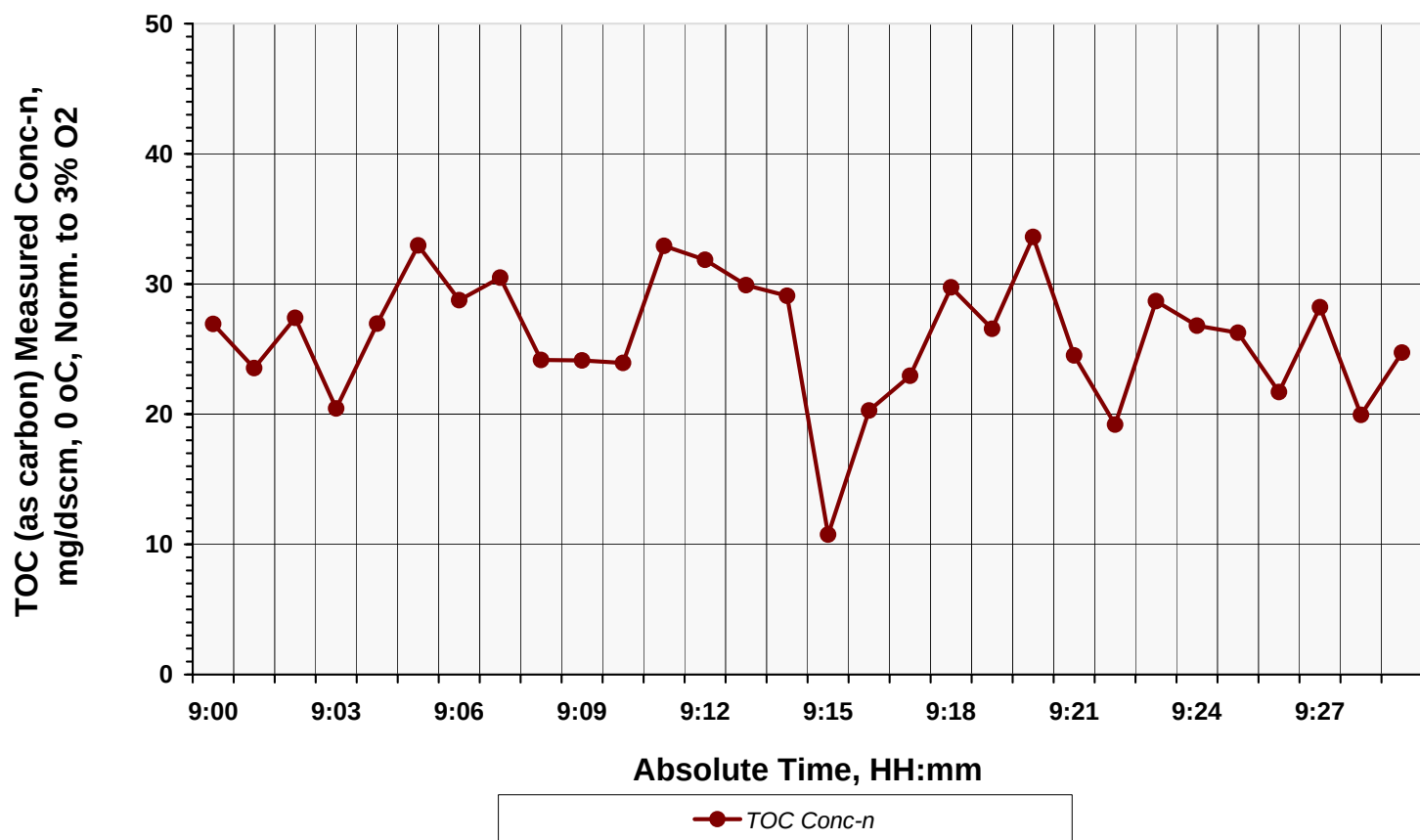
## **TOC (Total Organic Carbon) Determination.**

