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# 中国民用 机场集锦

主编 蒋作舟

A COLLECTION  
OF CHINA CIVIL AIRPORT



清华大学出版社

场·温州永强机场·哈尔滨太平国际机场·贵阳龙洞堡机场·济南遥墙机场·宁波栎社机场·长春大房身机场和龙家堡机场·天津滨海国际机场·南宁吴圩国际机场·南昌昌北机场·兰州中川机场·烟台莱山机场·合肥骆岗机场·张家界荷花机场·太原武宿机场·呼和浩特白塔机场·银川河东机场·石家庄正定机场·西宁曹家堡机场·舟山普陀山机场·徐州观音机场·北海福成机场·延吉机场·黄山屯溪机场·大理机场·武夷山机场·敦煌机场·牡丹江海浪机场·西双版纳嘎洒机场·通辽机场·香港国际机场·澳门国际机场

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## 序 Foreword

改革开放以来,我国经济发展迅速、对外开放不断扩大,有力地促进了航空运输的快速增长,民用机场建设取得了显著成就。“八五”和“九五”期间,一大批重点机场建设项目相继建成投产,改变了我国民用机场设施较为落后的局面。目前,我国大陆有民用运输机场129个,年旅客吞吐量达到1.34亿人次,初步形成了大、中、小机场配套,规模较为适宜的机场网络格局。另一方面,各机场的功能不断得到完善,旅客服务设施现代化水平不断提高,安全运行条件也明显得到改善。

这些机场分别建设于不同的历史时期,各机场的建设条件、建筑风格、规模标准、技术水平等方面均有很大不同、各具特色。但到目前为止,还没有一部较全面地介绍我国民用机场建设发展情况的书籍。

为了充分展示我国民用机场建设所取得的成就、总结我国民用机场建设经验,中国民航总局机场司组织中国民航学院等单位编写了《中国民用机场集锦》。本书收录了我国民用运输机场中具有代表性和工程建设富于特色的57个机场,为民航各部门、从事民用机场建设的广大工程技术人员、院校师生以及对我国民用机场事业感兴趣的中外人士提供了一部可读性较强、内容丰富的参考资料。

当前,我国社会经济发展前景良好。预计今后一段时期,民用航空运输业仍将以较高的速度发展。到2005年,我国大陆民用运输机场将达到170个左右。“十五”期间,我们要建设枢纽机场、完善干线机场、发展支线机场,认真落实国家西部大开发战略,加快西部地区支线机场建设步伐,因此,民用机场建设任务仍然很艰巨。希望《中国民用机场集锦》的出版能对今后我国民用机场建设有所启迪和借鉴,发挥一些积极作用。同时,也希望民航基本建设系统全体同志继续努力,进一步搞好民用机场建设工作,为推动我国民用航空运输事业持续、健康、快速发展做出新的贡献。

中国民用航空总局副局长



# 我国民用机场的建设与发展

## (代前言)

我国的民用航空是建国以后逐步发展起来的,民用机场也经历了从少到多、从小到大的发展历程。特别是改革开放以来,民用机场建设飞速发展,为我国民用航空事业的持续、快速发展做出了贡献。

### 一、民用机场建设回顾

1949年11月9日,中国、中央两家航空公司的部分员工和12架飞机从香港飞回大陆,这就是著名的“两航”起义。作为“两航”的基地,建国初期,民航对天津张贵庄机场进行了改造,这是我国第一个较大规模的机场建设项目。到1950年,我国仅有机场36个,并且这些机场规模小,设施设备极为简陋。从50年代到1978年,受客观条件的影响,我国民航的发展比较缓慢,基本建设总投资仅24亿元左右(年平均投资不足1亿元),先后新建、扩建了北京、上海、广州、天津、西安、太原、哈尔滨、乌鲁木齐、兰州、成都、南宁、武汉等20多个机场,使航班运行机场达到了70多个(其中,军民合用机场36个)。在这一时期,由于使用飞机机型小,因此所建设的机场规模也比较小,大多数是中小型机场。

我国实行改革开放政策以后,民用航空事业进入了新的发展时期,这为民用机场建设创造了有利条件。1979年—1985年,新建了厦门高崎、大连周水子、敦煌等机场,并对成都双流、海口大英山、桂林奇峰岭、福州义序等机场进行了改造或扩建。“七五”期间,沈阳桃仙、宁波栎社、重庆江北、温州永强等机场建成并投入运行。这一时期,我国陆续引进了大型中、远程宽体喷气式飞机,从而促进了机场在标准、规模、安全保障等方面建设水平的提高。

为了适应国家改革开放和经济快速发展的需要,满足迅速增长的航空运输需求,民航在90年代初确定了集中力量、抓重点的机场建设指导思想,并逐步拓宽了融资渠道,加大了投资力度,加快了机场建设步伐。“八五”和“九五”期间是我国民用机场建设的高峰时期。“八五”时期,民航基本建设投资122.07亿元,技术改造投资60.87亿元,新建了西安咸阳、西宁曹家堡、沈阳桃仙、济南遥墙、武汉天河、石家庄正定等16个机场,对昆明巫家坝、拉萨贡嘎、昌都邦达、太原武宿等27个机场进行了改造或扩建。“九五”时期,民航基本建设投资680亿元,技术改造投资126亿元,分别是“八五”时期的5.6倍和2.1倍。新建了桂林两江、郑州新郑、银川河东、上海浦东、海口美兰、杭州萧山、南昌昌北等17个机场,改造或扩建了北京首都、呼和浩特白塔、乌鲁木齐地窝堡、厦门高崎、兰州中川等35个机场。民航在建设好重点工程的同时,还建设和改造了舟山、临沂、阜阳、晋江、常州、恩施、安康、包头、广元、大理、迪庆、喀什、嘉峪关、乌兰浩特、通辽、延吉等一大批小型机场,改善了这些地区的航空运输基础设施条件,促进了当地的经济发展和对外开放。

