

QD100 GAS-STEAM COMBINED—CYCLE  
15MW POWER SET PROPOSAL

**Mongolia country item**



**CHINA AVIATION GAS TURBINE COMPANY., LTD.**  
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### content

1	China Aviation shixin gas turbine com.,ltd. Introduction-----	1
2	The data which provided in the forepart-----	6
3	QD100Gas-steam combined cycle genset assembly solution-----	8
4	Fuel supply-----	39
5	Cooling water system and compress air system requirement of the Combined-Cycle unit -----	42
6	Environmental protection-----	44
7	Scope of supply-----	46
8	design、 manufacture and accept standard-----	58
9	Power Set Manufacturing cycle-----	60
10	After service-----	60
11	Attached drawing-----	65

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## 1. China Aviation shixin gas turbine com., ltd. Introduction

### 1.1 Company profile

#### General

China Aviation shixin gas turbine com.,ltd. (hereinafter use the CAGT for short) as a gas turbine package company ,established by 13 independent *share holders* in accordance with the requirement of public companies as the results of the effective resource consolidation of the gas turbine core business within China Aviation Industry Corporation, Authorized by State Economic &Trade Commission, Authorize document No:2002-814,Booking in the State Administration for Industry &Commerce on Dec 25,2002. On Jan 10 2003,CAGT achieved the Certificate for High &New Technology Enterprise awarded by Beijing Science &Technology Committee. CAGT accede the gas turbine business of the companies belong to China aviation industry corporation I.. Its main business include: Design, development, manufacture and package of gas turbine unit ; Introduction and package of foreign gas turbine unit ; Prime contract of gas turbine unit , installation and commissioning, maintenance and repair ,running management ,spare parts supply of gas turbine ; Consultation ,planning ,service of gas turbine and related power engineering projects.

CAGT comprise of Shenyang branch, technical center, market department, quality control department, operating and planning department, general managing department and finance accounting department.

CAGT Shenyang branch is one entity belong to CAGT. It is a High &New Technology Enterprise. Its main business include:: Design, development, manufacture and package of gas turbine unit ; Introduction and package of foreign gas turbine unit ; Prime contract of gas turbine unit , installation and commissioning, maintenance and repair ,running management ,spare parts supply of gas turbine ; Consultation ,planning ,service of gas turbine and related power engineering projects. Design and manufacture of product line of Electro-mechanical equipment , non-standard ,special & test equipment , pressure vessel , thermalization product, and torch burmer etc. Shenyang branch is the research and manufacture basement of CAGT.

Human resource: Now, CAGT has 1,200 employees. Among them 105 employees are senior technicians (8.5%), 304 employees are intermediate technicians (26.4%).

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Machining capability: Machining workshop: 21,640 m<sup>2</sup> ; Machining equipment : more than 230 sets; Machining capability:866,250 hours per year; Welding equipment:200 sets; Welding capability:750,000hours per year

When the new modern workshop (18,000m<sup>2</sup>) special for gas turbine packaging come into use, it will has the production capability that package 20 sets medium and small gas turbine.

## 1.2 Product and achievement

China aviation industry corporation I develop the WP6G cogeneration industry gas turbine genset based on the aeroengine technology at the end of 1970s. it generates electricity power 4.8MW、 produce heat 4×10<sup>7</sup>kJ/h. The unit was developed successfully in 1984. It was installed and put into production in Daqing. After that, another 11 sets WP6G gas turbine units were supplied to Daqing, shengli, zhongyuan and Qinghai oil field in succession. They have been run more than 800,000 hours till the August ,2003. The units make their contribution to make up electric power shortage for oil field.

At the end of 1980's, according to the market requirement, the company developed the following business: installation, maintaince, operation and overhauling for imported gas turbine units. Up to August of 2003, the company finished installing and com missioning 50 sets gensets of 14 types imported gas turbines at home and abroad. The main types include: LM2500、 LM5000、 LM6000、 MS5001、 MS6001、 MS9001E、 Taurus60、 Mars100、 Titan130、 SK15HE、 FT8twin、 Typhoon、 GT13D and GT13E2; Ten types (MS5001、 MS6001、 MS9001E、 W101、 GT13D、 GT13E2、 SK15HE、 KG5、 251B11 及 V94.2) gas turbine gensets and five types (MS1002D、 MS5001、 Centaur40、 Tornado 及 PGT10) gas turbine compressors(altogether 208 sets) were examined ,repaired and overhauled at field; Many kinds of heat components of gas turbine (combustor flame chamber, changeover portion, turbine nozzle segment, turbine blade) were repaired. CAGT is a specially enterprise with rich experience. It installed and overhauled the most of imported gas turbine gensets in domestic.

When came into 2000's, the company developed QD128 type (12.8MW) and QD70 type (7MW) gas turbine genset with success. The two types adopt domestic advanced modified aeroengine as the gas turbine. The fist set of QD128 and QD70 both used as demonstrating unit were installed at Wenliu and Pucheng generating station of Zhongyuan oil field. In July of 2003, the units paralleled with grid and came into commercial operation.

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To meet domestic and international market requirement and continually improve competition ability of domestic gas turbine industry, CAGT introduced advanced gas turbine and its package technology through international cooperation in 2002. CAGT signed the entire cooperation agreement with GE oil and gas company (GE/NP) about purchasing GE10-1 type gas turbine. QD100 type gas turbine genset (10MW) designed and developed by CAGT just use the GE10-1 gas turbine which has advanced technology and high efficiency.

With the principle of“unified product planning ,unified product research and development ,unified product packages ,and unified after-sales service”,CAGT makes full use of its first-class aviation power technologies ,equipment and the integral advantages with distinctive features ,and actively participates in the competitions on both the domestic and international gas turbine markets ,so as to provide the clients with sets of high-quality gas turbines and their power engineering service.

CAGT enterprise spirit: Creating Harmony ,Pursuing Excellence.

CAGT enterprise philosophy: Creating value for users , Creating profit for shareholders, Creating future for employees, and Creating prosperity for society.

## **2. The information which provided in the forepart**

CAGT (China Aviation gas turbine co., ltd), as the company which deals with the gas turbine package and service, is interested in the EPC construction project of your power plant. To work out the most optimal project as soon as possible, please provide the data as follow:

**2.1.**The size of power plant and investment&production project of unit (cycle mode, simple cycle orcombined cycle, automatic degree)

**2.2.** GT fuel **type, component, pressure, flow, temperature, impurity**, ( natural gas/fuel oil)

**2.3.** Power feeding condition, for example voltage on power circuit, connection mode, etc.

**2.4.** Construction period

**2.5.** Transportation and installtion condition

**2.6.** **Water source condition**

**2.7.** **Field condition,hydrographic condition, weather condition and geologic condition**

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Annual average temperature	°C
the highest air temperature of the past years	°C
the lowest air temperature of the past years	°C
annual average relative humidity	%
maximum	g/m <sup>3</sup>
minimum	g/m <sup>3</sup>
annual rainfall	mm
Annual average air pressure	mba
past years average wind speed	m/s
altitude height of the factory site	m
the load supporting for foundation	kPa
basic earthquake intensity	

With the owners demand, the above information will help us to make a configuration as accurate as possible

### **3. QD100 Gas-steam combined cycle genset assembly solution**

#### **3.1 operating principle**

Operating principle of the gas-steam combined cycle genset as follow: the suction air (achived by gas turbine ) from the free air will be compressed by the compressor. Then the compressed air mixed with fuel will be burned to drive the turbine and the generator to generate electric power. The exhaust with large flow capacity and high temperature will be led in exhaust heat boiler. Then the steam with medium temperature, medium pressure and overheat steam will be generated. The steam enters the tubounit to generate electric power. The gas turbine genset, exhaust heat boiler and turbounit make up the gas-steam combined cycle genset.

Comparing with routine thermal power station, gas-steam combined cycle genset is a new technology. It has the following advantages:

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High thermal efficiency: because of take good use of the waste heat of the gas turbine exhaust, its heat efficiency can reach 40% or even higher. The value is much higher than the thermal power station with the same capacity

Performance is agility. 15 minutes will be needed from gas turbine start to full load. From exhaust heat boiler hot start, 45 minutes later it will reach full load (2 hours for cold start). Gas turbine itself can be adapted to big range load variety. So, combined cycle generating station not only can run with basic load economically but also can run as a peaking genset.

Occupation of land is small. Project period is short. Due to gas turbine genset is the principal part of the combined cycle power plant, the factory equipment is simple, no coal yard, no ash and flue gas cleaning system. Both gas turbine and exhaust heat boiler are compact modules. So the occupation of land is small and the project period is short. From the date that start work ,11 months later the gas turbine genset can pup into operation, 14 months later the combined cycle power plant can be completed and put into production.

Water consumption of the unit is low, personnel quota is in small numbers, automatization degree and reliability is high. As a result of no smoke let and there is little injurant, it will do benefit to environment protection. Garden style cleanly combined cycle power station can be built.

### **3.2 assembly solution**

1 QD100 gas turbine genset, 1 exhaust heat boiler and 1 steam turbine genset came into use in the solution of the proposal. They form the gas-steam combined cycle genset (which power is 15MW).

The basic processes of QD100 Gas-Steam Combined-Cycle Power genset: the nature gas for purification handled and compressed goes into the gas turbines to power, gas turbine exhaust is sent to Heat Recovery Steam Generatoy ,the medium temperature, medium pressure and overheating steam from the boiler rushes into steam turbine to power ,then achieves gas-steam combined cycle power generation.

#### **3.2.1. QD100 gas turbine genset**

##### **3.2.1.1. characteristics of QD100 gas turbine units**

QD100 gas turbine unit designed (according to GE standard )by CAGT uses nigh efficiency GE10-1 (from GE/NP) gas turbine as the core engine. It is packaged under the technical support of GE .It is a industry gas turbine and is suitable for application in China . The unit (rated power 10MW) with low emission standard is a new generation gas turbine pack serious product using medium and low heat value fuel.

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GE/NP carried out improvement of GE10-1 gas turbine by redesigning, adding stage load, reducing stages of shaft-flow compressor (from 17 stage to 11stage), raising total compress ratio, based on mature model PGT10A running about two million hours . Since the succession of study in 1998, fifty-two sets of GE10-1 gas turbine have been sold. Accumulated running hours is up to 200 thousand hours.It accumulates lots of running-hour experience; this series of products is easy to receive in the market.

