

TYPE APPROVAL CERTIFICATE

This is to certify:**That the Gas Turbine**

with type designation(s)
Mars 90 & Mars 100

Issued to

Solar Turbines Incorporated
San Diego CA, USA

is found to comply with

DNV GL rules for classification – Ships

DNV GL rules for classification – High speed and light craft

DNVGL-OS-D101 – Marine and machinery systems and equipment, Edition January 2018

DNVGL-OS-E201 – Oil and gas processing systems, Edition January 2017

Application :

Product(s) approved by this certificate is/are accepted for installation on all vessels classed by DNV GL.

Issued at **Houston** on **2018-02-12**

This Certificate is valid until **2023-02-11**.

DNV GL local station: **Long Beach**

for **DNV GL**

Approval Engineer: **Srujanbabu Sridharala**

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Meindert van Mierlo
Head of Section

This Certificate is subject to terms and conditions overleaf. Any significant change in design or construction may render this Certificate invalid. The validity date relates to the Type Approval Certificate and not to the approval of equipment/systems installed.



Job Id: **262.1-025201-1**
Certificate No: **TAM00000J6**

Product description

Mars 90, Dual shaft with Conventional combustor	90-13002	
Mars 90, Dual shaft with SoLoNox combustor	90-13002S	
Mars 100, Dual shaft with Conventional combustor	100-15002	100-16002
Mars 100, Dual shaft with SoLoNox combustor	100-15002S	100-16002S

Application/Limitation

The Gas Turbine is Approved for the following nominal continuous rating (at ISO reference conditions¹), no losses):

	Mars 90	Mars 100	
Natural Gas	13002/13002S	15002/15002S	16002/16002S
Gas Producer Speed(rpm)	11168	11168	11168
Power Turbine Speed max(rpm)	8778	9500	9500
Output Shaft Power(GS)(kWe*)	-	10685	11347
Output Shaft Power(CS/MD)(kW)	9860	11185	11856
Mass flow(kg/sec)	39	41.8	42.6
Compressor discharge pressure(bar)	15.53	16.6	16.8
T-5 Temperature (°C)	690	738	738

	Mars 90	Mars 100	
Diesel Fuel	13002/13002S	15002/15002S	16002/16002S
Gas Producer Speed(rpm)	10923	11004	11004
Power Turbine Speed max(rpm)	8436	9500	9500
Output Shaft Power(GS)(kWe*)	-	10002	10711
Output Shaft Power(CS/MD)(kW)	8582	10455	11172
Mass flow(kg/sec)	37	40.9	41.9
Compressor discharge pressure(bar)	14.4	16.0	16.3
T-5 Temperature (°C)	665	709	715

* output at generator terminals. Gear box efficiency 96%, Generator efficiency 96%

- 1) Ambient reference conditions corresponding to ISO standards are:
Ambient Pressure = 1.013 BAR Ambient Temperature = 15 Deg. C Relative Humidity = 60%

Application Constraints: Mars90 and Mars100

Application Max. allowable	Dual Shaft					
	List	Forward Trim	Aft Trim	Pitch forward	Pitch Aft	Roll
with bearing scavenging	22.5°	10°	15°	10°	15°	22.5°
without bearing scavenging	22.5°	10°	5°	10°	5°	22.5°
Max. allowable acceleration loads	Axial		Vertical		Lateral	

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	10g	6g	3g
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The above angular limits are valid for a gas turbine mounted in the direction of the vessel's longitudinal axis with no inclination relative to the vessel's horizontal plane.

*) Forward trim is defined as a static downward inclination of engine's air inlet end, and aft trim is defined as a static downward inclination of the engine's exhaust end.

Fuel type designation

Gaseous or Liquid fuel per Solar specification ES9-98

Max allowable salt content in inlet air(wppm)

The total sodium plus potassium level must be less than 0.01 ppmw Fuel Equivalent Concentration (FEC) per Solar Fuel, Air and Water specification ES9-98.

Type Approval documentation

Clause for certification

1. Gas turbines using gas as fuel should be fitted in gas-tight enclosures which are arranged in accordance with the requirements for ESD(emergency shut down) protected machinery spaces as per DNVGL rules for ships Part 6 Chapter 2 Section 5:10.2.21.
2. Gas turbines requiring a gas supply with pressures above 10bar, gas piping shall be protected with a secondary enclosure in accordance with the requirements in 5.1.5 of DNVGL rules for ships Part 6 Chapter2 Section 5:10.2.2.2.
3. All changes of components in the Gas flow path are to be forwarded to DNVGL for evaluation and approval prior to use in certified turbines
4. Operational hours submitted by SOLAR were acknowledged.
5. Only the gas turbine core engine is covered by this Type Approval. All other components delivered as part of the normal package are specifically excluded.
6. Gas turbine skin temperature is not to exceed 74°C for offshore applications and 220°C for Ship rules application. Where the application of insulation is not practical an enclosure is to be fitted.
7. This Type Approval replaces the Offshore Type Approval Certificate number M-12461(Mars 90) and M-12599(Mars 100).

The following is not covered by this Type Approval and compliance with relevant standard/rules must be documented for each application:

1. The control and monitoring system (software and hardware)
2. Gas turbine installation & arrangement (fire and safety system, mounting, ducting, ventilation and insulation)

Marking of product

The product is to be marked with manufacturer's name and trade mark and type number identification

Certificate Retention Survey

For retention of the Type Approval a DNV surveyor shall perform a survey report every second year and before expiry date of this certificate to verify that the conditions of the type approval are complied with.

END OF CERTIFICATE