空军 550 地下指挥所通信系统工程

Air Force 550 Underground Command Post Communication System Project

施 工 图 设 计

Construction Diagram Design

第九册　短波无线电收发信台安装工程

Volume IX Shortwave Radio Transceiver Installation Project

第一分册　综合部分

Division I　Comprehensive section

设计编号：0501S—ZH

Design number: 0501S-ZH

建设单位：空军司令部通信部

Construction Unit: Telecommunication Department of Air Force Command

设计单位：空军司令部通信工程设计所

Design Unit: Telecommunications Engineering Design Institute of the Air Force Command

空军司令部通信工程设计所

The Institute of Communication Engineering Design of the Air Force Command

二〇〇五年十一月

November 2005

分类： ZH　　**密级：** 机　　密

Category: ZH　　Secret level: Confidential

编号： 0501S　　**类型：** 施工图设计

No. 0501S　　Type: Construction Design

工程名称： 综 合 部 分

Name of the project: General part

批　　准：　陈克伟

Approval:　Chen Kewei

工 程 负 责 人：　海晓东

Project in charge　:　Hai Xiaodong

单项工程负责人：　任红桂

Single project in charge:　Ren Honggui

设　　计　　人：　朱海亮

Designer:　Zhu Hailiang

寇晓东

Kou Xiaodong

空军司令部通信工程设计所

The Communication Engineering Design Institute of the Air Force Command

二〇〇五年十一月

November 2005

设计文件分发表

Distribution of the designed documents

设计阶段 Design Phase	文件名称 File Title	发送单位及份数 Units and number of copies sent						
		工程主管部门①	建设单位②	施工单位③	监理单位④	建筑工程设计单位⑤	设计单位存档⑥	合计份数 Total number of copies
可行性研究报告 Feasibility Research Report	全套文件 Full set of files							
初步设计 Initial design	全套文件 Full set of files							
	全套概算表及说明 Full set of budget proposal table and Explanation							
施工图设计 Construction drawing design	全套文件 Full set of files	1		1	1		1	4
	施工图纸及说明 Construction drawings and instructions			1				1
	施工图预算及说明 Construction drawing budget and instructions			2				2

备注：1、一阶段设计的设计文件发送单位及份数同施工图设计阶段。

Note: 1. The design documents of the first stage design are sent to the same unit and the same number of copies as the construction drawing design stage.

2、各设计阶段设计文件发送单位及份数按规定分发。

2、 In each design phase, the design documents are sent to the relevant units and the number of copies is distributed according to the regulations.

① 工程主管部门 Engineering Authority

② 建设单位 Building Unit

③ 施工单位 Construction Unit

④ 监理单位 Supervision Unit

(5) 建筑工程设计单位 Architectural and engineering design institution

⑥ 设计单位存档 Design Unit Archive

目 录

Table of Contents

Formatted: Distributed, Indent: First line: 0 ch, Tab stops: 15.24 cm, Left

1、

三、图纸

Graphics

1、21 号工程总平面图

The general plan of Project No.21

2、1 号工程总平面图

The general plan of Project No.1

3、网络组织图

Diagram of network composition

4、系统设备连接图

Diagram of the system equipment connection

5、收信馈线系统组成图

Diagram of the composition of the receiving feeder system

6、发信馈线系统组成图

Diagram of the composition of the transmitting feeder system

7、通信方位图

Communication orientation map

8、21 号天线布置图

Diagram of No.21 antenna arrangement

9、1 号天线布置图

Diagram of No.1 antenna arrangement

一、 设计说明

Design instructions

1. 概述

Overview

1.1 设计依据

Design Rationale

1.1.1 总参通信部〔2004〕参通字 673 号《复指挥所通信和指挥控制系统建设工程任务书》。

The General Staff Communication Department [2004] Sen Tong Zi No. 673 《Reply to the Command Post Communication and Command Control System Construction Project Task Report》.

1.1.2〔2005〕司通字第 36 号《下达空军 550 等六个地下指挥所通信和指挥控制系统工程建设计划》。

[2005] Division General No. 36 《Issued the construction plan for Air Force 550 and other six underground command post communication and command control system projects. 》

1.1.3 2005 年 5 月 31 日与空司通信部通信处、指挥自动化处、导航工程处等有关单位会议记要。

May 31, 2005 Memorandum of Meeting held by the Communications Division of the Air Division, Communications Division, Command Automation Division, Navigation Engineering Division and other relevant divisions.

1.1.4 通信部通信处提供的《550 短波通信网络设置计划》

《550 Shortwave Communication Network Setup Plan》 provided by the Communications Division of the Ministry of Communications.

1.1.5 YDJ 10-84《无线电短波通信工程设计规范》

YDJ 10-84 《Radio Shortwave Communication Engineering Design Specification》

Formatted: Font: Not Bold

Formatted: Font: Times New Roman, 12 pt, Not Bold

1.1.6《电信工程设计手册》第 12 册《短波通信》

《Telecommunications Engineering Design Manual》, Volume 12,

《Shortwave Communications》

1.1.7《21 号工程总平面图》

《Master Layout Plan of Project No. 21》

1.1.8《1 号工程总平面图》

《Master Layout Plan of Project No. 1》

1.1.9 相关厂家提供的产品资料

Products information from relevant manufacturers

1.2 工程划分

Project Division

为方便设计文件编制和工程管理，550 短波无线电收发信台工程应划分为单项工程，具体划分见下表：

To facilitate the preparation of design documents and project management, the 550 short-wave radio transceiver station projects should be divided into individual projects, the specific division is shown in the following table.