.Single combustion chamber of GE10-1 gas turbine adopts DLN technology, to reduce effectively discharge index of pollution, eg NOx.Take natural gas for example, DLN technology can make NOx less than 25ppmv, CO lesser than 20ppmv.

Air inlet valve in the front of single burn combustion is adjustable in geometry ,namely the volume of the air coming into premix combustion field can be adjusted,so that combustion hamber has the ability of burning wide scope fuel and make sure that the unit can operate at any load.

QD100 gas turbine generator unit is suitable for liquid fuel having wide scope and different heat value, gas fuel having different contents, and fuel burning medium and low heat value. During burning medium and low heat fuel, adopt double fuel b combustion chamber to make sure normal operation of gas turbine.

QD100 gas turbine generator unit adopts modularization design, container structure, which is easy to installation, detachment and maintenance at site. Eg. during the inspect and repair, can detach combustion chamber singlely on the container , also can hang out the container from the up direction or slide out the whole unit from the side direction .

QD100 unit has high operation reliability (97.2%) and usability (95.6%) . The period of examine and repair (examine and repair interval) is long ,the unit is under normal operation ,the period is 8,000 hours ; the period of heat passage is 16,000 hours ; overhauling of the unit and inspect of accessory system is 32,000 hours . Moreover, no matter the combustion chamber, heat passage or the whole unit repairing can be performed at site; the downtime will be the shortest.

### **3.2.1.2. QD100 gas turbine genset introduction**

During the design and manufacture, CAGT strictly abides the GE standard and domestic correlative trade standard. Its design concept gives prominence to modularization and automatization. QD100 gas turbine genset has reached international level on the aspect of performance, reliability, durability and maintainability. However it possesses even more competitive power on the aspect of price and service.

QD100 gas turbine genset composes of gas generator, reducing gearbox, AC generator and accessories.

GE10-1 gas turbine from GE gas & oil company is used



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AC generator is purchased at home. Further information refers to technical specification of the generator.

Reducing gearbox is the product from Flender company (FRANCE)

The unit is installed on two pedestals that made of 700H profile steel welded connection. One dimension is 8430mm×3200mm×700mm (length×width×height) for gas turbine and gearbox installation; another is 6750mm×3200mm×700mm (length×width×height) for generator installation. The unit takes use of GE10/1 single shaft gas generator to drive generator (open air cooling, 11000V、6300V) through gearbox. The unit takes use of a lubeoil-air cooler (radiator style) to cool down the lube oil (in a separate tank). Air inlet system is made up of one inlet elbow and one self- purging filtering house. It can guarantee the air be filtered efficiently on site.

The unit introduces container structure (one is gas turbine enclosure, the other is generator enclosure) which arranged in open air and needs no building works.

The enclosure introduces frame type construction (convenient to transportation, installation and maintenance). There are inspection and repair doors on the enclosure.

Enclosure dimension as follow:

Gas turbine enclosure: 8430mm × 3200mm ×2325mm (Long x width x high)

Generator enclosure: 6750mm × 3200mm ×3400mm (Long x width x high)

### **3.2.1.3. accessory system introduction of the unit**

According to the operation requirement of the GE10-1 gas turbine, generator and reducing gearbox, the following auxiliary systems are installed.

- 1) air inlet filtering and noise elimination system
- 2) lubricating oil system
- 3) anti-surge bleeding system
- 4) enclosure ventilation system
- 5) compressor cleaning system
- 6) exhausting system

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- 7) water cooling system
  - 8) draining system
  - 9) gas fuel system
  - 10) starting system
  - 11) CO<sub>2</sub> fire fighting system
  - 12) instrument and control system
  - 13) electrical system
  - 14) local control room

The direction orientation of the general layout of the gas turbine genset should be based on the dominant wind direction of the four seasons of the location and the power plant general arrangement. The orientation of every system skid should be adjusted accordingly to avoid the gas turbine exhaust and pollution gas be sucked in the gas turbine.

There is CO<sub>2</sub> automatic fire extinguisher system in the enclosures of the gas turbine genset. Automatic warning device and portable CO<sub>2</sub> extinguisher are equipped in master control room.

#### **3.2.1.4. Electric part introduction**

Local control room is placed near the generator enclosure end. Inside the control room there are turbine control system, generator control system, excitation system, MCC, high voltage switchgear, DC system and fire fighting system.

##### **3.2.1.4.1. Main connection**

The generator main parameters of the gas turbine genset and the turbounit both are:

line voltage : 10.5Kv; frequency: 50Hz.

##### **3.2.1.4.2 . House supply system**

A house transformer provided with the gas-steam combined cycle power set supplies power for unit start, normal operation and the electro-equipments in the workshop and nearby workshops. For supply power reliably, 100% consumption margin are considered about the transformer quantity and capacity. The voltage of the house supply is 380

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/ 220V. Power and lighting share the same transformer. House transformer is energized by generator when generator is running and is energized by local power network when generator is standby.

#### **3.2.1.4.3. The main electric equipment selection principle**

in order to ensure the generating station operating reliably, the domestic high grade product are selected as possible. According to the approved voltage grade and the local condition, the outdoor breaker, distribution equipment, high voltage switchgear, low voltage switchgear and house transformer are selected in optimum.

#### **3.2.1.4.4. Generating station high voltage control system**

Inside the QD100 gas turbine genset Local control room there are gas turbine genset high voltage switchgear, and it exports and protects the high voltage of sets.

#### **3.2.1.4.5. Generating station overvoltage protection**

According to the relative items in 《power equipment overvoltage protect design technical order》, excess voltage protective measures for preventing direct lightning strike should be considered for the buildings and structures such as outdoor high voltage distribution equipment, stack and gas fuel booster station, etc. Excess voltage protection measures for preventing thunder intrude wave should be considered for high voltage overhead outgoing feeder. Surge arrester is installed near the generator outgoing line.

#### **3.2.1.4.6. Gas turbine set control system**

##### **3.2.1.4.6.1. Control system function**

- Control system, with display monitor
- Vibration and temperature monitor: Gas turbine and DGB(decelerates the gear box) vibration monitor. Gas turbine thrust bearing temperature monitor.
- Historical tendency demonstration
- It can realize long-distance control as far as 760 meters
- Unit system : metric
- Language: Chinese
- MOBUS, Profibust Communication port: MOBUS, Profibust

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Measure system: one

#### **3.2.1.4.6.2. Control system composes**

QD100 control system consists of core controller (MarkVI) ,procedure controller (AC800F) ,interface of person and machine (HMI) ,local instrument ,change and delivery instrument (anti-explosion ,safety separate bar uses MTL, satisfy IIAICT4 request), to make QD100 gas turbine has high reliability, security and high efficiency at any condition.

MarkVI, supplied by GE, by using important data of gas turbine; controlling fuel valve and regulating the fuel supply,controls rotate speed and generator power output; regulates the inlet air when starting; prevents engine surge according to the on&off of rotate speed control valve for exhausting; achieves engine over-rotated protection, exhaust overhigh temperature protection and extinguish protection, etc.

The system is based on MPU(microprocessor), delivering message and giving dictation by standard I / O block. The system is redundant and allow mistake, with perfect and reliable control function which is high-integration and anti-jamming. Software, which was compiled flexibly and conveniently, is able to finish the whole process of start, cool blowing、 ignition、 machine warming、 speedup、 combining web and load, can ensure the safety of gas turbine and operate steadily. So control system complete with perfect protection and restriction function, such as, speed control of gas turbine、 control of exhaust temperature、 temperature monitor 、 vibration monitor 、 invalidation、 monitor、 flameout protection and generator load limit, etc.

Boiler combustion system control connection.

The control of three-way baffle-board valve

#### **3.2.1.4.6.3. display**

All the display, are completed by CRT, display different information by different soft button configuration.

- alarm information page

Display alarm information on alarm information field which on control board CRT. Information is arranged orderly, the latest information is on the top. The old information will move to the next line, when the old information is attached. The old information will move up to fill the blank, alarm signal is always flaming before accepting.

- gas turbine data page

Gas turbine data pages display the latest data. Data is displayed on CRT, every page includes two columns, one column displays static content, the other displays dynamic

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content.

- generator data page

Display the state and temperature of generator , etc.

- auxiliary system data page

Display the information of turbo lube system, fuel system and vibration, etc.

- moment record

The set can record the moment data rapidly, and provide data easily inputted and outputted to analysis process. Computing & diagnosis data and software operation record is a request, when engine is operating. Record is also requested during the fault check process.

The system has data analysis record and long-time data trend analysis, etc.

#### 3.2.1.4.6.4. **instrument type selection principle**

Select the type has steady performance, high reliability and high performance price ratio, satisfy the request of exactness, locale condition, process condition and environment protection, etc.

#### 3.2.1.4.6.5. **generator control**

generator control、instrument : one set

protector completed with generator relay: one set (ABB product) . manual ready synchronization unit: one set . automatic ready synchronization unit: one set . generator measure instrument, system measure instrument, control switch, signal light, etc.

one set of generator excitation tank

Excitation tank, adopts WKKL—4 micro- excitation regulator, integrates modern excitation control theory of synchronization generator, uses more popular digital control technology in the world and semiconductor controllable commutation technology. Its control unit achieved optimal control of synchronization generator by optimizing operating data, operating curve and characteristic curve .

#### 3.2.1.4.6.6. **generator vibration and temperature monitor**

- vibration monitor system

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one set of BENTELI 3500 series vibration monitor for monitoring the forward and backward vibration of bearing

- generator temperature monitor

In the stator iron centre and stator winding, there are six measure temperature resistances separately: tow measure temperature resistances in hot- wind field and cold – wind of cooler; two measure temperature resistances on the forward and backward bearing, to achieve temperature monitor of generator by LCD.

#### **3.2.1.4.6.7. automatic start and synchronization**

Unit can achieve automatic start, automatic combine, automatic load and automatic power factor control.

#### **3.2.1.4.7. instrument and control**

According to the feature and requirement of the gas-steam combined cycle generating station, instrument measure and control system should be advanced, fast and secure. So, CAGT **suggested** the first party it is better to use the DCS system (based on microcomputer and digital communication) matched with minute quantity hard manual operating device (for tripped the unit safely when there is some wrong with the DCS ). The DCS communicates with the local monitoring control system (provided with gas turbine genset and turbounit) in serial port. Both of them constitute the complete automatical monitoring control system. Beside a engineer station, DCS system has two operator stations ( mutually redundant) and associate peripheral equipments such as mouse, keyboard and printer.