### 二、民用机场建设特点

经过这些年的大规模建设,我国民用机场数量大大增加了。截止2001年底,全国民用运输机场达到129个(不包括香港、澳门、台湾地区以及联航单独使用的机场),其中对外开放机场31个。我国所有的直辖市、省会、自治区首府以及沿海开放城市和主要旅游城市都拥有了设施较齐全的民用机场,一些边远地区也拥有相应规模的民用机场。总结起来,我国民用机场建设有下面几个特点:

#### 1. 全国机场规划布局逐步趋于合理

改革开放以前,我国基本没有对机场布局进行系统的规划,机场建设大都是为了配合国家各项政策进行的。如北京首都机场是“一五”计划时期作为国家重点工程之一进行建设的,杭州笕桥机场是为了保障美国总统尼克松访华而突击修建的。“大跃进”时期,民航还提出了“运输航空四通八达,专业航空遍地开花”的盲目指导思想,各地纷纷开辟航线,赶修机场,呼和浩特、银川、延安、包头、沙市、南阳等机场就是在这期间建成的。“三线”建设时期,鉴于当时的国际形势,机场建设执行的是“靠山、分散、隐蔽”的政策,从而使一些机场远离城市,净空条件较差。改革开放以来,民航逐步认识到要搞好机场建设,发展民航运输,发挥投资效益,重要的是统筹规划、合理布局,制订出适合国情、满足发展需要、与国民经济发展和其它交通运输方式相适应、能指导机场建设分阶段实施的中长期规划。于是民航总局及时制定了我国民用机场发展规划,正确引导了各地建设机场的积极性,使“八五”以来我国机场规划布局和建设规模基本能够保持合理和适度的发展。

#### 2. 投资渠道逐步拓宽,建设速度不断加快

80年代以前,机场建设全部由国家投资,并且年度投资总额基本没有超过1亿元。1950年—1977年,国家总共投入了约24亿元用于机场建设。改革开放以来,机场建设步伐加快,国家对民航基本建设投资

有了大幅度的增长。“八五”时期,国家对民航基本建设投资了122亿元,“九五”时期达到450亿元。同时,融资渠道也由国家包揽逐步转变为中央、地方及利用外资等多种渠道。2000年,民航基本建设和技术改造投资达125亿元,其中地方投资25亿元,占20%。一些机场建设还利用了外国政府贷款、出口信贷以及外国银行贷款。投资体制的变革和融资方式逐步多样化,不但缓解了民用机场建设资金的紧张状况,也推动了民用机场建设体制的转变。目前,我国民用机场建设项目都实行建设项目法人制。项目法人机构由各投资主体根据投资比例组建,具体实施工程项目建设,并对项目负责。这几年的实践证明,项目法人制、招标投标制、工程监理制、合同管理制、市场准入制等制度在民用机场建设中的普及保证了工程建设质量,提高了投资效益。今后,随着我国经济改革不断深入、对外开放的逐步扩大以及西部大开发的逐步实施,民航将进一步改革投资体制,拓宽融资渠道,采取多种丰富、灵活的融资形式,加快机场建设特别是西部地区机场建设步伐。

### 3. 机场设施逐步完善,安全运行保障水平不断提高

为了完善机场设施,保证飞行安全,提高服务水平,20年来,民航新建了一大批跑道、滑行道等机场飞行区设施,并对部分机场的跑道、滑行道系统进行了更新改造或改扩建。截止到2001年底,飞行区指标为4E的机场有23个,4D的机场有35个,4C及以下的机场有71个。飞行区惟一具有两条远距平行跑道的为北京首都国际机场;规划有两条远距平行跑道的有南京、福州、武汉、沈阳、深圳、西安、重庆、杭州、海口、桂林等机场;上海浦东国际机场规划了四条两对远距平行跑道;建设中的广州新白云国际机场规划了三条平行跑道,本期将同时建设两条远距平行跑道。部分机场还按照F类飞机的运行要求进行规划。这些机场的飞行区设施将满足日益增长的飞机运行需求以及使用机型的要求。另外,机场的航管、导航、通信、气象及目视助航设施的现代化程度都得以提高,大多数机场具备了I类精密进近条件。北京首都、上海浦东机场具备了开放II类精密进近的条件。此外,包括安检、监控等在内的安全空防设施日趋完善。由此,机场运行容量显著增大,安全保障能力明显提高。同时,为了适应旅客吞吐量迅速增长的需要,对一些机场的航站设施进行了更新改造或改扩建。据不完全统计,我国民用机场现有的旅客航站楼总面积约284.68万平方米。北京首都机场新航站楼、上海浦东等机场的建成使用,标志着我国已经有能力建设和管理设施齐全、设备先进的大型现代化民用机场。这些机场旅客航站的建成大大改善了服务设施,为提高服务水平创造了条件。

