Guideline No.: M-27(201904)

M–27

Gas Turbines

Issued date: 04 17 ,2019

Foreword

CCS Product Inspection and Testing Guideline (hereinafter referred to as this Guideline) contains the technical requirements, inspection and testing criteria related to classification and statutory survey of marine products to be applied for CCS approval/inspection.

This Guideline frees the users to adopt other test methods and requirements which are equivalent to or are stricter than this Guideline.

This Guideline is published and updated by CCS, and is released at http://www.ccs.org.cn. Your comments or suggestions are welcomed and may be sent to our email addressed mp@ccs.org.cn.

Historical versions and release date: M27(201904) 04 17, 2019

Main changes: New Release

CONTENTS

GAS TURBINES

1 Application

This Guideline is applicable to the approval and inspection of main propulsion gas turbines, auxiliary gas turbines and other marine gas turbines related to the classification, and can be used as a guide to gas turbine units for other purposes.

2 Normative refercence documents

(1) CCS *Rules for Classification of Sea-Going Steel Ships*

(2) CCS *Rules for Materials and Welding*

(3) ISO 2314 *Gas turbines-Acceptance Tests*

(4) ASME PTC 22 *Gas Turbines Performance Test Codes*

The documents referenced in this Guideline. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

3 Definitions

3.1 For the purposes of this Guideline, the definitions of the *CCS Rules for Classification of Sea-Going Steel Ships* apply.

3.2 The main definitions of this Guideline are as follows:

(1) Gas turbine: a (single-engine) rotary machine that converts thermal energy into mechanical work, and consists of the compressor, equipment for heating working medium (e.g. combustor), turbine, control system, and auxiliary equipment;

(2) Gas generator: a gas turbine assembly that generates high-temperature and high-pressure gas and delivers the gas to the technological process or free power turbine.

(3) Compressor: a gas turbine component that increases the pressure of a working medium by mechanical power, together with an increase in temperature;

(4) Combustor: a gas turbine component that increases the temperature of a working medium in the process where a fuel (heat source) reacts with the working medium;

(5) Turbine (turbo): a gas turbine component that produces mechanical power through expansion of working medium;

(6) Compressor turbine: a turbine that drives a single compressor or multiple compressors in a multi-shaft system;

(7) Power turbine: a turbine that is driven by the gas discharged from a gas generator, and produces output power through its independent shaft;

(8) ACS: i.e. the Alternative Certification Scheme, an inspection and certification scheme in which the classification society authorizes a manufacturer to undertake and witness tests instead of a surveyor from the classification society after evaluating the quality assurance and quality control arrangement of the manufacturer and confirming that it meets the requirements. refer to Section 10, Chapter 3, Part One of CCS Rules for Classification of Sea-going Steel Ships.

4 Plans and documents

4.1 Drawings/documents to be submitted during product plan approval

4.1.1 The gas turbine provided to apply for CCS approval and inspection shall be provided with drawings/documents for CCS approval and future reference in accordance with the requirements of Articles 8.1.6.1 and 8.1.6.2 in Chapter 8 , Part Three of CCS Rules for Classification of Sea-Going Steel Ships;

4.1.2 Except for the drawings/documents required in Article 4.1.1, the following drawings/documents shall be submitted for CCS approval:

(1) Cooling and sealing air system diagram;

(2) Power turbine component diagram;

(3) Startup system schematic;

(4) Bearing and coupling diagram;

(5) Design, welding procedures, heat treatment and nondestructive testing requirements for welded joints of the rotor, stator or other parts of a gas turbine constructed in welded structure;

(6) Control and monitoring system diagram.

4.1.3 Except for the drawings/documents required in Article 4.1.1, the following drawings/documents shall be submitted for CCS future reference:

(1) General assembly drawing or layout drawing of compressor bleed valve;

(2) Calculation and analysis of the containment performance of gas turbine cylinder (casing).