The system has the following functions: display; alarm; history data store and review; performance calculate; print and record various curves and report sheet.

The DCS system also can complete the following function of the combined cycle power set: protection; interlock; various logic control; main equipment operation and control.

PLC is selected as the monitoring equipment of the auxiliary system ( such as water handing, circulating water, pomphouse). As preceding stage monitoring control system, PLC connects with DCS system through field bus to become a whole system.

**Suggested** collective control points of the DCS system are in the central control room in the electric building. The whole control are divided into tow stage: master control room and a few local control room ( include control room for gas turbine monitoring, electrical watch room in houses such as the chemical water handing and pumphouse)

#### **3.2.1.5. performance introduction of the unit**

##### **3.2.1.5.1. Base load performance data (ISD)**

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under the standard atmosphere condition, suppose the surrounding pressure is 101.325Kpa, environment temperature is 15°C, relative humidity is 60%, load percentage is 100% and fuel is nature gas (100% methane), the performance of one QD100 gas turbine genset is as follow:

Generator output power	11249 kW
Generating heat efficiency	31.38 %
Specific heat consumption	11474 kJ/kWh
exhaust temperature	482.3 °C
Exhaust flow	47.49 kg/s
Fuel heat value(100% methane)	8549.4 kcal/NM <sup>3</sup>
Gas fuel consumption	3605.03 NM <sup>3</sup> /h

#### 3.2.1.5.2. Design point performance data

##### without specific parameter, self - suppose

under the above sea level 1000M, the surrounding pressure is 89.8Kpa, environment temperature is 10°C, relative humidity is 60%, load percentage is 100% and fuel is nature gas (98% methane), and inlet press loss 100 mmH<sub>2</sub>O、exhaust prloss 100 mmH<sub>2</sub>O、nothingness water injection、nothingness steam injection (combined - Cycle), the performance of one QD100 gas turbine genset is as follow:

Generator output power	9937 kW
Generating heat efficiency	30.99%
Specific heat consumption	11618 kJ/kWh
exhaust temperature	483.1 °C
Exhaust flow	42.21 kg/s
(98% 甲烷) Fuel heat value(98% methane)	8438.8 kcal/ Nm <sup>3</sup>
Gas fuel consumption	3267.0 Nm <sup>3</sup> /h

### 3.2.1.5.3. the impact of unit performance produced by the loss of the Inlet-exhaust pressure

Consider the impact of gas turbine performance produced by the loss of the Inlet-exhaust pressure as the following Schedule 1:

The impact of performance produced by the loss of the Inlet-exhaust pressure

Factors produced	power output	heat rate	exhaust temperature
each additional 100mmH <sub>2</sub> O of inlet press loss	-1.8%	+0.8%	-1.7°C
each additional 100mmH <sub>2</sub> O of exhaust press loss	-0.8%	+0.8%	-1.7°C

Design condition: the value of 1 QD100 guarantee is 9738.26 kW

Generator project voltage: 10.5 kV (6.3 kV); rated frequency: 50Hz; phase number: 3 phase

Generator efficiency: generator efficiency of QD100 gas turbine generator units is 97.4%, rated power factor 0.8.

Units layout: outdoor layout

Sets operation type: combine power circl operations. Basic electricity load: the load is up to 40~100% regulatory capacity.

The noise of the distance of 1 meter installed: ≤90 dBA.

Gas turbine exhaust: dust content ≤20 mg/m<sup>3</sup>, NO<sub>x</sub> ≤200 mg/m<sup>3</sup> (dry-low emission type)

### 3.2.1.5.4. characteristics data list

Supporting 2 QD100 genset combined cycle design point performance data list

Schedule 3 QD100 combined-cycle genset temperature characteristics data list (natural gas)

Schedule 4 QD100 combined-cycle genset 10 °C load characteristics data list (natural gas)

#### Supporting 2 QD100 genset combined - cycle design point performance data list

PARAMETER	COMBINED CYCLE (NATURAL GAS)
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T0(AMBIENT TEMP)	°C		10
ALTITUDE OF SITE	m		1000
P0(AMBIENT PRES)	kPa		89.8
RELAT. HUMIDITY	%		60
INLET PRESS.LOSS	mmH2O		100
T2-COMP.INL.TEMP	°C		10
P2-COMP.INL.PTOT	kPa		88.8
W2-COMP.INL.FLOW	kg/s		41.61
N2-COMP.SH.SPEED	rpm		11000
N2-COMP.SH.SPEED	%		100
T3-COMP.DIS.TEMP	°C		405.4
P3-COM.DIS.PSTAT	kPa		1393.1
COMP.S/T P.RATIO			15.680
EXHAUST PR. LOSS	mmH2O		100
P8-EXHAUST PSTAT	kPa		90.8
T8-EXH.GAS TEMP	°C		483.1
W8-EXH.GAS FLOW	kg/s		42.21
EXH.GAS SP. HEAT	kJ/(kg·K)		1.1345
EXH.GAS ENTHALPY	kJ/kg		799.9
EXHAUST GAS COMPOSITION VOLUME CONTENT			
O2	MOLE/WET EXH	%	14.78
AR	MOLE/WET EXH	%	0.94
N2	MOLE/WET EXH	%	75.37
CO2	MOLE/WET EXH	%	2.70
H2O	MOLE/WET EXH	%	6.21
EXH.G.MOL.WEIGHT	g/mol		28.53
GENERATOR OUTPUT	kW		9937

GEARBOX*GEN. EFF	%	96.34
FUEL MASS FLOW R	kg/s	0.6485
FUEL INLET TEMPE	°C	30
FUEL LOWER H.VAL	kJ/kg	49452
ELECT. HEAT RATE	kJ/(kW·h)	11618
ELECTRIC EFFIC	%	30.99

Schedule3 QD100 combined-cycle genset temperature characteristics data list (natural gas)

PARAMETER		status1	status 1	status 2	status 3	status 4	status 5
T0(AMBIENTTEMP)	°C	-5	0	5	10	15	20
ALTITUDE OF SITE	m	1000	1000	1000	1000	1000	1000
P0(AMBIENT PRES)	kPa	89.8	89.8	89.8	89.8	89.8	89.8
RELAT.HUMIDITY	%	60	60	60	60	60	60
INLET PRESS.LOSS	mmH2O	100	100	100	100	100	100
T2-COMP.INL.TEMP	°C	-5	0	5	10	15	20
P2-COMP.INL.PTOT	kPa	88.8	88.8	88.8	88.8	88.8	88.8
W2-COMP.INL.FLOW	kg/s	43.34	42.74	42.17	41.61	41.04	39.96
N2-COMP.SH.SPEED	rpm	11000	11000	11000	11000	11000	11000
N2-COMP.SH.SPEED	%	100	100	100	100	100	100
T3-COMP.DIS.TEMP	°C	386.2	392.6	399.1	405.4	411.6	416.5
P3-COM.DIS.PSTAT	kPa	1447.1	1428.4	1410.4	1393.1	1375.9	1341.2
COMP.S/T P.RATIO		16.288	16.078	15.875	15.680	15.486	15.096
EXHAUST PR. LOSS	mmH2O	100	100	100	100	100	100
P8-EXHAUST PSTAT	kPa	90.8	90.8	90.8	90.8	90.8	90.8
T8-EXH.GAS TEMP	°C	474. 5	477. 3	480. 2	483.1	486. 1	491. 2
W8-EXH.GAS FLOW	kg/s	43.98	43.37	42.78	42.21	41.63	40.53
EXH.GAS SP. HEAT	kJ/(kg·K)	1.1296	1.1309	1.1325	1.1345	1.1371	1.1411
EXH.GAS ENTHALPY	kJ/kg	788.3	791.9	795.8	799.9	804. 5	812. 2
EXHAUS TGAS COMPOSITION VOLUME CONTENT							
O2	%	14.76	14.78	14.78	14.78	14.75	14.69
AR	%	0.95	0.95	0.95	0.94	0.94	0.94
N2	%	75.74	75.66	75.54	75.37	75.14	74.83

CO2	%	2.75	2.73	2.71	2.70	2.68	2.67
H2O	%	5.80	5.89	6.02	6.21	6.49	6.87
EXH.G.MOL.WEIGHT	g/mol	28.58	28.57	28.56	28.53	28.50	28.46
GENERATOR OUTPUT	kW	10844	10528	10225	9937	9660	9210
GEARBOX*GEN. EFF	%	96.53	96.47	96.40	96.34	96.28	96.17
FUEL MASS FLOW R	kg/s	0.6890	0.6748	0.6613	0.6485	0.6361	0.6172
FUEL INLET TEMPE	°C	30	30	30	30	30	30
FUEL LOWER H.VA	kJ/kg	49452	49452	49452	49452	49452	49452
ELECT. HEAT RATE	kJ/(kW·h)	11310	11412	11515	11618	11724	11929
ELECTRIC EFFIC	%	31.83	31.55	31.26	30.99	30.71	30.18

Schedule4 QD100 combined-cycle genset 10°C load characteristics data list (natural gas)

PARAMETER		status 1	status 2	status 3	status 4	status 5
<b>PAITIAL LOAD</b>	<b>%</b>	<b>20%</b>	<b>40%</b>	<b>60%</b>	<b>80%</b>	<b>100%</b>
T0(AMBIENT TEMP)	°C	10	10	10	10	10
ALTITUDE OF SITE	m	1000	1000	1000	1000	1000
P0(AMBIENT PRES)	kPa	89.8	89.8	89.8	89.8	89.8
RELAT. HUMIDITY	%	60	60	60	60	60
INLET PRESS.LOSS	mmH2O	100	100	100	100	100
T2-COMP.INL.TEMP	°C	10	10	10	10	10
P2-COMP.INL.PTOT	kPa	88.8	88.8	88.8	88.8	88.8
W2-COMP.INL.FLOW	kg/s	29.49	29.50	30.91	34.92	41.61
N2-COMP.SH.SPEED	rpm	11000	11000	11000	11000	11000
N2-COMP.SH.SPEED	%	100	100	100	100	100
T3-COMP.DIS.TEMP	°C	350.1	356.8	367.4	378.5	405.4
P3-COM.DIS.PSTAT	kPa	891.2	934.7	1020.3	1166.7	1393.1
COMP.S/T P.RATIO		10.031	10.521	11.485	13.131	15.680
EXHAUST PR. LOSS	mmH2O	100	100	100	100	100
P8-EXHAUST PSTAT	kPa	90.8	90.8	90.8	90.8	90.8
T8-EXH.GAS TEMP	°C	418.0	474.8	520.0	512.4	483.1
W8-EXH.GAS FLOW	kg/s	29.78	29.86	31.36	35.45	42.21
EXH.GAS SP. HEAT	kJ/(kg·K)	1.1048	1.1263	1.1439	1.1434	1.1345