工程名称 Project Title	550 短波无线电收发信台工程 550 shortwave radio transceiver station projects
单项工程名称 Individual project title	21 号短波收信设备安装工程 No. 21 Short-wave receiving equipment installation project
	1 号短波发信设备安装工程 No.1 Short-wave transmitting equipment installation project
	21 号天馈线安装工程 No. 21 Antennas Feeder Installation Project
	1 号天馈线安装工程 No. 1 Antennas Feeder Installation Project

	21 号防雷接地系统安装工程 No. 21 lightning protection and grounding system installation project
	1 号防雷接地系统安装工程 No. 1 lightning protection and grounding system installation project

1.3 设计文件编册

Compilation of design documents

本工程按一阶段设计，设计文件共编 5 册

The project is designed in Phase I. The design documents are compiled in 5 volumes.

第一册：综合部分

Volume 1: General section

第二册：21 号收信台设备安装单项工程

Volume II: Individual project for the installation of the equipment of No.21 receiving station

第三册：1 号发信台设备安装单项工程

Volume III: Individual project of installation of equipment of No.1 transmitting station.

第四册：21 号天馈线安装单项工程

Volume IV: Individual project for the installation of No.21 antenna feeder.

第五册：1 号天馈线安装单项工程

Volume 5: Individual project for No. 1 antenna feeder installation

1.4 设计范围和分工

Design Coverage and Division of Labor

短波收发信设备安装工程与天馈线安装工程以天线交换器的输出端为界。

The installation project of short-wave transceiver equipment and the installation project of antenna feeder is bounded by the output end of the antenna exchanger.

防雷接地系统安装工程与天馈线安装工程以地线接地体为

界。

The installation of a lightning protection grounding system and the installation of antenna feeders are bounded by the grounding body.

1.5 主要工程量表

Table of major volumes of work

本工程需要安装的主要设备见表 1.5

The main equipment to be installed in this project is shown in Table 1.5

表 1.5　主要安装工程量

Table 1.5 Major installation work volume

设备名称 Equipment name	数量 Quantity	单位 Units
安装 1000W 自适应通信系统 Installation of 1000W adaptive communication system	64	套 Sets
安装集中控制系统 Installation of Centralized Control System	5	套 Sets
安装综合终端 Installation of Integrated Terminals	64	部 Sets
安装三线式天线 Installation of Three-wire antennas	54	副 Sets
安装小菱形发信天线 Installation of Small Rhombus Transmitting Antenna	8	副 Sets
安装小鱼骨收信天线 Installation of Small Fishbone Receiving Antenna	8	副 Sets
安装伞锥发信天线 Installation of Cone Sending Antenna	1	副 Sets
安装旋转对数发信天线 Installation of Rotating Logarithmic Transmitting Antenna	1	副 Sets
安装发信天线交换器(16×16)	5	部

Formatted: Font: 14 pt, Not Bold

Formatted: Font: Times New Roman, 12 pt

Installation of Transmitting Antenna Exchanger (16×16)		Sets
安装 16 路收信天线共用器 Installation of 16-channel Receiving Antenna Diplexer	10	部 Sets

2. 设计方案

Design proposals

2.1 工程概况

Project Overview

550 短波通信系统由集中收信台和集中发信台组成，集中收信台位于 21 号工程，集中发信台位于 1 号工程。

The 550 Shortwave Communication System consists of a centralized receiving station and a centralized transmitting station. The Centralized Receiving Station is located in Project No. 21 and the Centralized Transmitting Station is located in Project No. 1.

21 号工程位于北京市海淀区温泉乡，工程设 6 个收信机房，收信机房面积 124.1 平方米，可安装收信机和终端 120 部，详见《21 号工程总平面图》。

Project No. 21 is located in Wenquan Town, Haidian District, Beijing. The project has 6 receiving rooms. The size of receiving room is 124.1 square meters, and 120 receiving machines and terminals can be installed. For details, please refer to《The Diagram of General Plan of No.21 Project》for details.

1 号工程位于北京市怀柔区九度和镇局里村，工程设 5 个发信机房，发信机房面积 534.1 平方米，可安装 1000 瓦发信机 105 部，10 千瓦发信机 5 部，详见《1 号工程总平面图》。

Project No.1 is in Jvli Village, Jiuduhe Town, Huairou District, Beijing. There are 5 transmitter rooms in the project. The size of the transmitter room is 534.1 square meters, and 105 1000-watt transmitters and 5 10-kilowatt transmitters can be installed, please refer to 《 The Diagram of General Plan of Project No.1》 for details.

