

# TYPE APPROVAL CERTIFICATE

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

with type designation(s)

**Centaur 40/50, Taurus 60/70, Mars 90/100, Titan 130, Titan 250 Generator Packages**

Issued to

**Solar Turbines Incorporated  
San Diego CA, United States**

is found to comply with

**DNV-OS-E201 "Oil and Gas Processing Systems" October 2010****DNV's Offshore Standard DNV-OS-D101 "Marine and Machinery Systems and Equipment"****Application :****Offshore Topsides Power Generation**

| Type              | Max. outlet power |
|-------------------|-------------------|
| <b>Centaur 40</b> | <b>3515 kWe</b>   |
| <b>Centaur 50</b> | <b>4600 kWe</b>   |
| <b>Taurus 60</b>  | <b>5670 kWe</b>   |
| <b>Taurus 70</b>  | <b>7965 kWe</b>   |
| <b>Mars 90</b>    | <b>9450 kWe</b>   |
| <b>Mars 100</b>   | <b>11350 kWe</b>  |
| <b>Titan 130</b>  | <b>15000 kWe</b>  |
| <b>Titan 250</b>  | <b>21,745 kWe</b> |

**Product(s) approved by this certificate is/are accepted for installation on all vessels classed by DNV GL.**This Certificate is valid until **2016-12-31**.Issued at **Houston** on **2015-09-29**DNV GL local station: **Long Beach**Approval Engineer: **Jaime Hinke**for **DNV GL**

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**Nick Prokopuk  
Team Lead**

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.

## Product description

The Gas Turbine Generator (GTG) packages consist of an enclosed gas turbine engine that drives a constant speed generator through a reduction gear. There is a flexible coupling between the reduction gear and the generator. In addition to the drive train components, the complete gas turbine package includes the driver and driven base frame, enclosure with engine lifting appliances, and dedicated auxiliary systems.

The auxiliary systems are the ventilation system, lubricating oil system, fuel system, starting system, seal system, and fire protection/suppression systems. There is also an integrated control and safety system for the gas turbine package.

The gas turbine engine package can be designed for operation on liquid fuel, gas fuel, or dual-fuel.

Ancillary components can be located on the skid with the turbine enclosure, or located off skid.

## Application/Limitation

1. The unit to operate within these limits when the package is installed parallel to the vessel's axis:

| Package motion limitation |                  |                          |                        |
|---------------------------|------------------|--------------------------|------------------------|
| Parameter                 | ACS 11A1 (Basic) | ACS 11A3 (Moderate Duty) | ACS 11A5 (Severe Duty) |
| Pitch, dynamic            | 2°               | 7.5°                     | 10°                    |
| Roll, dynamic             | 2°               | 7.5°                     | 22.5°                  |
| Trim, static              | 2°               | 5°                       | 5°                     |
| List, static              | 2°               | 5°                       | 15°                    |
| g-force, max. operating   | 0.1 g            | 0.5 g                    | 0.75 g                 |
| g-force, max survival     | 0.5 g            | 0.75 g                   | 1.0 g                  |

Installed package "g" forces can act in any direction independently or in the vector sum of any two directions simultaneously. Gravity is additional.

A vessel's deck deflections for multi-point or three-point mounted packages, while experiencing maximum operating "g" forces and independent of gimbal or AVM mounting options, must not exceed:

- Hogging and sagging: 0.38 mm per meter (0.0046 in. per ft) of mounted span, measured at the midpoint of the span.
  - Deck Twist: 0.02 degrees per meter (0.006 degrees per ft) of mounted span.
2. For limitations of the core engine, including details on power ratings and limitations on gas turbine temperatures, refer to the specific DNV GL Type Approval for the gas turbine core engine.

## Approval Conditions

1. A typical Gas Turbine Generator package (GTG) will include the following type approved components, and these components are excluded from this certificate:
  - a. Gas Turbine engine
  - b. Base frame for driver and driven unit with integrated lubricating oil tank
  - c. Engine handling lifting appliances

A valid DNV GL Type Approval Certificate is required for the core engine configuration and application.