### 4. 机场建设技术水平不断提高

在工程建设中采用先进技术,是提高民用机场建设标准和水平、保证工程建设质量的关键。近些年,一批新技术、新工艺、新设备、新材料在民用机场建设中得到广泛应用。

#### (1) 飞行区我国地域辽阔,地质条件千差万别

许多机场往往受其它条件的限制而位于不良地质区域,如软弱土、湿陷性黄土、填海地基等。针对不同情况,施工单位分别采取了不同的处理方法,取得了良好效果。例如,西宁曹家堡等机场采用了强夯法处理III级自重湿陷性黄土,宁波栎社等机场采用了堆载预压法处理沿海软弱地基,贵阳龙洞堡机场采用大块石高填筑地基,厦门高崎机场采用非破损灌浆加固道面基础;其中贵阳龙洞堡机场地基处理获得国家科技进步三等奖。这些技术的成功应用,基本上解决了我国民用机场建设中常见的几种不良工程地质条件的处理问题。

机场道面基础施工以前都是人工摊铺,施工质量不易控制。近几年随着半刚性基础的大量使用,一些新的施工工艺逐步被采用。如广州新白云机场道面基础施工采用了机械摊铺的施工工艺,不但提高了施工速度,降低了施工费用,而且铺筑的基础均匀、平整、外观好,工程施工质量明显提高。

80年代以前,我国民用机场飞行区道面大都采用水泥混凝土道面。近些年柔性道面技术性能大大提高,在民用机场场道工程中被广泛采用。特别是改性沥青的使用,不仅满足了飞机重轮载作用以及道面防滑要求,而且能充分发挥柔性道面滑行平稳等优点,改善了飞机起降时旅客的舒适度。北京首都机场东跑道道面改造采用了沥青玛蹄脂碎石盖被,使用效果良好,获得了国家科技进步二等奖。另一方面,目前我国民用机场旧道面改造也大都采用柔性加盖,其不停航施工的施工技术和管理日趋成熟。不停航施工有效解决了机场运行和工程施工之间的矛盾,使机场能够连续正常为城市和地区服务,其直接或间接的效益是显而易见的。

目前,我国民用机场飞行区建设标准已经基本与国际接轨。1985年,民航部门参照国际上普遍采用的国际民航组织关于机场建设与管理的有关标准,制定了我国民用机场飞行区技术标准。16年来,所有新建

的民用机场飞行区设施设备都是按照国际民航组织的标准建造的。同时,对一些老机场的飞行区设施设备也按照该标准进行了改造和扩建。大多数机场的飞行区标准得到提高,适用机型加大,安全运行条件也得到改善。

## (2) 航站区

一是机场航站楼设计概念多样化。90年代以前,我国民用机场旅客航站楼建筑面积较小,概念设计比较简单,大部分为前列式或远距式。个别机场如北京首都机场采用了前列式、卫星式与远距式相结合的方式。目前,我国民用机场规模普遍扩大,一些机场的旅客航站楼建筑面积大大增加,高峰期飞机运行架次多,因此,近几年建设的机场,旅客航站楼设计概念逐步多样化,前列、指廊、卫星、远距等方式相互结合,互为补充,增加了近机位,方便了旅客,同时,提高了机位利用率和机坪运行效率,满足了繁忙机场飞机运行的需求。

二是航站楼设计水平提高。北京首都、上海浦东、杭州萧山等机场的航站楼均采用大跨度钢屋架结构、预应力混凝土及高强度混凝土,外形各具特色,楼内柱间距大大增加,空间宽阔,流程通畅。机场航站楼总体设计水平明显提高。

三是航站楼内设施设备逐步现代化。在已建成和正在建设的旅客航站楼中,值机、安检、航班动态显示、时钟、监控、广播、计算机信息管理、旅客离港、系统集成、楼宇自控、行李自动传输与分拣、自动步道、自动扶梯、旅客登机桥等较先进的设施设备日益完善,提高了航站楼内设施设备的现代化程度。一方面,解决了在航站楼内如何做到信息及时、流程顺畅、方便高效的难题,同时也促进了航站楼运营管理和服务水平的提高。

四是普遍重视航站区以及航站楼内的环境设计。杭州萧山、上海浦东等机场航站区布置了大面积绿化、水池、喷泉、雕塑等,营造出花园式的机场环境;室内装修不单纯追求豪华,而是注重以人为本,强调和谐的艺术效果。大面积玻璃幕墙和半透明屋面的广泛使用使得室内自然采光好、明亮,内外景相互交融,缩短了旅客与飞机间的距离,候机环境优美、舒适,同时,也节约了能源。

五是积极引进国外设计方案,借鉴国外先进技术和设计理念。近年来,在机场航站楼设计中,采取国际国内公开招标选择设计方案和设计单位。北京首都、上海浦东、广州新白云等机场最终采用了国外著名公司的设计方案。这种方式缩小了我国与国外航空发达国家在机场航站楼设计中的差距,提高了我国民用机场的建设水平。

当然,我国的民用航空业还处于发展的初级阶段,民用机场建设还存在许多不足。首先,由于我国幅员辽阔,地区差异大,东西部经济发展不平衡,使我国的机场建设未能完全按照规划进行,造成我国现有民用机场在布局上仍不尽合理。东南沿海地区机场较多,密度较大,个别地区的机场密度过大,同等规模机场距离过近,影响了机场效益的发挥;而西北地区机场偏少,密度偏小。例如,华东地区的机场密度是西北地区的5.1倍。因此,需要根据国家经济发展以及航空市场需求和航线结构,不断调整规划,合理布局,适度控制建设规模。另外,我国若干机场特别是偏远地区的支线机场仍然存在飞行区等级偏低、航站偏小、设施落后的问题。第二,机场建设体制、投资体制还不完善,不能适应市场经济发展需要,使机场建设资源得不到最有效的利用。部分机场飞行区规模不尽合理,少数机场航站楼规模超前。第三,在机场建设中,由于分析和研究不深入,预测的准确性差,规划的科学性不够等原因,致使部分机场的各种设施容量不平衡,导致一扩再扩,不停地建设,造成投资浪费,给正常生产运营也带来一定影响。第四,一些机场在功能流程等方面还不能适应航线结构调整的需要。这些问题需要在今后机场建设中予以重视和完善。

