



SUSTAINABLE ENERGY DEVELOPMENT AUTHORITY (SEDA) MALAYSIA

GUIDELINE

**ON BIOGAS POWER PLANT ACCEPTANCE TEST AND
PERFORMANCE ASSESSMENT (AT&PA) FOR FEED-IN
TARIFF (FIT) PROJECTS IN MALAYSIA (CHECKLIST)**

June 2018

TABLE OF CONTENTS

GLOSSARY OF TERMS.....	1
GUIDELINE (CHECKLIST).....	2
INTRODUCTION	3
1.0 CHECKLIST OF ACCEPTANCE TEST & PERFORMANCE ASSESSMENT DOCUMENTATION	4
2.0 INFORMATION ABOUT THE PROJECT	6
3.0 INFORMATION ABOUT THE PLANT	7
4.0 ACCEPTANCE TEST & RELIABILITY RUN.....	9
5.0 FUEL SAMPLING & ELECTRICAL EFFICIENCY	12

GLOSSARY OF TERMS

Abbreviations

AT&PA	Acceptance Test & Performance Assessment
AT	Acceptance Test
EE	Electrical Efficiency
FAT	Factory Acceptance test
FiAH	Feed-in Approval Holder
FiT	Feed-in Tariff
FiTCD	FiT Commencement Date
IOD	Initial Operational Date
REL	Rated Engine Load
RE	Renewable Energy
RR	Reliability Run
SAMM	<i>Skim Akreditasi Makmal Malaysia</i>

GUIDELINE (CHECKLIST)

The Feed-in Tariff (FiT) is a policy mechanism in Malaysia which allows electricity produced from renewable resources to be sold to power utilities at a fixed premium price for a specific duration to enable financial viability of renewable energy (RE) plant development. The FiT mechanism was introduced through Renewable Energy Act 2011 [Act 725] in order to promote RE generation in Malaysia. One of the renewable energy (RE) resources which qualify under FiT is biogas which abundantly available from waste resources such as landfill, sewage gas or agriculture waste including animal waste as fuel source.

It is the legal responsibility of SEDA Malaysia, the Authority to ensure that all biogas installations approved are designed and constructed in accordance to the international standards and best practices, while meeting minimum national safety standards for the protection of personnel and equipment. **The Guideline on Biogas Power Plant Acceptance Test and Performance Assessment (AT&PA) for FiT Projects in Malaysia** is prepared to provide assistance to the Feed-in Approval Holder (FIAH) under the biogas installation. This Guideline is useful when preparing the plant performance assessment reporting by the biogas project developers in preparing test report for FiT Commencement Date (FiTCD).

This Guideline/Checklist is in addition to, and intended to complement, not replace, the Electricity Supply Act, the Renewable Energy Act, the Occupational Safety and Health Act, and their related subsidiary legislation. It serves to provide simple yet clearer guide as to the step-by-step in conducting the AT&PA as required by the Authority.

This Guideline/Checklist consists of five (5) parts;

- a) Checklist of AT&PA documentation;
- b) Information about the Project;
- c) Information about the Plant;
- d) Acceptance Test & Reliability Run; and
- e) Fuel sampling & Electrical Efficiency.

The AT&PA must be carried out by the respective FIAH/FIAH's Qualified Person. A minimum notice of 14 days is required for the AT&PA arrangement.

The notice to be sent;

SEDA Malaysia (AT&PA of Biogas Project)

Galeria PjH, Aras 9, Jalan P4W, Persiaran Perdana, Presint 4,
62100 Putrajaya, W.P. Putrajaya

Tel: +603-8870 5800; Fax: +603-8870 5900; Email: MO@seda.gov.my

INTRODUCTION

The most common approach to produce electricity from biogas is through gas engine either spark ignition (SI) or compression ignition (CI). It is because gaseous fuelled reciprocating is matured technology in terms of global manufactures supply and support efficient infrastructure. Moreover, this technology is more tolerant to biogas impurities and need less initial cost than other technology. Meanwhile, biogas is a renewable and sustainable energy carrier produced via Anaerobic Digestion (AD) in humid condition with absence of Oxygen or biological decomposing or organic matter in landfills. Biogas mainly consists of Methane (40-65%), Carbon Dioxide (30-45%) and some other compounds. The compositions of biogas vary from one source to another and also depend on condition of the digester or the landfill.