4.1.4 Other drawings/documents deemed necessary by CCS

4.2 Drawings/documents to be submitted during product approval

4.2.1 The drawings/documents to be submitted during product approval shall at least include the following contents:

(1) Technical characteristics of products;

(2) Type test program for items to be witnessed by CCS (including exemption instructions, if applicable);

(3) Type test report (to be submitted upon completion of type test);

(4) Technological process documents for important components, including the welding procedures (in which the welding procedure qualification and approval shall be subject to CCS Rules for Materials and Welding or relevant requirements of recognized standards), and the procedures for shot blasting process, spraying process, production process of castings and forgings, product process, etc.;

(5) Manufacturer overview: including the manufacturer name, address, production history, production capacity, technical and inspection personnel, main products, affiliation, and product trademarks;

(6) List of raw material and main component suppliers;

(7) Other valid documents, reports and certificates showing that the applicant has the production capacity and can provide the required quality of the products within the approved scope;

(8) Quality assurance system documents, including quality manuals, procedures related to product quality control, main product production equipment, and inspection and testing equipment;

(9) Enterprise registration certificate, business license, qualification certificate and/or production license (if any);

(10) Nameplates, use signs, instructions for use/operation and quality certificates (including the referenced standards, product performance, quality assurance, and responsibilities) of the marine products to be subject to CCS product inspections shall be written in the language specified by the ordering party, and English version must be included in the case of ships engaged in international voyages.

(11) Documents specified in Article 3.4.3.3 of Section 4 in Chapter 3 ,Part One of CCS Rules for Classification of Sea-Going Steel Ships shall be provided for gas turbines to apply for Type Approval mode A;

(12) The manufacturer who intends to adopt the Alternative Certification Scheme shall provide the appropriate documents according to the relevant requirements of Article 3.10.3.1 of Section 10 in Chapter 3 ,Part One of CCS Rules for Classification of Sea-Going Steel Ships.

5 Design and technical requirements

5.1 Ambient conditions

The design, selection and arrangement of a marine gas turbine shall assure proper operation of the gas turbine at the ship's inclination angle and under ambient temperature conditions specified in Section 2 ,Chapter 1 , Part Three of CCS *Rules for Classification of Sea-Going Steel Ships*.

5.2 Overload capacity

The gas turbine used for main propulsion and prime mover of generator set shall have the capacity of operating at 110% rated power.

5.3 Astern power

The astern power of the main gas turbine propulsion unit shall conform to the relevant provisions of Article 1.2.4 of Section 2 , Chapter 1 , Part Three of CCS *Rules for Classification of Sea-Going Steel Ships*.

5.4 Materials and nondestructive testing

The general requirements, high-temperature performance requirements, as well as the requirements for tests and nondestructive testing of gas turbine components and materials shall all be consistent with Article 1.2.8 , Chapter 1, Part Three and Section 2, Chapter 8,Part Three of CCS *Rules for Classification of Sea-Going Steel Ships*, and the relevant provisions of this Guideline.

5.5 General requirements for design and construction

All components of the gas turbine compressor and turbine shall have fits and clearances consistent with the thermal expansion requirements; the gas generator and power turbine bearings shall be such arranged that the lubrication of bearings is not influenced by hot gas, and effective measures shall be taken to prevent lubricating oil leaks from coming into contact with high-temperature components.

5.6 Vibration

When the gas turbine operates at a speed within the normal speed range, the rotors, impellers and vanes of the turbine and compressor shall be free of vibrations that are beyond the allowable design range, and the calculation of critical speed shall be performed. If the critical speed is within the normal speed range during calculation, rotor vibration measurement shall be conducted.

5.7 Adjustable vane

When a variable guide vane (VGV), inlet guide vane (IGV) and/or variable stator vane (VSV) are used to control compressor flow, the actuator shall be designed to operate the vane adjustment mechanism under any conditions.

5.8 Containment requirements

Gas turbine cylinder (casing) shall be designed in accordance with the containment requirements, and the loss of any vane of axial rotor shall not result in cylinder penetration and disintegration.

5.9 Combustion unit and burners

The combustor shall be equipped with dual igniters, and these igniters shall not remain in the primary combustion zone during operation. The flame monitoring measures shall enable monitoring of the flame during operation.

Provisions shall be made for inspection of the combustor system such that all important sections can easily be inspected, particularly the burner area and combustor outlet.

Appropriate discharge facilities shall be installed at the fuel manifold and fuel nozzles in the system (if the design of the gas turbine itself can avoid the accumulation of excess fuel, the installation of a separate drainage system is not necessary);

The combustor shall be provided with a separate drainage system to prevent fuel accumulation after a startup failure.

The fuel nozzle shall be easily accessible and removable without the need to disassemble the burner. The fuel nozzle shall be replaced as a complete unit without the need for major adjustment after replacement.