## 三、我国民用机场发展水平

2000年,我国所有民用机场旅客吞吐量为1.34亿人次,货物吞吐量399.2万吨。根据国际机场协会的统计,2000年,在机场旅客吞吐量排序前50名中,美国有25家,中国只有香港和北京两家,其中,美国的亚特兰大排名第一,为8017万人次,中国的香港新机场排名第22位,北京首都、广州白云、上海虹桥分别排名第42、73、74位,北京首都机场只有亚特兰大的27%。我国只有7个旅客吞吐量在500万以上的机场(500万排名在150位左右)。在货邮吞吐量排序前50名中,美国有22家,中国只有5家(包括台北)。其中,美国的蒙菲斯排名第一,为249万吨;香港第二,为228万吨;北京首都、上海虹桥、广州白云分别排名第31、33、34位。机场数量方面,我国国土面积与美国相当,但民用机场只有美国的1/34,航班运输机场只有美国的1/5。因此,无论在机场数量,还是在机场业务量方面,我国与世界发达国家间的差距还很大。这也从另一方面说明我国的民用机场具有很大的发展潜力。



#### 四、民用机场发展前景

据预测,今后五年我国的旅客和货物运输量将年均增长8%和13%,民用机场建设发展前景广阔。根据民航“十五”计划和十年规划,“十五”期间,民航基础设施建设投资将达到1100亿元左右。将重点建设3个大型枢纽机场;培育发展6个区域性中型枢纽机场;新建2个、改扩建10个干线机场;新建33个、改扩建10个支线机场,加快发展支线机场。预计到2005年,全国民用运输机场将达到172个左右,旅客吞吐量达到2亿人次,货物吞吐量560万吨。2010年,全国民用运输机场将达到237个左右。

近些年,为适应航空运输市场发展需要,世界航空发达国家都先后进行了航线网络结构的调整,逐步实现了以城市对为主的航线网布局向以航空公司为核心的中枢辐射式航线结构的转变。这些国家的实践证明,中枢航线结构对于有效利用航空市场资源,提高航线运输量,有效增加城市间的航班频率,增强航空公司的竞争优势,提高航空公司和机场的经济效益,激发区域经济活力有着十分明显的作用。建设中枢式航线结构已成为我国民航适应未来长远发展需要和参与国际竞争的战略选择。目前,我国的航线网络结构仍然停留在城市对结构的水平,航空公司为核心、机场为依托的中枢航线网络的建设刚刚开始。机场方面,我国还没有形成枢纽、干线、支线相配套,布局合理的机场体系,特别是枢纽机场和支线机场还远远不能满足要求。因此,加强枢纽机场,完善干线机场,发展支线机场,是今后一段时期我国民用机场建设的主要任务。

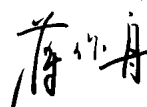
##### 1. 枢纽机场建设

我国航空市场的成长、航线结构与飞机选型、机场建设等方面都存在不少矛盾。目前我国还没有一个真正意义上的枢纽机场,即便是新近建设的上海浦东机场和扩建后的北京首都机场,仍然存在中转功能不健全等不足。因此,民航总局决定:将按照调整航线结构、完善和建设航空枢纽的需要,重点把北京首都、上海浦东、广州新白云机场建设为国际、国内综合枢纽,对这些大型枢纽机场的建设重点是进一步完善各项配套设施,提高和完善中转功能,使之成为全国性航空客货集散中心。北京首都国际机场按最终建成大型综合枢纽机场进行规划,“十五”期间按承办奥运会以及满足自身发展的要求扩建飞行区和航站区;上海浦东国际机场按最终建成国际大型航空枢纽的要求规划,并进行二期工程的前期准备;广州新白云国际机场按满足枢纽机场要求在“十五”期间完成一期工程的建设。由于当前我国的航空运输结构调整、航空公司集团化等还没有形成规模,从一定意义上制约了枢纽机场建设和改造的进程。同时,亚洲各国已经认识到建设枢纽机场是占领亚太地区国际航空市场的有效手段之一,都在全力进行航空枢纽建设,韩国仁川、日本东京成田、新加坡樟宜、泰国曼谷等机场都是我国三大机场强有力的竞争者。因此,我们在这方面存在不少困难和挑战。沈阳、武汉、成都、昆明、西安、乌鲁木齐6个机场将建设成为区域型中型航空客货集散中心,对航站楼和相关配套设施进行改扩建,不断完善机场客货处理综合功能。

