HCIE-Data Center Facility Design V1.0 Lab Exam Guide

Huawei HCIE-Data Center Facility Design V1.0 Certification Exam

Certification	Exam Code	Exam Name	Language	Exam Cost	Exam Duration	Pass Score/ Total Score
HCIE-Data Center Facility Design (New Version)	H12-466	HCIE-Data Center Facility Design (New Lab)	English	1200USD	180min	80/100

Exam Contents

HCIE-Data Center Facility Design V1.0 exam covers: Data Center Infrastructure Consulting and Planning, Power Distribution System Planning, UPS System Planning, Case Analysis and Optimization of Data Center Power Supply and Distribution Architecture, Data Center Cooling System Planning, Data Center Air Conditioner Terminal System Configuration and Load Calculation, Chilled Water Air Conditioner System Configuration, and Data Center Cooling System Energy Saving Solution and DCIM system planning, etc.

Key Points Percentage

Key Points	Written Percentage	Lab Percentage
Data Center Infrastructure Consulting and Planning Guide	15%	17%
Data Center Power Distribution System Planning and Design Overview	7%	6%
Data Center UPS System Planning	7%	10%
Data center low-voltage power distribution system planning	4%	8%
Data Center D.G. System Planning	4%	3%

Key Points	Written Percentage	Lab Percentage
Data Center Power Supply and Distribution Architecture Case Analysis	7%	3%
Data Center Power Supply Solution Optimization Practice	5%	3%
Data center cooling system planning	6%	2%
Configuration and Load Calculation of Air Conditioner Terminal System in Data Centers	10%	10%
Chilled Water Air Conditioner System Configuration	11%	10%
Energy-Saving Solution Configuration for the Cooling System of the Data Center	7%	4%
Data center cooling system practice	3%	7%
DCIM System Planning Overview	3%	2%
DCIM Architecture and Functions	6%	7%
DCIM System Planning	5%	8%

NOTE

The test content mentioned in this document is only a general test guide. Other contents not mentioned in this document may also appear in the test.

Reference

Huawei Certified HCIE-Data Center Facility-Design V1.0 Course

Related materials provided by the development, construction, and operation department of the construction company

Existing site planning conditions

Materials and conditions provided by relevant professions

Current national and local design schemes

ANSI/TIA-942 Telecommunications Infrastructure Standard for Data Centers

Uptime Standard

ANSI/ASHRAE/IES Standard 90.1-2019

Other References

HCIE-Data Center Facility Design V1.0 Lab Exam Instructions

NOTE **The following are very important and should be read carefully:**

1. The following attachments are the simulation materials for the lab exam, which are mainly used to describe the form of the lab exam and simulate the answer process. The clues and known conditions provided by the questions are assumed and do not represent the actual situation and are for reference only.

2. The following attachment test questions are based on the HCIE-Data Center Facility Design V1.0 certification course to check candidates' mastery of the planning and design of data center infrastructure subsystems.

3. HCIE-Data Center Facility Design V1.0 consists of any two of the three modules: data center power distribution system planning, data center cooling system planning, and data center DCIM system planning. The number of questions ranges from 9 to 11.

4. Due to space limitation, only some test types and answer sheets are displayed and related answers are provided for reference only. All conclusions cannot be used in the actual test process.

5. The **answerCard.xls** file is the only valid answer method.

Attachment:

HCIE-Data Center Facility Design Version 1.0 Lab Mock Exam

HUAWEI TECHNOLOGIES CO., LTD.

2021-08-11

Exam Instructions

- Based on the HCIE-Data Center Facility Design V1.0 certification course, it aims to examine the mastery of data center facility subsystem planning and design.
- Exam duration: 3 hours.
- Total score: 100 points (passing score: 80 points).
- Note: This document provides exam questions, clues, and known conditions. No point is given if you provide answers on this document. Please answer the questions in the **answerCard.xls** file.

Contents

1 Data Center Power Distribution System Overview

Introduction

With the rapid development of electronic information technologies, the scale and number of data centers are increasing. This poses higher requirements on the design of the power supply and distribution system, which must ensure that the electronic information system runs safely, stably, and reliably. Therefore, the power supply and distribution system must be advanced, cost-effective, safe, and environmental-friendly.

Power Distribution System Structure

The planning and design cover the power supply and distribution systems of 35 kV or lower, including the 35 kV/10 kV/400 V transformer, 35 kV/10 kV/400 V diesel generator (DG), high-voltage or low-voltage power distribution frame (PDF), bus, UPS, and ATS.

The following figure shows a typical power supply and distribution system.