5.10 Fuel and salt deposits

5.10.1 Gas turbines in which harmful deposits are formed because of fuel combustion shall be provided with appropriate measures for regular removal of these deposits.

5.10.2 Measures shall be taken to prevent the accumulation of salt deposits in the compressor and turbine.

5.11 Inspection openings

Generally, the gas turbine should be provided with sufficient inspection openings to enable inspections of the compressor/turbine rotors and the combustor interior with the help of a borescope or other instruments without disassembly of the gas turbine.

5.12 Bleed valve

The location and dimensions of the bleed valve shall be indicated in the drawing. For a variable bleed valve, the characteristics related to the mass flow of the compressor and the opening degree of the bleed valve shall be recorded. Any single failure in the actuating control system shall not

have detrimental effect on the compressor.

5.13 Bearings

Bearings shall be designed in accordance with the manufacturer's standards, and shall have adequate service life under the loads generated by full-load operation of turbine. The bearings shall be equipped with sufficient replaceable seals, and operate reliably under normal or abnormal transient conditions.

5.14 Internal air cooling system

The internal air cooling system shall be designed to provide sufficient air flow to keep the turbine temperature within the design limits under full load conditions.

5.15 Intake and exhaust systems

5.15.1 The intake system of gas turbine shall be designed to prevent harmful foreign objects from entering the compressor and turbine, and the intake pipes and components (e.g. filters, silencers and anti-icing equipment) shall be manufactured and installed in a manner to minimize the risk of loose components entering the gas turbine.

5.15.2 The exhaust system of gas turbine shall be arranged to prevent the discharged gas from entry into the compressor. For the gas turbine with heat exchanger installed in the exhaust pipe, it is required that the back pressure of the gas does not exceed the maximum value specified by the gas turbine manufacturer.

5.16 Anti-icing facilities

Icing environment shall be taken into account with regard to gas turbine, and an anti-icing device shall be installed in the air intake system.

5.17 Compressor cleaning

The compressor air passage shall be consistent with the compressor cleaning method (by water, solvent or steam) required to remove salt and industrial dirt. After cleaning, the maximum output power at the same turbine inlet temperature shall not be lower than the rated power. Cleaning shall be done without removing any parts. On-line cleaning shall be possible if required.

5.18 Turning gear

The main gas turbine unit shall be equipped with turning gear. If a motor turning gear is used, the device shall be interlocked with starting arrangements.

5.19 Starting system

5.19.1 The starting arrangements and starting air pipes,the capacity of electric starting device shall conform to the relevant provisions of Section 5 , Chapter 9 ,Part Three of CCS *Rules for Classification of Sea-Going Steel Ships*.

5.19.2 Automatic or interlocked means are to be provided for clearing all parts of the main gas turbine of the accumulation of liquid fuel or for purging gaseous fuel, before ignition commences on starting or recommences after failure to start. Where means are provided for automatic starting, a purging program is to be included in the starting sequence.

5.19.3 Starting devices are to be so arranged that firing operation is discontinued and main fuel valve is closed within pre-determined time, when ignition is failed.

5.20 Lubricating oil system

The lubricating oil system of gas turbine shall comply with the relevant provisions of Section 6 , Chapter 4 ,Part Three of CCS *Rules for Classification of Sea-Going Steel Ships.*

5.21 Speed governor

The configuration and technical requirements for gas turbine speed governor are detailed in Article 8.4.2 of Section 4 , Chapter 8,Part Three of CCS *Rules for Classification of Sea-Going Steel Ships.*

5.22 Control, alarm and safety protection system

The control, alarm and safety protection system of gas turbine shall be in accordance with the relevant regulations of Section 4 , Chapter 8, Part Three and Part 7 of CCS *Rules for Classification of Sea-Going Steel Ships*.

5.23 Fuel conversion

For non-single fuel gas turbines, an automatic control system for fuel conversion shall be installed, and the conversion from one fuel mode to another fuel mode (and vice versa) shall be easy and quick. The power fluctuation shall be minimized.

5.24 Thermal insulation

If the surface temperatures of the gas generator casing, power turbine casing and exhaust volute exceed 220℃ during operation, proper insulation and wrapping shall be carried out to prevent fire caused by exposure to combustible liquid. If the surface of insulation facilities is oil-absorbing or may be penetrated by oil, it shall be properly wrapped with thin steel sheets or similar materials.

