

天生桥一级水电站

TIANSHENGQIAO

No.1 HYDROPOWER STATION

中国南方电力联营公司

SOUTH CHINA ELECTRIC POWER
JOINT VENTURE CORPORATION



中国电力出版社

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前言

天生桥，这个由南盘江穿山度壑汇集千川万流奔腾而下形成的险滩，水流湍急、落差大，是我国名川大河中罕见的水电“富矿”和“黄金地段”，令无数中外水电专家为之倾倒。

十一届三中全会以来，改革的春风吹遍神州大地，国民经济的迅速发展加大了对电力的需求，一批时代的弄潮儿——水电建设者们踏上了这片淌金泻银的处女地。隆隆的机器声鸣奏着人类征服南盘江的凯歌，天生桥一级水电站——这个珠江源流南盘江上的龙头电站矗立起来了。

天生桥一级水电站工程自1991年初开工建设以来，走过了奋斗与艰辛、成功与曲折交织在一起的路程。中国南方电力联营公司和设计、监理、施工等参建单位的全体职工，在国家有关部门、国家电力公司及广东、广西、贵州省（区）政府的正确领导下，在各投资方的大力支持下，高举邓小平理论伟大旗帜，坚持党的基本路线和改革开放的方针政策，以科学的管理、先进的工艺和技术建设一流的电站为目标，艰苦奋斗，团结协作，积极探索，克服了一个又一个艰难险阻，在工程质量、建设进度和投资效益上，都取得了好的成绩，主体工程施工连创多项全国第一，实现大江截流后连续四年安全度汛，开创了百万千瓦级水电站从截流至首台机组发电只用四年时间的新纪录。

天生桥一级水电站能有今天，是南电公司全体职工和无数水电建设者为了祖国的繁荣昌盛，用自己的青春和热血铸就的。八年奋战，八载艰辛，天生桥一级水电站的建设者们在南盘江峡谷树起了我国第一座200米级的混凝土面板堆石坝，走出了由国家与数省（区）按资本金制度合资建设并实行业主责任制、建设监理制和招标承包制的改革之路。天生桥一级水电站是我国实行开发西南电力资源，实现西电东送能源战略的大型电源项目，对促进南方电网建设和电力市场的形成将发生深远的影响。

为昭示天生桥一级水电站建设者的卓越贡献，诲导后人艰苦奋斗、努力工作；为感谢国家有关部门和粤、桂、黔三省（区）政府领导人以及社会各界和当地人民对电站的关心、支持，有关部门特从灿如百花园的各类花丛中采撷出一些珍贵的瞬间，奉献给读者。当您展开这本画册之际，南盘江上这个闪光点已经光芒四射了……

汪恕博

一九九八年十二月

Preface

Tianshengqiao, a series of rapids with torrential flow and tremendous water head, formed by Nanpan River which crosses mountains and valleys, and gathers thousands of tributaries, is recognized as the "rich mine" and golden "terrain" of hydropower resources which is rarely seen. It is deeply concerned by the domestic and foreign experts working in the area of hydropower.

Since the 3rd Plenary Session of the 11th Central Committee of the Communist Party of China, the reform policy promoted the rapid development of national economy which increased the demand for electric power. At that time, a group of hydropower constructors, the pioneers of the time, arrived this fertile virgin land. In the boom of machines sounded like the triumph song of human being conquering Nanpan River, Tianshengqiao No.1 Hydropower Station, the head station on Nanpan River, the upper reach of Zhujiang River, has been established.

