



Storyboard for
China 1000kV Line Project 8 PULL 8 Stringing Operation
中国1000kV特高压线路项目“八牵8”架线施工图册

2008-07-22





新的挑战 The Challenging Problem 2006

新的1000 kV特高压试验线路带来了许多新的技术难题，其中之一就是如何安全且有效率地**同时展放8分裂导线**。

The new 1000 kV experimental power line brought a lot of new technical questions on the table, one of them is how to **string 8 bundled conductors at the same time** in efficient and safe way.



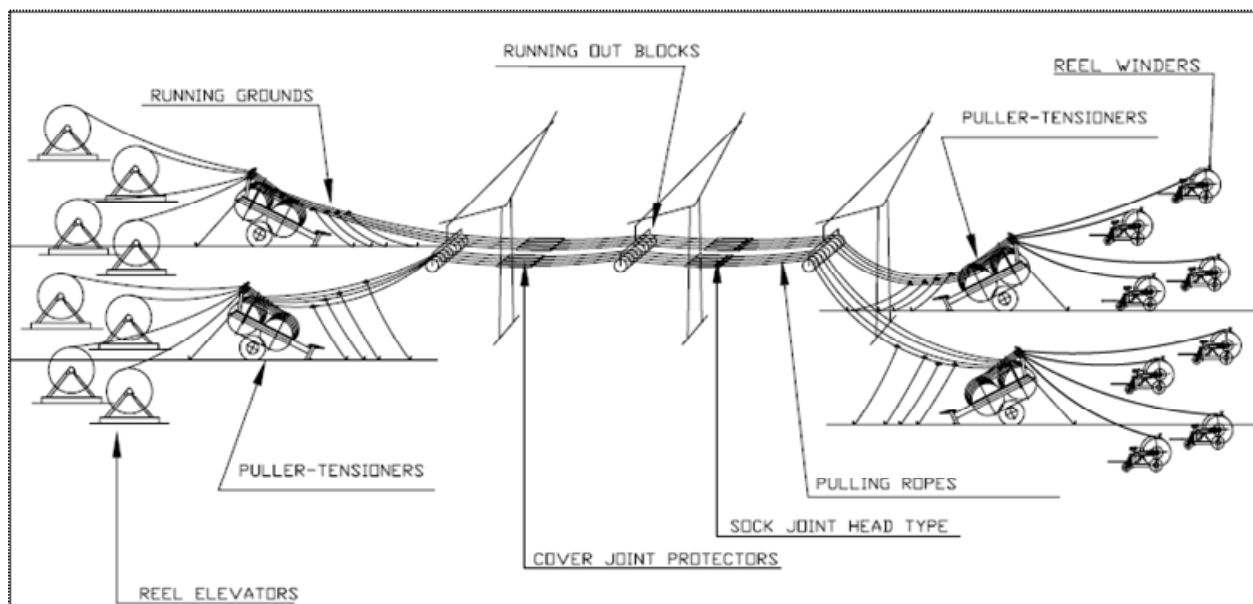
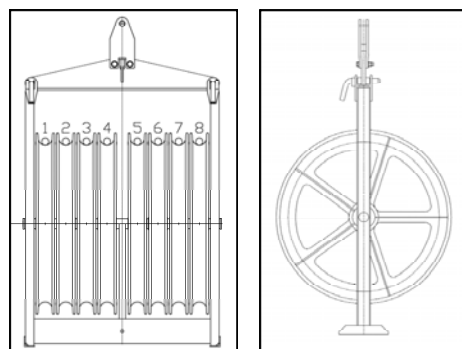
思路 The Idea 2006 - 12

采用传统的1牵8架线方式是一种可能性，即使用1台大牵引机用1根牵引绳通过走板连接同时展放8根独立导线。但是这种方法有一个重要的限制：最大牵引力不能大于280 kN。这一限制使得传统的架线方法无法满足一些极限工况的要求，特别是**河流大跨越**。

泰斯美克技术部门获得了使用多功能机（即牵张一体机）的想法，通过牵张一体机之间的电子同步连接可以将最大牵引力增加至540 kN。

The traditional stringing method of one big puller with one pulling rope stringing 8 independent conductors by a running board was a possibility but with one important limitation: The max pulling force cannot be higher than 280 kN. This limitation not allows to overcome some critical section of the line, in particular the **River Crossing Section**.