2.2 网络组织

Network Composition

本期工程开设短波通信网络和专向共23个，详见网络组织图。

There are 23 short-wave communication networks and special directions in this project, please refer to 《The Diagram of Network Composition》 for details.

2.3 系统设备组成

System equipment components

短波通信系统主要由短波自适应通信系统、集中控制系统、短波终端、发信天线交换器、收信天线共用器和短波天馈线等组成。系统设备连接图见图。

The shortwave communication system is mainly composed of a shortwave adaptive communication system, centralized control system, shortwave terminal, transmitting antenna exchanger, receiving antenna diplexer, and shortwave antenna feeder. The diagram of the system equipment connection is shown in Fig.

2.4 链路参数计算

Calculation of link parameters

2.4.1 工作频率预测

Prediction of operating frequency

短波通信是利用电离层反射实现远距离通信，反射信号的强度与工作频率和入射角有关。对于一定的入射角有一个最高工作频率，高于此最高工作频率的电波将不再反射回地面。最高工作频率与入射角成正比，入射角是由短波通信距离决定的，距离越远入射角越大，也就是说，短波通信电路的距离越远，最高工作频率就越高。

Short-wave communication is the use of ionospheric reflection to achieve long-range communication。 The strength of the reflected signal is related to the operating frequency and the angle of incidence. For a certain angle of incidence, there is a maximum operating frequency, and waves above this maximum operating frequency will not be reflected to the ground. The maximum operating frequency is proportional to the angle of incidence. The angle of incidence is determined by the distance of the shortwave communication, the farther the distance the greater the angle of incidence, in other words, the farther the distance of the shortwave communication circuit, the higher the maximum operating frequency.

本工程短波通信的范围限于国土范围，最远距离 3224 公里。最高工作频率的计算采用《电信工程设计手册-短波通信》中的方法，计算结果见附表 1，可以看出远距离日间可用工作频率为 18MHz 左右，夜间可用工作频率为 6MHz 左右。

The range of shortwave communication in this project is limited to the national territory, and the farthest distance is 3224 km. The calculation of the highest operating frequency is based on the method in 《Telecommunications Engineering Design Manual - Shortwave Communication》. The calculation results are shown in Appendix 1, and it can be seen that ~~the~~ available operating frequency for long-distance daytime is about 18MHz, and the available operating frequency for night-time is about 6MHz.

2.4.2 大圆距离

Great circle distance

已知发射端和接收端的经纬度，则两端点之间的大圆距离可按下式计算：

Knowing the latitude and longitude of the transmitting and receiving ends, then the great circle distance between the two endpoints can be calculated by the following equation:

$$\cos d=\sin x_1 \sin x_2+\cos x_1 \cos x_2 \cos(y_1-y_2)$$

$$D=d\times 117.17$$

式中： x_1—发射端的地理纬度

In the formula: x1 --- Geographic latitude at the launch end

x_2—接收端的地理纬度

x2 --- Geographical latitude of the receiving end

y_1—发射端的地理经度

y1 - geographic longitude at the transmitter

y_2—接收端的地理经度

y2 - geographic longitude at the receiver

各电路大圆距离计算结果见附表 2。

The results of the calculation of the great circle distance of each circuit are shown in Appendix 2.

2.4.3 两端点的方位角：

2.4.3 Azimuth of the two endpoints.

$$\cos b_1=(\sin x_2-\sin x_1\cos d)/\cos x_1\sin d$$

$$\cos b_2=(\sin x_1-\sin x_2\cos d)/\cos x_2\sin d$$

式中： b_1—发射端至接收端的方位角

Formula: b1 --- the azimuth of the transmitting end to the receiving end

b_2—接收端至发射端的方位角

b2 --- azimuth from the receiver to the transmitter

各电路方位角计算结果见附表 2。

The results of the azimuth calculation for each circuit are shown in Appendix 2.

2.4.4 最佳辐射仰角

2.4.4 Optimum radiation elevation angle

射线辐射仰角可由下式计算：

The angle of elevation of the radioactive radiation can be calculated by the following equation:

$$tg\Delta = \frac{\beta - (1+\beta)(1-\cos\theta)}{(1+\beta)\sin\theta}$$

式中： β =h/R；

In the equation: β =h/R；

θ =90dpR；

Δ —辐射仰角；

Δ —Elevation angle of radiation；

h—反射层高度，千米；

h—Altitude of reflective layer, km；

R—地球半径，6370 千米；

R—Earth radius, 6370 km；

d—跳距，千米。

d --- jump distance, kilometers.

由于都是国内电路，距离不大于 4000 千米，因此采用一跳方式，F2 层反射高度 320 千米。路径仰角计算结果见附表 2。

Since they are all domestic circuits and the distance is not greater than 4000 km, thus the one-hop approach is used, and the F2 layer reflection height is 320 km. The results of the path elevation angle calculation are shown in Appendix Table 2.

2.4.5 传输损耗

2.4.5 Transmission losses

从发射端至接收端的传输损耗以下式计算：

The transmission loss from the transmitting end to the receiving end is calculated by the following equation:

$$L_b = L_{bf} + L_i + L_g + L_k + Y_p$$

式中：L_b——基本传输损耗 dB。

In the formula: Lb --- basic transmission loss dB.