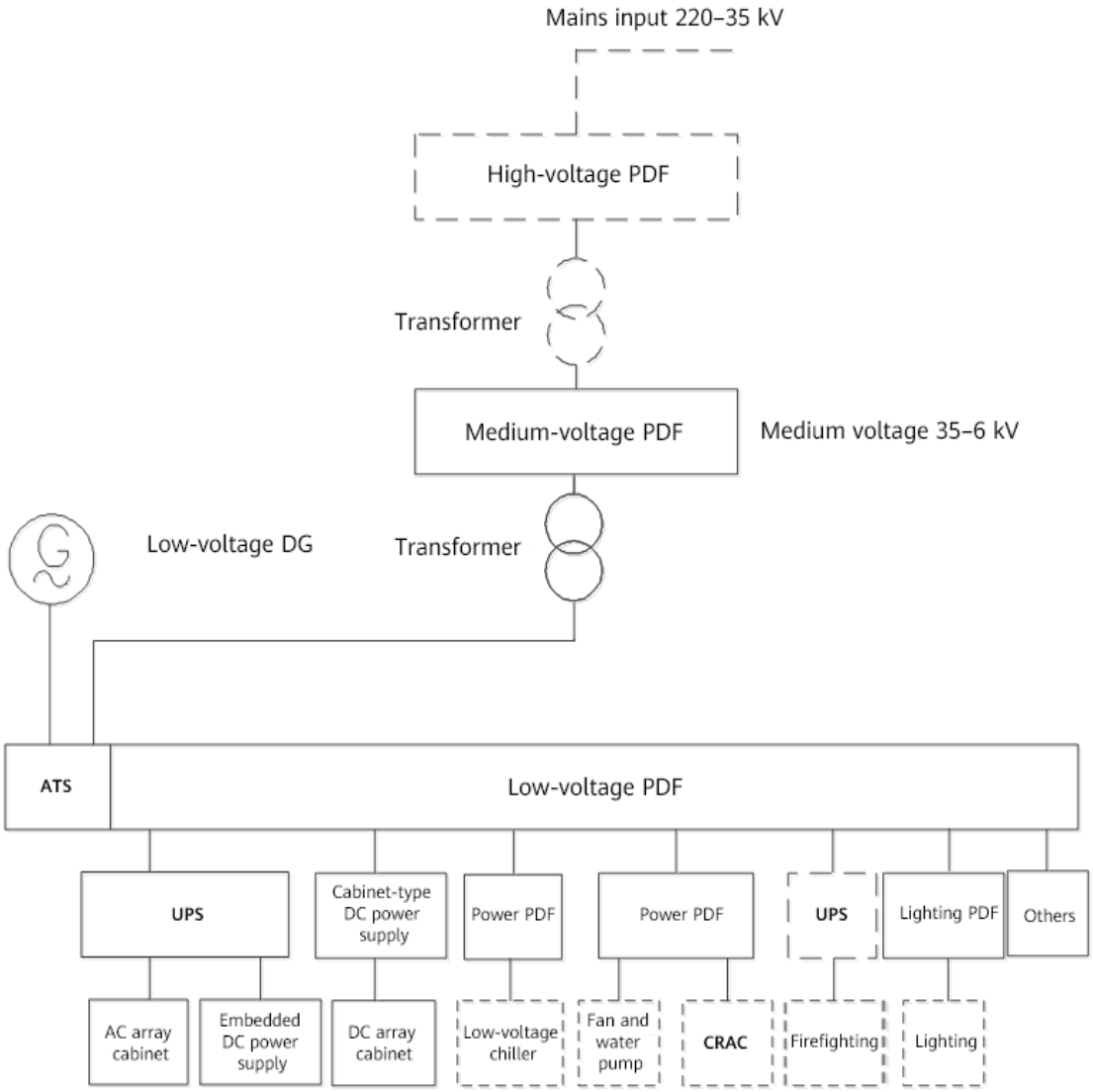

Figure 1-1 Power supply and distribution system (low-voltage DG)

Requirements of the Data Center Power Distribution System

Uptime Tier Ⅰ: basic data center infrastructure

An Uptime Tier Ⅰ basic data center has non-redundant capacity components and a single non-redundant power distribution route to serve the critical environment. The infrastructure of an Uptime Tier I data center includes dedicated space for IT systems, UPSs, cooling equipment, and engine generators.

Uptime Tier Ⅱ: redundant capacity components for the data center infrastructure

An Uptime Tier Ⅱ data center has redundant capacity components and a single non-redundant power distribution route to serve the critical environment. Redundant components include additional UPSs, cooling equipment, and engine generators.

Onsite fuel reserve should support 12-hour operation of N engine generators.

Uptime Tier Ⅲ: concurrently maintainable data center infrastructure

Data centers that can be concurrently maintained have redundant capacity components and multiple independent power distribution routes to serve critical systems. At any time, only one power distribution route is required to serve the critical environment.

All IT devices use dual power supplies and are properly installed to be compatible with the data center architecture topology. If the critical environment does not meet this specification, a transmission device such as a switch must be used.

Onsite fuel reserve should support 12-hour operation of N engine generators.

Uptime Tier Ⅳ: fault tolerant data center infrastructure

A fault tolerant data center has multiple independent systems that are physically isolated to provide redundant capacity components and multiple independent, different, and activated power distribution routes to serve the critical environment at the same time. Redundant capacity components and different power distribution routes should be configured based on the following principle: If any

facility is faulty, the "N" capacity provides power and cooling for the critical environment.

All IT devices use dual power supplies and are properly installed to be compatible with the data center architecture topology. If the critical environment does not meet this specification, a transmission device such as a switch must be used.

Power distribution routes must be physically isolated (partitioned) to prevent any single event from affecting two systems or power distribution routes at the same time.

Continuous cooling is required.

Onsite fuel reserve should support 12-hour operation of N engine generators.

2 Data Center Power Distribution System Project Background

Project Overview

This data center covers a construction area of about xxx m^2 and involves xxx cabinets. The building has two floors. The first floor houses power equipment, high-voltage cable entry cabinets, and auxiliary areas. The second floor is composed of computer rooms, and the corresponding low-voltage power distribution rooms and auxiliary areas. Four computer rooms are deployed on the second floor, and five modular data centers are deployed in each computer room. Each modular data center contains 20 IT cabinets. The average power density of each cabinet is 7 kW.

The system is configured with four chillers. Each chiller is 150 kW and is configured with a 20 kW chilled water pump and a 18 kW cooling water pump. Four 15 kW cooling towers and 150 air conditioner indoor units are configured. The cooling output of each air conditioner is 30 kW, and the power consumption of each air conditioner is 2 kW.

Devices such as chillers, cooling towers, chilled water pumps, and cooling water pumps are configured in N+1 redundancy mode. The system will not be interrupted if any unit or device is faulty or maintained.

