DNV·GL

Certificate No:
TAM00000R7

TYPE APPROVAL CERTIFICATE

This is to certify:

That the Gas Turbine

with type designation(s)
Saturn 20

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-E201 – Oil and gas processing systems, Edition January 2017
DNVGL-OS-D101 – Marine and machinery systems and equipment, Edition January 2018

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**

Approval Engineer: **Srujanbabu Sridharala**

for **DNV GL**

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: **262.1-027123-1**
Certificate No: **TAM00000R7**

Product description

Single shaft turbine (Cold End Drive) Saturn 20-1601
Dual shaft turbine (Hot End Drive) Saturn 20-1602

Application/Limitation

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

Natural Gas/Diesel Fuel	**Dual Shaft - 1602**	**Single Shaft - 1601**
Gas Producer Speed	22300rpm	22516 rpm
Output Shaft Power	1186 kW	1204 kWe*
Mass flow	6.4 kg/sec	6.53 kg/sec
Compressor discharge press.	6.5 bar	6.8 bar
T-5 Temperature	685 °C	694°C

* output at generator terminals. Gear box efficiency 96%, Generator efficiency 96% (Performance is at ISO1, no losses)

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

Application Constraints

Application Max. allowable	Single Shaft						Dual Shaft					
	List	Forward Trim	Aft Trim	Pitch forward	Pitch Aft	Roll	List	Forward Trim	Aft Trim	Pitch forward	Pitch Aft	Roll
with bearing scavenging	30°	24°	10°	See below	See below	See below	30°	24°	10°	See below	See below	See below
without bearing scavenging	30°	24°	3°	See below	See below	See below	30°	24°	3°	See below	See below	See below
Max. allowable acceleration loads	Axial		Vertical		Lateral		Axial		Vertical		Lateral	
	1g		1g		1g		0.5g		0.5g		0.5g	

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.

*) Bearing scavenging is not a standard option for the Saturn engine, and will require the submission of an SER.

Max allowable pitch & roll:

Angular velocity is not limiting criterion for the gas turbine engine provided the resultant acceleration does not exceed the recommended level.

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.

Max allowable shear force and bending moment on output shaft (N):

Single-shaft:
The maximum allowable combined V = shear force (N) and M = bending moment (Nm) on the reduction gearbox output shaft, as limited by the total static and dynamic loading of the number four bearing, is bounded by the equation: **0.23V + M =468**

Dual-shaft:
The maximum allowable combined V = shear force (N) and M = bending moment (Nm) on the reduction gearbox output shaft, as limited by the total static and dynamic loading of the number four bearing, is bounded by the equation: **0.189V + M =86.13**

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. 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.
5. 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.
6. This Type Approval replaces the Offshore Type Approval Certificate number M-12451.

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