In reciprocating engine, the combustion occurs in enclosed combustion chamber where the thermal energy that generated due to combustion expand and converted into mechanical energy by rotating the crankshaft which is coupled with generator to produce electricity. Figure 1, shows the typical biogas fired gas engine power plant.

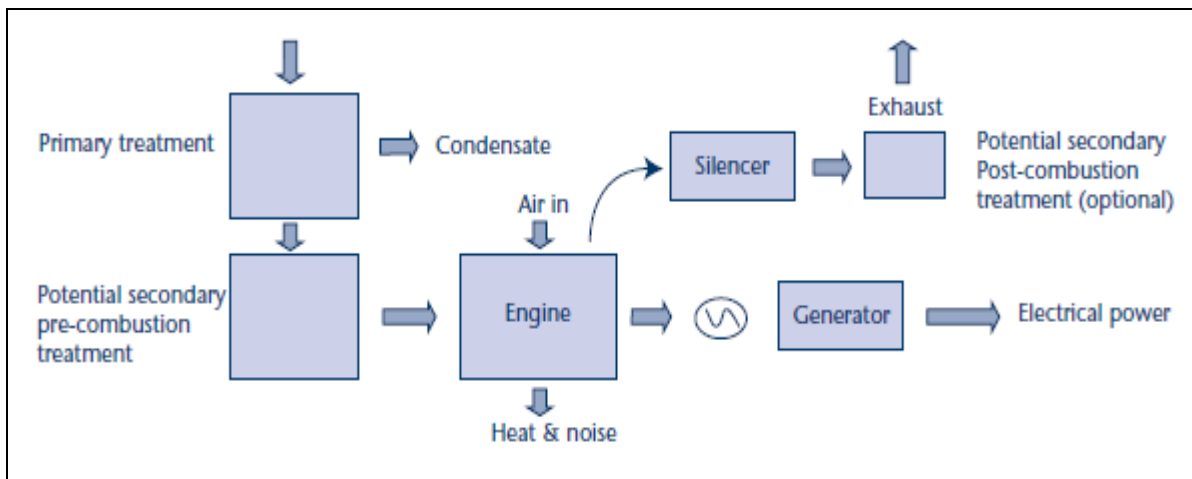


Figure 1: Gas Engine unit with Generator Set

1.0 CHECKLIST OF ACCEPTANCE TEST & PERFORMANCE ASSESSMENT DOCUMENTATION

FORM 1: Checklist of Acceptance Test & Performance Assessment Documentation

No.	Documents	Prepared by FIAH	Checked by SEDA	Remarks
1.	PART - A: Information About Project			
a)	Form 2: Information About Project			Submitted
b)	Overall Plant Management Team Organization Chart			Submitted
c)	List of Key Personnel that will be present during the test and their contact number (mobile)			Submitted
d)	Proposed Test Schedule of Acceptant test & Reliability Run			Submitted
e)	Copy of Initial Operational Date (IOD) approval letter from the Distribution Licensee			Submitted
f)	Copy of Competent Person Certificate (Chargeman) under Electricity Regulation, 1994, Energy Commission			Submitted
g)	Copy of <i>Kebenaran Bertulis</i> (plant upgrading/clean air) under Environment Quality Act, 1974, Department of Environment (DOE)			Submitted

2.	PART - B: Information About Plant			
a)	Form 3: Information About Plant			Submitted
b)	Document of overall plant layout inclusive of gas treatment system, biogas engine and generator system.			Submitted
c)	Electrical Single Line Diagram (SDL) – Generator to PMU			Submitted
d)	Biogas engine operation and maintenance manual which include Performance, losses and correction curves data.			Submitted softcopy
e)	Generator operation manual and maintenance manual which include Performance, losses and correction curves data.			Submitted softcopy
f)	Report of Factory Acceptance Test (FAT) of gas engine.			Submitted
g)	Data Acquisition System Display Diagram / Schematic			Submitted
h)	Process Flow Diagram (PFD) Document for overall plant			Submitted
i)	Piping and Instrumentations Diagram (P&ID) Document for overall plant			Submitted
j)	Fuel (biogas) operation control, monitoring and measurement system manual			Submitted
k)	List of equipment being used for data measurement inclusive of type and location of installation			Submitted
l)	Valid Certificate of calibration for installed measuring instrument ;			
	a) Flowmeter			Submitted

	b) Temperature			To be provide soon (Still waiting complete document from manufacturer/ contractor)
	c) Pressure			Submitted
	d) Permanent Gas Analyser (if any)			Submitted
	e) Power/ Energy Meter			Submitted
	f) Continuous Emission Monitoring System (CEMS) (Optional)			(if available)