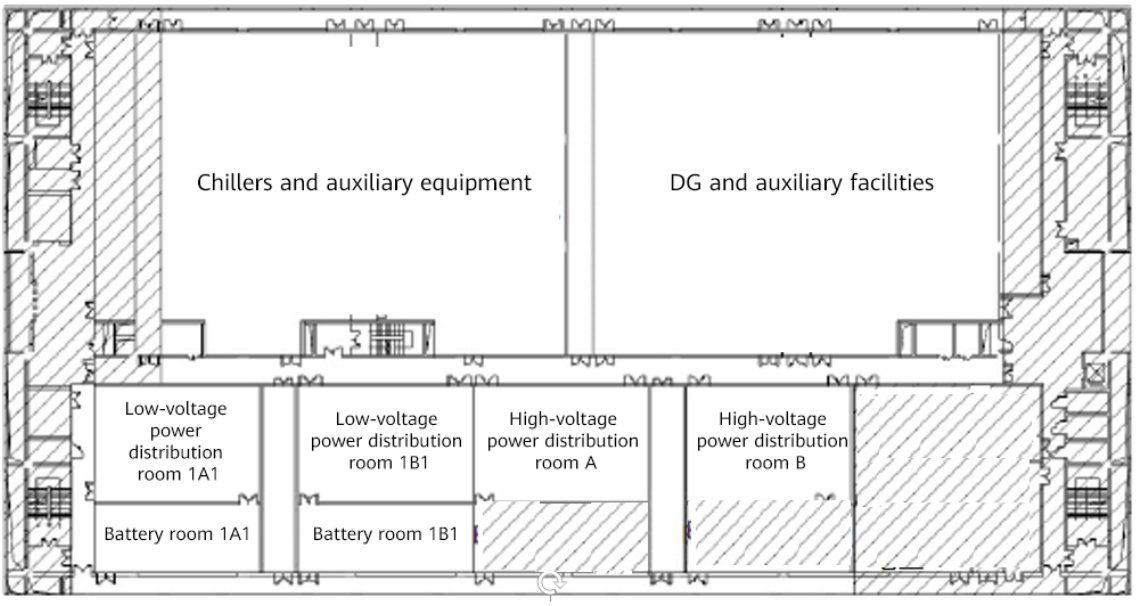

Figure 2-1 Drawing of the first floor

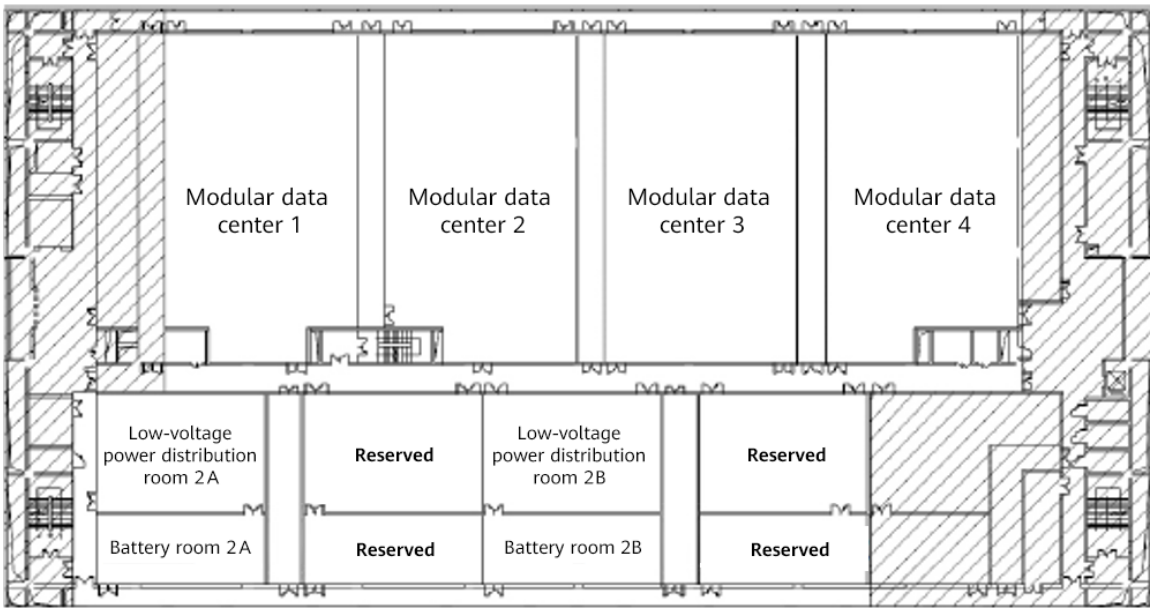

Figure 2-2 Drawing of the second floor

Project Requirements

The customer requires that the data center should meet the requirements of Uptime Tier Ⅲ. The 2N power distribution architecture is used, and N+1 DGs are configured.

The power supply system has routes A and B. If one route is faulty, the other route can supply power to all loads in the data center.

The continuous cooling function must be configured for the cooling system.

3 Data Center Power Distribution System Planning Tasks

Question 1: Load Statistics (10 Points)

IT Load Statistics

The following table lists the IT load statistics of the second floor. Fill in the following table based on the following information.

4 computer rooms are deployed on each floor. 5 modular data centers are deployed in each computer room. Each modular data center contains 20 IT cabinets. The IT load power factor is 0.95.

The average power density of each cabinet is 7 kW, and the maximum power of each cabinet is 15 kW. This ensures that the power distribution capacity of cabinets in the same smart module can be shared.

Except that the average power and maximum power at the cabinet level are inconsistent, the rated power and peak power of the IT areas, computer rooms, and floors are consistent.

Reserve 10% of cabinets for each smart module to ensure that the power distribution capacity can be fully used when the deployed capacity is lower than the expected capacity. No space needs to be reserved for rooms and floors.

Table 3-1 IT load statistics of the second floor

		Floor/Computer Room	Computer Room/IT Area	IT Area/Cabinet
Power density specifications	Number of units	4	5	20
	Designed average power density of each unit			
	Peak value of each unit			
	Power uncertainty of each unit	/	/	10%

Space specifications	Reserved space of each unit	/	/	
Computer room performance specifications	Rated system power			140 kW
	Rated power of each unit			7 kW/cabinet
	Rated peak power of each unit			15 kW/cabinet
	Expected unused space	/	/	10%

Cooling System Load Statistics

The following table lists the cooling system load statistics. Fill in the table based on the project information.

