| Eskom | Works Information | Peaking OU |
|---|---|---|

Title: **Ankerlig and Gourikwa OCGT Conversion Natural Gas Supply Technical Specification**

| | |
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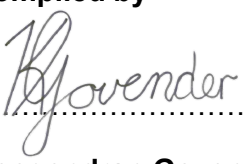
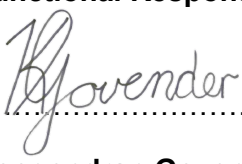
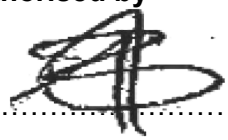
|  |  |  |
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| Date: 2021-11-15 | Date: 2021-11-15 | Date: 2021/11/18 |

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# FIGURES



# TABLES

# 1. INTRODUCTION

The existing Siemens SGT5-2000E Open Cycle Gas Turbine (OCGT) units at Ankerlig and Gourikwa Power Plants form part of the Peaking Generation fleet and were intended to be used during peaking periods and emergency situations to supply electricity to the Eskom National Grid. The plant currently operates on diesel as a primary fuel. Due to the high electricity demand on the National Grid, the plant has been operated at higher load factors which has led to higher operational and maintenance costs associated with the expensive diesel fuel.

The high operating costs have brought about a need to investigate alternative fuels for cost-effective operation of the plant. The plant will be modified to enable dual fuel operation with both natural gas and diesel fuels used interchangeably for power generation.

Eskom Holding SOC Ltd has identified a need to convert all five OCGT units at Gourikwa Power Station and all nine OCGT units at Ankerlig Power Station from currently operating only on diesel to dual fuel operational capability, with natural gas and diesel fuel, interchangeably. To facilitate dual fuel operation, gas burners have already been installed within the gas turbine. Natural gas is required to be sourced for the gas turbines to reduce the gas turbine operating fuel costs and environmental footprint.

# 2. SUPPORTING CLAUSES

## 2.1 SCOPE

### 2.1.1 Purpose

The purpose of this document is to define the technical specification for the natural gas supply to Ankerlig and Gourikwa Power Stations.

### 2.1.2 Applicability

This document shall apply to the Ankerlig and Gourikwa OCGT Conversion project.

## 2.2 NORMATIVE/INFORMATIVE REFERENCES

### 2.2.1 Normative

[1] ISO 9001 Quality Management Systems.

[2] 240-53113953 Manage Engineering Accountability Procedure

[3] 240-53114026 Project Engineering Change Management Procedure

[4] 240-53114002 Engineering Change Management Procedure

[5] 240-50317699 Manage Technical Queries Procedure

[6] 240-53113685 Design Review Procedure

[7] 240-48929482 Tender Technical Evaluation Procedure

[8] Ankerlig and Gourikwa Power Stations Conversion Project – Phase 1: Dual Fuel Conversion Document Title report (194-PRJ-1-ADDB-D00179-3)

[9] Ankerlig and Gourikwa Power Stations Conversion Project: Phase 1 – Dual Fuel Conversion Document Title (194-PRJ-1-AABZ26-RP0000-2)

[10] Ankerlig and Gourikwa Power Stations Conversion Project – Phase 1: Dual Fuel Conversion Project Engineering Management Plan (194-PRJ-1-BDDB-D00179-1)

[11] Ankerlig and Gourikwa Conversion Project (Phase 1): Project Design Manual (194-PRJ-1-ADDB-D00180-2)

### 2.2.2 Informative

[12] G.02.01.01, SGTx-2000E, Siemens Fuel Specification, Conventional Fuels, Fuel Gas, 2013-11-18 GT LGT PLM PM 4 4

## 2.3 DEFINITIONS

**Design Value:** A “design value” must be selected between the minimum and maximum values for the ranges indicated. This will be the value that will be managed by the gas sales agreement.

**Natural Gas:** Flammable gas, consisting largely of methane and other hydrocarbons, occurring naturally underground (often in association with petroleum) and used as fuel.

### 2.3.1 Disclosure Classification

**Controlled disclosure**: controlled disclosure to external parties (either enforced by law, or discretionary).

## 2.4 ABBREVIATIONS

| Abbreviation | Description |
|---|---|
| OCGT | Open Cycle Gas Turbine |
| SOC | State Owned Company |

## 2.5 ROLES AND RESPONSIBILITIES

**Compiler:** Responsible to compile the document and to ensure that the content is integrated to reflect the requirements of every stakeholder forming part of this project.