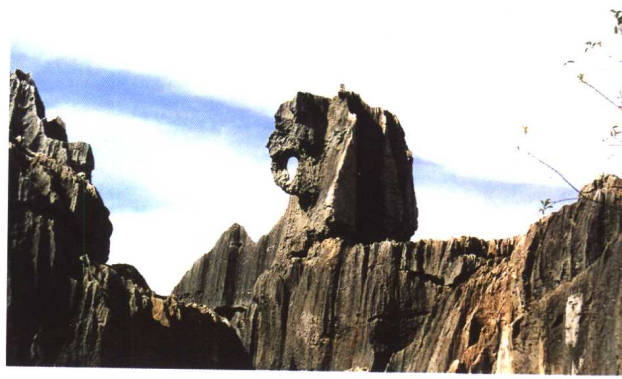
After the commencement of the construction in the beginning of 1991, Tianshengqiao No.1 Hydropower Project experienced struggles, arduousness, zigzags and successes. In the support of the related department of State, State Power Company and Guangdong, Guangxi, Guizhou Provincial (Regional) Governments, as well as various investors, the entire staff and workers of the South China Electric Power Joint Venture Corporation (SCEPJVC) and participant organizations including design, supervision, construction and so on, held highly the Great Banner of Deng Xiaoping's Theory, insisted on the fundamental route and the policy of reform and open to the outside, and targeted to construct a first-class power station with scientific management and advanced technology. Striving, coordinating, exploring, overcoming one by one difficulty, they gained great achievements in project quality, construction speed and investment benefit. Some of the construction of main works occupied first place in China. The project passed safely the flood season of continuous four years after the river closure, and set the record that it took only four years from the river closure to power generation of the first unit for a hydropower station in the order megakilowatt.

Tianshengqiao No.1 Hydropower Station is founded by the entire staff and workers of SCEPJVC and innumerable hydropower constructors with their youth and blood. After eight years' fighting and hardness, the constructors have built the first concrete face rockfill dam in order of 200m in the valley of Nanpan River, and opened up the reform way that the State and several provinces (region) jointly invest in light of the capital system, and carry out project owners' responsibility system, construction supervision system, competitive bidding and contract system. The power station is a major hydropower project for developing the power resources in Southwest China and transmitting electricity from west to east, which will have a profound effect on the promotion of establishing the united power grid and the form of the power market in South China.

For propagandizing the prominent contribution of the constructors of Tianshengqiao No.1 Hydropower Station, giving guidance to the successor, thanking the leaders of related State departments and Provincial (Regional) Governments, all walks of life and the local people for their support to the station, the editors gathered some precious instances from the long and difficult construction, and dedicated them to the readers. This major hydropower station on Nanpan River is already put into operation when you have just got this beautiful book.