Table 3-2 Cooling system load statistics

Equipment Name	Power Factor	Active Power (kW)	Reactive Power (kVAR)	Apparent Power (kVA)
Chiller	0.8			
Chilled water pump	0.8			
Cooling water pump	0.8			
Cooling tower	0.8			
Air conditioner indoor unit	0.9			
Auxiliary equipment	0.8	30		
Monitoring and control system	0.9	20		
Total	/			

Question 1: Load Statistics Answer Card Display

Note: For reference only, the answer sheet is an Excel file and is used together with the question file.

<table>
<tr><th>No.</th><th>Power Distribution System Planning Answer Sheet: 1</th><th>Remark</th></tr>
<tr><td>1</td><td>
<table>
<tr><th colspan="6">Load Statistics</th></tr>
<tr><td rowspan="9">1.</td><td colspan="5">IT load statistics of the second floor</td></tr>
<tr><td colspan="2"></td><td>Floor/Computer Room</td><td>Computer Room/IT Area</td><td>IT Area/Cabinet</td></tr>
<tr><td rowspan="4">Power density specifications</td><td>Number of units</td><td>4</td><td>5</td><td>20</td></tr>
<tr><td>Designed average power density of each unit/kW</td><td></td><td></td><td></td></tr>
<tr><td>Peak value of each unit/kW</td><td></td><td></td><td></td></tr>
<tr><td>Power uncertainty of each unit</td><td>/</td><td>/</td><td>10%</td></tr>
<tr><td>Space specifications</td><td>Reserved space of each unit</td><td>/</td><td>/</td><td></td></tr>
<tr><td rowspan="4">Computer room performance specifications</td><td>Rated system power/kW</td><td></td><td></td><td>140 kW</td></tr>
<tr><td>Rated power of each unit/kW</td><td></td><td></td><td>7 kW/cabinet</td></tr>
<tr><td>Rated peak power of each unit/kW</td><td></td><td></td><td>15 kW/cabinet</td></tr>
<tr><td>Expected unused space</td><td>/</td><td>/</td><td>10%</td></tr>
<tr><td rowspan="11">2.</td><td colspan="5">Cooling system load statistics</td></tr>
<tr><td colspan="2">Equipment Name</td><td>Power Factor</td><td>Active Power</td><td>Reactive Power (kVAR)</td><td>Apparent Power (kVA)</td></tr>
<tr><td colspan="2">Chiller</td><td>0.8</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Chilled water pump</td><td>0.8</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Cooling water pump</td><td>0.8</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Cooling tower</td><td>0.8</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Air conditioner indoor unit</td><td>0.9</td><td></td><td></td><td></td></tr>
<tr><td colspan="2">Auxiliary equipment</td><td>0.8</td><td>30</td><td></td><td></td></tr>
<tr><td colspan="2">Monitoring and control system</td><td>0.9</td><td>20</td><td></td><td></td></tr>
<tr><td colspan="2">Total</td><td>/</td><td></td><td></td><td></td></tr>
</table>
</td><td></td></tr>
</table>

Question 1: Load Statistics Reference Answers

Note: The answers are for reference only.

<table>
<tr><th>No.</th><th>Power Distribution System Planning Answer Sheet: 1</th><th>Remark</th></tr>
<tr><td>1</td><td>
<table>
<tr><th colspan="5">Load Statistics</th></tr>
<tr><td rowspan="8">1.</td><td colspan="4">IT load statistics of the second floor</td></tr>
<tr><td colspan="2"></td><td>Floor/Computer Room</td><td>Computer Room/IT Area</td><td>IT Area/Cabinet</td></tr>
<tr><td rowspan="4">Power density specifications</td><td>Number of units</td><td>4</td><td>5</td><td>20</td></tr>
<tr><td>Designed average power density of each unit/kW</td><td>700</td><td>140</td><td>7</td></tr>
<tr><td>Peak value of each unit/kW</td><td>700</td><td>140</td><td>15</td></tr>
<tr><td>Power uncertainty of each unit</td><td>/</td><td>/</td><td>10%</td></tr>
<tr><td>Space specifications</td><td>Reserved space of each unit</td><td>/</td><td>/</td><td>2 racks</td></tr>
<tr><td rowspan="4">Computer room performance specifications</td><td>Rated system power/kW</td><td>2800</td><td>750</td><td>140 kW</td></tr>
<tr><td>Rated power of each unit/kW</td><td>700kW/Room</td><td>140kW/IT area</td><td>7 kW/cabinet</td></tr>
<tr><td>Rated peak power of each unit/kW</td><td>700kW/Room</td><td>140kW/IT area</td><td>15 kW/cabinet</td></tr>
<tr><td>Expected unused space</td><td>/</td><td>/</td><td>10%</td></tr>
<tr><td rowspan="10">2.</td><td colspan="5">Cooling system load statistics</td></tr>
<tr><td>Equipment Name</td><td>Power Factor</td><td>Active Power (kW)</td><td>Reactive Power (kVAR)</td><td>Apparent Power (kVA)</td></tr>
<tr><td>Chiller</td><td>0.8</td><td>600</td><td>450</td><td>750</td></tr>
<tr><td>Chilled water pump</td><td>0.8</td><td>80</td><td>60</td><td>100</td></tr>
<tr><td>Cooling water pump</td><td>0.8</td><td>72</td><td>54</td><td>90</td></tr>
<tr><td>Cooling tower</td><td>0.8</td><td>60</td><td>45</td><td>75</td></tr>
<tr><td>Air conditioner indoor unit</td><td>0.9</td><td>300</td><td>145.296</td><td>333.333</td></tr>
<tr><td>Auxiliary equipment</td><td>0.8</td><td>30</td><td>22.5</td><td>37.5</td></tr>
<tr><td>Monitoring and control system</td><td>0.9</td><td>20</td><td>9.686</td><td>22.222</td></tr>
<tr><td>Total</td><td>/</td><td>1162</td><td>786.483</td><td>1403.139</td></tr>
</table>
</td><td></td></tr>
</table>

Question 2: UPS System Configuration (12 Points)

1. UPS Configuration for IT Loads

Requirements:

The UPS system for IT loads must be configured in 2N mode.