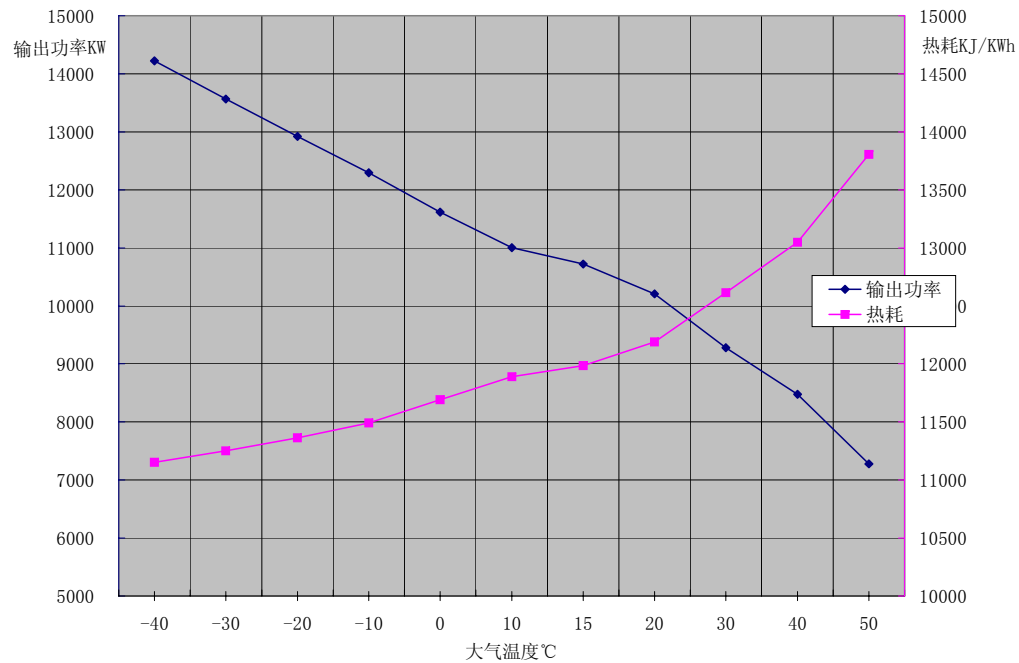
EXH.GAS ENTHALPY	kJ/kg	720.5	787.2	841.9	834.1	799.9
EXHAUST GAS COMPOSITION VOLUME CONTENT						
O2	%	16.62	15.66	14.79	14.59	14.78
AR	%	0.95	0.95	0.94	0.94	0.94
N2	%	76.02	75.68	75.38	75.31	75.37
CO2	%	1.86	2.30	2.69	2.78	2.70
H2O	%	4.55	5.41	6.20	6.38	6.21
EXH.G.MOL.WEIGHT	g/mol	28.64	28.58	28.53	28.52	28.53
GENERATOR OUTPUT kW						
GEARBOX*GEN. EFF	%	92.17	93.90	95.09	95.82	96.34
FUEL MASS FLOW R	kg/s	0.3152	0.3901	0.4809	0.5620	0.6485
FUEL INLET TEMPE	°C	30	30	30	30	30
FUEL LOWER H.VAL	kJ/kg	49452	49452	49452	49452	49452
ELECT. HEAT RATE	kJ/(kW·h)	23983	17472	14359	12586	11618
ELECTRIC EFFIC	%	15.01	20.60	25.07	28.60	30.99

### 3.2.1.5.5. Performance Curve

#### 3.2.1.5.5.1. Temperature character

Environment temperature is the important signal of the unit operating mode. The variation of the environment temperature will affect the heat consumption and output power of the unit observably. With the environment temperature increasing, the unit output power decreases markedly and the heat consumption increases markedly

The following picture lists the curve that the output power of QD100 gas turbine genset varies with the environment temperature changing from  $-40^{\circ}\text{C}$  to  $+50^{\circ}\text{C}$ . The curve is based on the environment pressure is 101.3KPA and the relative humidity keeps at 60%.

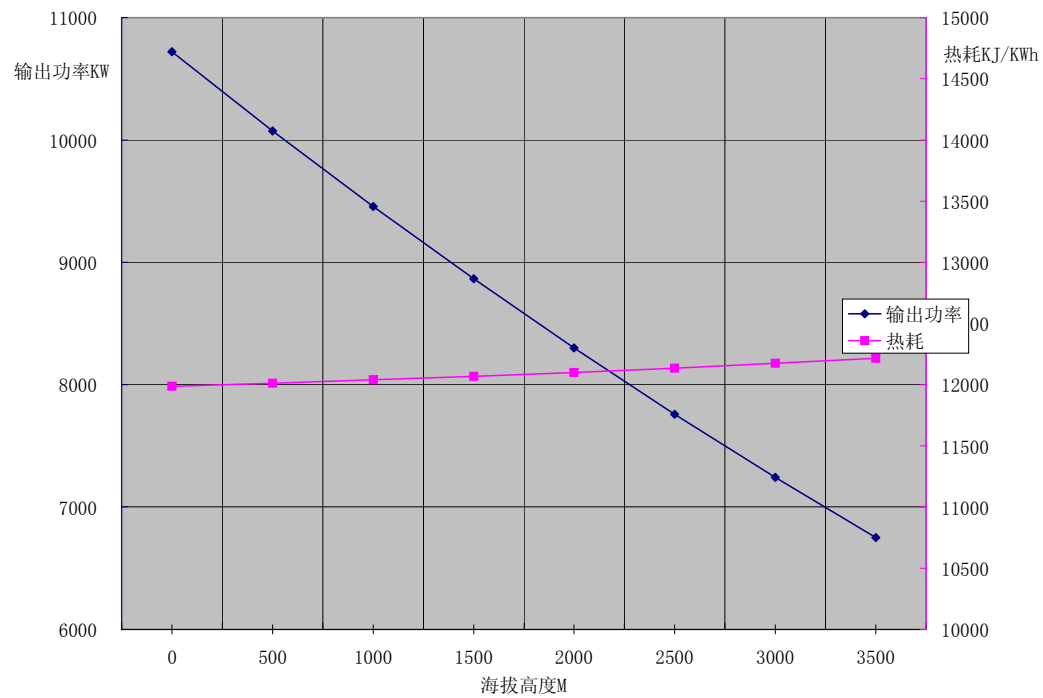


Curve-QD100 gas turbine genset performance target changing with environment temperature

### 3.2.1.5.5.2. Height character

On the conditions of environment temperature be held at 15°C and relative humidity be held at 60%, the following curve shows the unit output power and heat loss varies with the height above sea level.

The variety of the altitude will not affect the heat loss too much. However it influences the unit output power observably. The unit output power will decrease observably with the altitude rising.



QD100 output character change with altitude

### 3.2.1.5.5.3. Humidity character

In a word, the changes of relative humidity will not influence the unit performance markedly. The increase of the relative humidity will enhance the unit output power and decrease the heat loss slightly.

on the conditions of environment temperature be held at 15°C and environment pressure be held at 101.3Kpa, the following curve shows the unit output power and heat loss varies with the relative humidity.



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heat passage repair	≥16000 h
whole unit repair	≥32000 h

### 3.2.2. Heat Recovery Steam Generator

The exhaust heat boiler matched with QD100 gas turbine unit is a nonstandard product. The boiler is a horizontal type air flue, natural circuit and double pressure exhaust heat boiler. The boiler has the following characters: Its flue gas completeness is good; heating power inside the boiler is homogeneous; heat deviation is small; flue gas resistance pressure is low; exhaust heat is utilized sufficiently; the frame is fixed; mass center is rational; stability is good; it can resist typhoon and earthquake. For taking good use of the gas turbine exhaust heat, the heat is utilized in graduate. The boiler also can take use of double pressure system. Medium temperature and medium pressure steam generated by boiler enters the steam turbine to work. Low pressure saturated steam is used for deoxidization. Without high pressure heater, low pressure heater and oxygen removal regeneration system, the output of the steam turbine can be improved. The gas turbine exhaust heat can be taken full use.

Under the Design condition:

The main parameters of the exhaust boiler :

Boiler shape: horizontal type, natural circuit

Gas turbine extraction flow	151.96 t/h
Gas turbine exhaust temperature	484.9 °C
Medium pressure steam pressure	3.43 MPa
Medium pressure steam temperature	435 °C
Medium pressure steam flow	16.95 t/h
Low pressure steam pressure	0.05 MPa

Low pressure steam temperature: saturation (supply for oxygen removal)

Low pressure steam flow	2.8 t/h
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Boiler exhaust fume temperature                      167 °C

### 3.2.3. Turbounit

Matched with the steam flow of the exhaust boiler, a standard condensed steam type turbounit(type:N6-3.43) can be selected.

Main parameters of the steam turbine:

Rated power	6000	KW
Rated initial steam flow	25.4	t/h
Rated initial steam pressure	3.43	MPa
Rated initial steam temperature	435	°C
Exhaust steam pressure	6.86	kPa
Specific steam consumption	4.2	kg/kWh

According to factual steam flow (16.95t/h) produced by the exhaust heat boiler, the output of the turbounit is 4005kW.

### 3.2.4. Main technical & economic target of the combined cycle unit

Under the Design condition:

One QD100 gas turbine genset, one exhaust heat boiler and one turbounit make up of one combined cycle power set. the main parameters are as follow:

QD100 gas turbine genset total output	9851 kW
Gas turbine generating heat efficiency	30.72 %
Turbounit total output	4005 kW
Combined cycle power set total output	13856 kW
Combined cycle generating heat efficiency	43.22 %

Combined cycle generating gas consumption	0.2358 M <sup>3</sup> /(kw·h)
Combined cycle gas consumption per hour	3267 M <sup>3</sup> /h
Annual operation hours	8000 h
Annual output of plant	11084.8 万kWh
House supply rate	5 %
Annual power supply	10530.6 万kWh
Combined cycle total capacity	15.0 MW

#### 4. Fuel gas supply system

##### 4.1. Fuel gas requirement

Natural gas used in gas turbine fuel is from natural gas tubing handling devices, the combustible engine electric enter pressure to import natural gas is 2.5±0.1 MPa (gauge pressure), the temperature is 40 degrees ~ 50 degrees.