##### 2. 西部地区支线机场建设

长期以来,国家一直很重视西部地区的机场建设,新建或改扩建了一大批民用机场。但与东南沿海地区相比,由于我国东西部经济发展不平衡,造成了西部地区的民用机场在布局、规模、现代化水平等方面还相对滞后。随着国家西部大开发战略的实施,西部地区民用机场建设的步伐将会加快。目前,西部地区12个省、市、自治区共有机场57个。在省会级机场中,除成都、桂林、昆明、贵阳、兰州、乌鲁木齐、西宁、银川、呼和浩特机场外,西安、重庆、拉萨机场正在进行更新改造或扩建。工程完成后,这12个机场的功能将得到完善,设施设备的现代化水平将大大提高。其它机场均为小型机场,功能较为单一,设施设备较落后。西部地区大部分是中小城市,人口少,密度小,社会经济发展比较落后,适宜于大力发展支线机场。“十五”期间,西部地区将新建九寨沟、黎平、临沧、林芝、固原、那拉提等25个机场,迁建赤峰、榆林、库尔勒等7个机场,改扩建锡林浩特、西双版纳、嘉峪关、和田等13个机场,使机场总数达到82个。2010年,西部地区机场总数将达到106个左右。西部地区自身经济实力不强,机场建设资金匮乏。因此,机场建设将立足于贯彻落实国家西部大开发战略,促进当地社会经济发展,扩大对外开放,改善投资环境以及适应全国航线网络需要,多方筹集资金,提高投资效率,积极稳妥,逐步展开。

中国民用航空总局机场司司长



2002年1月10日

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# The Construction and Development of Civil Airport in China

(Substitute for Preface)

Civil aviation industry in China is developed step by step since the foundation of P.R.China. Construction of civil airport is also experienced the process gradually increase in quantity and scale. Especially, since the implementation of the reform and open policy in China, the construction of civil airport is developed very rapidly and makes contribution for the sustained and rapid development of civil aviation industry in China.

## 1. The Retrospection of Civil Airport Construction

On November, 9, 1949, some employees and twelve aircraft of CNAC and CATC fled back the Mainland from Hong Kong, which was the famous uprising of "CNAC & CATC". As the base of "Two Airlines", Tianjin Zhanguizhuang Airport was rebuilt in the initial stages of P.R.China. It was first large-scale construction project of airport in China. By the end of 1950, there were only 36 airports in our country, moreover the scales of these airports mostly were small and the installations and facilities of these airports were tatty. From 1950s to 1978, civil aviation industry in China developed slowly because of the conditions of impersonality, the total investment of capital construction was only about 2.4 billion RMB. More than 20 airports were constructed and expanded successively in Beijing, Shanghai, Guangzhou, Tianjin, Xi'an and so on. The total number of airports used for scheduled flights was around 70, which including 36 airports jointly used by civil aviation and military. During this period the scales of airport construction were relatively small and most of them were medium or small airports.

In pace with the implementation of reform and open policy in China, civil aviation industry stepped into a new developing phase. This offered the valuable conditions for the construction of civil airports. From 1979 to 1985, New airports completed were Xiamen / Gaoqi, Dalian / Zhoushuizi, Dunhuang, etc. and some airports were reconstructed or expanded, such as Chengdu / Shuangliu, Haikou / Dayingshan, Guilin / Qifengling and so on. During the "Seventh Five-Year Plan" period, New airports, including Shenyang / Taoxian, Ningbo / Lishe, Chongqing / Jiangbei, were constructed and put into service. At this stage, our country successively imported some intermediate-range or long-range large jumbo aircraft, therefore this promoted the improvement of airport construction level in criterion, scale and secure guarantee, etc..

In order to not only also adapt to the need of reform and open up in our country and the rapidly development of national economy, but also meet the demand of great development in air transportation, civil aviation established the guidelines of airport construction. The guidelines were concentrating on the strength and grasping the major projects in the early 1990s. And financing channel should be gradually widened, while investments should be enlarged and airport construction steps should be speeded up. The phases of "Eighth Five-Year Plan" and "Ninth Five-Year Plan" are the peak time of our civil airport construction. During the period of "Eighth Five-Year plan", the civil capital construction investments were 12.207 billion RMB and technical alteration investment was 6.087 billion RMB. 16 new airports were constructed in Xi'an / Xianyang, Xining / Caojiabao, Shenyang / Taoxian, Wuhan / Tianhe and so on. 27 airports were reconstructed and expanded, including Kunming / Wujiaaba, Lasha / Gongga, Changdu / Bangda, etc. During the period of "Ninth Five-Year Plan", the civil capital construction investments were 68 billion RMB and technical alteration investment was 12.6 billion RMB. These investments individually were 5.6 and 2.1 times respectively, compared with that of "Eighth Five-Year Plan". 17 new airports were constructed in Guilin / Liangjiang, Shanghai

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/ Pudong, Haikou / Meilan, Hangzhou / Xiaoshan and so on. 35 airports have been reconstructed and expanded, including Beijing / Capital, Wulumuqi / Diwopu, Xiamen / Gaoqi, Lanzhou / Zhongchuan, etc.. Keeping up with high quality construction of major projects, a great bulk of small airports are constructed and reconstructed in Zhoushan, Dali, Jiayuguan and Yanji, etc.. Thus the conditions of air transportation facilities are improved, the development of local economy is promoted and the step of reform and open is speeded up.