Calculation formula: E ⩾ 1.2 x P (E is the basic UPS capacity, and P is the calculated UPS load.)

The 500 kVA modular UPS is selected. The output power factor is 0.99, the IT load power factor is 0.97, and a maximum of four UPSs can be connected in parallel.

Due to the large load capacity, the UPS systems in routes A and B are divided into two groups respectively. Each group supplies power to the IT loads in two rooms.

Configure the UPS systems based on the floor plan.

Table 3-1 UPS configuration for IT loads

	UPS Group	Room Receiving the Power	Number of UPSs	Calculation Process
Low-voltage power distribution room 2A	UPS group A1			
	UPS group A2			
Low-voltage power distribution room 2B	UPS group B1			
	UPS group B2			

2. UPS Battery Configuration for IT Loads

Requirements:

The UPS supports a single battery string consisting of 240 batteries (2 V each).

The end-of-discharge (EOD) voltage is 1.67 V/cell, and the battery inversion efficiency is 0.95.

A maximum of four battery strings can be connected to one UPS.

200 Ah/2 V lead-acid batteries from a brand are required. Its constant power discharge specifications is as follows.

The formula for calculating the constant power is: $W = P/\eta/(n \times 6)$.

During calculation, please use the load capacity.

The backup time of the UPS system in each route is 15 minutes.

Table 3-2 Discharge specifications at a constant power of a battery from a brand

EOD = 1.67 V/cell, W/cell, 25°C					
Specification/Time (min)	5 min	10 min	15 min	30 min	50 min
GFM200	558	476	422	307	224

Table 3-3 UPS battery configuration for IT loads

Single Battery Capacity	Number of Batteries in a Battery String	Number of Battery Strings Required for Each UPS	Calculation Process

Question 2: UPS System Configuration Answer Card Display

Note: For reference only, the answer sheet is an Excel file and is used together with the question file.

<table>
<tr><th>No.</th><th>Power Distribution System Planning Answer Sheet: 2</th><th>Remark</th></tr>
<tr><td>2</td><td>
<table>
<tr><td colspan="6">UPS System Configuration</td></tr>
<tr><td colspan="6">UPS configuration for IT loads</td></tr>
<tr><td rowspan="5">1.</td><td></td><td>UPS Group</td><td>Room Receiving the Power</td><td>Number of UPSs</td><td>Calculation Process</td></tr>
<tr><td rowspan="2">Low-voltage power distribution room 2A</td><td>UPS group A1</td><td></td><td></td><td rowspan="4"></td></tr>
<tr><td>UPS group A2</td><td></td><td></td></tr>
<tr><td rowspan="2">Low-voltage power distribution room 2B</td><td>UPS group B1</td><td></td><td></td></tr>
<tr><td>UPS group B2</td><td></td><td></td></tr>
<tr><td rowspan="3">2.</td><td colspan="5">UPS battery configuration for IT loads</td></tr>
<tr><td>Single Battery Capacity</td><td>Number of Batteries in a Battery String</td><td>Number of Battery Strings Required for Each UPS</td><td colspan="2">Calculation Process</td></tr>
<tr><td></td><td></td><td></td><td colspan="2"></td></tr>
</table>
</td><td></td></tr>
</table>

Question 2: UPS System Configuration Reference Answers

Note: The answers are for reference only.

<table>
<tr><th>No.</th><th>Power Distribution System Planning Answer Sheet: 2</th><th>Remark</th></tr>
<tr><td>2</td><td>
<table>
<tr><th colspan="6">UPS System Configuration</th></tr>
<tr><th colspan="6">UPS configuration for IT loads</th></tr>
<tr><td rowspan="5">1.</td><td></td><td>UPS Group</td><td>Room Receiving the Power</td><td>Number of UPSs</td><td>Calculation Process</td></tr>
<tr><td rowspan="2">Low-voltage power distribution room 2A</td><td>UPS group A1</td><td>Modular Data center 1 and Modular Data center 2</td><td>4</td><td rowspan="4">the loads of two modular data centers：100*7*2=1400kW.
then need 1400/0.97*1.2=1731.95 kVA.
so need 500kVAUPS 4.</td></tr>
<tr><td>UPS group A2</td><td>Modular Data center 3 and Modular Data center 4</td><td>4</td></tr>
<tr><td rowspan="2">Low-voltage power distribution room 2B</td><td>UPS group B1</td><td>Modular Data center 1 and Modular Data center 2</td><td>4</td></tr>
<tr><td>UPS group B2</td><td>Modular Data center 3 and Modular Data center 4</td><td>4</td></tr>
<tr><td rowspan="3">2.</td><td colspan="5">UPS battery configuration for IT loads</td></tr>
<tr><td>Single Battery Capacity</td><td>Number of Batteries in a Battery String</td><td>Number of Battery Strings Required for Each UPS</td><td colspan="2">Calculation Process</td></tr>
<tr><td>200Ah</td><td>240</td><td>4</td><td colspan="2">In each "N" system, there are 4 UPS. And the requirement is each route the backup time is 15min, so each UPS the load is 1400/4=350 kw, and the backup time is 15min, the fomula is :W=350000/0.95/40/6=1535, refer to the table, we should 4 groups. Total is 1688</td></tr>
</table>
</td><td></td></tr>
</table>

NOTE

Note: Follow-up questions are not presented, please note.

4 Background of the Data Center Air Conditioning System Project

Project Name

Hangzhou XX Cloud Data Center Civil Engineering Project

Background

A data center building is planned in the Hangzhou XX Cloud Data Center Civil Engineering Project. In this project, the data center building has one floor above ground and one underground floor, and covers an area of 10,281 m2. For details about the functional areas and construction area, see the figure "Hangzhou data center layout plan" in the attachment. As a technical engineer of the project, Tom needs to make a feasibility study report on the air conditioning system. The air conditioning system requires a preliminary configuration solution. For details about the data center building layout, see the attachment.