L_i——电离层吸收损耗，按 5dB 计算。

L_i—— ionospheric absorption loss, calculated by 5dB.

L_g——地面反射损耗，反射一次 4dB。

L_g——ground reflection loss, one reflection 4dB.

L_k——馈线系统损耗，发信按 1.5dB，收信按 4dB 计算。

L_k——feeder system loss, send a signal by 1.5dB, receive signal by 4dB.

Y_p——附加系统损耗，按 14dB 计算。

Y_p——additional system loss, calculated by 14dB.

L_{bf}——自由空间基本传输损耗 dB。

L_{bf}——free space fundamental transmission loss dB.

$L_{bf}=32.44+20\lg f+20\lg D$ (dB)

f 为频率，以 MHz 计，D 为大圆距离，以 km 计。

f is the frequency in MHz , and D is the great circle distance in km.

2. 4. 6 接收场强

2.4.6 Receiving Field Strength

接收场强按下式计算：

The received field strength is calculated by the following equation:

$$E=107.2 + 20\lg f + G_t + P_t - L_b$$

式中：L_b——基本传输损耗 dB

In the formula: Lb --- basic transmission loss dB

G_t——天线增益 dB

G_t——antenna gain dB

P_t——发射功率 dB

P_t——transmission power dB

2.4.7 射频信噪比

2.4.7 RF signal-to-noise ratio

为使某种通信业务达到预期的质量等级，接收端的射频信号电平必须比噪声电平高出一定的数值，即要求有一个最低的射频信噪比。同时，由于短波信号场强存在衰落和起伏现象，因此在考虑链路系统方案时，还必须根据可靠度的要求，对信噪比留有一定的保护余量。

To achieve the desired quality level for a certain communication service, the RF signal level at the receiving end must be higher than the noise level, which means a minimum RF signal-to-noise ratio is required. At the same time, because of the fading and undulation of the shortwave signal field strength, a certain protection margin for the signal-to-noise ratio must also be left in accordance with the reliability requirements when considering the link system solution.

射频信噪比按下式计算：

The RF signal-to-noise ratio is calculated by the following equation:

$$S/N=E - P - N$$

式中：S/N——射频信噪比 dB

In the formula: S / N ---- RF signal-to-noise ratio dB

E——接收场强 dB

E——receiving field strength dB

P——干扰保护比 dB

P——interference protection ratio dB

N ——噪声电平 dB

N ——noise level dB

本工程干扰保护比 P 按 60dB 计算，噪声电平 N 按-100dB 计算,业务种类为抑制载波单边带，可靠度按商业可用标准（80％时间保护），射频信噪比不小于 67dB。

The project interference protection ratio P is calculated by 60dB. Noise level N is calculated by -100dB. Operational type is suppressed carrier single sideband, reliability according to commercially available standards (80%time protection), RF signal-to-noise ratio not less than 67dB.

各链路传输损耗计算结果见附表 3。

The results of the transmission loss calculation for each link are shown in Appendix

2.5 设备选型 (Equipment Selection)

2.5.1 短波自适应通信系统 (Short-wave adaptive communication system)

由短波收、发信机、自适应控制器组成，可实现短波电路的自动建链。发信机根据发射功率分为 400W 和 1000W 两种。

It is composed of the shortwave transceiver, transmitter, and adaptive controller, which can realize automatic chain building of shortwave circuit. The transmitter is divided into 400W and 1000W according to the transmitting power.

2.5.2 集中控制系统 (Centralized control system)

集中控制系统由综合传输交换设备、通信监控器、显示控制台和串行通信控制器等组成，可实现对自适应控制器、短波终端、发信机和天线交换器的集中控制与交换，从而达到自动选择空闲设备完成发报和收报效果。

以上设备均采用总参通信部配发的750厂设备。

The centralized control system consists of integrated transmission and exchange equipment, communication monitor, display console and serial communication controller, which can realize the centralized control and exchange of the adaptive controller, shortwave terminal, transmitter, and antenna exchanger, to achieve the effect of automatic selection of idle equipment to complete transmitting and receiving.

All the above equipment uses the NO. 750 factory equipment distributed by the General Staff Communication Department.

2.5.3 短波发信天线交换器(Short-wave transmitting antenna exchanger)

短波天线交换器用于完成天线与发信机之间的多路互换互联，可人工操作也可远程遥控。

Short-wave antenna exchanger is used to complete the interconnection between antenna and transmitter, which can be manually operated or remotely controlled.

主要指标：(Main indicators)

供电电源：220×（1±20%）V 50±3Hz

Power supply: 220×(1±20%)V 50±3Hz

环境温度：0℃~50℃

Ambient temperature: 0℃~50℃

特性阻抗：50W

Characteristic impedance: 50W

传输射频功率：<2kw

Transmission RF power: <2kw

工作频带宽度：2~30MHz

Operating band width: 2~30MHz

交换容量：16（发信机）×16（天线）

Switching capacity: 16 (transmitter) × 16 (antenna)

Remote control interface: RS-232/RS-422

Conversion mode: manual/automatic

插入损耗：〈0.3dB

Insertion loss: <0.3dB

转换时间：<60s

Conversion time: <60s

遥控接口：RS-232/RS-422

Remote control interface: RS-232/RS-422

转换方式：手动/自动

Conversion mode: manual/automatic

2.5.4 收信天线共用器 (Receiving antenna shared device)

选用性能较好的收信天线共用器可大大减少收信天线数量，有 8 路、10 路、16 路等多种产品。

Choosing the better performance of the receiving antenna share device can greatly reduce the number of receiving antenna, there are 8, 10, 16, and other products.