Natural gas components and impurities components in Schedule 5 and Schedule 6

##### schedule 5 Natural gas components

designation	(V%)component								thermal value kJ/m <sup>3</sup>
	H <sub>2</sub>	CO <sub>2</sub>	CH <sub>4</sub>	O <sub>2</sub>	iC <sub>4</sub>	CO	N <sub>2</sub>	total	
natural gas	1.2	0.05	98.00	0.2	0.10	0.05	0.40	100.0	35318

##### schedule 6 Natural gas impurities components

designation	mg/SCM		ppmv
	total sulfur	mercaptan	H <sub>2</sub> S



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Exhaust mol quality	28.53 kg/mole
Exhaust specific heat	1.1350 kJ/kg·K
Exhaust enthalpy	802.0 kJ/kg

## 5. Cooling water system and compress air system requirement of the Combined-Cycle unit

### 5.1. Unit cooling water system requirement

The user offers cycle cooling water to cool for gas turbine powered generator units' oiling system, generator, steam turbine unit' condenser and auxiliary cooler.

To ensure the chilling effect of the generator, gas turbine lube oil system, the cooling water for the gas turbine auxiliaries is **suggested** customer set-up by two separate water circulating pumps (one in operation, one standby). The backwater of the cooling water is combined to return pipe of the steam turbine recirculating cooling water. Then flow to the forced ventilation cooling water to be used as cooling water circularly .

#### Main parameters:

flow of cooling water:

the flow of cooling water for the generator 100 t/h,

the flow of cooling water for the lube oil cooler 110t/h.

flow of make up water few, to be regarded by the manufacturer

feed water pressure: 0.30 MPa

feed water temperature :  $\geq 33$  °C.

requirement of water quality

transparent, pure, no granular sundries inside

pressure loss of cooler

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cooler of generator : 3.3 kPa。

lube oil cooler : 30 kPa。

The cooling water of the steam turbine condensator and auxiliaries cooler is **suggested** provide by the circulating water system of the cooling tower with forced ventilation device. build a 1500M<sup>3</sup>/h medium temperature cooling tower and a 200M<sup>3</sup> closedcirculation pool. The volume of circulating water is about 1300M<sup>3</sup>/h; the circulating cooling water temperature is not higher than 32°C and the pressure is 0.3MPa.

The gas turbine generator、 lube oil system backwater of the cooling water is combined to return pipe of the steam turbine recirculating cooling water. Then flow to the cooling tower circulating cooling water together.

## 5.2. combined cycle unit sweet-water demand

User offers sweet-water tanks to clean gas turbo-compressor and Heat Recovery Steam Generator.water press: 103 - 448 kPag.

## 5.3. Compress air requirement

Dry clean compressed air is required in unit work, the compressed air used in inlet filters back blow and in instrument wind must be clean (solid particles are not more than 5um), dry (liquid content is not more than 5ppm). Air largest consumption for the single unit is 0.5kg/s, gas pressure is 0.6~0.8MPa, temperature is not exceeding 75 degrees.

## 6. Drainage system

### 6.1. Requirement of the environmental protection department for the three waste treatment.

Environmental protection performs the following standards:

- (1) Environmental air quality is required according to the secondary class regulated in GB3095-1996 《enviromental air quality standard》 .
- (2) Fatory boundary noise level is performed according to GB12348-90 《industrial organization factory boundary noise standard》 . Environment noise level is performed according to the third level regulated in GB3093-93 《city area environment noise standard》 .
- (3) Oily soil water effluent standard is performed according to GL8978-88 《waste water compositive effluent standard》 .

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## **6.2. Environmental protection governing measure**

So far, gas turbine gensets have been installed and operated in many regions of china. Gas turbine genset itself has taken effective measure for environmental protection. The power station pollutes and influences the ambience slightly. The main pollution source is the NO<sub>x</sub> and SO<sub>2</sub> from the exhaust gas and the noise. Comparing with the coequal size heat engine plant, its emission standard is much lower. Accompany with the further effective measure, the various emission can be decreased greatly. As a result, the power station will be a environmental protection enterprise like a garden.

### **6.2.1. Exhaust fume treatment**

QD100 gas turbine unit utilized the dry low emission (DLE) combustion technique can reduce the NO<sub>x</sub> and CO content of the exhaust effectively to meet the strict emission requirement of the customer.

The estimate of the contaminant emission will be confirmed after the purchaser provides the impurity content of the fuel gas.

Usually, emission density of the various contaminant of the gas turbine unit is not high. It can meet the requirement in the 《heat engine plant air contaminant emission standard》 GB13223-1996.

### **6.2.2. Noise treatment**

Noise source of the generating plant come from gas turbine, steam turbine, waste heat boiler and generator. The others normally are contributed by mechanical movement which attenuate quickly and will not influence the ambience.

Air inlet, exhaust and mechanical noise contribute to the gas turbine noise. So the silencer is installed at the inlet and exhaust port. And the sound insulation enclosure is designed for eliminating mechanical noise. The noise is less than 90dB(A) one meter from the unit.

Moreover, the principal machine is arranged at the place that will influence the central office slightly. Forest is planted in the factory to absorb the noise.

## **7. Supply scope**

### **7.1 QD100 Gas turbine genset Supplyc contents**

**Single set QD100 Gas turbine genset Supply contents**

<b>Serial number</b>	<b>Components number</b>	<b>name</b>	<b>number</b>	<b>note</b>
1		GE10-1 Gas turbine	1	
2		AC generator	1	
3		reducing gearbox	1	
4		flexible lamination coupling	1	
5	QD100.1	air inlet filtering and noise elimination system	1	
6	QD100.2	AC generator pedestal	1	
7	QD100.3	generator enclosure	1	
8	QD100.4	shield of low speed coupling	1	
9	QD100.5	oil system	1	
10	QD100.6	gas turbine enclosure	1	
11	QD100.7	anti-surge bleeding system	1	
12	QD100.8	compressor cleaning system	1	optional
13	QD100.9	water cooling system	1	
14	QD100.10	starting system	1	
15	QD100.12	shield of high speed coupling	1	
16	QD100.13	gas turbine pedestal	1	
17	QD100.14	exhausting system	1	
18	QD100.15	CO2 fire fighting system	1	
19	QD100.16	enclosure ventilation system	1	
20	QD100.17	gas fuel system	1	
21	QD100.18	draining system	1	
22	QD100.19	Walk ladder (left)	1	
23	QD100.20	walk ladder (right)	1	
24	QD100.21	local control room	1	optional
25	QD100.25	high voltage electrical system	1	The electric parts

Serial number	Components number	name	number	note
26	QD100.26	MCC	1	interface: high voltage interface for generator circuit breaker into line terminals, low voltage and dc power interface for supplier into line terminals. Low voltage power supply into line shall be five line system, pick up all the way 400kW frequency conversion motor, all the way after 200kW motor control center. Gas turbine ontology and auxiliary system internal all cables and pipelines and stent by the supplier delivery
27	QD100.27	unit lighting system	1	
28	QD100.28	ground protection system	1	
29	QD100.29	DC electrical system	1	
30	QD100.30	auxiliary Measure control system	1	
31	QD100.31	control system	1	

**7.1.1. GE10-1 gas turbine include:**

- inlet upturned inlet casing
- axial flow compressor with IGV
- reflux can burner module
- heavyduty efficient turbine



- 
- 2 vibrating sensor
  - rotor speed sensor
  - thermocouples for gas turbine temperature measure

#### **7.1.2 Steel structure baseplates for installing gas turbine, generator, gearbox and accessories**

#### **7.1.3 Frequency conversion motor start system**

#### **7.1.4 Gas fuel (natural gas) system**

- gas fuel filter
- gas feed pressure regulator valve
- velocity ration control valve
- stainless steel gas fuel piping after the filter
- dust removal and purify device for gas fuel

#### **7.1.5 Lubricating oil system for gas turbine, gearbox and generator**

- oil tank module
- main oil pump driven by gearbox
- auxiliary oil pump driven by AC motor
- emergency oil pump driven by DC motor
- dual oil filter and manual operation valve
- oil pipe
- pressure regulating valve, temperature regulating valve and water cooler
- instruments and the necessary protection devices
- oil mist separator at the oil tank vent port

#### **7.1.6 Reduction gear box and coupling**

- 
- planet reduction gear box, output speed 3000rpm/r
  - lamination flexible coupling for connecting gas turbine and gearbox
  - lamination flexible coupling for connecting gearbox and generator
  - shield of coupling
  - gearbox vibration sensor
  - gearbox thermocouple

#### **7.1.7. Sound insulation enclosure mounted on the baseplate, include gas turbine enclosure and generator enclosure**

- painted carbon steel constructure
- employee in and out door
- gate for gas turbine dismounting and maintenance
- flame detector
- gas density detector
- CO<sub>2</sub> fire fighting line and spray cup
- sound and light crossing-signal for extinguishant release
- ventilation baffle of the enclosure (operated by nitrogen)
  - gas turbine enclosure ventilation system, include intake air port, silencer, exhaust blower and exhaust silencer driven by 2 AC motors at the exhaust port

#### **7.1.8. Inlet system**

- impulse selfpurging inlet filter device with 180 filter elements, supported by carbonsteel bracket
- free air diffuser, join the filter house and gas turbine inlet casing, composed of flexible link, built up connection piece, elbow and silencer
- blowback device

#### **7.1.9 exhaust system**

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·expansion joint, changeover portion and gusset flange

#### **7.1.10 CO2 fire fighting system**

·CO<sub>2</sub> bottles (two group)

#### **7.1.11 Alternator and electrical equipment**

·brushless (6.3kV) 10.5kV alternator, speed 3000rpm

·water cooler

·brushless excitation system

·2 vibration sensors on generator shaft shell

·battery, group charger and alternating current distribution panel

·MCC

·high voltage switch cabinet, instrument cabinet

#### **7.1.12 Control system**

Control system is installed in local control room, it include:

(1) MARK VI processor with the following functions :

·control and protect for gas turbine genset

·state monitoring

·alarm

·fire and gas monitor

·vibration monitor

·generator integration control

·serial data port (RS232 standard industry bus)