Outdoor Design Specifications

Table 4-1 Outdoor Design Specifications

Winter		Summer	
Atmospheric pressure (hPa)	1020.9	Atmospheric pressure (hPa)	1000.5
Calculated dry-bulb temperature of the air conditioner (°C)	–4	Calculated dry-bulb temperature of the air conditioner (°C)	35.7
Calculated relative humidity of the air conditioner (average temperature in the coldest month; unit: %)	77	Calculated relative humidity of the air conditioner (average temperature in the coldest month; unit: %)	80
Average wind speed (m/s)	1.1	Calculated Outdoor Wet-Bulb Temperature of the Air Conditioner (°C)	28.5

Data Center Design Technique Requirements

According to the requirements of Huawei, this project is designed based on the requirements of the ANSI/TIA-942 Telecommunications Infrastructure Standard for Data Centers. The main specifications are as follows:

The temperature and humidity must be controlled to provide a continuous operating temperature and humidity range:

- Dry-bulb temperature: 20°C (68℉) to 25°C (77℉)
- Relative humidity: 40% to 55%
- Maximum dew point: 21℃(69.8°F)
- Maximum temperature change rate: 5℃ (9°F) per hour

Service Level and Cabinet Power Consumption

Service Type Setting

Considering the service importance of the data center, the air conditioning system complies with Uptime Tier III or higher standards and TIA-942 Class 4 design.

Configuration of the Service Type and Cabinet Power Consumption

Considering that this project will be completed one year later and it takes four years for all devices to be installed, the power consumption density of cabinets in various industries will be further increased based on the trend of higher power consumption of data center cabinets.

1.Cabinets for financial services: 3 kW (35%), 5 kW (55%), and 7 kW (10%). The average power consumption is 4.5 kW.

2.Cabinets for Internet services: 5 kW (30%) and 7 kW (70%). The average power consumption is 6.4 kW.

3.Cabinets for services in other industries: 3kW (35%), 5 kW (55%), and 7 kW (10%). The average power consumption is 4.5 kW.

4.The overall rated power of the data center is 7 kW per cabinet. Some cabinets have a rated power of 5 kW to meet special requirements.

Installation Capability of the Data Center Building

Table 4-2 Installation capability of the data center

Computer Room	Number of Cabinets	Power Consumption of a Single Cabinet (kW)	Room Area
Room 1-1	256	5	540
Room 1-2	250	5	542
Room 1-3	136	7	305
Room 1-4	125	7	305
Room 1-5	136	6	305
Room 1-6	134	6	305
Room 1-7	250	5	250
Room 1-8	250	5	250

Training Design Scope

Air Conditioning System Design Contents

The design contents of the air conditioning system in this project include:

(1)Cooling source design for the water-cooled chilled water air conditioner in the data center

(2)Selection of the water-cooled chilled water air conditioner indoor unit in the data center

Basis and Scope of the Feasibility Study Report

1.Materials obtained from the onsite survey and face-to-face interview conducted with the development, construction, and operation department of the construction company

2.Related materials provided by the development, construction, and operation department of the construction company

3.Existing site planning conditions

4.Materials and conditions provided by relevant professions

5.Current national and local design schemes

6.ANSI/TIA-942 Telecommunications Infrastructure Standard for Data Centers

5 Total Cooling Load Determination of Data Center Air Conditioners

Question1: Determine the Total Cooling Load (18 Points)

Calculate the cooling load of the air conditioner in each room and the total cooling load of the air conditioning system based on the figure "Hangzhou data center layout plan" in the attachment. Fill in the following table. (Estimate the power density of an IT room based on the cabinet power density. Estimate the power density of a power and battery room or UPS room based on the room area.)

Table 5-1 Cooling load calculation for IT rooms

No.	Room	Number of Racks	Power Consumption of a Single Cabinet (kW)	Total Power Consumption (kW)	Room Cooling Load (kW)
1	Room 1-1	256	5	1280	1536
2	Room 1-2	250	5		
3	Room 1-3	136	7		
4	Room 1-4	125	7		
5	Room 1-5	136	6		
6	Room 1-6	134	6		
7	Room 1-7	250	5		
8	Room 1-8	250	5		

Table 5-2 Total cooling load of the power supply and distribution equipment room

No.	Room	Room Area (m^2)	Cooling Load Indicator (W/m^2)	Room Cooling Load (kW)
1	Power room 1-1	300	350	105
2	Power room 1-2	300	350	
3	Power room 1-3	295	350	
4	Power room 1-4	295	350	
5	UPS room	412	350	
6	Power transformation and distribution room 1	600	350	
7	Power transformation and distribution room 2	600	350	
8	High-voltage power distribution room	460	350	

Analysis

1. Calculate the total power consumption of each IT room and the cooling load of the room, and fill in table "Cooling load calculation for IT rooms."

Example:

The following uses room 1-1 as a modular data center example.

Q1-1 = Number of racks x Power density x Simultaneous coefficient x Comprehensive coefficient = 1408 x 1 x 1.2 = 1690 kW

The following uses room 1-2 as a common room example.

Q1-2 = Number of racks x Power density x Simultaneous coefficient x Comprehensive coefficient = 1375 x 1 x 1.5 = 2063 kW

2. Obtain the cooling load per unit area in the "Cooling Load Indicator" column.

The upper limit, lower limit, or median value of the cooling load indicator is selected based on the environment conditions. You are advised to select the upper limit.

3. Calculate the cooling load of each room in the power supply and distribution equipment room and fill in the table. The power density of the battery room and UPS room is estimated as 350 W/m^2.

4. Calculate the total cooling load of the data center building.

Question1: Determine the Total Cooling Load Answer Card Display

Note: For reference only, the answer sheet is an Excel file and is used together with the question file.

