

|                                  |          |                              |              |
|----------------------------------|----------|------------------------------|--------------|
| ENGINE SPEED:                    | 1500     | FUEL:                        | LOW ENERGY   |
| COMPRESSION RATIO:               | 10.3:1   | FUEL SYSTEM:                 | LPG IMPCO    |
| JACKET WATER - MAX. OUTLET (°C): | 99       |                              |              |
| COOLING SYSTEM:                  | JW+OC    | FUEL PRESS. RANGE (KPAg):    | 10.0 - 34.5  |
| IGNITION SYSTEM:                 | CDIS     | THC:FREE INERT RATIO         | 1.9          |
| EXHAUST MANIFOLD:                | WC       | RATED ALTITUDE (m):          | 153          |
| COMBUSTION:                      | STANDARD | AT AIR TO TURBO. TEMP. (°C): | 25           |
|                                  |          | EXHAUST O2 EMISSION LEVEL:   | 2.0 %O2      |
|                                  |          | FUEL LHV (MJ/Nm3):           | 23.3         |
|                                  |          | APPLICATION:                 | 50 Hz GENSET |

| RATING AND EFFICIENCY    |                     | NOTES      | LOAD     | 100%        | 75%         | 50%         |
|--------------------------|---------------------|------------|----------|-------------|-------------|-------------|
| ENGINE POWER             | (WITHOUT FAN)       | (1)        | KW       | 112         | 84          | 56          |
| GENERATOR POWER          | (WITHOUT FAN)       | (2)        | EKW      | 106         | 80          | 53          |
| <b>ENGINE EFFICIENCY</b> | <b>(ISO 3046/1)</b> | <b>(3)</b> | <b>%</b> | <b>30.1</b> | <b>27.7</b> | <b>25.1</b> |
| ENGINE EFFICIENCY        | (NOMINAL)           | (3)        | %        | 30.0        | 27.7        | 25.1        |
| THERMAL EFFICIENCY       | (NOMINAL)           | (4)        | %        | 60.7        | 63.1        | 65.7        |
| TOTAL EFFICIENCY         | (NOMINAL)           | (5)        | %        | 90.7        | 90.8        | 90.8        |

| ENGINE DATA                        |                      |            |                  |              |           |              |
|------------------------------------|----------------------|------------|------------------|--------------|-----------|--------------|
| <b>FUEL CONSUMPTION</b>            | <b>(ISO 3046/1)</b>  | <b>(6)</b> | <b>MJ/bkW-hr</b> | <b>11.98</b> | <b>13</b> | <b>14.34</b> |
| FUEL CONSUMPTION                   | (NOMINAL)            | (6)        | MJ/bkW-hr        | 11.98        | 13        | 14.34        |
| AIR FLOW (0 °C, 101.3 kPa)         |                      | (7)        | Nm3/bkW-hr       | 3.45         | 3.71      | 4.16         |
| AIR FLOW                           |                      | (7)        | kg/bkW-hr        | 4.45         | 4.8       | 5.37         |
| INLET MAN. PRESSURE                |                      | (8)        | KPAa             | 89           | 75        | 61           |
| INLET MAN. TEMPERATURE             | (MEASURED IN PLENUM) | (9)        | °C               | 32           | 31        | 32           |
| TIMING                             |                      | (10)       | °BTDC            | 26           | 26        | 26           |
| EXHAUST STACK TEMPERATURE          |                      | (11)       | °C               | 578          | 550       | 516          |
| EXHAUST GAS FLOW (0 °C, 101.3 kPa) |                      | (12)       | Nm3/bkW-hr       | 3.79         | 4.09      | 4.57         |
| EXHAUST MASS FLOW                  |                      | (12)       | kg/bkW-hr        | 5.04         | 5.43      | 6.07         |