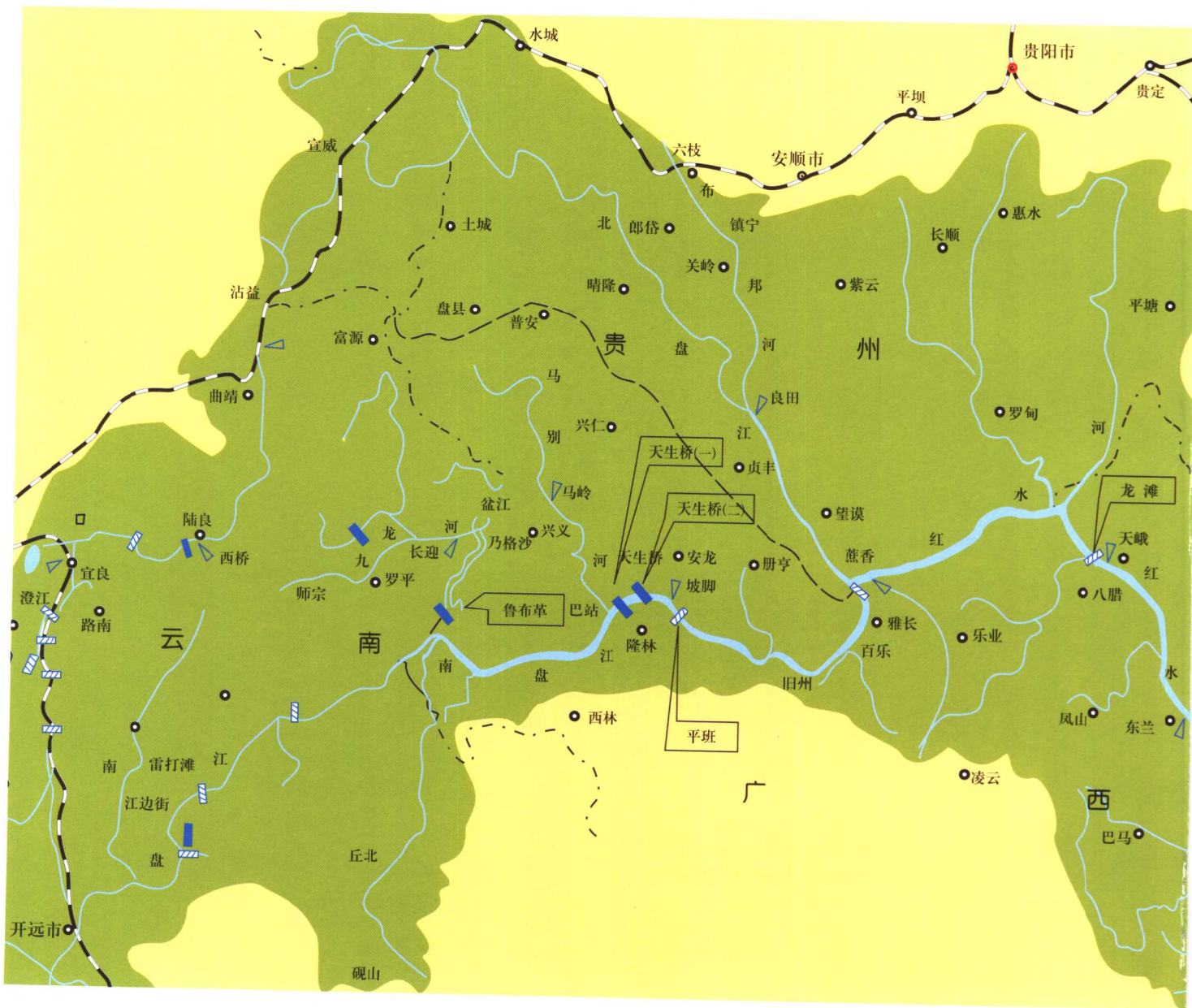
Wang Shucheng

December, 1998



南盘江红水河流域概况图

The skeleton diagram of the catchment of Nanpan River and Hongshui River





天生桥一级水电站工程简介

天生桥一级水电站是红水河梯级电站的第一级，位于南盘江干流上，控制流域面积50139km²。坝址左岸是贵州安龙县，右岸是广西隆林县。下游约7km是天生桥二级水电站首部枢纽，上游约62km是南盘江支流黄泥河上的鲁布革水电站厂房，直线距贵阳240km，距昆明250km，距南宁440km，距广州850km。

电站以发电为主，水库正常蓄水位为780m，死水位为731m，总库容为102.6亿m³，装机容量120万kW，保证出力40.5万kW，年发电量52.3亿kW·h，水库淹没耕地3.61万亩，迁移人口4万余人。电站出线为一回500kV交流和一回±500kV直流向华南送电，另有四回220kV线路向广西、贵州地方输电。

本工程主要建筑物由混凝土面板堆石坝、开敞式溢洪道、放空隧洞、引水系统和地面厂房等主要建筑物组成。

混凝土面板堆石坝坝顶高程791m，最大坝高178m，坝顶长度1168m，坝顶宽度12m，上游坝坡1:1.4，下游平均坝坡1:1.4，是当今世界上在建的高混凝土面板堆石坝之一。堆石坝体分为8区，混凝土面板顶部厚度为0.3m，底部厚度为0.9m。坝体填筑量1800万m³。

溢洪道设于右岸坝口，总长1745m，其中引渠1122m，底宽120m。最大开挖边坡高达125m，在溢流堰顶(760m)上，设五扇13m×20m弧形工作门，堰后为陡槽段，长538m，宽81~73.5m，其间设置掺气槽5个。出口采用挑流消能，最大泄量21750m³/s，是我国目前已建岸坡式溢洪道中最大的工程。开挖总量达2000万m³。

放空洞设在右岸，洞身全长1062m，内设平板链轮事故闸门(6.8m×9.0m)和弧形工作门(6.4m×7.5m)。工作门前为有压隧洞，内径9.6m，门后为无压城门隧洞，宽×高为8m×12m；工作门的校核水头为130m，总水推力达89000kN，在国内已建工程中处于先进行列。

引水发电系统布置在左岸，包括进口引渠进水塔，4条内径为9.6m混凝土衬砌隧洞(其中1/3洞段采用后张法预应力混凝土衬砌)，后接高压钢管，内径为8.7~7.0m和地面厂房，内装4×30万kW机组。厂房后山开挖边坡高达109m，为泥岩、砂岩互层，地质构造复杂，采用混凝土喷锚及预应力锚索加固处理。