### **according to EPA Method No. 25a.**

| Meaure-<br>ment | Time         | FID<br>Reading<br>as<br>Propane | TOC<br>Conc-n<br>(calculated,<br>as<br>Carbon) | TOC<br>Conc-n<br>(calculated,<br>as Carbon,<br>St-d Cond-s,<br>0 oC) | TOC<br>Conc-n<br>(calculated,<br>as Carbon,<br>St-d Cond-s,<br>0 oC, Norm.<br>to 3 % O2) | TOC<br>Emission<br>Rate<br>(as Carbon) | Remarks |
|-----------------|--------------|---------------------------------|------------------------------------------------|----------------------------------------------------------------------|------------------------------------------------------------------------------------------|----------------------------------------|---------|
| No.             | HH:mm        | ppm                             | ppm                                            | mg/dscm                                                              | mg/dscm                                                                                  | g/Hour                                 |         |
| 1               | 9:00         | 12.87                           | 38.60                                          | 24.3                                                                 | 26.9                                                                                     | 419.7                                  |         |
| 2               | 9:01         | 11.25                           | 33.74                                          | 21.3                                                                 | 23.5                                                                                     | 366.9                                  |         |
| 3               | 9:02         | 13.09                           | 39.26                                          | 24.7                                                                 | 27.4                                                                                     | 426.9                                  |         |
| 4               | 9:03         | 9.77                            | 29.30                                          | 18.5                                                                 | 20.4                                                                                     | 318.6                                  |         |
| 5               | 9:04         | 12.88                           | 38.63                                          | 24.3                                                                 | 27.0                                                                                     | 420.0                                  |         |
| 6               | 9:05         | 15.75                           | 47.24                                          | 29.8                                                                 | 33.0                                                                                     | 513.7                                  |         |
| 7               | 9:06         | 13.74                           | 41.21                                          | 26.0                                                                 | 28.8                                                                                     | 448.1                                  |         |
| 8               | 9:07         | 14.57                           | 43.70                                          | 27.5                                                                 | 30.5                                                                                     | 475.2                                  |         |
| 9               | 9:08         | 11.54                           | 34.62                                          | 21.8                                                                 | 24.2                                                                                     | 376.5                                  |         |
| 10              | 9:09         | 11.53                           | 34.58                                          | 21.8                                                                 | 24.1                                                                                     | 376.0                                  |         |
| 11              | 9:10         | 11.44                           | 34.31                                          | 21.6                                                                 | 23.9                                                                                     | 373.1                                  |         |
| 12              | 9:11         | 15.73                           | 47.19                                          | 29.7                                                                 | 32.9                                                                                     | 513.2                                  |         |
| 13              | 9:12         | 15.22                           | 45.66                                          | 28.8                                                                 | 31.9                                                                                     | 496.5                                  |         |
| 14              | 9:13         | 14.29                           | 42.87                                          | 27.0                                                                 | 29.9                                                                                     | 466.2                                  |         |
| 15              | 9:14         | 13.90                           | 41.69                                          | 26.3                                                                 | 29.1                                                                                     | 453.3                                  |         |
| 16              | 9:15         | 5.14                            | 15.41                                          | 9.7                                                                  | 10.8                                                                                     | 167.5                                  |         |
| 17              | 9:16         | 9.69                            | 29.06                                          | 18.3                                                                 | 20.3                                                                                     | 316.0                                  |         |
| 18              | 9:17         | 10.96                           | 32.88                                          | 20.7                                                                 | 22.9                                                                                     | 357.6                                  |         |
| 19              | 9:18         | 14.21                           | 42.62                                          | 26.9                                                                 | 29.7                                                                                     | 463.4                                  |         |
| 20              | 9:19         | 12.69                           | 38.06                                          | 24.0                                                                 | 26.6                                                                                     | 413.8                                  |         |
| 21              | 9:20         | 16.06                           | 48.17                                          | 30.4                                                                 | 33.6                                                                                     | 523.8                                  |         |
| 22              | 9:21         | 11.71                           | 35.13                                          | 22.1                                                                 | 24.5                                                                                     | 382.0                                  |         |
| 23              | 9:22         | 9.17                            | 27.51                                          | 17.3                                                                 | 19.2                                                                                     | 299.2                                  |         |
| 24              | 9:23         | 13.70                           | 41.10                                          | 25.9                                                                 | 28.7                                                                                     | 447.0                                  |         |
| 25              | 9:24         | 12.80                           | 38.40                                          | 24.2                                                                 | 26.8                                                                                     | 417.6                                  |         |
| 26              | 9:25         | 12.54                           | 37.62                                          | 23.7                                                                 | 26.3                                                                                     | 409.1                                  |         |
| 27              | 9:26         | 10.37                           | 31.10                                          | 19.6                                                                 | 21.7                                                                                     | 338.2                                  |         |
| 28              | 9:27         | 13.48                           | 40.44                                          | 25.5                                                                 | 28.2                                                                                     | 439.8                                  |         |
| 29              | 9:28         | 9.53                            | 28.58                                          | 18.0                                                                 | 19.9                                                                                     | 310.8                                  |         |
| 30              | 9:29         | 11.81                           | 35.44                                          | 22.3                                                                 | 24.7                                                                                     | 385.4                                  |         |
| <b>Average</b>  | <b>-----</b> | <b>12.38</b>                    | <b>37.13</b>                                   | <b>23.40</b>                                                         | <b>25.91</b>                                                                             | <b>403.83</b>                          |         |