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(2) generator control panel with the following functions:

- manual and automatic synchronization
- generator protect

(3) excitation control panel

- auto voltage regulator (A.V.R)
- generator excitation control

### 7.1.13 Others

·name plate and warning plate

·packaging, suitable for transportation

·painting ,suitable for the customer place

·cables in the unit

·junction box outside the enclosure

·drawings and documents: system interface drawing and installation drawing, important outsourcing member and system operating instruction manual, spare piece

bill, unit installation manual and commissioning outline, unit operation and maintenance manual

### 7.2. Exhaust heat boiler supplyc contents

·Exhaust heat boiler(natural circuit) and its auxiliaries, electric control system

·Medium pressure steam-pocket (include the device inside the boiler)

·Overheater heating surface (tube bundle and header tank)

·Medium pressure heating surface (tube bundle and header tank)

·Economizer heating surface (tube bundle and header tank)

- 
- Low pressure steam-pocket (include the device inside the boiler)
  - Low pressure heating surface (tube bundle and header tank)
  - Framework, chamber wall
  - inlet combustion flue, main fume stack(linkingup with expansion joint)
  - control instrument in the scope of boiler
  - Control panel on site
  - Medium feed pump
  - Subpressure feed pump
  - Device for adding drug
  - Blow down diffuser

### **7.3. Steam turbine part supply contents**

- turbounit(standard condensed steam type), model:N6-3.43, its auxiliaries and electrical control system
- Steam turbine, enclosure, mounting
- Steam turbine door and hanging bracket
- Water purifier, oilfilter, steam strainer
- Steam turbine oil pump and self start-up device
- Oil tank cooler
- Condensator
- High pressure heater, low pressure heater
- Four stage emanation, air removal jet
- Piping line and instruments, electric appliance, thermometer
- Steam turbine generator:6000KW    3000 rpm    10.5KV

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## 7.4. exclusion part

### 7.4.1.: the following item is not in the CAGT supply scope:

The following systems are options, and don't include the goods that are supplied by CHINA AVIATION GAS TURBINE COMPANY., LTD., but they can be afforded in repay.

#### 7.4.1.1. Compressor off-line scavenger system (option)

#### 7.4.1.2. Exhaust part (option)

exhaust elbow、 silencer 、 Wye flapper valve 、 chimney and steel bracket

#### 7.4.1.3. Electrical part (option)

- DCS control system (centralization of control)
- House transformer and its electrical conduit system
- local control room house

### 7.4.2. The following item is not in the CAGT supply scope:

- Suggested operation spare parts
- Citywork and city planning work
- Transport from delivery site to field
- Drain and exhaust air pipe of gas turbine
- The outside pipe of enclosure of compressor air system
- The cable and cable trays and cable canal in the outside of Gas turbine
- Field facility
- Fuel storage and treatment
- Gas turbine fuel

- 
- Lube oil charging for the first time
  - Consumable material during the installation ,completion and operation
  - Common resource about power supply ,water and compressed air
  - disassembly and assembly sling for unit maintenance
  - lube for unit commissioning and operation
  - Floor space
  - Factory lighting
  - Other training except supply scope
  - The expenses for customer review and test
  - Investigation of the third party

## **7.5. Supply scope interface**

### **7.5.1. Fuel gas system**

1m of unit enclosure inside,natural gas pipe

### **7.5.2. Compressor air system**

compressor air inlet flange of blowback device in the inlet filter room , compressor air connect flange of washing skid, air compressor and air store tank

### **7.5.3. Air exhaust and drain system**

The interface of air exhaust and drain system in turbine base plate and enclosure

### **7.5.4. Cooling water system**

The inlet and outlet flange of cooler in gas turbine lubrication system and generator

### **7.5.5. AC generetor**

## 8. Design, manufacture and accept standard

QD100 gas turbine genset during the packaged design, the working standards adopt the associate national standards and aerial standards. Trade standards introduce the RP11PGT 《gas turbine package》 and relative API standards. In the case of no standard can be applied, the enterprise standards will be specified.

Boilers are national correspond standard, corollary equipment and parts meet enterprise standard. Some main standards are listed below:

GB10489-89 aero modified gas turbine general technical requirements

GB/T15736-95 gas turbine accessories technical conditions

JB/T7074-93 gas turbine generator general technical conditions

GB50193-93 (1999 edition) CO2 fire fighting system design specifications

GB50205-2001 steel structure engineering construction and accept specifications

GB50235-97 industry metallic pipe engineering construction and accept specifications

GEI41040g gas fuel specification

GEI41047k liquid fuel specification

SOM17366-A-5 oil specification

SOM45055-A-2 gear box specification

GB12348-90 《industrial organization factory bound noise standard》

JB/T6696-1993 power station boiler technical condition

DL647-1998 Test rules of power industry boiler pressure vessel

JB/T1609-93 boiler cylinder technical condition of manufacture

JB/T1611-1993 Boiler pipe's technical condition of manufacture



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JB/T1620-1993 Boiler steel construction's technical condition of manufacture

Boiler heat calculation meets standard method of boiler unit calculation

Intensity calculation meets the intensity calculation of hose boiler press module

Smoke and wind resistance calculation meets standard method of boiler aerodynamic calculation

## **9. Manufacturing cycle aircraft crew**

After feasibility research report is approved and all the investor signed the contract, the technical and the commercial negotiation of the main equipments order will be carried out immediately. The contract will be signed. Meanwhile preliminary design will be performed. Working plan will be completed based on the job above. Usually for a combined cycle power plant, 12 months later from starting, the combined cycle power genset can be put into operation.

## **10. after service**

### **10.1. installation and commissioning give instruction service**

CAGT can provide installation、commissioning and reliability operation service for QD100 gas-steam combined cycle power set or send professional technician to give instruction on site.

Field-service contents include:

- (1). Basic maijian in advance, seller dispatches one engineer, the working life is 1.0 month
- (2). Equipment installation, seller dispatches one senior engineer, the working life is 2.0 months, two electric controlled senior engineers,2.0 months.
- (3). Equipment debugging, seller dispatches two senior engineers, the working life is 2 months, one engineer from gas turbime company, 2 months.

### **10.2. Customer training**

CAGT provides a complete set of training service of the QD100 gas-steam combined cycle unit for operators and maintenance. CAGT has compiled a complete set of training material for the customer. Fulltime professional trainers are responsible for teaching relative course. The training way include three modes: CAGT plant training, scene training and product manufacture review.

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### 10.2.1. CAGT plant training,

according to the training material, introduce the integral structure, include the unit constitutes, unit performance, unit working theory and function introduce of each system and factory training、 introduce the attentive items about unit transportation and storage. The above training will occupy 6 working days. **Vendee can decide the number of persons who take part in training and pay themselves.**

### 10.2.2. Site training

introduce the attentive items about the unit operation and running; the whole operation course from the unit start to normal shut down. The training is performed according to the operation criterion which explains the operation steps of each stage in detail. It includes: each system state check before start; start and accelerate process; stable empty/full load, rated speed operate process; increase/decrease load and parallel in/ stand alone process; shutdown cooling process and check after shutdown. trouble shooting, record, emergency shutdown treatment are also include. The course above can be arranged in 6~12 working days.

My company also offers corresponding technically training about exhaust-fired Steam Generator. Training contents are synchronal to progress of works. We arrange 2 workoing-times courses.

**The vendee pays for the flied-training sevice to CHINA AVIATION GAS TURBINE COMPANY according to sevice standard.**

### 10.2.3. overview the production plan

It is an important step to overview the production plant and the product customer to enhance the knowledge of the product. CAGT can provide all the information and

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service for the customer to know about the product quality and the production condition. According to the customer requirement, CAGT can provide the following service: to visit QD100 Gas-Steam Combined-Cycle Power genset each part production plant (Italy NP company). **The cost is payed by vendee themselves.**

In addition, if vendee demands more detailed training or requires to train in GE Company, the two sides can make another agreement.

### **10.3. quality assurance stage**

In quality assurance stage CAGTC will who offer necessary technological service.

In quality assurance stage CAGTC will offer instead spare parts in the fastest speed

CAGTC will call at vendee aperiodically, help to increase running attention level, answer technological questions, and introduce the equipment improvement situation.

### **10.4. Toll technological service of CAGTC**

**About the following technological service CHINA AVIATION GAS TURBINE COMPANY should make addition agreements with vendee.**

#### **10.4.1. installation and debugging service for QD100 Gas-Steam Combined-Cycle Power genset.**

According to customer requirement and mutual contract, CAGT can provide installation and debugging project service for QD100 Gas-Steam Combined-Cycle Power genset.

#### **10.4.2 repair service**

According to customer requirement and mutual contract ,CAGT can provide examine and repair, overhauling service for QD100 Gas-Steam Combined-Cycle Power genset. Mainly include schedule repair and nonscheduled repair on site:

(1) combustion chamber inspect and repair (minor overhaul)

(2) heat passage inspect and repair (medium repair)

(3) the whole unit repair (complete overhaul)

(4) nonscheduled overhaul for faults eliminating

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### **10.4.3. technical consultation service**

CAGT product service center owns professional service person of various specialties. They can explain many kinds technology issues about gas turbine unit and provide high level technical consultation service, include power plant build, invest analyse, technique feasibility report, unit operation status analyse, fault analysis, fault diagnosis and treatment. For all of the above service, the technicians can go to site