本工程由国家和广东省、广西壮族自治区及贵州省按资本金比例2:5:2:1合资建设，由中国南方电力联营公司代承业主职责负责建设管理，中国南方电力联营公司天生桥电站建设管理局负责电站具体建设事宜。电站的设计单位是昆明勘测设计研究院，长江水利委员会负责实施监理。工程总投资为103.52亿元人民币(内含部分外资)。主要施工单位有南水公司(武警水电一总队和巴西M·J公司联营体)，水电第七工程局、第九工程局、第十四工程局，葛洲坝工程局等。设备制造厂商为哈尔滨电机厂(主机)、西安变压器厂(主变)。

电站按国家审批的初步设计安排，总工期为9.5年。其中准备工作半年，1991年6月开工，1994年12月截流，截流后四年左右大坝基本建成，1998年12月第一台机组发电，然后每半年投产一台机组。

Brief Introduction to Tianshengqiao No.1 Hydropower Project

Tianshengqiao No.1 Hydropower Project, situated on the mainstream of Nanpan River, which controls a catchment area of 50,139 km², is the first cascade of the Hongshui River Cascade Power Stations. The left bank of the dam site is Anlong County, Guizhou Province and the right is Longlin County, Guangxi Zhuang Autonomous Region. The head complex of Tianshengqiao No.2 Hydropower Station is located about 7 km downstream, and the Lubuge Hydropower Station on Huangni River, a tributary of Nanpan River, is located about 62 km upstream. The straight distance from the dam site to Guiyang City is 240km, Kunming City 250km, Nanning City 440km and Guangzhou City 850km.

The power station is mainly used for electricity generating, with the installed capacity of 1200MW, the guaranteed output of 405MW and the annual energy output of 5.23TWh. The reservoir, with the normal storage level of 780m, the dead water level of 731m and the total capacity of 10260 million m³, resulted in submerged cultivated land of 36.1 thousand mu and resettling population of more than 40 thousand. The power station will transmit electricity to Southern China with one circuit 500kV AC line and one circuit ± 500 kV HVDC line, and to Guangxi and Guizhou with other 4 circuits 220kV line.

The project mainly consists of concrete face rockfill dam (CFRD), open spillway, emptying tunnel, water diversion system and surface powerhouse.

The concrete face rockfill dam, with a maximum height of 178m, the upstream slope of 1:1.4 and the downstream slope of 1:1.4 in average, is one of the highest being built in the world. Its top, resting at elevation 791m, measures 1168m long and 12m wide. The rockfill dam embankment with a volume of 18 millions m³ is divided into 8 zones. The thickness of concrete slabs at the top and bottom is 0.3 and 0.9 m respectively.

The spillway, with a total length of 1745 m, is set on the right bank. The approach channel is 1122m, in length and 120m in width. Its maximum excavation depth is 125m high. There are five radial service gates sized 13m \times 20m on the overflow weir with an elevation of 760m. After the overflow weir, there is a discharging chute of 538m long and 81~73.5m wide with 5 aeration slots. The spillway, adopting flip-bucket energy dissipation, with a maximum discharge of 21750m³/s, is the largest among the side spillways having been built in China. The gross amount of excavation is up to 20 million m³.

The emptying tunnel, with a total length of 1062m is set in the right bank. It is equipped with a plate caterpillar emergency gate sized 6.8m \times 9.0m and a radial service gate sized 6.4m \times 7.5m. There are pressure tunnel with a internal diameter of 9.6m at the upstream side and a free-flow tunnel of 8m wide and 12m high at its downstream side. The service gate with a check hydraulic head of 130m and a gross water thrust of 89000kN is in advance of the projects of same type having been built in China.

The diversion and power generation system, located in the left bank, includes an inlet approach channel, an intake tower, 4 concrete-lined power tunnels with an internal diameter of 9.6m (1/3 of which adopts post-tensioned prestressing concrete lining), and steel lined high pressure tunnels with an internal diameter of 8.7~7.0m. The surface powerhouse houses four 300MW power generating units. The rock slope with a maximum excavation depth of 109m, at the back side of the powerhouse, with a complex geological structure, is consisted by interlayers of mudstone and sandstone. It is strengthened by shotcreting and anchoring, as well as pre-stressed anchorage cable.