- Remarks:**
1. The Concentrations were Calculated at Standard Conditions (Dry Gas, 0 oC, Atmospheric Pressure) and Normalized to 3% O2.
  2. Analytical Method: TOC FID Analyser.  
Flame Ionization Detector (FID) was Calibrated before the Test with 3 Propane Calibration Gases (EPA Protocol Quality)
  3. Measuring Time: **09:00-09:29**

**Noble Energy - Leviathan Sea Platform. Heater-4 Stack.  
Technology Test .14/02/2019. Set-1. TOC as Carbon.**



## **CALCULATIONS.**

|                                           |                        |                     |            |
|-------------------------------------------|------------------------|---------------------|------------|
| Barometric Pressure (Pbar):.....          | <b>758</b> mm Hg =     | <b>29.84</b> in. Hg | Measured   |
| InStack Static Pressure (Pg):.....        | <b>7.32</b> mm Hg =    | <b>0.288</b> in. Hg | Measured   |
| InStack Absolute Pressure (Pso):.....     | <b>765.3</b> mm Hg =   | <b>30.13</b> in. Hg | Calculated |
| InStack Gas Temperature (Tso):.....       | <b>149.6</b> o C =     | <b>761</b> o R      | Calculated |
| Dry Gas Molecular Weight (Md):.....       | <b>29.86</b> g/Mole    |                     | Measured   |
| Water Content in the Gas Stream:.....     | <b>0.15</b> Mole Parts |                     | Assumed    |
| Wet Gas Molecular Weight :.....           | <b>28.08</b> g/Mole    |                     | Calculated |
| Pito't Tube Calibration Factor (Cp):..... | <b>0.84</b> Calibrated | at 18/11/19         | Calibrated |

## **Stack Gas Velocity and Flowrate**

|                                                    |                       |            |
|----------------------------------------------------|-----------------------|------------|
| <b>Stack Gas Velocity (Vso):.....</b>              | <b>20.70</b> m/sec    | Calculated |
| <b>Stack Gas Flowrate (Stack Cond., Qao):.....</b> | <b>31,168</b> acm/Hr  | Calculated |
| <b>Stack Gas Flowrate (St-d Cond., Qso):.....</b>  | <b>17,255</b> dscm/Hr | Calculated |

# **TOC Analyser Calibration Data.**

## **TOC Calibration Field Test.**

$$\text{Calibration Error (\%)} = ((CR - CTC) / CTC) * 100\%$$

| Calibration Gas     | Certified TOC Conc-n (CTC)<br>ppm | Analyser Reading (CR)<br>ppm | Adjusted to<br>ppm | Calibration Error<br>% | Max. Allowed Error<br>% of CTC | Status | Average Response Time<br>sec | Remarks |
|---------------------|-----------------------------------|------------------------------|--------------------|------------------------|--------------------------------|--------|------------------------------|---------|
| Zero                | 0.0                               | 0.05                         | 0.01               | -----                  | -----                          | -----  |                              |         |
| Low-Level (~30%)    | 6.4                               | 6.43                         | -----              | <b>0.31</b>            | + - 5%                         | V      |                              | Diluted |
| Mid-Level (~50%)    | 12.3                              | 12.34                        | -----              | <b>0.08</b>            | + - 5%                         | V      |                              | Diluted |
| High Level (~85%)   | 22.1                              | 22.02                        | 22.10              | -----                  | -----                          | -----  | <b>24</b>                    | Diluted |
| Span Value (~2*ELV) | 25.0                              |                              |                    |                        |                                |        |                              |         |