5.25 Instrumentation

The main propulsion gas turbines shall be provided with necessary monitoring device so as to display and/or record various principal parameters such as temperature, pressure and speed. The monitoring device shall at least meet the requirements of Article 8.3.9 in Section 3 , Chapter 8 , Part Three of CCS *Rules for Classification of Sea-Going Steel Ships*.

5.26 Acceptance criteria for nondestructive testing of main components and piping system

The commonly used nondestructive testing (NDT) criteria for main components and piping system of a gas turbine shall be consistent with the recognized standard requirements. If the manufacturer or patent party has formulated any NDT process and acceptance criteria, the NDT process and acceptance criteria of the manufacturer or patent party will be accepted once evaluated and approved by CCS.

6 Main components and parts

6.1 The materials and components shall be controlled according to the relevant requirements of current Rules of CCS.

6.2 For the main components required in Article 6.1 of this Guideline, if these components are produced by the gas turbine manufacturer itself, the surveyor can just sign the report after participation in the corresponding tests and inspections, without the need to issue a component completion certificate. In case of outsourcing, the supplier shall apply to CCS for inspection and certification. For materials ordered from other manufacturers, the relevant material manufacturer shall apply to CCS for inspection and certification, and the on-site surveyor shall check the material certificate when carrying out the component completion inspection.

7 Type test

Type tests are only valid for a specific type of gas turbine, and do not cover a range of design

changes. The maximum speed, maximum combustion temperature, maximum turbine inlet temperature, exhaust temperature, mass flow rate and other parameters are fixed for a given type of gas turbine.

For each type of gas turbine that requires approval, the gas turbine manufacturer shall apply for the CCS type approval certificate. The approval process, documentation process and requirements shall be in accordance with the requirements of Section 4 in Chapter 3， Part One and Chapter 8 ,Part Three of CCS *Rules for Classification of Sea-Going Steel Ships*, as well as the requirements of this Guideline.

When a specific gas turbine is provided to apply for Approval Type, effective operational evidence of no major failures or component replacements (which can be obtained by internal tests or application on board) during a period of 3000h (for gas turbines which are usually operated at a high utilization rate, such as main propulsion devices and driving generators; such period of time can be shortened to 1000h for gas turbines which are operated at a low utilization rate, such as yachts, hydrofoils, booster propulsion units and engine-driven emergency generators) shall be provided during application, and the operation overview and power values recorded through relevant operational experience shall be consistent with the gas turbine to be type approved.

7.1 Typical prototype

The gas turbine to be approved shall be selected from each model for type test, and the following contents shall be ascertained before the test:

(1) The prototype has been manufactured according to the requirements of drawings and technical documents approved by CCS;

(2) The manufacturer has conducted internal tests and assured the reliable performance.

7.2 Type test items

The type test of gas turbine shall be carried out according to the following items specified in this article.

7.2.1 Inspections/tests of main components

See Table 7.2.1 for inspection and test requirements of main components of a gas turbine. For the

components not specified in Table 7.2.1, such as piping system, valve parts, heat exchanger, gear transmission device and electrical control box, the inspections and tests shall be carried out according to applicable requirements of CCS *Rules for Classification of Sea-Going Steel Ships*.

Inspection and test requirements for main components of gas turbine① Table 7.2.1

Test item / Component name		Material performance	Nondestructive testing	Hydraulic test/tightness test	Dimension check (including surface condition)	Coating inspection (if applicable)	Visual inspection	Performance ② test	Fatigue test (if applicable)
Shaft		CC+M	UT+MT/PT	-	X	X	X	-	
Impeller	Forged	CC+M	UT + MT/ PT	-	X	-	X	-	
	Cast	CC+M	RT+FPI	-	X	-	X	-	
Vane	Forged	CC+M	UT +MT/PT	-	X	-	X	-	X
	Cast	CC+M	RT+FPI	-	X	X	X	X	X
Wheel disc		CC+M	UT+MT/PT	-	X	-	X	-	
Guide vane		CC+M	RT/UT+MT/PT	-	X	X	X	-	
Turbine and compressor cylinder (casing)	Forged	CC+M	UT/RT+MT/PT	X	X	-	X	-	
	Cast	CC+M	RT+FPI	X	X	-	X	-	
Combustor (including flame tube)		CC+M	RT+ MT/PT	-	X	X	X	X	
Stay bolt and connecting bolt		CC+M	UT+MT/PT	-	X	-	X	-	

Notes: ①

(1) The dimension check items specified in above table can be checked randomly in a certain proportion or the

test reports of the manufacturer can be reviewed according to the actual situation of the manufacturer;

(2) When it is impossible to perform the hydraulic test, the manufacturer shall submit the alternative approach that can ascertain the absence of defects in the components to CCS for review;

(3) If the rotor, cylinder, flame tube and other components involve welding operations, the relevant welding procedures shall be approved by CCS, and RT, PT or FPI tests shall be conducted after welding.