| EMISSIONS DATA                                |  |      |              |      |      |      |
|---|--|------|--------------|------|------|------|
| NOx (as NO2) (corr. 5% O2)                    |  | (13) | mg/Nm3 (dry) | 7613 | 7117 | 6540 |
| CO (corr. 5% O2)                              |  | (14) | mg/Nm3 (dry) | 1788 | 1673 | 1537 |
| THC (corr. 5% O2), molecular weight of 15.84) |  | (14) | mg/Nm3 (dry) | 1022 | 973  | 917  |
| NMHC (corr. 5% O2, molecular weight of 15.84) |  | (14) | mg/Nm3 (dry) | 154  | 146  | 138  |
| EXHAUST O2                                    |  | (15) | % DRY        | 2.0  | 2.0  | 1.9  |
| LAMBDA  |  |      |              | 1.07 | 1.07 | 1.08 |

| HEAT BALANCE DATA                        |  |           |    |     |     |     |
|--|--|-----------|----|-----|-----|-----|
| LHV INPUT                                |  | (16)      | KW | 373 | 303 | 223 |
| HEAT REJECTION TO JACKET (JW)            |  | (17) (21) | KW | 123 | 110 | 89  |
| HEAT REJECTION TO ATMOSPHERE             |  | (18)      | KW | 15  | 12  | 9   |
| HEAT REJECTION TO LUBE OIL (OC)          |  | (19) (21) | KW | 19  | 17  | 14  |
| HEAT REJECTION TO EXHAUST (LHV to 25°C)  |  | (20)      | KW | 104 | 79  | 55  |
| HEAT REJECTION TO EXHAUST (LHV to 120°C) |  | (20)      | KW | 84  | 64  | 43  |

### CONDITIONS AND DEFINITIONS

ENGINE RATING OBTAINED AND PRESENTED IN ACCORDANCE WITH ISO 3046/1 (STD. REF. CONDITIONS OF 25°C, 100 KPA BAROMETRIC PRESSURE, 152 m ALTITUDE). NO OVERLOAD PERMITTED AT RATING SHOWN. CONSULT ALTITUDE CHARTS FOR APPLICATIONS ABOVE MAXIMUM RATED ALTITUDE AND/OR TEMPERATURE.

EMISSION LEVELS ARE BASED ON THE ENGINE OPERATING AT STEADY STATE CONDITIONS. EMISSION TOLERANCES SPECIFIED ARE DEPENDANT UPON FUEL QUALITY. METHANE NUMBER CANNOT VARY MORE THAN ± 3. PUBLISHED PART LOAD DATA MAY REQUIRE ENGINE ADJUSTMENT.

ENGINE RATING IS WITH 1 ENGINE DRIVEN JACKET WATER PUMP.

FOR NOTES INFORMATION CONSULT PAGE THREE.

### FUEL USAGE GUIDE

|                      |      |     |      |      |      |      |      |      |      |      |      |      |
|----------------------|------|-----|------|------|------|------|------|------|------|------|------|------|
| THC:FREE INERT RATIO | <1.0 | 1.0 | 1.1  | 1.2  | 1.3  | 1.4  | 1.5  | 1.6  | 1.7  | 1.8  | 1.9  | >2.0 |
| IGNITION TIMING      | -    | -   | 26   | 26   | 26   | 26   | 26   | 26   | 26   | 26   | 26   | 26   |
| DERATION FACTOR      | 0    | 0   | 0.78 | 0.82 | 0.86 | 0.90 | 0.93 | 0.95 | 0.97 | 0.99 | 1.00 | 1.00 |