**Functional Responsibility:** The Functional Responsible person is responsible to approve the content of the document and assure its correctness before the document is submitted for authorisation.

**Authoriser:** The document Authoriser is responsible to ensure that the correct processes were followed in developing this document and that the relevant stakeholders have been involved. The Authoriser also reviews the document for alignment to business strategy, policy, objectives and requirements. He/she shall authorise the release and application of the document.

## 2.6 PROCESS FOR MONITORING

This document shall be utilised as the technical specification for the supply of natural gas to Ankerlig and Gourikwa Power Stations. Should the document require modification, the Project Engineering Change Procedure [3] shall be adhered to.

## 2.7 RELATED/SUPPORTING DOCUMENTS

N/A

# 3. DOCUMENT CONTENT

## 3.1 DESCRIPTION OF THE WORKS

### 3.1.1 Executive Overview

The *Employer* has identified a need to convert all fourteen Open Cycle Gas Turbine (OCGT) units at Ankerlig and Gourikwa Power Stations from currently operating only on diesel to dual fuel operational capability, with natural gas and diesel fuel, interchangeably. To facilitate dual fuel operation, gas burners have already been installed within the gas turbine. To further enable the dual fuel functionality, a new gas supply system is required to supply natural gas at the plant site boundary/delivery point at the required process conditions and gas quality.

### 3.1.2 Employer's Objectives and Purpose of the works

The purpose of the works is to enable full dual fuel operation functionality on all fourteen Siemens SGT5-2000E gas turbine units at Ankerlig and Gourikwa Power Stations such that natural gas and diesel can be used as fuels. Although the OCGT units are currently operating only on diesel fuel, their original design allows for dual fuel operation on both diesel and natural gas. The dual fuel functionality entails the capability for on-line fuel changeover between the two fuels during power generation. Natural gas is to be supplied to both power stations for any potential operating scenarios.

### 3.1.3 Scope of Work

1. The scope of work entails the project management, design, supply, installation, testing, commissioning, storage, delivery and off-loading / transfer and re-gasify (if applicable) of the complete natural gas supply logistic solution to Ankerlig and Gourikwa Power Stations delivery point for the contracted period.
2. The natural gas supply will be continuously metered, and composition analysed prior to transferring to Eskom. This would need to be negotiated with the successful contractor.
3. **Table 1** provides the gas constituents/specification limits that need to be supplied at the delivery point:

**Table 1: Required Natural Gas Constituents/Specification Limits**

| Gas constituents | Unit | Value |
|---|---|---|
| $CH_4$ | Vol. % | ≥ 80 |
| $C_2H_2$ | Vol. % | ≤ 0.1 |
| $C_2H_6$ | Vol. % | ≤ 15 |
| $C_nH_m$ | Vol. % | ≤ 10 sum of $C_nH_m$ with n ≥ 2, excluding $C_2H_6$<br>cf. condensation point |
| $H_2$ | Vol. % | ≤ 1 |
| CO | Vol. % | normally not a constituent of natural gas |
| $H_2O$ | Vol. % | cf. condensation point |
| $N_2$ + Ar + $CO_2$ | Vol. % | ≤ 20 |
| $O_2$ | Vol. % | ≤ 0.1 |

4. **Table 2** provides the maximum gas contaminants for the supplied natural gas at the delivery point:

**Table 2: Natural Gas Contaminants Limits**

| Contaminants | Unit | Value |
|---|---|---|
| Dust:<br>d < 2 µm<br>2 < d < 10 µm | ppm(wt) | ≤ 20<br>≤ 18.5<br>≤ 1.5 |
| Na + K | ppm(wt) | ≤ 0.5 |
| Ca | ppm(wt) | ≤ 10.0 |
| V | ppm(wt) | ≤ 0.5 |
| Pb | ppm(wt) | ≤ 1.0 |
| $H_2S$ | ppm(v) | ≤ 10 |
| Total sulphur | ppm(wt) | ≤ 20 |

5. **Table 3** indicates the natural gas properties/requirements to be supplied at the delivery point.