### **11. an attached or enclosed graph**

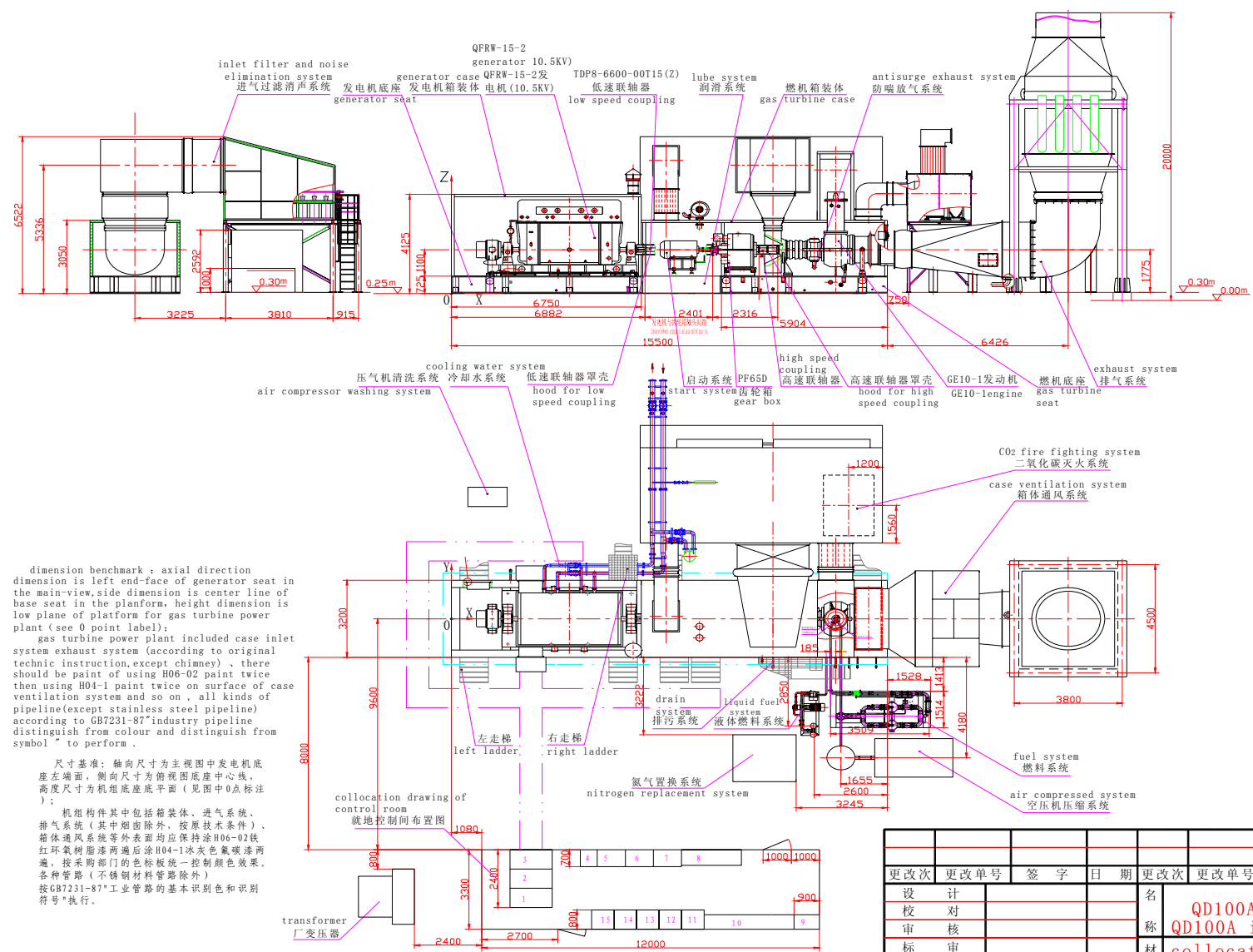
QD100 gas turbine genset assembly drawing.

QD100 gas-steam combined cycle genset factory floor plan

QD100 gas-steam combined cycle genset \_thermodynamic system illustrative diagram

QD100 gas-steam combined cycle genset-high voltage system diagram

序号 增加序号



dimension benchmark ; axial direction dimension is left end-face of generator seat in the main-view, side dimension is center line of base seat in the planform, height dimension is low plane of platform for gas turbine power plant (see 0 point label);

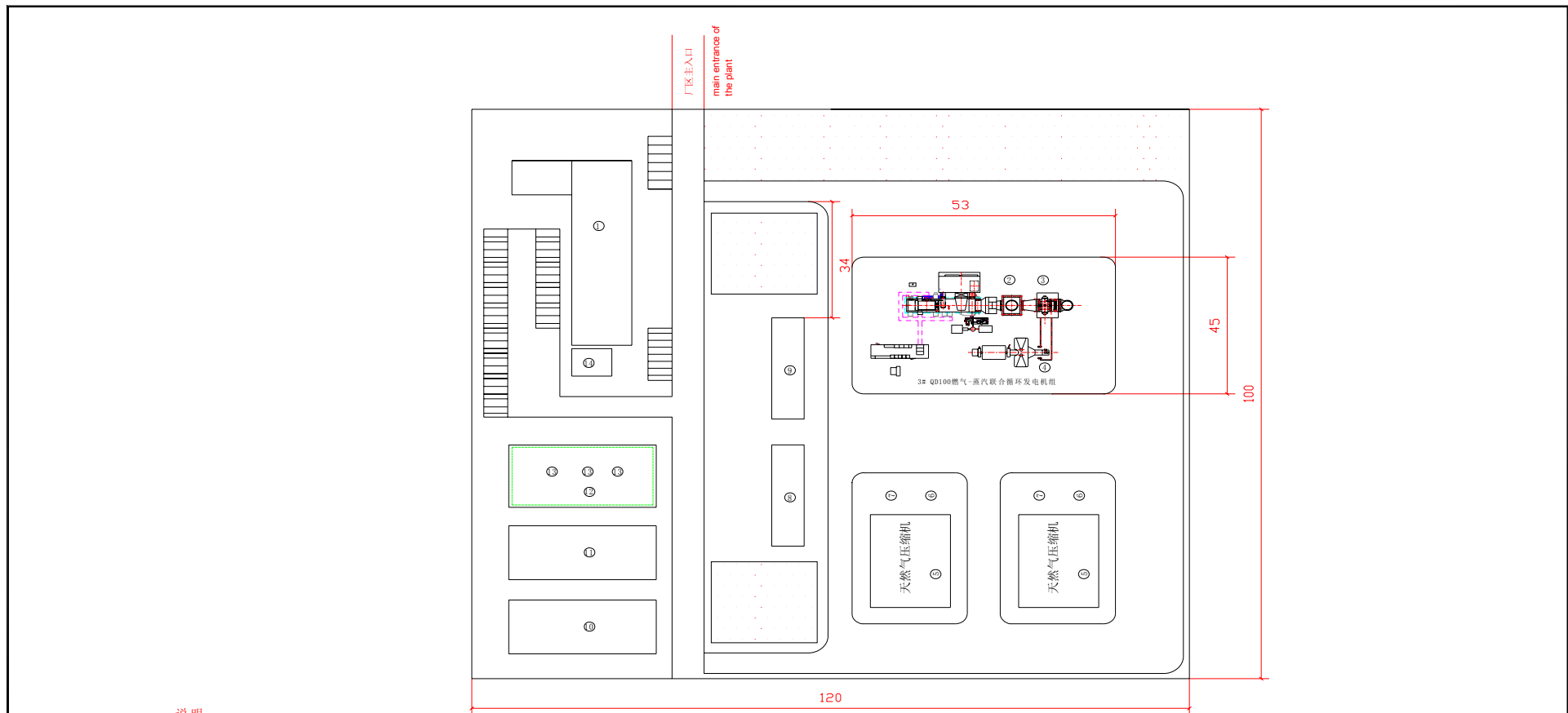
gas turbine power plant included case inlet system exhaust system (according to original technic instruction, except chimney), there should be paint of using H06-02 paint twice then using H04-1 paint twice on surface of case ventilation system and so on, all kinds of pipeline(except stainless steel pipeline) according to GB7231-87"industry pipeline distinguish from colour and distinguish from symbol" to perform.

尺寸基准: 轴向尺寸为主视图中发电机底座左端面, 侧向尺寸为俯视图底座中心线, 高度尺寸为机组底座底平面(见图中0点标注);

机组构件其中包括箱体、进气系统、排气系统(其中烟筒除外, 按原技术条件)、箱体通风系统等外表面均应保持涂H06-02铁红环氧树脂漆两遍后涂H04-1冰灰色氟碳漆两遍, 按采购部门的色标板统一控制颜色效果, 各种管路(不锈钢材料管路除外)按GB7231-87"工业管路的基本识别色和识别符号"执行。

原用图号  
代替图号  
旧底图总号  
底图总号  
签字及日期

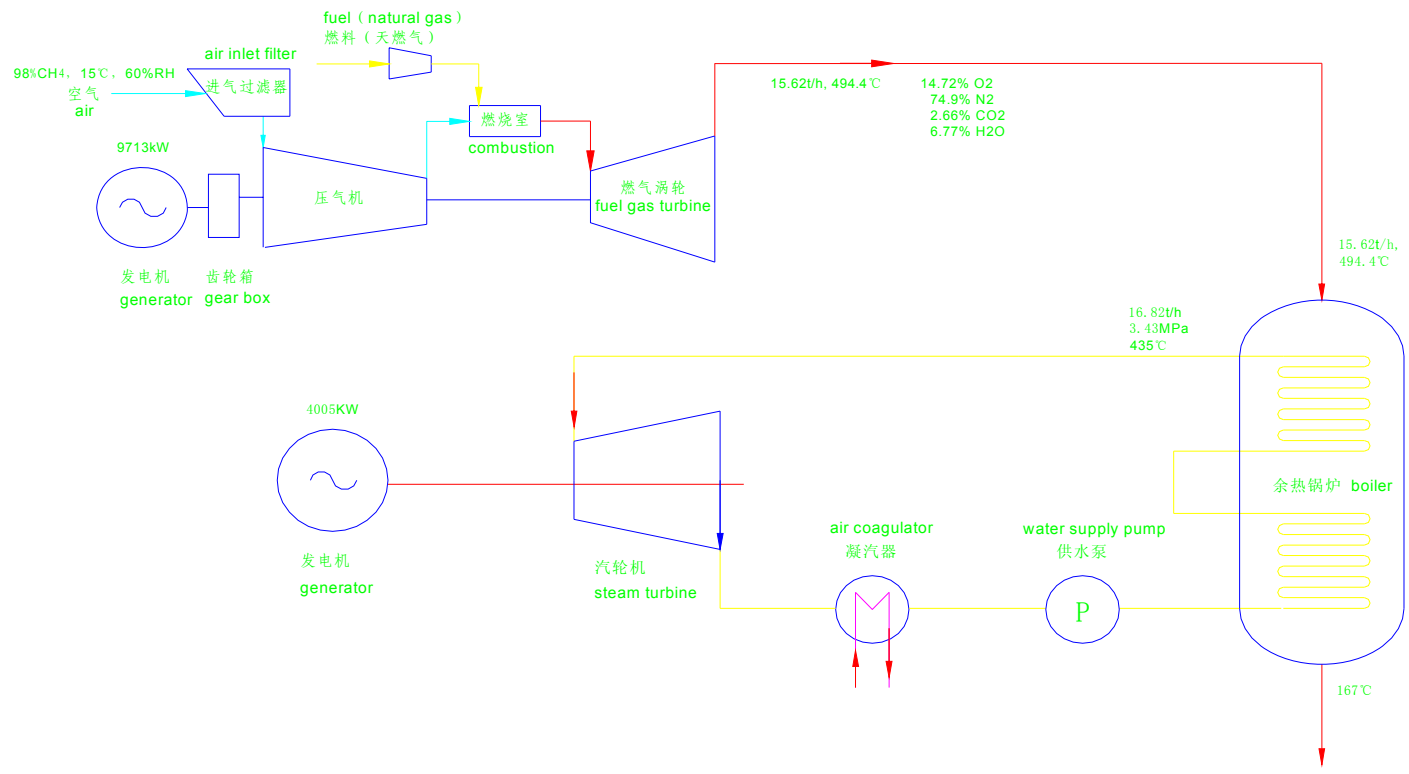
更改次	更改单号	签字	日期	更改次	更改单号	签字	日期	型号
设计				名				号
校对				称	QD100A总体布置图			项目号
审核				材	QD100A integer			重量
标				料	collocation drawing			比例
审								C
定								共 1 页
				装				第 1 页
				配				中航世新燃气轮机股份有限公司
批				处				
				代				
				号				