<table>
<tr><th>No.</th><th>Cooling System Planning Answer Sheet: 1</th><th>Remark</th></tr>
<tr><td>1</td><td>
<table>
<tr><th colspan="5">Total cooling load calculation for IT rooms</th></tr>
<tr><th>Room</th><th>Number of Racks</th><th>Power Consumption of a Single Cabinet (kW)</th><th>Total Power Consumption (kW)</th><th>Room Cooling Load (kW)</th></tr>
<tr><td>Room 1-1</td><td>256</td><td>5</td><td>1280</td><td>1536</td></tr>
<tr><td>Room 1-2</td><td>250</td><td>5</td><td></td><td></td></tr>
<tr><td>Room 1-3</td><td>136</td><td>7</td><td></td><td></td></tr>
<tr><td>Room 1-4</td><td>125</td><td>7</td><td></td><td></td></tr>
<tr><td>Room 1-5</td><td>136</td><td>6</td><td></td><td></td></tr>
<tr><td>Room 1-6</td><td>134</td><td>6</td><td></td><td></td></tr>
<tr><td>Room 1-7</td><td>250</td><td>5</td><td></td><td></td></tr>
<tr><td>Room 1-8</td><td>250</td><td>5</td><td></td><td></td></tr>
<tr><th colspan="5">Total cooling load of the power supply and distribution equipment room</th></tr>
<tr><th>Room</th><th>Room Area (m^2)</th><th colspan="2">Cooling Load Indicator (W/m^2)</th><th>Total Cooling Load (kW)</th></tr>
<tr><td>Power room 1-1</td><td>300</td><td colspan="2"></td><td></td></tr>
<tr><td>Power room 1-2</td><td>300</td><td colspan="2"></td><td></td></tr>
<tr><td>Power room 1-3</td><td>295</td><td colspan="2"></td><td></td></tr>
<tr><td>Power room 1-4</td><td>295</td><td colspan="2"></td><td></td></tr>
<tr><td>UPS room</td><td>412</td><td colspan="2"></td><td></td></tr>
<tr><td>Power transformation and</td><td>600</td><td colspan="2"></td><td></td></tr>
<tr><td>Power transformation and</td><td>600</td><td colspan="2"></td><td></td></tr>
<tr><td>High-voltage power distribution room</td><td>460</td><td colspan="2"></td><td></td></tr>
<tr><td>Total cooling load calculation</td><td colspan="4"></td></tr>
</table>
</td><td></td></tr>
</table>

Question1: Determine the Total Cooling Load Reference Answers

<table>
<tr><th>No.</th><th>Power Distribution System Planning Answer Sheet: 1</th><th>Remark</th></tr>
<tr><td>1</td><td>
<table>
<tr><th colspan="5">Total cooling load calculation for IT rooms</th></tr>
<tr><th>Room</th><th>Number of Racks</th><th>Power Consumption of a Single Cabinet (kW)</th><th>Total Power Consumption (kW)</th><th>Room Cooling Load (kW)</th></tr>
<tr><td>Room 1-1</td><td>256</td><td>5</td><td>1280</td><td>1536</td></tr>
<tr><td>Room 1-2</td><td>250</td><td>5</td><td>1250</td><td>1875</td></tr>
<tr><td>Room 1-3</td><td>136</td><td>7</td><td>952</td><td>1143</td></tr>
<tr><td>Room 1-4</td><td>125</td><td>7</td><td>875</td><td>1313</td></tr>
<tr><td>Room 1-5</td><td>136</td><td>6</td><td>816</td><td>980</td></tr>
<tr><td>Room 1-6</td><td>134</td><td>6</td><td>804</td><td>1206</td></tr>
<tr><td>Room 1-7</td><td>250</td><td>5</td><td>1250</td><td>1500</td></tr>
<tr><td>Room 1-8</td><td>250</td><td>5</td><td>1250</td><td>1875</td></tr>
<tr><th colspan="5">Total cooling load of the power supply and distribution equipment room</th></tr>
<tr><th>Room</th><th>Room Area (m^2)</th><th colspan="2">Cooling Load Indicator (W/m^2)</th><th>Total Cooling Load (kW)</th></tr>
<tr><td>Power room 1-1</td><td>300</td><td colspan="2">350</td><td>105</td></tr>
<tr><td>Power room 1-2</td><td>300</td><td colspan="2">350</td><td>105</td></tr>
<tr><td>Power room 1-3</td><td>295</td><td colspan="2">350</td><td>104</td></tr>
<tr><td>Power room 1-4</td><td>295</td><td colspan="2">350</td><td>104</td></tr>
<tr><td>UPS room</td><td>412</td><td colspan="2">350</td><td>145</td></tr>
<tr><td>Power transformation and</td><td>600</td><td colspan="2">350</td><td>210</td></tr>
<tr><td>Power transformation and</td><td>600</td><td colspan="2">350</td><td>210</td></tr>
<tr><td>High-voltage power distribution room</td><td>460</td><td colspan="2">350</td><td>161</td></tr>
<tr><td>Total cooling load calculation</td><td colspan="4">Q_{Total}= Q1-1 + Q1-2 + Q1-3 + Q1-4 + Q1-5 + Q1-6 + Q1-7 + Q1-8= 11428+1146 kW=12574 kW</td></tr>
</table>
</td><td></td></tr>
</table>

Question 2: Selection of Data Center Air Conditioner Cold Source Devices(8 Points)

Chiller Selection

1. Select chillers based on the calculated total cooling load of the air conditioning system and the attachment Centrifugal Chiller Data, fill in the following table. Obtain the total cooling load of the chiller based on the following formula: Cooling source load (installed capacity) = Total cooling load of the air conditioning system x Simultaneous coefficient (0.8-1).

Table 5-3 Technical specifications of chillers

No.	Specifications	Centrifugal Chiller
1	Cooling capacity of each chiller	
2	Quantity	
3	Power consumption of cooling capacity per unit with full load (COP) (W/W)	
4	Inlet and outlet chilled water temperatures (°C)	
5	Inlet and outlet cooling water temperatures (°C)	
6	Evaporator water pressure drop (kPa)	
7	Condenser water pressure drop (kPa)	
8	Power consumption	

Analysis

1. Determine the type, chiller quantity, and redundancy mode of the air conditioning system based on the total cooling load, environment conditions, and running status of the air conditioning system. (You can draw the diagram of the air conditioning system and do not need to present the diagram on the answer sheet.)