**Table 3: Natural Gas Properties/Requirements**

| Properties, Condition | Condition(s) | Limits |
|---|---|---|
| **Pressure** | | |
| Design value | | 35-70 barg |
| Tolerance | - at 0 – 15 % of the max. fuel flow | ±5.0 % of design value |
| | - at 15 – 100 % of the max. fuel flow | ±2.5 % of design value |
| Change rate | | dp/dt ≤ 0.2 bar/s |
| **Temperature** | | |
| Permissible range | LHV, min. 40.0 MJ/kg<br>LHV, max. 50.0 MJ/kg | 5 °C to 120 °C |
| Condensation point | | min. 10 K above dew point of the gas mixture |
| | | min. 15 K above the dew point of water |
| Tolerance | | ±10 K from startup and/or design value |
| Change rate | | dT/dt ≤ 1 K/s |
| **Lower heating value (LHV)** | | |
| Design range | 0 % – 100 % output | LHV, min. 40.0 MJ/kg<br>LHV, max. 50.0 MJ/kg (100 % methane) |
| Design value | | To be selected in the design range |

| | | |
|---|---|---|
| Tolerance | | ±5.0 % of design value |
| Change rate | | d LHV/dt ≤ 0.1 %/s |
| **Lower Wobbe Index (WI)** | | |
| Permissible range | 5 °C to 120 °C for | $WI_{u,min}$ 40.3 $MJ/m^3_{STP}$<br>$WI_{u,max}$ 51.0 $MJ/m^3_{STP}$ |
| Design value | | To be selected in the design range |
| Tolerance | | ±5 % of design value |
| Change rate | | d WI/dt ≤ 0.1 %/s |

Legend:
T = Temperature
LHV = Lower heating value
WI = Lower Wobbe index
t = Time
p = Pressure

6. **Table 4** and **Table 5** provides the estimated gas quantities required for Ankerlig and Gourikwa Power Stations.

**Table 4: Ankerlig and Gourikwa Power Stations Estimated Gas Quantities**

| Description | Units | Ankerlig Power Station | Gourikwa Power Station |
|---|---|---|---|
| No. of Units | | 9 | 5 |
| Maximum Hourly Quantity | TJ/hr | 14.1 | 7.84 |
| Maximum Hours per Day | Hours | 24 | 24 |
| Maximum Daily Quantity | TJ/day | 338.48 | 188.04 |

**Table 5: Ankerlig and Gourikwa Power Stations Load Factor Gas Quantities**

| **Ankerlig Power Station** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Load Factor** | | **1%** | **2%** | **3%** | **4%** | **5%** | **6%** |
| Weekly hours of operation | Hours | 15.1 | 30.2 | 45.4 | 60.5 | 75.6 | 90.7 |
| Gas supply per week | TJ/week | 23.7 | 47.4 | 71.1 | 94.8 | 118.5 | 142.2 |
| Annual Quantity | PJ/year | 1.2 | 2.5 | 3.7 | 5.0 | 6.2 | 7.4 |
| **Gourikwa Power Station** | | | | | | | |
| **Load Factor** | | **1%** | **2%** | **3%** | **4%** | **5%** | **6%** |
| Weekly hours of operation | Hours | 8.4 | 16.8 | 25.2 | 33.6 | 42.0 | 50.4 |
| Gas supply per week | TJ/week | 13.2 | 26.3 | 39.5 | 52.7 | 65.8 | 79.0 |
| Annual Quantity | PJ/year | 0.7 | 1.4 | 2.1 | 2.8 | 3.4 | 4.1 |

7. The natural gas supply must be for an annual load factor range of between 1% and 6% for a contract period of between 5 and 10 years.

8. Due to the peaking operating regime of Ankerlig and Gourikwa Power Stations, anything from a single unit to all units of each power station could be utilised in a week. In the 2020 and 2021 financial years, the annual load factor 80$^{th}$ percentile for Ankerlig and Gourikwa Power Stations was 10-15% and 20-25%, respectively. This can be seen in Figure 1 and Figure 2 which are illustration of the weekly load factors in a percentile format for both Ankerlig and Gourikwa Power Stations, respectively.