## **2. The Characteristics of Civil Airport Construction**

After the large-scale construction in these years, the number of our civil airports has greatly increased. By the end of 2001, the total number of civil transportation airports in China is 129, which not including Hong Kong, Macao, Taiwan and airports solely used by CUA. In these airports, there are 31 airports are opened for foreign countries. There are civil airports with relatively perfect facilities in all of municipalities, provincial capitals, capitals of autonomous regions, coastal opened cities and major tourist cities in our country, and there are airports with corresponding scales in the remote and border area. In summary, there are some characteristics in our civil airport construction as following:

### **(1) The planning and layout of airports in China tends to reasonable step by step**

Before implementation of reform and open policy, there hardly is national airport system planning. The airport constructions mostly were carried through in light of various national policies. Since 1978, civil aviation authority have gradually recognized that it is important to formulate overall plans and reasonable allocation, and to establish medium-term or long-term planning in order to do well the airport construction, develop civil air transportation and exert the investment benefits. The planning should suit to the situation of our country, meet the demands of development, and adapt to the development of national economy and other transport models, which also be capable of guiding the phaseout of airport construction. So CAAC establish national civil airport developing planning in time, and correctly guide the enthusiasm of local government in constructing airport. Thus, since "Eighth Five-Year Plan", the airport planning and construction scales in China can be kept reasonable and suitable on the whole.

### **(2) Investment channel gradually is widen and construction speed is promoted constantly**

Before 1980s, all airport construction financing was invested by country, and the total amount of annual investment didn't exceed 100 million RMB. After the implementation of reform and open policy, the step of airport construction has speeded up and the national investment of civil aviation capital construction has greatly increased. At the same time, the financing channel has been gradually transferred to extend channels from unitary national investment, involving national investment, local investment and foreign capitals. In 2000, the civil capital construction and technical alteration investments are 12.5 billion RMB, involving 2.5 billion RMB of local investment, which accounts for 20%. In some airport constructions, foreign governmental loans, export credits and foreign bank loans are used. The reform of investment system and diversification of financing mode not only relax the shortage situation of financing, but also promote the transform of investment system of civil airport construction. Now all airport construction projects in China adopt the legal person system of construction project. With responsibility for the implementation of project construction, legal person organization of project is constituted with the main investors in terms of the ratio of investments. The practices of these years have proved that these systems have been popular and strictly enforced in civil airport construction, including the legal person system, the invite bidding and bid system, the project supervision

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system, the contract management system and the market admittance system, etc. Therefore the project quality is guaranteed and the investment benefits are improved. Henceforth keeping up with the deepened economy reform and the widened open policy in China and the implementation of the Western Great Exploitation gradually, civil aviation will further reform the investment system, widen the financing channel. Various and flexible financing modes will be adopted to quicken the steps of airport construction in our country, especially in the Western.

(3) Airport facilities are continually upgraded and the levels of operation safety guarantee are improved

In order to upgrade the airport facilities, guarantee the flight safety and improve the service standard, in past 20 years, a great deal of new airport maneuvering area facilities including runways and taxiways were constructed, and some airport runways and taxiways also were reconstructed and expanded. By the end of 2001, there are 23 airports that aerodrome reference code number is 4E, 35 airports belong to 4D and 71 airports belong to 4C or 4C below. Beijing Capital International Airport uniquely has two far-distance parallel runways in Mainland; these airports, which including Nanjing, Wuhan, Shenyang, Shenzhen, Xi'an and so on, are planning to have two far-distance parallel runways; Shanghai Pudong International Airport plans 4 runways with two dual-lane parallel runways; Guangzhou New Baiyun International Airport in constructing plans 3 runways, and in this phase two far-distance parallel runways will be built at the same time; Some airports are planned according to the operating standards of aircraft design group F. These airport maneuvering area facilities will meet the increasingly demand of aircraft operation and aircraft types used.

In addition, the advanced equipment for ATC, navigation, communications, weather and visual aids facilities are upgraded. Most of airports have equipped with category precision approach instrument, while Beijing Capital Airport and Shanghai Pudong Airport have both equipped with category precision approach instrument. Furthermore safety and security equipment including security-check, supervisor, etc increasingly are updated. So airport operation capacity is fairly increasing and the control of safety and security is obviously improved. Meantime in order to adapt to the demand of increasing passenger volume, some airport terminals also are updated, reconstructed and expanded. According to the incompletely statistics, the existing total area of passenger terminal buildings is around 284.68m<sup>2</sup>. The operation of the new terminal in Beijing Capital Airport and the new Shanghai Pudong Airport signify that our country has been capable of building and managing well the large modernized civil airport with perfect facilities and advanced equipment.

(4) The technical level of airport construction is gradually improved

It is key to adopt the advanced technology in project construction so as to improve the civil airport construction criterions and levels, and guarantee the project quality. In these years some new technology, new techniques, new equipment and new materials are used widely in civil airport construction.

#### a. Maneuvering area

Our national territory is vast and its geological condition is quite various. So many airports had to situate ill geological zone because of other limited factors, such as soft soil, water sensitive loess, subgrade filling in near shore, etc. Different treatment methods were adopted in terms of various situations, and had made better effects. For example, Airports such as Xining / Caojiabao applied the strong tamper method to dispose the grade deadweight water sensitive loess; Airports such as Ningbo / Lishe adopted pre-loading method to dispose the coastal soft soil; Guiyang Longdongbao Airport adopted the technology of dynamic consolidation of boulder foundation; Xiamen Gaoqi Airport adopted the grouting reinforcing technique for without damage of

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surface pavement foundation. And the foundation treatment in Guiyang Longdongbao Airport won the third prize of State Science and Technology Development Award. The successful applications of these techniques have basically solved the treatment problems for some familiar ill geological conditions in our civil airport construction.