2.5.5 天线 (Antenna)

采用总参通信部配发的三线天线、旋转对数周期天线和伞锥天线。各种天线性能指标如下：

Adopt the three-wire antenna, rotating logarithmic period antenna, and umbrella cone antenna distributed by the General Staff Communication Department. Various

antenna performance indexes are as follows.

2.5.5.1 三线短波宽带全向天线 (Three-wire shortwave broadband Omni-directional antenna)

名 称(Name)	指标(Indicators)
频率范围 (Frequency range)	1.5～30MHz
输出阻抗 (Output impedance)	50Ω
驻波比(VSWR)	≤2
增益(Gain)	≥3dB
承受功率 (Withstand power)	1KW、2KW
极化方式 (Polarization power)	水平、线极化 (Horizontal, linear polarization)
振子长度 (Length of the oscillator)	30m、50m
天线架设高度 (Antenna erection height)	9 米(meter)
工作温度 (Operating temperature)	-40℃～+50℃
占地面积 (Floor space)	约≤250m^2
抗风能力 (Wind resistance)	11 级风天线能正常工作，12 级风不破坏 (11-level wind antenna can work normally, 12 level wind does not destroy)

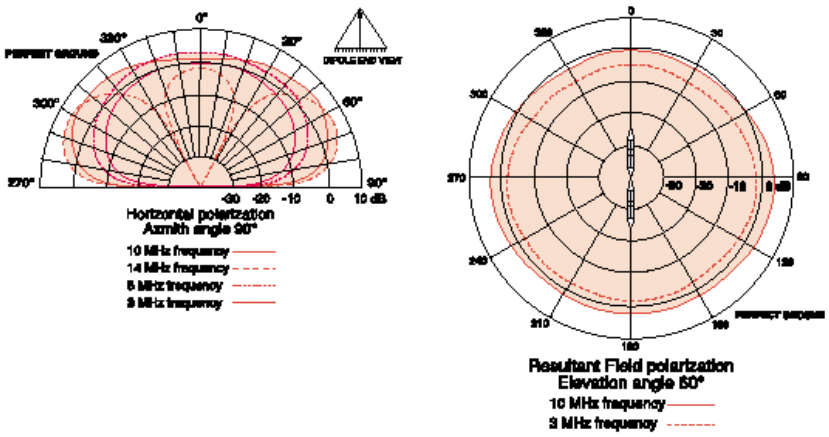
该天线架设方式有水平架设和倒 V 架设两种，两种架设方式相比较，水平架设的定向性强，但驻波比高，占地大。水平架设的一个突出特点是低仰角的方向性强,高仰角的方向性弱，

即一副天线可以兼顾远近通信对象。

The antenna erection way has a horizontal erection and inverted V erection two, two erection way compared, horizontal erection directional strong, but high VSWR occupies a large area. A prominent feature of horizontal erection is the directionality of a low elevation angle is strong, and the directionality of a high elevation angle is weak, that is, a pair of antennas can consider near and far communication objects.

下为三线天线的方向图，振子长度 30 米的天线架高 12 米，振子长度 50 米的天线架高 15 米。

The following is the directional diagram of the three-wire antenna, the height of the antenna stand is 12 meters for the oscillator length of 30 meters and 15 meters for the oscillator length of 50 meters.



2.5.5.2 小菱形短波高增益宽频带定向发信天线

Small diamond-shaped short-wave high-gain wideband directional transmitting antenna.

名称(Name)	指标
工作频率 (Operating Frequency)	1.6～30MHz
输出阻抗 (Output Impedance)	50Ω
驻波比(VSWR)	≤2
承受功率 (Withstand power)	1.6KW
天线增益 (Antenna Gain)	>36.5dB
天线尺寸 (Antenna Size)	边长 21 米，对角宽 17.75 米,架高 12 米 (Side length 21m, diagonal width 17.75m, frame height 12m)
抗风能力 (Wind Resistance)	11 级风天线能正常工作，12 级风天线不被破坏 11-level wind antennas can work normally, a 12-level wind antenna is not destroyed

2.5.5.3 小鱼骨短波高增益宽频带定向收信天线

名称(Name)	指标

工作频率 (Operating Frequency)	1.6～30MHz
输出阻抗 (Output Impedance)	50Ω
驻波比(VSWR)	≤2
天线增益 (Antenna Gain)	>20dB
天线尺寸 (Antenna Size)	边长 21 米，宽 4 米,架高 13.8～25 米 (Side length 21m, Width 17.75m, frame height 13.8-25m)
抗风能力 (Wind Resistance)	11 级风天线能正常工作，12 级风天线不被破坏 11-level wind antennas can work normally, 12-level wind antenna is not destroyed