2. The following main components and systems are typically subject to individual certification according to the relevant DNV Offshore Standards, and therefore not covered by this certificate.
  - a. Reduction gear
  - b. Flexible coupling
  - c. Electrical generator
  - d. Control, monitoring and safety systems
3. The fire detection / protection system has been reviewed and is subject to the comments in Appendix A. These address integration of the package and vessel systems, and need to be addressed on an individual basis for each specific installation.
4. Additional Flag State and local Shelf State requirements may be applicable, and are to be evaluated on a case-by-case-basis.
5. Components and equipment that require individual DNV GL certification as per the relevant DNV-OS shall be delivered with appropriate certification from Solar Turbine suppliers.
6. A torsional vibration analysis of the complete drive train shall be submitted for approval for each project.
7. Area requirements such as intake location and exhaust location are not included as part of the type approval. However, inlet air shall be taken from, and discharge of exhaust air shall be into areas, that are non-hazardous with respect to flammable atmospheres.
8. All piping is evaluated only to the skid boundary for the gas turbine packages
9. All electrical equipment and instrumentation are evaluated only to the skid boundary.
10. Blast loads for the enclosure and components are not covered.
11. The ventilation system providing dilution ventilation shall be provided with 2 times 100% fan capacity.
12. The overall area classification inside the gas turbine enclosure is Zone 2, temperature T3 or better and gas group IIA, IIB or IIB + H2. All electrical equipment shall comply with the minimum certification requirements.
13. The Type Approval is only valid for GTG packages in which the components and system described in the Type Approval Documentation are used. All changes of a major nature having an effect either on the whole package or on the individual components are to be forwarded to DNV for evaluation and approval prior to use in a DNV certified package.

## Type Approval documentation

1. Complete ACS (Long Proposal Equipment Description with Application Guidelines and Proposal Scope)
2. Turbomachinery Package Specification, Solar Turbines
  - a. Centaur 40 Generator Set TPS40GS/309
  - b. Centaur 50 Generator Set TPS50GS/309
  - c. Taurus 60 Generator Set TPS60GS/309
  - d. Taurus 70 Generator Set TPS70GS/309
  - e. Mars 90 & 100 Generator Set TPS90-100GS/309
  - f. Titan 130 Generator Set TPS130ARGS/309
  - g. Titan 250 Generator Set DS250GS/1109

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Job Id: **262.1-013325-1**  
Certificate No: **TAM0000025**

### **Periodical assessment**

For retention of Type Approval, 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.

## **APPENDIX A – Fire Detection & Protection Integration Requirements**

When the Type Approved power generation package is installed onboard a offshore installation, the requirements pertaining to integration of package and unit fire protection systems are to be adhered to.

### General requirements:

1. Pressurized components, e.g. gas bottles, pressure vessels, pipes and fittings, are to comply with requirements to DNV approval, construction and certification.
2. The turbine enclosure shall have controlled ventilation shut-down and door closing upon fire detection. All ventilation opening of forced ventilation arrangement shall be capable of automatic closure or shutdown prior to system discharge.
3. The system shall be interfaced with a suitable approved detection, control and release system.
4. The system shall be automatic released upon confirmed fire/gas detection, and the system shall be interlocked with fuel shut down.
5. The fire suppression system must be installed in accordance with the manufacturers design, installation, operation, and maintenance manual.

### Requirements to CO2 Fixed Fire Extinguishing System:

1. The volumetric calculation for the CO2 system is assumed to include the volume for gas turbine enclosure ventilation ducts up to ventilation dampers.
2. An audible and visual alarm is to be provided for the gas turbine enclosure when CO2 is to be released, If electrically operated, the alarm is to be supplied with power from the main and emergency source of electrical power.
3. All connections on high pressure side are to be of approved type. Restrictions apply to threaded connections for unit subject to DNV Classification. Use of section valves with treads will be considered on a case by case basis for valves of sizes up to DN25.
4. The gas turbine enclosure is considered an unattended space and the CO2 system is considered a small local system. Therefore, the system is designed with automatic discharge without time delay. The entry to the turbine enclosure shall be controlled by entry permits including isolation of the CO2 system.
5. Two separate controls shall be provided for releasing CO2 into the protected space and to ensure the activation of the alarm. One control shall be used for opening the valve of the piping which conveys the gas into the protected space and a second control shall be used to discharge the gas from its storage containers. Positive means shall be provided so they can only be operated in that order. The two controls shall be located inside a release box clearly identified for that particular space.
6. The testing requirements of the CO2-manifold and the pipes have to be specified. The CO2 bottles are to be located outside the protected space in a designated CO2 room.

7. One manual release station is to be arranged outside the protected machinery space.
8. Turbine shut-down sequence including ventilation shut-down, damper closing and timing is to allow for safe and efficient fire extinguishing by CO2 upon fire inside the gas turbine enclosure.

Requirements to Watermist System:

1. The system is examined with respect to Factory Mutual (FM) Approval Report J.I. 0D5A4.AH Class 5560 dated February 9 1998 and Marioff Design, Installation, Operation and Maintenance Manual MO/PES/01/DIOM/FM/97, rev. 1.2 dated May '97, with water supply according to NFPA 750 Ch. 10.3.1. The system holds a Certificate of Compliance from FM Approvals (id. 0D5A4.AH).
2. Applicable standards and requirements for the fire extinguishing system are subject to case-by-case decision by each project, based on flag state and local shelf state regulations.
3. The fire system cabinet and section valves shall be installed in a room having ambient temperature between +4 °C and +45 °C.