### ALTITUDE DERATION FACTORS

|                            |                                   |      |      |      |      |      |      |      |      |      |      |      |      |      |
|----------------------------|-----------------------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| AIR<br>TO<br>TURBO<br>(°C) | 50                                | 0.94 | 0.91 | 0.88 | 0.86 | 0.83 | 0.80 | 0.78 | 0.75 | 0.73 | 0.71 | 0.68 | 0.66 | 0.64 |
|                            | 45                                | 0.95 | 0.93 | 0.90 | 0.87 | 0.84 | 0.82 | 0.79 | 0.77 | 0.74 | 0.72 | 0.69 | 0.67 | 0.65 |
|                            | 40                                | 0.97 | 0.94 | 0.91 | 0.88 | 0.86 | 0.83 | 0.80 | 0.78 | 0.75 | 0.73 | 0.71 | 0.68 | 0.66 |
|                            | 35                                | 0.99 | 0.96 | 0.93 | 0.90 | 0.87 | 0.84 | 0.82 | 0.79 | 0.77 | 0.74 | 0.72 | 0.69 | 0.67 |
|                            | 30                                | 1.00 | 0.97 | 0.94 | 0.91 | 0.88 | 0.86 | 0.83 | 0.80 | 0.78 | 0.75 | 0.73 | 0.71 | 0.68 |
|                            | 25                                | 1.00 | 0.99 | 0.96 | 0.93 | 0.90 | 0.87 | 0.84 | 0.82 | 0.79 | 0.77 | 0.74 | 0.72 | 0.69 |
|                            | 20                                | 1.00 | 1.00 | 0.97 | 0.94 | 0.92 | 0.89 | 0.86 | 0.83 | 0.80 | 0.78 | 0.75 | 0.73 | 0.71 |
|                            | 15                                | 1.00 | 1.00 | 0.99 | 0.96 | 0.93 | 0.90 | 0.87 | 0.85 | 0.82 | 0.79 | 0.77 | 0.74 | 0.72 |
|                            | 10                                | 1.00 | 1.00 | 1.00 | 0.98 | 0.95 | 0.92 | 0.89 | 0.86 | 0.83 | 0.81 | 0.78 | 0.76 | 0.73 |
|                            |                                   | 0    | 250  | 500  | 750  | 1000 | 1250 | 1500 | 1750 | 2000 | 2250 | 2500 | 2750 | 3000 |
|                            | ALTITUDE (METERS ABOVE SEA LEVEL) |      |      |      |      |      |      |      |      |      |      |      |      |      |

### FREE FIELD MECHANICAL & EXHAUST NOISE

| 100% Load Data                      |   |     | dB(A)        |               | (dB)          |               |              |              |              |              |      |  |
|-------------------------------------|---|-----|--------------|---------------|---------------|---------------|--------------|--------------|--------------|--------------|------|--|
| Free Field<br>Mechanical            | DISTANCE FROM<br>THE ENGINE<br>(METERS) | 1   | 92.5         | 74.2          | 78.2          | 77.7          | 87.2         | 88.7         | 86.2         | 81.2         | 78.2 |  |
|                                     |   | 7   | 82.5         | 67.3          | 71.3          | 70.8          | 74.8         | 78.8         | 76.8         | 71.8         | 66.8 |  |
|                                     |   | 15  | 76.5         | 64.3          | 59.3          | 63.8          | 65.3         | 72.3         | 71.8         | 66.3         | 59.3 |  |
| Free Field<br>Exhaust               | DISTANCE FROM<br>THE ENGINE<br>(METERS) | 1.5 | 107.0        | 114.7         | 100.7         | 101.2         | 97.2         | 101.2        | 101.7        | 98.2         | 97.2 |  |
|                                     |   | 7   | 93.6         | 103.8         | 89.3          | 85.3          | 83.3         | 85.8         | 86.8         | 88.3         | 84.3 |  |
|                                     |   | 15  | 87.0         | 86.4          | 77.9          | 78.9          | 77.9         | 79.9         | 80.4         | 81.4         | 77.9 |  |
| <b>Overall SPL</b>                  |   |     | <b>63 Hz</b> | <b>125 Hz</b> | <b>250 Hz</b> | <b>500 Hz</b> | <b>1 kHz</b> | <b>2 kHz</b> | <b>4 kHz</b> | <b>8 kHz</b> |      |  |
| Octave Band Center Frequency (OBCF) |   |     |              |               |               |               |              |              |              |              |      |  |

#### FUEL USAGE GUIDE:

This table shows the derate factor required for a given fuel. Note that deration occurs as the THC:Free Inert ratio decreases.

This Fuel Usage Guide is intended for digester/biogas applications only. Standard rating is based on digester fuel with 130 MN and 1.9:1 THC:Free Inert Ratio.

#### ALTITUDE DERATION FACTORS:

This table shows the deration required for various air inlet temperatures and altitudes. Use this information along with the fuel usage guide chart to help determine actual engine power for your site.