This project, with the total investment of 10352 million RMB (including partial foreign funds), is jointly invested by the State and Guangdong, Guangxi, and Guizhou provinces (region) in the capital proportion of 2:5:2:1. Its construction works are managed by South China Electric Power Joint Venture Corporation (SCEPJC), acting in charge of the owner, and the concrete affairs is under the charge of the Tianshengqiao Construction Management Bureau of SCEPJC. The project is designed by Kunming Exploration, Design and Research Institution (KEDRI). The supervision engineers are from Changjiang Water Resources Committee (CWRC). The main constructors Nanshui Company (a joint venture of the Armed Police Hydropower Corps No.1 and the MJ Company of Brazil), No.7, No.9, No.14 Hydropower Construction Bureau and Gezhouba Hydropower Construction Incorporation. The main generators are supplied by Harbin Electric Machine Manufactory and the main transformers by Xi'an Transformer Manufactory.

According to the preliminary design examined and approved by the State, a total of 9.5 years is needed for construction work. The construction was started in June 1991 after half a year's preparation. The river closure was in December 1994. The dam was completed about 4 years later. The first unit is put into operation in December 1998. After that, one unit will be put into operation each half a year.



经过八年艰苦卓绝的努力，天生桥一级水电站首台机组并网发电了。这是几代人为之奋斗的西电东送又一丰硕成果，是投资各方和建设管理单位及施工单位团结协作，国家计委、国家开发银行、南方四省（区）政府大力支持的结果，在国家与南方四省（区）合作办电历史上写下了光辉的一页。在首台机组发电总结大会上，国家电力公司高严总经理（右）及四省（区）政府负责人出席大会祝贺

After eight years' hardness, the first generating unit is put into operation. This is another harvest of the project transmitting electricity from west to east which generations of people have fight for, is the achievement resulted by various investors, supervision organizations and construction organizations and in the support of the State Planning Committee, the State Development Bank and four southern provinces (region). It puts down a brilliant page on the history of the State and four southern provinces (region) jointly building power. Gao Yan, president of State Power Company (right) and leaders of four southern provinces (region) attend the summing-up meeting of generating of the first unit