In the past, the constructions of airport pavement foundation all are paved by manual acting, which constructing quality couldn't be controlled easily. These years with the application of semi-rigid foundation, some new construction techniques gradually are applied. For example, the pavement foundation in Guangzhou New Baiyun Airport adopted the mechanical paving technique; it not only quickened the constructing speed, but also reduced the constructing cost. Meantime it improved the constructing quality obviously.

Before 1980s, pavements of maneuvering area in our civil airport mostly adopted cement concrete pavement. Recently the technical performances of flexible pavement are greatly improved and widely applied in civil airport pavement project. Especially the use of modified asphalt satisfied the demands of the aircraft's heavy-duty wheel loading effects and the skid-proof in pavement. The advantages of flexible pavement such as smooth taxiing could be utilized by civil airport, so the passengers' comfort degree could be improved while landing or take-off. The renovation project of east runway of Beijing Capital Airport adopted the asphalt overlay technique of SMA and PE+SBS, which reached better effects, and this technique won the Second prize of State Science and Technology Development Award. In the meantime the renovations of used airport pavements mostly adopt the flexible overlay, the construction technique and management of non-stop are increasingly mature. The non-stop construction solves effectively the contradiction of airport operation and project construction, and causes airport to serve for cities and regions normally. So these direct or indirect benefits are very obvious.

Nowadays in our civil airport the maneuvering area standards have jointed with international on the whole. In 1985 the maneuvering area technical standards of civil airport in China had been established in light of the relative standards of ICAO on aerodromes construction and operation. Since 1985, all of new facilities and equipment in the maneuvering area of civil airport are carried out in light of ICAO standards, so do the renovation and expand of some used facilities and equipment in the maneuvering area.

#### b. Terminal area

Firstly, airport terminal design concepts are diversified. Before 1990s, the terminal building area of civil airport was relatively small, and the design concept was simple, which most of airports were linear or transporter concept. One or two airport such as Beijing Capital Airport and the few adopted the mixed configuration of linear, satellite and transporter. Now our airport scales are enlarged generally and some airport terminal building area and the aircraft movements in peak time are greatly increasing, so in recently several years, terminal design concept are increasingly diversified. These concepts, like linear, satellite, finger satellite and transporter, combined and supplemented with each other so as to increasing the number of nearby stands and offering convenience to passengers. At the same time, the stand utilization and apron operation efficiency also are improved, and satisfied the demand of operation in the busy airports.

Secondly, the level of terminal design is improved. Airport terminals all adopt the large span steel roof structure, pre-stressed concrete and high-intensity concrete, such as Beijing / Capital, Shanghai / Pudong, and Hangzhou / Xiaoshan, etc.. These terminals' architectural forms differ from each other, the column spacing in terminal are greatly incremental, and interior spaces are open and the flows of terminal are fluently. In summary,

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the design levels of airport terminals are remarkably improved.

Thirdly, the facilities and equipment in terminal are modernized step by step. For having built or being building terminals, some advanced facilities and equipment are increasingly improved, such as check-in, security-check, flight information display, clock system, supervisor, broadcasting, computer information management, passenger departure, system integration, automatic building control system, boarding bridges, automatic baggage handling and sorting system, automatic walkways, escalator, etc.. The modern standards of these facilities and equipment in terminal are upgraded. On the one hand, it solves the problem of how to assure of information transmission in time, fluent flows, conveniences and high efficiency; on the other hand, it also promotes the improvement of the levels in terminal operation management and service.

Fourthly, the environment designs are paid prevalently attention in terminal area and within terminal building. Airport terminal areas, such as Hangzhou / Xiaoshan and Shanghai / Pudong, are arranged with a great deal of large green area, water pools, fountains and sculptures, etc, which build the airport environments as gardens. Terminal interior decorations are not only chased with the luxury, but also pay attention to human and stress the harmony and artistic effect. Large glass curtain walls and semi-transparent roofing are applied widely. With bright natural light, terminal exterior and interior blend with each other, it decreases the distance between passengers and aircraft. Meantime waiting environments are beautiful and comfortable and the energy also is economized.

Fifthly, foreign design schemes with advanced technology and design concept are positively introduced into China taken as the reference. Since recent years, in terminal design, the design scheme and design units are selected by inviting public bidding for domestic and overseas units. Airports like Beijing / Capital, Shanghai / Pudong and Guangzhou / New Baiyun finally adopt the design schemes of famous foreign corporation. By this way the gap in terminal design will be reduced between our country and overseas aviation developed countries and the level of our civil airport construction will be improved.

### **3. The level of civil airport development**

In 2000 the total traffic volumes of all civil airports in China were 134 million passengers, the freight traffic volume was 3.992 million tons. According to the statistics of ACI in 2000, among the top 50 airports with highest passenger traffic volume, there were 25 airports in America and only 2 airports in China, which were Hong Kong Airport and Beijing Capital Airport. Atlanta Airport in America stood the first with 80.17 million passenger volumes, and Hong Kong Airport stood the 22nd place. Beijing / Capital, Guangzhou / Baiyun and Shanghai / Hongqiao stood the 42nd place, 73rd place and 74th place respectively. The passenger traffic volume in Beijing / Capital accounted for 27% of that in Atlanta Airport. There were 7 airports whose passenger traffic volume was in excess of 50 million passenger volumes annually. Among the top 50 with the highest freight traffic volume, there were 22 airports in America and only 5 airports in China, including Taipei / Taoyuan. Memphis Airport in America stood the first with 2.49 million tons, and Hong Kong Airport stood the 2nd place with 2.28 million tons. Beijing / Capital, Shanghai / Hongqiao and Guangzhou / Baiyun stood the 31st place, 33rd place and 34th place respectively. The passenger volume in Beijing / Capital accounted for 27% of that in Atlanta Airport. The country area in China is pretty much the same thing as that in America. While the number of civil airports in China only account for 1/34 of that in America, and the number of flight operation airports in China only account for 1/5 of that in America. Thus there are bigger gap between China

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and world developed countries whether the number of airports or airport capacities. On the other hand these data also demonstrate the potential developing space in our civil airports.