## **TOC Calibration POST-RUN Test.**

$$\text{Calibration Error (\%)} = ((CR - CTC) / SPAN) * 100\%$$

| Time<br>HH:mm | Calibration Gas | Certified TOC Conc-n (CTC)<br>ppm | Analyser Reading (CR)<br>ppm | Calibration Drift<br>% | Max. Allowed Error<br>% of SPAN | Status | Remarks |
|---------------|-----------------|-----------------------------------|------------------------------|------------------------|---------------------------------|--------|---------|
| 9:35          | Zero            | 0.00                              | -0.04                        | <b>-0.16</b>           | + - 3%                          | V      |         |
| 9:39          | Mid-Level       | 12.33                             | 12.29                        | <b>-0.16</b>           | + - 3%                          | V      |         |

# **Table of Results.**

| Stack ID              | Facilities Connected to the Stack    |                         | Test Methods         |              |           |            |                        | Test Results    |                   |                            |             |                   |                      |                                        |         |               |
|-----------------------|--------------------------------------|-------------------------|----------------------|--------------|-----------|------------|------------------------|-----------------|-------------------|----------------------------|-------------|-------------------|----------------------|----------------------------------------|---------|---------------|
|                       |                                      |                         | Hazard               | Test         | Sampling  | Analytical | Hazard                 | Stack           | Stack             | Stack                      | Oxygen      | Oxygen            | Hazard               | Hazard                                 | Remarks | Hazard        |
|                       | Facility                             | Worked in the Same Time | Tested               | Uncertainty  | Method    | Method     | TA-LUFT Classification | Gas Temperature | Gas Water Content | Gas Flowrate (St-d Cond-s) | Measured    | for Normalization | Conc-n (St-d Cond-s) | Conc-n (St-d Cond-s, Norm-d to Oxygen) |         | Emission Rate |
|                       |                                      |                         |                      | %            |           |            |                        | o C             | % v               | dscm/Hr                    | % v         | % v               | mg/dscm              | mg/dscm                                |         | Kg/Hr         |
| <b>Heater-4 Stack</b> | <b>Heater-4 Test No.: 343-H-4-26</b> | <b>1</b>                | <b>TOC as Carbon</b> | <b>12.70</b> | EPA-25a * | FID *      | <b>OS-III</b>          | <b>149.6</b>    | <b>15</b>         | <b>17,255</b>              | <b>4.73</b> | <b>3.0</b>        | <b>23.40</b>         | <b>25.91</b>                           |         | <b>0.4038</b> |
|                       |                                      |                         |                      |              |           |            |                        |                 | assumed           |                            |             |                   |                      |                                        |         |               |
|                       |                                      |                         |                      |              |           |            |                        |                 |                   |                            |             |                   |                      |                                        |         |               |
|                       |                                      |                         |                      |              |           |            |                        |                 |                   |                            |             |                   |                      |                                        |         |               |
|                       |                                      |                         |                      |              |           |            |                        |                 |                   |                            |             |                   |                      |                                        |         |               |
|                       |                                      |                         |                      |              |           |            |                        |                 |                   |                            |             |                   |                      |                                        |         |               |

**Remarks:** 1. The Concentrations were Calculated at Standard Conditions (Dry Gas, 0 oC, Atmospheric Pressure) and Normalized to 3% O2.  
2. TOC Concentrations were Calculated as Carbon.  
3. "< LOD" = less than the Limit of Determination. "< LOQ" = less than the Limit of Quantification.  
4. "\*" - the Test was Proceeded under ISO-17025 Accreditation.

**\*\*\* END OF THE REPORT \*\*\***