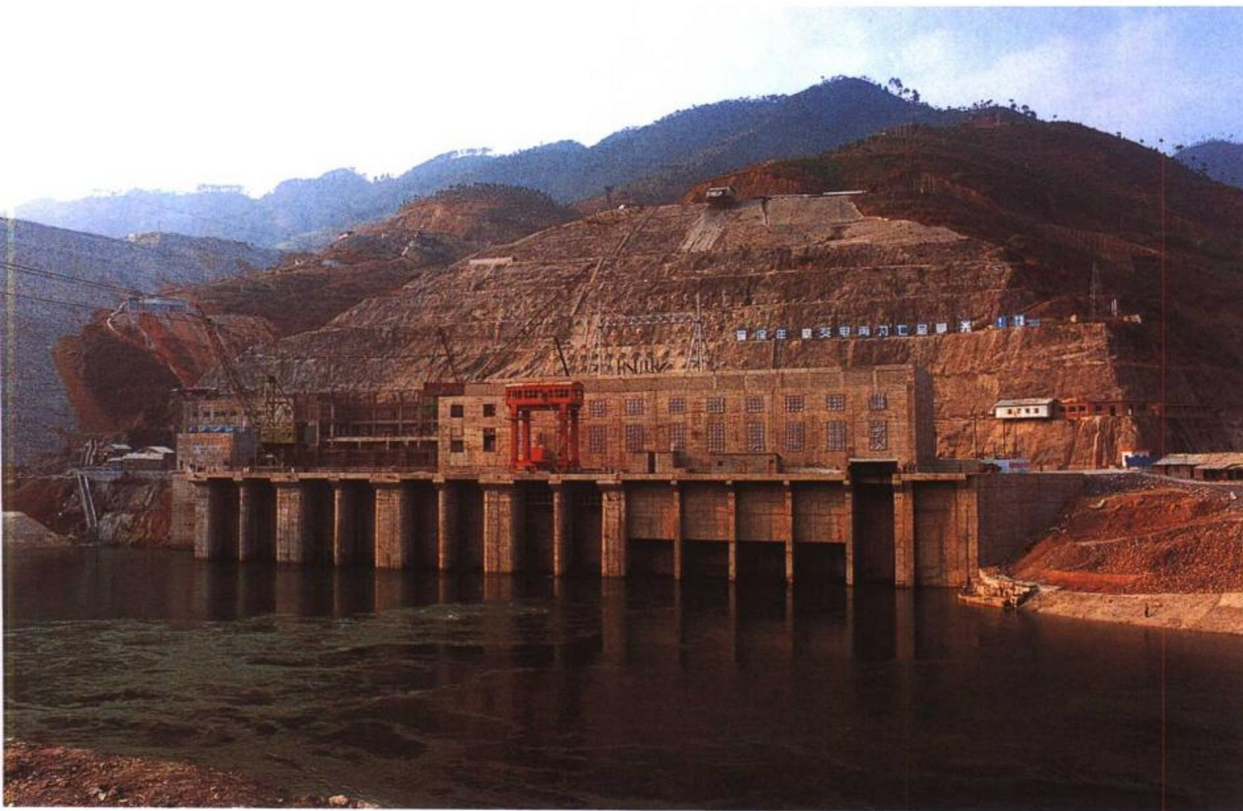
国家电力公司高严总经理为天生桥一级水电站首台机组并网发电剪彩

Gao Yan, president of State Power Company (SP) cuts the ribbon for paralleling into the network and generating of the first unit of Tianshengqiao No.1 Hydropower Station

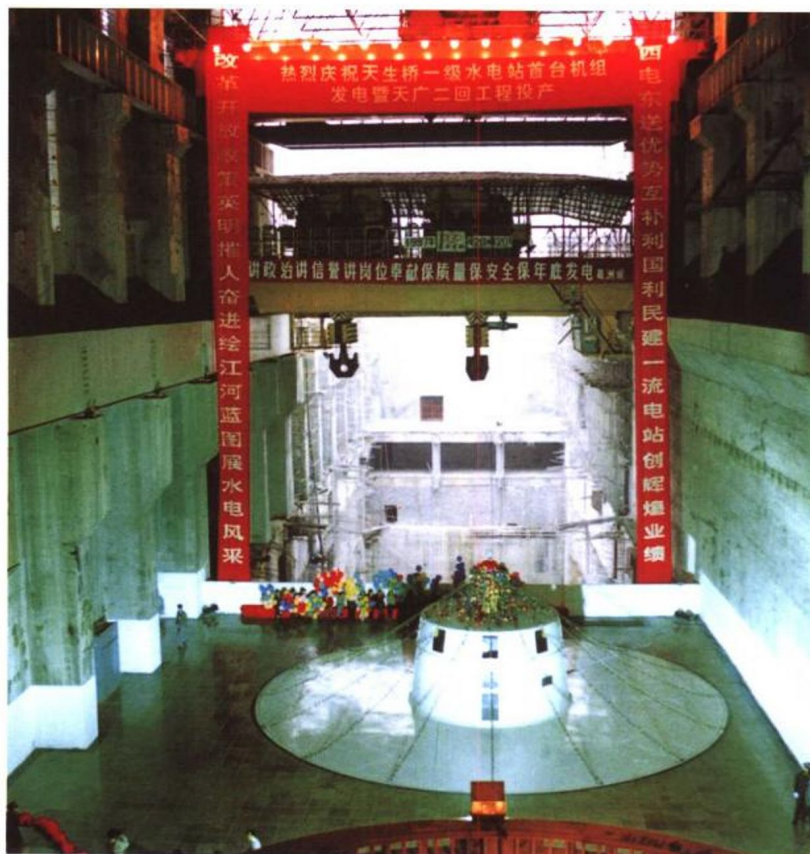


南电公司袁懋振总经理在庆祝天生桥一级水电站首台机组发电暨天广二回输电工程投产大会上讲话

Yuan Maozhen, president of SCEPJC has a speech on the meeting celebrating for generating of the first unit of Tianshengqiao No.1 Hydropower Station and commission of two-circuit Tian-Guang transmission project



天生桥一级水电站发电厂房外景
The outer view of the powerhouse of
Tianshengqiao No.1 Hydropower Station



天生桥一级水电站首台投产发电的机组
The picture shows the first generating unit of Tianshengqiao No.1
Hydropower Station