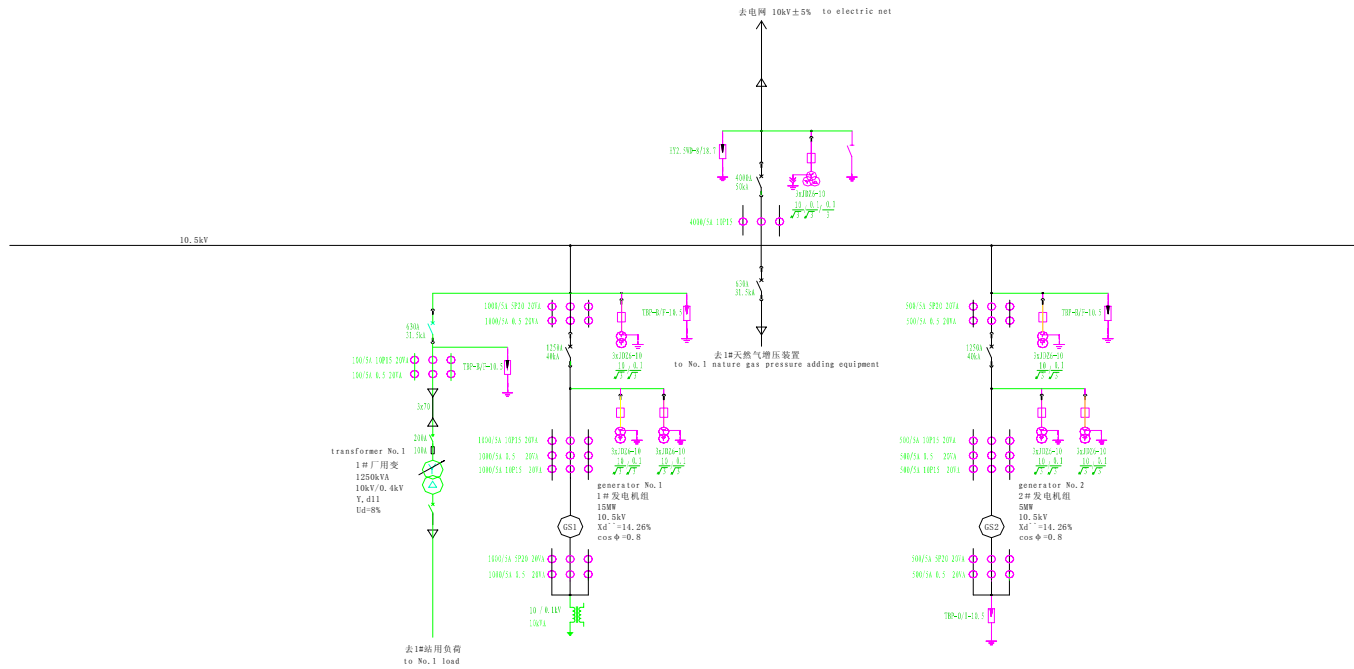
说明

- ① 综合楼 building
  - ② QD100燃气轮机发电机组 QD100 gas turbine unit 图例 cutline
  - ③ 余热锅炉 boiler
  - ④ 汽轮机 steam turbine
  - ⑤ 天然气压缩机 natural gas compressor
  - ⑥ 天然气出口分离器 natural gas separator
  - ⑦ 冷却器 cooler
  - ⑧ 升压站 pressure adding station
  - ⑨ 电气楼 electric building
  - ⑩ 水处理间 water treatment room
  - ⑪ 消防、循环水联合泵房 fire fighting and cycling water combine pump room
  - ⑫ 循环水集水池 cycling water pool
  - ⑬ 循环水冷却塔 cycling water cooling tower
  - ⑭ 污水处理池 sewage treatment pool
- ▭ 建筑物 erection
  - ▭ 室外构筑物 outdoor erection
  - ▭ 地下构筑物 erection underground
  - ▭ 道路 road
  - ▭ 绿地 greenbelt
- 设计单位：米  
design unit : m
- 北 north

更改次	更改日期	签名	日期	更改次	更改日期	签名	日期	型号	
设计				名称	厂区平面布置图			图号	
校对				材料	plane arrangement drawing of the plant			项目号	重量
审核								比例	
审定				装配处				共	页
批准				代				第	页
								中航世新燃气轮机股份有限公司	

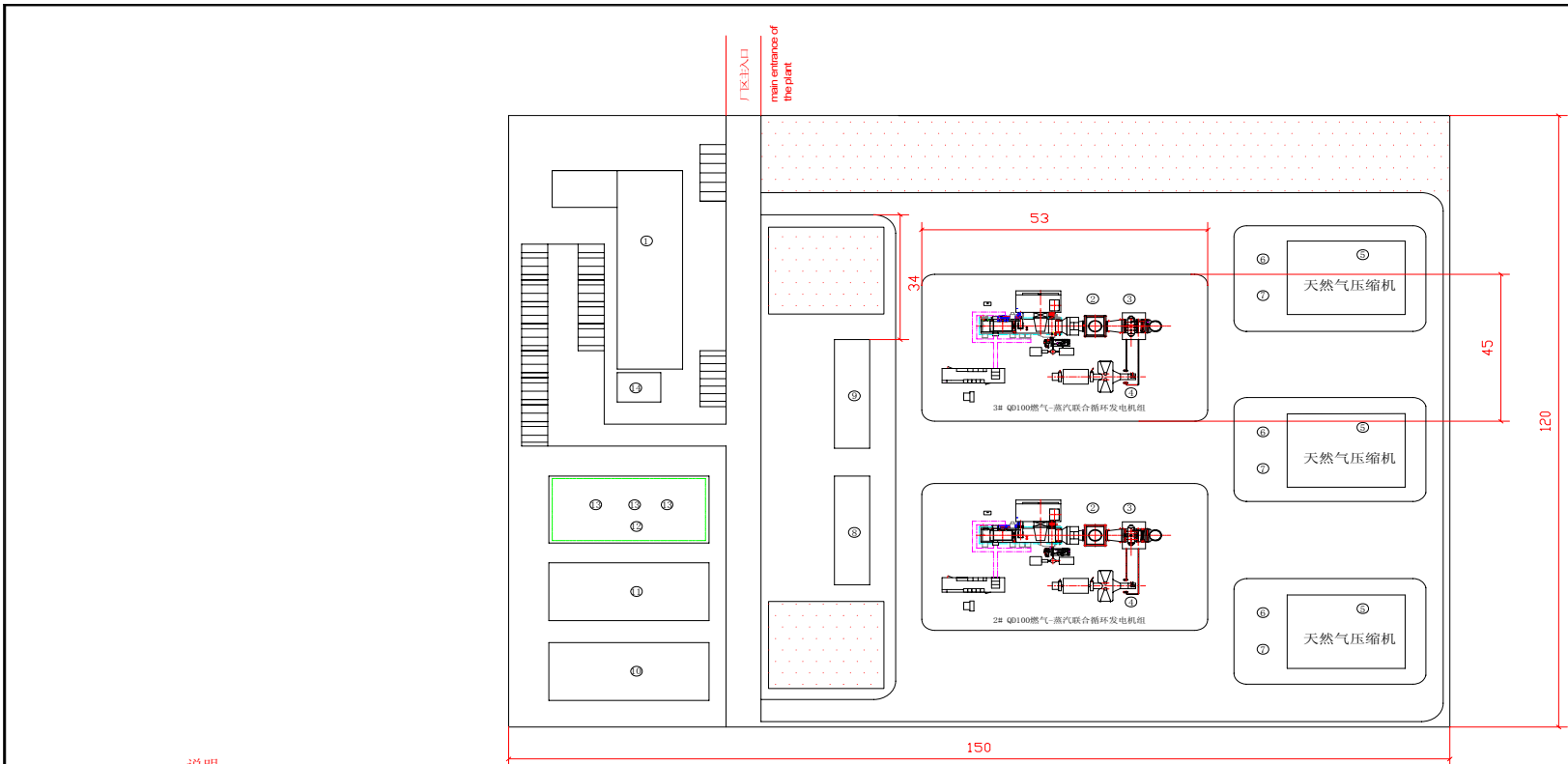


更改次	更改日期	签名	日期	更改次	更改日期	签名	日期	型号
设计				名称	原则性热力系统图			图号
校对				材料	schematic diagram of the fundamental thermodynamics system			项目号
审核				装配处				重量
审定				代号				比例
批准								共 页 第 页
								中航世新燃气轮机股份有限公司



更改次	更改单号	签字	日期	更改次	更改单号	签字	日期	型号
设计				名称	高压电气一次系统图			图号
校对				材料	schematic diagram of first high pressure electric system			比例
审核				料				C
审定				装配处				共 1 页 第 1 页
批准				代号				中航世新燃气轮机股份有限公司





说明

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											型号			
更改次	更改日期	签名	日期	更改次	更改日期	签名	日期	<b>厂区平面布置图</b> plane arrangement drawing of the plant			图号			
设计											项目名称	重量	比例	
校对											共	页	第	页
审核											中航世新燃气轮机股份有限公司			
审定														
批准								装配处代号						