3.	PART - C: Acceptance Test (AT), Reliability Run (RR) & Electrical Efficiency (EE)			
a)	Form 4a: Acceptance Test at 50% REL			
b)	Form 4a: Acceptance Test at 75% REL			
c)	Form 4a: Acceptance Test at 100% REL			
d)	Form 4b/c: Reliability Run at min 50% Net Export			
e)	Plant operation data during Acceptance Test in CSV format (CD)			
	i) Acceptance Test			
	ii) Reliability Run			
f)	Form 5a: Fuel Sampling			
g)	Form 5b: Electrical Efficiency			
	Detail calculation of Electrical Efficiency			

Signature		
	FiAH/FiAH's Qualified Person	SEDA Malaysia's Officer
Name		
Date		
Designation		

2.0 INFORMATION ABOUT THE PROJECT

FORM 2: Information about the Project

Project details	
FIT application number	
Name of Feed-in Approval Holder (FiAH)	
Project description	Biogas (agriculture / landfill / sewage / animal waste)
Site GPS coordinates (Latitude, Longitude)	
Site address	
Date of inspection (dd/mm/yyyy)	

Feed-in Approval Holder (FiAH) details	
Name of Contact (Person in-charge for Acceptance Test & Reliability Run)	
Mobile phone number/Ground phone number	
Email address	
FiT Bonus	<input type="checkbox"/> use of gas engine technology with electrical efficiency of above 40% <input type="checkbox"/> use of locally manufactured or assembled gas engine technology <input type="checkbox"/> use of landfill, sewage gas or agricultural waste including animal waste as fuel source

Installation details	
Date of completion of installation	
Date of Initial Operational Date (IOD)	
Energy meter reading (kWh)	
Remarks:	

Signature		
	FiAH/FiAH's Qualified Person	SEDA Malaysia's Officer
Name		
Date		
Designation		

3.0 INFORMATION ABOUT THE PLANT

FORM 3: Information about the Plant

No.	Item	Details
1.	Plant Capacity	<p><u>Feed-in Approval;</u></p> <ol style="list-style-type: none"> 1. Installed capacity, kW: 2. Net Export capacity, kW: <p><u>Actual capacity at site;</u></p> <ol style="list-style-type: none"> 1. Engine capacity, kW: 2. Generator capacity, kW:
2.	Biogas Sources	<ol style="list-style-type: none"> 1. Type of waste: agriculture / landfill / sewage / animal waste 2. Feedstock capacity, (m³/hr or ton/day):
3.	Biogas Production system	<p><u>Anaerobic Digester;</u></p> <ol style="list-style-type: none"> 1. Type: covered lagoon/digester tank 2. Biogas capacity, (m³/hr): 3. Technology origin: <p><u>Landfill;</u></p> <ol style="list-style-type: none"> 1. Type of landfill: closed dumpsite/sanitary landfill 2. Biogas capacity, (m³/hr): 3. Top cover material: HDPE liner/compacted soil
4.	Biogas Clean-up System	<ol style="list-style-type: none"> 1. Manufacturer: 2. Type: 3. Technology origin: 4. Capacity, (m³/hr): 5. Maintenance Frequency:
5.	Engine Details	<ol style="list-style-type: none"> 1. Manufacturer: 2. Model: 3. No. of engine at site: 4. Rated Capacity: 5. Engine Type: 6. Stroke: 7. Engine efficiency during FAT: (At which load 100% or all including 75% and 50%) <ul style="list-style-type: none"> - 100% load: - 75% load: - 50% load: 8. Minimum load/Gas Flow, (m³/hr): 9. Maximum load/Gas Flow, (m³/hr): 10. Naturally aspirated/Turbocharger: 11. Spark or Compression engine: 12. Engine speed, (rpm): 13. Fuel Consumption:
6.	Data Acquisition	<ol style="list-style-type: none"> 1. Manufacturer: 2. Availability of SCADA: YES/NO