2.5.5.4 旋转对数周期天线 (Rotating log-periodic antenna)

名称(Name)	指标(Indicators)
频率范围 (Operating Frequency)	6～30MHz
输出阻抗 (Output Impedance)	50Ω
驻波比(VSWR)	≤2
增益 (Gain)	≥11.5dB
承受功率 (Withstand power)	10KW、30KW
极化方式 (Polarization method)	水平(level)
交叉极化 (Cross-polarization)	20dB
天线最大转角 (Maximum Antenna Rotation Angle)	360 度(degree)
天线转速 (Antenna speed)	≤0.5 转/分
最长振子长度 (Maximum oscillator length)	15 米(m)
工作温度	-40℃～+40℃

(Operating temperature)	
占地面积 (Floor space)	≤150m²
抗风能力 (Wind resistance)	150km/h 风正常工作，230km/h 风不损坏 150km/h wind works normally, 230km/h wind will not damage

特点：方向性强，半功率角 10 度；通信方向可调整，增益大，占地少，架设维护方便，适合远距离定点和组网通信。

Features: strong directional, half-power angle of 10 degrees; adjustable communication direction, large gain, small footprint, easy to set up and maintain, suitable for long-distance fixed-point and group network communication.

2.5.5.5 伞锥形天线 (Umbrella Conical Antenna)

名称(Name)	指标(Indicators)
频率范围 (Operating Frequency)	3～30MHz
输出阻抗 (Output Impedance)	50Ω
驻波比 (VSWR)	≤2
增益(Gain)	≥4dBi
承受功率 (Withstand power)	40KW
极化方式 (Polarization method)	垂直(Vertical)
抗风能力 (Wind resistance)	250km/h 风正常工作 250km/h wind normal operation
半径	26 米(m)

Diameter	
高度 Altitude	24 米(m)

结构：该天线用于全方向长距离通信，垂直极化，低角度发射，有多种频率范围和带宽可供选择。

发射器为双锥笼形，由舰船级不锈钢制成。

标准支撑结构为一个镀锌三角钢杆，底部有一个大负载陶瓷绝缘器，最大可以承受 305km/h 的风速。

Structure: The antenna is used for omnidirectional long-range communications, vertically polarized, low angle transmitting, with a variety of frequency ranges and bandwidths available.

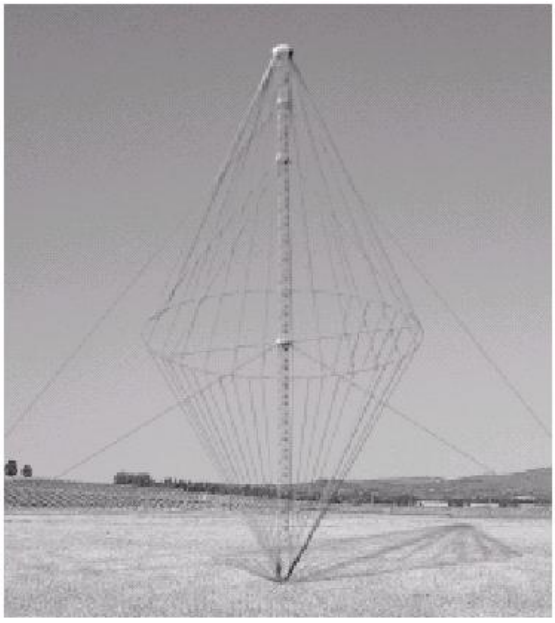
The transmitter is double cone cage shaped and made of naval-grade stainless steel.

The standard support structure is a galvanized triangular steel pole with a large load ceramic insulator at the bottom, which can withstand a maximum wind speed of 305km/h.

标准支撑结构为一个镀锌三角钢杆，底部有一个大负载陶瓷绝缘器，最大可以承受 305km/h 的风速。

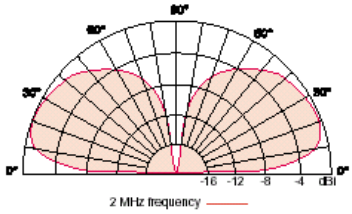
The standard support structure is a galvanized triangular steel pole with a large load ceramic insulator at the bottom, which can withstand a maximum wind speed of

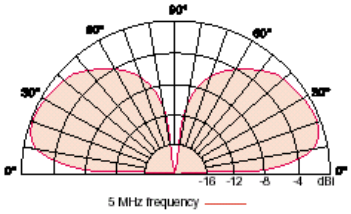
305km/h.

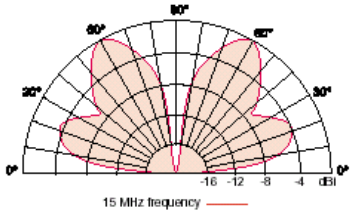


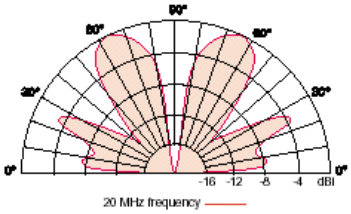
伞锥天线方向图和增益：

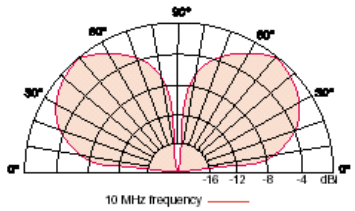
Umbrella cone antenna orientation diagram and gain.