2. Determine the cooling capacity of each chiller, select an appropriate chiller based on the chiller selection data, and enter the specifications in the table.

Note:

1. The number of chilled water units (N) that can meet the cooling requirements is not less than 4, not greater than 6.

2. This project is a class-A data center. The equipment can be configured in N+1 or 2N mode. The temperature of the supply and return water is 7/12° C.

3. Candidates can answer one possible solution.

Question 2: Selection of Data Center Air Conditioner Cold Source Devices-Attachment

Note: This document is only for demonstration. The attachment is displayed in PDF format only after you click Topology.

Attachment	Basis for chiller selection	
1		

Model	Cooling Capacity		Input Power (kW)	Full-load Power Consumption (kW/TR)	NPLV	Full-load Current (A)	Startup Current (A)	Evaporator			Condenser			Dimensions (mm)			Transportation Weight (kg)	Operating Weight (kg)	Estimated Refrigerant Amount (kg)
	TR	kW						Water Flow Rate (L/s)	Water Pressure Drop (kPa)	Pipe Size (mm)	Water Flow Rate (L/s)	Water Pressure Drop (kPa)	Pipe Size (mm)	L	W	H			
YKC3CQQ45CHG	300	1055	199	0.663	0.593	352	822	50	36	200	60	53	200	4245	1676	2217	6491	7172	384
YKCCCPQ45CJG	350	1231	228	0.651	0.575	396	936	59	65	200	69	88	200	4245	1676	2217	6755	7418	374
YKCCCPQ55CKG	400	1406	260	0.650	0.599	451	1017	67	82	200	79	110	200	4245	1676	2422	7095	7757	373
YKE3EPQ65CLG	450	1582	292	0.649	0.561	508	1125	76	44	250	89	71	250	4280	1880	2532	8168	9076	509
YKECEFQ65CMG	500	1758	316	0.632	0.541	549	1234	84	82	250	99	85	250	4280	1880	2532	8219	9119	479
YKCECDQ75CNF	550	1934	357	0.649	0.549	620	1270	92	89	250	109	101	250	4308	1880	2357	8260	9160	563
YKCECEQ75COF	600	2110	394	0.657	0.564	682	1467	101	104	250	119	88	250	4308	1880	2357	8490	9450	563
YKG3EVP85CPG	650	2285	420	0.648	0.546	727	1500	109	55	250	129	77	250	4314	2108	2788	10,074	11,290	603
YKGCEVP85CQG	700	2461	443	0.633	0.529	769	1631	118	54	250	138	88	250	4314	2108	2788	10,222	11,437	537
YKGCEVP95CRG	750	2637	471	0.628	0.523	835	1867	126	106	250	148	99	250	4314	2108	2698	10,530	11,745	536
YKGDEVP95CSG	800	2813	512	0.640	0.541	888	1831	134	83	250	158	111	250	4314	2108	2698	10,725	12,019	568
YKK8K2H95CTG	850	2989	545	0.641	0.519	943	1831	143	71	300	169	90	250	4997	2299	2988	13,026	14,537	799
YKK8K3H95CUG	900	3164	581	0.646	0.530	994	2165	151	78	300	179	77	250	4997	2299	2988	13,277	14,970	786
YKK8K3H95CVG	950	3340	611	0.643	0.525	1046	2232	160	86	300	188	85	250	4997	2299	2988	13,325	15,018	784

Question 2: Selection of Data Center Air Conditioner Cold Source Devices Answer Card Display

Note: For reference only, the answer sheet is an Excel file and is used together with the question file.

<table>
<tr><th>No.</th><th>Cooling System Planning Answer Sheet: 2</th><th>Remark</th></tr>
<tr><td>2</td><td>
<table>
<tr><th colspan="2">Technical specifications of chillers</th></tr>
<tr><th>Specifications</th><th>Centrifugal Chiller</th></tr>
<tr><td>Cooling capacity of each chiller</td><td></td></tr>
<tr><td>Quantity</td><td></td></tr>
<tr><td>Power consumption of cooling capacity per unit with full load (COP) (W/W)</td><td></td></tr>
<tr><td>Inlet and outlet chilled water temperatures (°C)</td><td></td></tr>
<tr><td>Inlet and outlet cooling water temperatures (°C)</td><td></td></tr>
<tr><td>Evaporator water pressure drop (kPa)</td><td></td></tr>
<tr><td>Condenser water pressure drop (kPa)</td><td></td></tr>
<tr><td>Power consumption</td><td></td></tr>
</table>
</td><td></td></tr>
</table>

Question 2: Selection of Data Center Air Conditioner Cold Source Devices Answer Card Display Reference Answers

Note: The answers are for reference only.

<table>
<tr><th>No.</th><th>Cooling System Planning Answer Sheet: 2</th><th>Remark</th></tr>
<tr><td>2</td><td>
<table>
<tr><th colspan="2">Technical specifications of chillers</th></tr>
<tr><th>Specifications</th><th>Centrifugal Chiller</th></tr>
<tr><td>Cooling capacity of each chiller</td><td>750TR</td></tr>
<tr><td>Quantity</td><td>6</td></tr>
<tr><td>Power consumption of cooling capacity per unit with full load (COP) (W/W)</td><td>5.6</td></tr>
<tr><td>Inlet and outlet chilled water temperatures (°C)</td><td>12/7°C</td></tr>
<tr><td>Inlet and outlet cooling water temperatures (°C)</td><td>32/37°C</td></tr>
<tr><td>Evaporator water pressure drop (kPa)</td><td>106</td></tr>
<tr><td>Condenser water pressure drop (kPa)</td><td>99</td></tr>
<tr><td>Power consumption</td><td>471kW</td></tr>
</table>
</td><td></td></tr>
</table>

NOTE

Note: Follow-up questions are not presented, please note.