#### ACTUAL ENGINE RATING:

To determine the actual rating of the engine at site conditions, one must consider limitations due to fuel characteristics and air system limitations. The Fuel Usage Guide deration establishes fuel limitations. The Altitude/Temperature and RPC (reference Caterpillar Methane Program) are added together to establish air system limitations.

Determine the actual site power available with the following equation:

$$\text{Spec Sheet Power} * (1 - ((1 - \text{FUG deration}) + (1 - \text{Altitude Deration Factor})))$$

Note: Spec sheet rating is based on digester fuel with 130 MN, 96 RPC and 1.9:1 THC:Free Inert ratio.

#### SOUND DATA:

Data determined by methods similar to ISO Standard DIS-8528-10. Accuracy Grade 3. SPL = Sound Pressure Level.

**NOTES**

- 1 ENGINE RATING IS WITH 1 ENGINE DRIVEN JACKET WATER PUMP. TOLERANCE IS  $\pm 3\%$  OF FULL LOAD.
- 2 GENERATOR POWER DETERMINED WITH AN ASSUMED GENERATOR EFFICIENCY OF 94.9% AND POWER FACTOR OF 0.8 [GENERATOR POWER = ENGINE POWER  $\times$  GENERATOR EFFICIENCY].
- 3 ISO 3046/1 ENGINE EFFICIENCY TOLERANCE IS (+)0, (-)5% OF FULL LOAD % EFFICIENCY VALUE. NOMINAL ENGINE EFFICIENCY TOLERANCE IS  $\pm 5\%$  OF FULL LOAD % EFFICIENCY VALUE.
- 4 THERMAL EFFICIENCY: JACKET HEAT + LUBE OIL HEAT + EXH. HEAT TO 120°C.
- 5 TOTAL EFFICIENCY = ENGINE EFF. + THERMAL EFF. TOLERANCE IS  $\pm 10\%$  OF FULL LOAD DATA.
- 6 ISO 3046/1 FUEL CONSUMPTION TOLERANCE IS (+)5, (-)0% OF FULL LOAD DATA. NOMINAL FUEL CONSUMPTION TOLERANCE IS  $\pm 5\%$  OF FULL LOAD DATA.
- 7 UNDRIED AIR. FLOW TOLERANCE IS  $\pm 5\%$
- 8 INLET MANIFOLD PRESSURE TOLERANCE IS  $\pm 5\%$
- 9 INLET MANIFOLD TEMPERATURE TOLERANCE IS  $\pm 5^{\circ}\text{C}$ .
- 10 TIMING INDICATED IS FOR USE WITH THE MINIMUM FUEL METHANE NUMBER SPECIFIED. CONSULT THE APPROPRIATE FUEL USAGE GUIDE FOR TIMING AT OTHER METHANE NUMBERS.
- 11 EXHAUST STACK TEMPERATURE TOLERANCE IS (+)35°C, (-)30°C.
- 12 WET EXHAUST. FLOW TOLERANCE IS  $\pm 6\%$
- 13 NOX VALUES ARE "NOT TO EXCEED".
- 14 CO, CO<sub>2</sub>, THC, and NMHC VALUES ARE "NOT TO EXCEED".
- 15 O<sub>2</sub>% TOLERANCE IS  $\pm 0.5$ .
- 16 LHV INPUT TOLERANCE IS  $\pm 5\%$ .
- 17 HEAT REJECTION TO JACKET TOLERANCE IS  $\pm 10\%$  OF FULL LOAD DATA, BASED ON TREATED WATER.
- 18 HEAT REJECTION TO ATMOSPHERE TOLERANCE IS  $\pm 50\%$  OF FULL LOAD DATA, BASED ON TREATED WATER.
- 19 HEAT REJECTION OF LUBE OIL TOLERANCE IS  $\pm 20\%$  OF FULL LOAD DATA, BASED ON TREATED WATER.
- 20 HEAT REJECTION TO EXHAUST TOLERANCE IS  $\pm 10\%$  OF FULL LOAD DATA, BASED ON TREATED WATER.

**SITE SPECIFIC COOLING SYSTEM SIZING EQUATIONS (WITH TOLERANCES)**

- 21 TOTAL JACKET CIRCUIT (JW+OC) = (JW  $\times$  1.1) + (OC  $\times$  1.2).