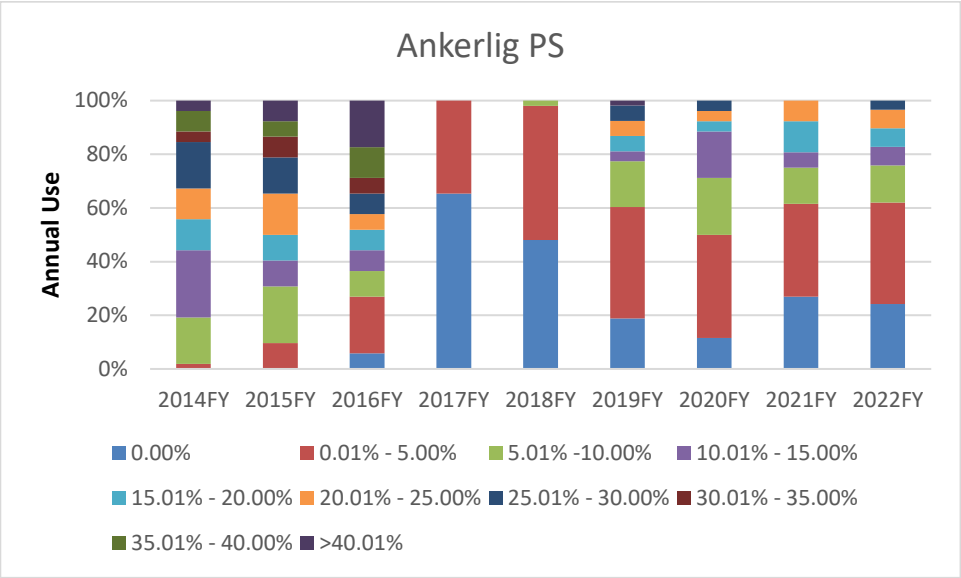


**Figure 1: Ankerlig Power Station Weekly Load Factors per Financial Year**

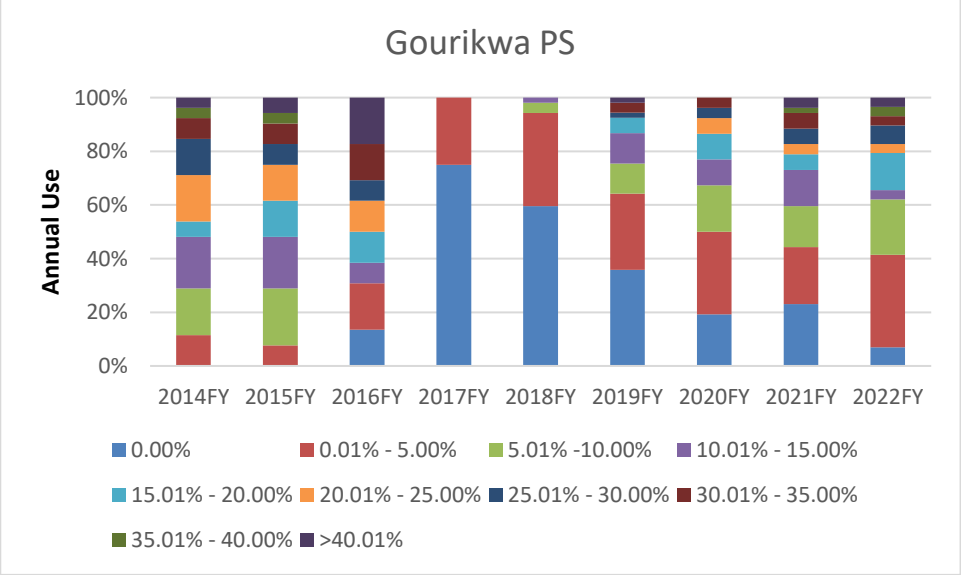


**Figure 2: Gourikwa Power Station Weekly Load Factors per Financial Year**

9. Due consideration of the plant operating regime when sizing the gas storage, transport infrastructure and logistically solution.

### 3.1.4 Interpretation and Terminology

Refer to Section 2.2 and Section 2.4 above.

### 3.1.5 Definitions

Refer to Section 2.3.

### 3.1.6 Limit of Supply and Services

The delivery point for Ankerlig and Gourikwa Power Station is the site boundary fence as illustrated in the site layout pictures in Appendix A and Appendix B.

## 4. AUTHORISATION

This document has been seen and accepted by:

| Name & Surname | Designation |
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| Cobus Dippenaar | Project Engineering Manager |
| Koogendran Govender | Chief Engineer – Peaking Asset Management |
| Reggie Chippe | Peaking Client Office |
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| Tinus Keyser | System Engineering Manager – Peaking Turbine Plant |
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## 5. REVISIONS

| Date | Rev. | Compiler | Remarks |
|---|---|---|---|
| September 2021 | 0.1 | K Govender | First draft review |
| November 2021 | 1 | K Govender | Authorisation of first revision |

## 6. DEVELOPMENT TEAM

The following people were involved in the development of this document:

- Cobus Dippenaar
- Koogendran Govender
- Reggie Chippe
- Saneshan Govender
- Tinus Keyser
- Wynand Cilliers

## 7. ACKNOWLEDGEMENTS

- None

## APPENDIX A: ANKERKLIG POWER STATION LAYOUT (GOOGLE EARTH)

## APPENDIX B: GOURIKWA POWER STATION LAYOUT (GOOGLE EARTH)