(4) Description of relevant symbols in above table:

C—Chemical composition; M—Mechanical properties; MT—Magnetic particle testing; UT—Ultrasonic testing; PT—Penetrant testing; RT—Radiographic testing; FPI—Fluorescent penetrant inspection

(5) "X"—Applicable; "-"—Not applicable.

Note: ②

For cast vanes, performance tests include the pressure drop and flow tests of air passage in cooling hole. For flame tubes, performance tests include the flow tests of cyclone and flame tube.

7.2.2 Rotor dynamic balance test

The rotor assembly of the compressor and turbine shall be assembled with the driving part of the coupling for dynamic balance test. The test results shall meet the manufacturer's criteria or grade G2.5 in DS/ISO 1940.

7.2.3 Overspeed test

The rotor assembly shall be overspeed tested at a minimum speed of 115% rated speed for 5 minutes. CCS may accept the mathematical proof of stresses in rotating parts at overspeed as an alternative to the overspeed test, provided that reliable calculations of the design are possible and that the rotating parts have been thoroughly nondestructive tested and confirmed to be free of defects.

7.2.4 Internal verification test.

As a final verification of a new gas turbine design, internal verification test shall be performed on a gas turbine within the expected application range. The duration of the verification test shall depend on the extent of design changes in the master-pattern gas turbine, but shall be not less than 100 hours. No major failures shall occur during the test. The start-full load-stop cycles shall be specified with an exact quantity in the test program and approved by CCS before being implemented in the type test. Upon completion of the test, the gas turbine shall be disassembled for inspection, and the test procedure and test report shall be submitted to CCS for approval. The

verification shall be carried out in the factory, and the surveyor may request to witness the relevant test according to the actual situation.

7.2.5 Starting test

A total of six starts tests shall be carried out, and the first start test shall be carried out two hours after the gas turbine is shut down. There shall be at least one start failure of the gas turbine before trying to start it properly. It is necessary to ascertain the minimum fuel discharge period of time specified by the manufacturer. The gas turbine shall be started properly for at least 3 times within 15 minutes after emergency shutdown (unless otherwise specified). For gas turbines used for emergency purposes, quick start test shall be carried out.

7.2.6 Speed governor test

The following conditions shall be satisfied when gas turbines operate at full load and are suddenly unloaded. For the main propulsion gas turbine equipped with reversing gear, controllable pitch propeller or electric transmission gear, the speed governor shall control the speed of the power turbine when suddenly unloaded, without causing the overspeed protection device to act. For the auxiliary gas turbine device driving the generator, the speed governor shall enable the instantaneous speed regulation rate be not more than 10% of the rated speed, the stable speed regulation rate be not more than 5% of the rated speed, and the stabilization time (that is, the time for the speed to return to the fluctuation rate within ±1%) be not more than 5s.

7.2.7 Safety protection device test

The gas turbine safety protection device shall be tested for the items listed in Table 7.2.7, and the relevant tests shall be conducted before the gas turbine operation test, which can be verified by actual operation or simulation according to the specific conditions of the test bench.

Test items of gas turbine safety protection device **Table 7.2.7**

S/N	Test items
1	Too low lubricating oil pressure protection
2	Flameout protection during operation
3	Ignition failure protection

Continued table 7.2.7

S/N	Test items
4	Overspeed protection
5	Excessive vibration
6	Large axial displacement of rotor (if applicable)
7	Turning gear interlocking
8	Emergency shutdown It shall be performed once at full load (if allowed by the manufacturer) in the hot state
9	Too high exhaust temperature
10	Low lubricating oil pressure of reduction gearbox (if applicable)
11	High inlet vacuum pressure
12	Other safety protection items specified by the manufacturer

7.2.8 Mechanical operation test

The gas turbine shall run at idle speed until the temperatures of bearings and lubricating oil reach the operating range specified by the manufacturer and the shaft vibration is stable. The unit shall then be accelerated to the lowest speed and run in increments from the lowest speed to the highest continuous speed. At each speed increment, the unit shall be allowed to stabilize and the parameters shall be recorded.