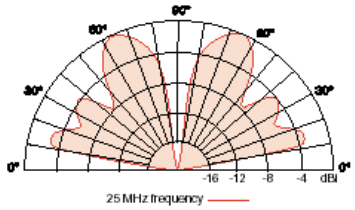


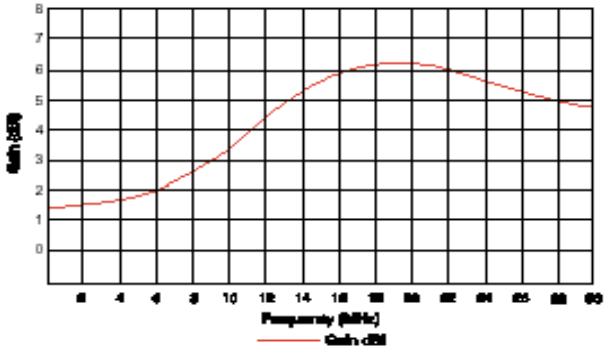












2. 5. 6 馈线系统

2.5.6 Feeder systems

2. 5. 6. 1 馈线系统组成

2.5.6.1 Feeder system components

短波发信馈线系统由室内馈线、天线交换器、坑道馈线、防雷保护器、天线场馈线和跳线等部分组成。馈线系统组成图见图。防雷保护器设置在天线引入堡内，以阻止天线场雷电对机房设备的危害。跳线用于馈线与设备或天线阻抗匹配器连接的部分，一般使用较细的馈线以便于灵活连接，但损耗较大，应尽可能短。

The shortwave transmitting feeder system consists with an indoor feeder, antenna exchanger, pit feeder, lightning protector, antenna field feeder, ~~and~~ jumper, etc. The feeder system composition diagram is shown in the figure. The lightning protector is set in the antenna introduction fort to stop the harm of antenna field lightning to the equipment in the server room. The jumper is used for the part of the feeder connected to the equipment or antenna impedance matcher, generally use the thinner feeder for flexible connection, but the loss is larger and should be as short as possible.

2.5.6.2 馈线损耗分配

2.5.6.2 Feeder loss distribution

根据设计规范要求，发信馈线损耗不大于 1.5dB，收信馈线损耗不大于 4dB。

According to the design specification, the transmitting feeder loss is no more than 1.5dB and the receiving feeder loss is no more than 4dB.

由于发信馈线以天线交换器的输出口为界分为两段，分别属于发信设备安装工程设计和天馈线安装工程设计，因此发信馈线损耗应在两段间进行分配，设备段 0.5dB，天馈线段 1dB。

Because the transmitting feed line to the output port of the antenna switch as the boundary is divided into two sections, respectively, belonging to the transmitting equipment installation engineering design an antenna feed line installation engineering design, ~~so~~ the transmitting feed line loss should be distributed between the two sections, equipment section 0.5dB, antenna feed line section 1dB.

2.5.6.3 馈线选型

2.5.6.3 Feeder Selection

适用于短波频段的射频同轴电缆有空气绝缘和物理发泡绝缘两种，后者转弯容易，不需定期充气，维护方便，是目前得到广泛使用的产品。

There are two types of RF coaxial cables for short-wave frequency bands: air insulation and physical foam insulation, the latter is easy to turn, does not require regular inflation, is easy to maintain, and is widely used at present.

物理发泡射频电缆按线径大小有多种型号，各种型号电缆的性能参数见附表 4。

Physical foam RF cable has a variety of models according to the size of the wire diameter, and the performance parameters of various models of cable are shown in Table 4.

本工程由于大部分馈线距离较长，在 200～350 米，因此馈线的选型应在施工图设计中根据损耗分配的要求进行选择。

In this project, since most of the feeders have a long distance of 200 to 350 meters, the feeders should be selected in the construction drawing design according to the requirements of the loss distribution.

2.6 天线配置

2.6 Antennas configuration

三线式天线有收信天线与发信天线之分，应从满足需要、隐蔽抗毁、施工方便等方面综合考虑作出合理的数量配置。

Three-wire antenna with receiving antenna and transmitting antenna should be from the need to meet, concealed anti-destruction, construction, and other aspects of comprehensive consideration to make a reasonable number of configurations.