#### **4. Prospects of civil airport development**

According as the forecast, in near future five years, the passenger and freight traffic volume will annually grow by 8% and 13% respectively, so the developing prospect of civil airport construction is extensive. In terms of civil Aviation "Tenth Five-Year Plan" and ten-year plan, the capital construction investments of civil aviation will reach about 100 billion RMB during "Tenth Five-Year" period. Three large hub airports will be constructed as the key project. Six regional medium hub airports will be fostered and developed; Two new trunk airports will be constructed and ten trunk airports will be renovated and expanded; Thirty-three new regional airports will be constructed and ten regional airports will be renovated and expanded. Regional airports will be rapidly developed. It is anticipated that there are around 172 civil airports by 2005, passenger traffic volumes will be added up to 200 million passengers and freight traffic volumes will up to 5.6 million tons. By the end of 2010, there are around 237 civil airports.

Recent years, in order to adapt to the demand of aviation transport market development, world aviation advanced countries all adjusted the airline network structure early or late, and realized the transform from the airline network giving priority to city pairs airline to hub-and-spoke network taking airline company as core. The practices in these countries proved that hub-and-spoke airline network had fairly good effects on using effectively aviation market resource, improving the traffic volume of airline, increasing efficiently the flight frequency between cities, strengthening the competitive advantage of airline company, improving the economic benefit, activating the vigor of regional economy. Building hub-and-spoke airline network has become the strategic choice of our civil aviation to adapt to future long-term developing demand and participation in the international competition. At present, the structure of airline network in China still stagnates on the level of city pair network. The hub-and-spoke airline network, which lies on airports and center on airline companies, just begins to build. At airport aspect, in China there isn't airport system with reasonable layout, which hub airport, trunk airport and regional airport don't cooperate with each other. Especially the numbers of hub airport and regional airport are far from the demand. So it is main task in civil airport construction to strengthen hub airports, improve trunk airports and develop regional airports in future.

##### **(1) The construction of hub airport**

There are some contradictions among growth of aviation market, airline structure and aircraft types, airport construction, etc.. Now no any hub airport really and truly appears in China. General Civil Aviation Administration of China confirms that according to the demand of adjusting airline structure, perfecting and building aviation hub, Beijing Capital Airport, Guangzhou New Baiyun Airport and Shanghai Hongqiao Airport will be built as international and national integrated hub. These airports will become the national distributing center of air passenger and freight. Beijing Capital Airport will be planed in light of future large integrated hub, and during "Tenth Five-Year Plan" its terminal area and maneuvering area will be expanded according to the need of undertaking Olympic Games and meeting the requirement of developing itself. Shanghai Hongqiao Airport will be planed in terms of future international large aviation hub, and ready for prophase works of second phase project. The first phase project of Guangzhou New Baiyun Airport will be completed during "Tenth Five-Year Plan" in light of the requirement of hub airport. Six airports such as

Shenyang, Wuhan, Chengdu, Kunming, Xi'an and Wulumuqi will be built as regional medium distributing center including the air passenger and freight. Terminals and relative auxiliary facilities of these airports will be reconstructed and expanded; the integrated function of passenger and freight handling in these airports will be improved continually.

(2) The construction of regional airport in the Western

Because of the non-balance of economy development between the Eastern region and the Western region of China, the civil airport of the Western relatively lagged the ones of the Eastern region in airport layout, scales and modern levels, etc. With the implementation of national Western Great Exploitation, the steps of airport construction in the Western will be speeded up. Now in the Western there are total 57 airports in 12 provinces, municipality and autonomous regions. Airports of 12 provincial capitals, including Chengdu, Kunming, Wulumuqi, Chongqing, Xi'an and Lasha, mostly have completed the renovation or expand. As soon as these projects have been finished, the functions of these airports will be perfected and the modernized levels of facilities and equipment will be improved.

In the Western most of cities are medium or small ones, the numbers of population are fewer and the density is lower. The level of social economy relatively lags behind. So the Western suits to develop regional airport. During the period of "Tenth Five-Year Plan", the new 25 airports, including Jiuzhaigou, Liping, Lincang and Linzhi, etc., will be constructed. 7 airports such as Chifeng, Yulin and Kuerle will be moved and constructed. 13 airports will be reconstructed and expanded, such as Xilinhaote, Xishuangbanna, Jiayuguan and Hetian, etc.. Then the total number of airports in the Western will be up to 82 airports. The total number of airports in the Western will be added up to around 106 airports by the end of 2010. Because the Western economic strength themselves aren't strong, the capitals are scanty, airport construction should lie on carrying out the national stratagem of the Western Great E Exploitation, promoting the development of local social economy, enlarging open up, improving investing environment and adapting to the national airline network. Airport construction financing should be raised with various styles, the investment efficiency should be improved, and airport construction should, positively and reliably, be evolved step by step.

Director of Airport Department of CAAC

Jiang Zuozhou

January 10, 2002



# 中国民用机场分布图(2000年)