During test, all the transverse vibration characteristics of gas generator shafts at a speed within the range of 0% to 100% rated speed shall be recorded. Vibration levels produced at a speed of 0% to 100% rated shaft speed up to idle speed and generated because of sliding-induced speed drop and final stop shall be recorded. If 100% speed is impossible due to environmental conditions, the recorded results of previous tests can be used as a substitute for verifying vibrations produced at higher speeds. The relevant vibration measurement results shall meet the calibration requirements specified by the manufacturer.

If no damage occurs to the gas turbine, the test functions and operating parameters are within the specified range, and the vibrations meet the requirements, the gas turbine will be deemed to have passed the mechanical operation test. After the test, if it is considered necessary to make changes to the design, a complete test shall be conducted again.

7.2.9 Performance test

A leak check shall be performed prior to all operational tests.

Performance tests shall be performed in a manner equivalent to a recognized standard, including ISO 2314 Gas turbines—Acceptance tests or ASME PTC 22 Performance Test Code on Gas Turbines.

Gas turbines shall be operated according to the power/speed curve for the intended use (e.g. propulsion characteristic curve for mechanical propulsion, load characteristic curve for driving a generator);

The gas turbine shall be tested at a minimum of 4 load points (between 25% and 100%) within an approximately equal spacing range. The operating time recorded at each load point depends on the size of the gas turbine (conditions to reach steady state) and the time required to collect the operating data. The gas turbine shall also be tested for a minimum of 4 hours at maximum load within the limits of the control system. For dual-fuel gas turbines, both fuels shall be tested separately.

The data measured and recorded during the gas turbine test at each load point shall include all the primary operating parameters of the gas turbine, such as power, speed, torque, pressure, temperature, vibration level, position of variable stator vanes, or the opening position of bleed valve. For the specified test points, the test data shall be recorded after the gas turbine has reached steady state.

When the measured test parameters do not meet the design specifications (e.g. high temperature), formal changes to the design specifications shall be made and recorded before accepting the test results. Otherwise, the test may be considered a failure.

Before the on-load test, the gas turbine and control system shall be operated under no load for at least 20 minutes without failure.

The lubricating oil shall be sampled to check the contamination of metal wear particles before and after the test. The relevant results shall comply with the manufacturer's technical regulations.

The acceleration and deceleration tests of the gas turbine shall be witnessed by the surveyor.

7.2.10 Fuel conversion test (if applicable)

The gas turbine to be operated with dual fuels shall be tested for fuel conversion at the operating point specified by the manufacturer. When the gas turbine is converted from one fuel to another,

such as from liquid to gas fuel or vice versa, no harmful changes in the operating parameters shall occur during the conversion process.

7.2.11 Component condition inspection (borescope inspection/disassembly)

Borescope inspection/disassembly shall be performed after type test.

There shall be no cracks or major wear on rotating parts after the test of each new gas engine. Gas turbines with minor cracks, pits or wear on non-critical fixed parts may be accepted on the basis of acceptance criteria.

The following components shall be provided with borescope inspections when the gas turbine design permits (e.g. the location of inspection openings):

—Compressor (vanes and nozzles)

—Combustor

—Burner

—Gas generator turbine (vanes and nozzles)

—Power turbine (vanes and nozzles)

Appropriate instruments and necessary personnel shall be provided during the inspection.

After type test, the sensitive parts of the gas turbine shall be visually inspected after disassembly. The scope of the disassembly and inspection shall be agreed by the manufacturer and CCS. However, it shall be, as the minimum requirement, easy to visually inspect the interiors of vanes, bearings and cylinders.

The inspection and disassembly report shall be submitted for future reference, and the records of the borescope inspection shall be part of the report.

7.3 Test conditions

7.3.1 If the test bench of the manufacturer serves as an approved test site, it shall enable the testing of all test items specified in the program. CCS will verify and confirm that its conditions such as

test capabilities, testing methods and test personnel meet the requirements. Otherwise, the tests shall be carried out in a place that CCS considers to have the conditions.