由于收信天线可以采用天线共用器进行分配，同时收信台地形有限，林木繁茂，从防侦查和减少施工难度等角度考虑，应尽量减少天线数量。计划架设小鱼骨天线 8 副供远距离专向使用，方向为乌鲁木齐、和田、拉萨、昆明、南宁、广州、910、福州，7 副 30 米水平架设对准鼎新、兰州、西安、南京、15 军、成都、襄樊方向，配套 7 部 8 路天线共用器可供 56 部收信机中距离使用，3 副 30 米倒 V 架设作为全向天线，配套 3 部 16 路天线共用器可供 48 部收信机近距离使用，共 18 副天线。

As the receiving antennas can be distributed by antenna sharers, at the same time, the receiving station should minimize the number of antennas from the perspective of anti-detection and reduce construction difficulties due to the limited terrain and thick forest. It is planned to set up 8 pairs of small fishbone antennas for long-distance dedicated direction use, the direction is Urumqi, Hotan, Lasha, Kunming, Nanning, Guangzhou, 910, and Fuzhou. 7 pairs of 30m horizontal antennas are set up to align with the directions of Dingxin, Lanzhou, Xi'an, Nanjing, 15 Military, Chengdu, and Xiangfan, matching with 7 8-way antennas for 56 receivers in the middle distance, 3 pairs of 30m

inverted V antennas are set up as omni-directional antennas, matching with 3 16-way antennas for 48 receivers in the close distance, total 18 pairs of antennas.

发信天线配置 8 幅小菱形天线供 8 个远距离专向使用，45 副 30 米水平架设对准鼎新、兰州、成都、西安、襄樊、15 军南京、济南、沈阳方向中距离使用，11 副 30 米倒 V 架设作为对空全向天线近距离使用。

The transmitting antennas are configured with 8 small rhombus antennas for 8 long-distance dedicated direction use; there are 45 pairs of 30-meter horizontal erection to align Dingxin, Lanzhou, Chengdu, Xi'an, Xiangfan, 15 armies Nanjing, Jinan, Shenyang direction for medium-distance use; 11 pairs of 30-meter inverted V erection as air-to-air Omni-directional antennas for near-distance use.

3. 需要说明的其他问题

3. Other issues to be clarified

3.1 需要上级机关进一步明确的问题

3.1 Issues that need further clarification from higher authorities

3.1.1 天线和设备的最终需求数量。

3.1.1 the Final number of antennas and equipment requirements.

3.1.2 天线和设备的备份要求。

3.1.2 Requirements for backup of antennas and equipment.

3.1.3 对空台、集中报知、警报台、值班台的覆盖范围和业务种类，三线天线倒 V 架设全向增益大于 3dB 的范围在 400 千米以内，超出此范围只能使用定向天线。

3.1.3 For the coverage and services of the air station, centralized reporting, alarm station, duty station, three-wire antenna inverted V erection omnidirectional gain greater than 3dB range should be within 400 km, beyond this range can only use a directional antenna.

3.1.4 终端设备的组织方式和数量，如雷达数传和短波数据链。

3.1.4 Organization and number of terminal devices, such as radar digital transmission and

shortwave data chains.

3.2 天线场地狭小

3.2 Limited antenna space

发信台的天线场比较狭小，天线屏蔽距离难以达到规范要求，今后也难以扩容。

The antenna field of the transmitting station is quite limited, and the antenna shielding distance is difficult to meet the specification, and it is difficult to expand the capacity in the future.

3.3 大功率天线的位置

3.3 Location of high-power antenna

伞锥天线由于占地面积大，山顶架设有困难，馈线距离过长，现架设在大功率机房口外的平地上，则北方的大同方向受遮挡。

Due to the umbrella cone antenna covering a large area, there are difficult to erect on the top of the mountain and the feed line distance is too long. When it is readily erected on the flat ground outside the entrance of the high-powered machine room, then the direction of Daido in the north is blocked.

3.4 天线性能测试

3.4 Antenna Performance Test

短波无线电通信的质量在很大程度上取决于天馈线系统的设计和施工质量。以往的实践中都是以通话质量来简单衡量天馈线性能，而通话质量的优劣是由频率选择、天馈线系统质量、收信台干扰等多种因素综合影响的，因此这种测试方法很难科学准确地反映天馈线系统质量。

The quality of shortwave radio communication depends largely on the design and the quality of the construction of the antenna system. In the past practice, the antenna performance was simply measured by the call quality, and the call quality was influenced by a combination of factors such as frequency selection, antenna system quality, and interference from the receiving station, so the test method was difficult to reflect the quality of the antenna system scientifically and accurately.

另外，厂家提供的辐射方向图是在平地架设的测试结果，如果天线架设在山地上，由于地形的不规则反射将使方向图发生畸变。

In addition, the radiation direction chart provided by the manufacturer was the result of the test in the flat ground erection, if the antenna is erected on a mountain, the direction chart will be distorted due to the irregular reflection of the terrain.

衡量天馈线系统质量的主要参数有驻波比和天线方向图。驻波比用网络分析仪即可进行测试，天线方向图的测试则比较复杂，需用气球或遥控直升机将场强仪升至天线辐射方向 300 米左右的高度，在不同位置上测试电场强度，从而得到天线实际的辐射方向图。

The main parameters to measure the quality of the antenna feeder system are VSWR and antenna directional map. VSWR can be tested with a network analyzer. The testing of the antenna direction map is more complicated. It needs to use a balloon or remote-control helicopter to raise the field strength meter to about 300 meters in height of the antenna radiation direction. The electric field strength is tested in different positions to get the actual radiation direction map of the antenna.