		3. Interval time, (minute): 4. List of data: to be attached 5. Storage capacity: 6. Data format (CSV) Excel: YES/NO
7.	Generator	1. Manufacturer: 2. Type of generator: 3. Efficiency, (%): 4. Continued rated output, (kW/kVA): 5. PF & Frequency, (Hz): 6. No. Poles: 7. Correction factor: Power factor: 8. Full load current (Amp):
8.	Transformer	1. Manufacturer: 2. Continue rating: 3. Nominal system voltage (HV/LV): HV= _____ V; LV= _____ V 4. Transformer type:
9.	Sub-station	1. Capacity, (KV): 2. Type of cable: 3. Distance cable from plant:
10.	Flowmeter	1. Manufacturer: 2. Model: 3. Type: 4. Flowrate (min/max) (m ³ /hr): 5. Date of calibration: 6. Setting Condition at Site : <ul style="list-style-type: none"> • Temperature : • Pressure : • Methane % :
	Permanent Gas Analyzer (if any)	1. Manufacturer: 2. Model: 3. Type: 4. Date of calibration: 5. List of biogas parameters to be analyzed: <ul style="list-style-type: none"> a) b)
Remarks:		

Signature		
	FiAH/FiAH's Qualified Person	SEDA Malaysia's Officer
Name		
Date		
Designation		

4.0 ACCEPTANCE TEST & RELIABILITY RUN

4.1 Acceptance Test (AT)

- a) A data logger is required to capture all data during AT.
- b) The engine shall run at three (3) load points.
 - ✓ Biogas Plant operating with single engine:- minimum load of **50% REL, 75% REL and 100% REL**. Each test run will be conducted twice and two sets of reading shall be taken for each load. Each test run shall be conducted for a minimum of four (4) hours. Ten percent (10%) tolerance will be given during the test load at 100% REL only. However, it must never exceed the Net Export capacity.
- or;
- ✓ Biogas Plant operating with multiple engines:- minimum load of **50% REL, 75% REL and 100% REL**. Each test run will be conducted twice and two sets of reading shall be taken for each load. Each test run shall be conducted for a minimum of four (4) hours. Ten percent (10%) tolerance will be given during the test load at 100% REL only.
- c) FiAH is required to complete **Form 4a** for the AT documentation.

4.2 Reliability Run (RR)

- a) A data logger is required to capture all data during RR.
- b) Test run shall be performed at minimum load requirement of **50% Net Export Capacity**.
- c) Test shall be conducted for duration of **336 hours (approximately for 14 days, 24 hours operation) and shall achieve minimum of 90% uptime**.
- d) FiAH is required to complete **Form 4b** for the RR documentation.

Table 4a: Acceptance Test Form

Project :	Date of Test :	Run Number :	Rated Engine load :	kW
Plant Name :	Run Number :	RUN#1 RUN#2	Engine No. :	
Type of Assessment :	Run Load :	50% 75% 100%		
Acceptance Test (AT)				

GDU (optional)					Engine Data							Generator Data					Ambient/Surrounding Data			
Time (15 min interval)	Biogas Flowrate meter 1 (m ³ /hr)	Biogas temp (°C)	Biogas pressure (mbar)	Methane value (%)	Biogas Flowrate meter 2 (m ³ /hr)	Biogas temp (°C)	Fuel-air mixture temp (°C)	Engine speed (rpm)	Jacket water inlet (°C)	Jacket water outlet (°C)	Combustion temp (average) (°C)	Frequency (Hz)	Voltage (Volt)	Current (Amp)	Power factor	Real power (kW)	Pressure (mbar)	Temp (°C)	Humidity (% RH)	

Signature	FiAH/FiAH's Qualified Person SEDA Malaysia's Officer	Remarks;
Name		
Date		
Designation		

FORM 4b: Reliability Run with the Data Logger

Project :	Plant Capacity :	kW	Minimum Plant Running Power (kW)
Plant Name :	Net Export :	kW	= 50% Net Export
Type of Assessment : Reliability Run (RR)	Engine No. :		= kWe

Summary of Daily Reliability Run Result Form (Plant with Data Logger)