7.3.2 The measuring instruments for testing shall have valid metrological verification certificates, and their accuracy shall meet the requirements of recognized standards.

7.4 Exemptions of type test items

For the gas turbine provided to apply for CCS approval, if the applicant can provide sufficient supporting materials (e.g. type test report signed and confirmed by IACS member classification societies), some or all the type test items can be exempted once it is assessed acceptable by CCS.

8 Unit/bach inspection

Each gas turbine to be installed on CCS class ship shall be provided with unit/ batch inspections, and shall have the CCS marine product certificate. The gas turbine manufacturer shall obtain the CCS marine product certificate in accordance with the relevant provisions of Section 2 , Chapter 3 ,Part One of CCS *Rules for Classification of Sea-Going Steel Ships*.

8.1 Unit/ batch inspection after approval

8.1.1 The certification requirements for materials and components of gas turbine shall meet the requirements of Article 6 of this Guideline.

8.1.2 Only gas turbines that have passed the inspection/test by the manufacturer and have reached the deliverable state can apply for CCS unit/ batch inspection.

8.1.3 Inspections shall be carried out in accordance with the inspection plan approved at the time of approval on a one by one basis, and the factory test of gas turbines shall be carried out in accordance with the approved inspection plan at the time of approval. Moreover, the following requirements shall be included.

(1) Before the certification test, the gas turbine and its control and monitoring system shall be operated under no load and free of failures for 20 minutes;

(2) The lubricating oil shall be sampled to check the contamination of metal wear particles before and after the test, and the results shall meet the technical requirements of the

manufacturer;

(3) Test items

① The items listed in Articles 7.2.1,7.2.2,7.2.3,7.2.5, 7.2.6, 7.2.7 and 7.2.10 of this Guideline shall be tested once the unit/batch inspection after approval;

② The gas turbine shall be tested at the power level approved by CCS.The test should simulate the expected operating conditions, including the typical start-stop cycle and load point test. The number of stable operating points shall be sufficient to establish the characteristic operating values of the gas turbine according to the expected application (stable operating points represent the typical 100%, 90%, 75%, 50%, 25% and 10% output power of gas turbine, with the operation at 110% overload to be verified). The operating time recorded at each load point depends on the size of the gas turbine (steady-state conditions achieved) and the time taken to collect the operating parameters. Gas turbine shall be operated at 100% load point for at least 90 minutes. The functions of starting, idling, accelerating, decelerating and stopping shall be simultaneously verified;

③ Vibration measurements shall be performed during test. The requirements of the manufacturer indicate that the steady-state vibration levels at different speeds and powers shall be recorded, and the vibration levels shall meet the criteria of the manufacturer;

④ Inspection of components (borescope inspection).

The gas turbine submitted for inspection shall be subjected to borescope inspection once the factory test is completed according to the requirements of Article 8.1.3, and the scope of inspection shall be the same as that in Article 7.2.11 of this Guideline;

The on-site surveyor shall confirm the borescope inspection. For gas turbines with CCS type approval, disassembly inspection may not be required if the on-site surveyor satisfies the borescope inspection.

8.1.4 When applying for unit/ batch inspection, the product certificates, quality certificates or inspection/test records of the main components or materials of the batch of products controlled according to Article 6 of this Guideline shall be submitted to CCS surveyor for review.

8.2 Product inspection for manufacturers that have obtained CCS Type Approval A or Alternative Certification Scheme (ACS).

(1) For the inspections performed on the products of manufacturers that have obtained CCS Type Approval A or ACS mode, the test items that require witnessed by CCS surveyor can be reduced to a certain amount or exempted; the manufacturer is allowed to implement some or all inspections and tests without the CCS surveyor; the factory test can be formulated in the inspection plan according to the evaluation of quality system at the time of approval.

(2) Manufacturers that have obtained CCS Type Approval A or Alternative Certification Scheme shall apply for periodical audit on time according to the requirements of Section 4 or Section 10 in Chapter 3 , Part One of CCS Rules for Classification of Sea-Going Steel Ships.

8.3 Unapproved unit/ batch inspection

In principle, all type tests shall be carried out in accordance with the requirements of Article 7 of this Guideline for gas turbines that are not approved by CCS but are provided to apply for CCS unit/ batch inspection. For the test items specified in Article 8.1.3, new corresponding tests shall be conducted if the type test does not cover these items.