Day	Date		Time		Plant Running Hour Counter reading		Total Plant Running hour (hr)	Downtime recorded, (hr)	Average Power Output during plant uptime, (kWe)	Energy exported during plant uptime, (kWh)	Remarks
	Start	End	Start	End	Start	End					
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											
14											
15											

Signature			Supporting document; 1. 2. 3. 4. 5.
	FiAH/FiAH's Qualified Person	SEDA Malaysia's Officer	
Name			
Date			
Designation			

5.0 FUEL SAMPLING & ELECTRICAL EFFICIENCY

Should the Engine data sheet and FAT certificate show a value of less than 40% electrical efficiency, the fuel sampling and electrical efficiency test will not be conducted.

5.1 Fuel Sampling;

- The fuel sampling shall be carried out by an Accredited Laboratory of *Skim Akreditasi Makmal Malaysia* (SAMM).
- It is recommended that the fuel sampling be taken at 100% Rated Engine Load (REL).
- Minimum parameters of biogas to be analysed;
 - ✓ Methane composition, CH₄ (%)
 - ✓ Carbon Dioxide, CO₂ (%)
 - ✓ Oxygen, O₂ (%)
 - ✓ Hydrogen Sulphide, H₂S (%)
 - ✓ Ammonia (NH₃), ppm
 - ✓ Ammoniacal Nitrogen, NH₄ (%) - (if biogas landfill)
 - ✓ Net Heating value of biogas (kJ/kg)
 - ✓ Moisture content (ppm)
 - ✓ Gross Heating Value, MJ/kg at 0°C and 15°C, 101.325kPa
 - ✓ Net Heating Value, MJ/kg at 0°C and 15°C, 101.325kPa
 - ✓ Real Density of biogas (kg/m³) at 0°C and 15°C, 101.325kPa
- FiAH is required to complete **Form 5a** for fuel sampling documentation.

5.2 Electrical Efficiency;

- The Electrical Efficiency (EE) requirement is to measure gas engine performance by using actual biogas at site. FiAH is required to complete **Form 5b** for electrical efficiency documentation.
- FiAH needs to provide the EE detail calculation. The plant log data (in VSC format) and laboratory result are to be attached to support the calculation.
- The maximum EE value for each test will be based on the Factory Acceptance Test (FAT) certificate for each engine.
- FiAH is eligible for the FiT bonus of use of gas engine technology with EE if the calculation of EE is above 40%.

FORM 5a: Fuel Sampling

Project :	Rated Engine Load :	kW
Plant Name :	Engine No. :	
Type of Assessment :	Fuel Sampling	

**Plant Data
(to be filled by FiAH's representative)**

Date :	Time :
Biogas Flowrate, m ³ /hr :	Power, kW :
Biogas Temperature, °C :	Biogas Gauge Pressure, mbar :
Ambient Temperature, °C :	Ambient Pressure, mbar :
Methane composition, % :	Absolute Pressure, mbar :

Description of Sampling (to be filled by Accredited Lab's representative)	Remarks
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Sample No. :		
Sampling method :		
Sample capacity :		
Parameters to be analysed :	1. 2. 3. 4. 5.	

Signature			
	FiAH/FiAH's Qualified Person	Accredited Lab's representative	SEDA Malaysia's Officer
Name			
Date			
Designation			

FORM 5b: Electrical Efficiency

Project :	Rated Engine Load :	kW
Plant Name :	Engine No. :	
Type of Assessment :		

Plant Data

Date :	Time :
Biogas Flowrate, m ³ /hr :	Power, kW :
Biogas Temperature, °C :	Biogas Gauge Pressure, mbar :
Ambient Temperature, °C :	Ambient Pressure, mbar :
Methane composition, % :	Absolute Pressure, mbar :

Electrical Efficiency calculation (to be submit the detail calculation in separate sheet);

Determine Energy input, E _{in} (kJ/s) :
Determine Energy output, E _{out} (kJ/s) :
Electrical Efficiency, $\eta = (E_{out} / E_{in}) \times 100$:

List of Supporting Documents;

- 1.
- 2.
- 3.
- 4.
- 5.

Signature		
	FiAH/FiAH's Qualified Person	SEDA Malaysia's Officer
Name		
Date		
Designation		