Tesmec technical department got the idea of **using multiple machines (called puller-tensioner)** electronically connected each other in order to increase the **max pulling force up to 540 kN**.





解决方案 The Solution 2007 - 01

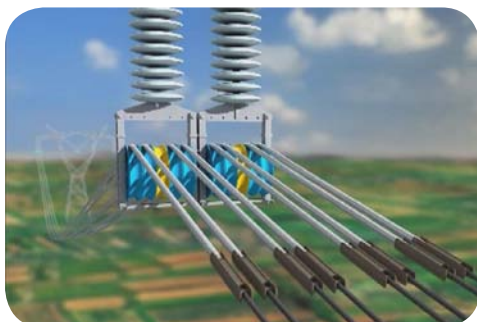
最终的解决方案是通过与项目的各方面人员进行了多次的技术交流及深入研究后达成的。最终选择的方案是使用泰斯美克 AFB506 型 90 kN (45 kN+45 kN) 牵张一体机。采用四台牵张一体机通过电子连接作为牵引机使用，以最大总牵引力360 kN 通过 8 根牵引绳同步展放 8 根独立导线。或采用六台牵张一体机通过电子连接作为牵引机使用，以最大总牵引力540 kN 通过 6 根牵引绳同步展放 6 根独立导线。

The final solution was the result of several technical meeting where different aspects of the job to be carried out were deeply analyzed. The final preference was given to the Tesmec 90 kN (45 kN+45 kN) Puller-Tensioner model AFB506. Four machines connected working as puller guaranteed the simultaneous stringing of 8 bundled conductors with 8 independent pulling ropes at the max total force of 360 kN. Six machines connected working as puller guaranteed the simultaneous stringing of 6 bundled conductors of bigger section with 6 independent pulling ropes at the max total force of 540 kN.

模拟试验 The Simulation 2007 - 06

对于任何优秀的工业设计来说，数据的验证非常重要。出于此目的，我们在真实的工地现场进行了模拟试验，使用老型号的牵张一体机通过 4 根牵引绳展放 4 根独立导线。这一模拟试验非常的成功，并证实了泰斯美克的架线方案是简单且可行的。

In any good engineering process is very important to validate an idea, for this purpose a simulation of the real job site was carried out by using older Puller-Tensioner to string independently 4 bundled conductors with 4 pulling ropes. The simulation was successful and demonstrated that the ideas was good and simple and can be applied in appropriate way.





设计 The Designing 2007 - 05 ~ 09

机器的设计过程需要面对很多难点并需要解决大量的问题。首先，需要对机器的电子硬件及软件进行全新的设计，以满足多机速度同步工作的需求。机器部件的选择也受到了需要满足如此复杂的电子控制的限制。包括柴油发动机厂商、液压部件厂商、电子硬件及软件工作室、仪器仪表生产商在内的多个技术团队与泰斯美克技术部门一起攻关这个富有挑战性的课题。

The designing process needed to face several difficulties and solve a huge number of problems. First of all a completely new electronic hardware and software needed to be designed in order to allow the multiple machines work in speed synchronization. The possible choice of components was consequently limited to the ones that can allows such sophisticated electronic controls. Several teams work together with Tesmec technical department on this challenging issue including Diesel Engines and Hydraulic components manufacturers , Electronic Hardware and Software houses, Instruments manufactures and so on.



生产制造 The Manufacturing ~ 2008 - 06

由于前期大量的细致深入的技术准备工作，机器的生产制造过程非常的顺利，即使一些部件是全新的或特别设计的。

The manufacturing process went smoothly in consideration of the huge technical preparation, even if some component were completely new and designed on purpose.





出场前测试及校准 The Home Testing and Calibration 2008 - 04-06

泰斯美克的设备厂房允许进行完整的机器校准及性能测试。尤其是对这一类型的机器需要很长的硬件设置及软件调试过程，以达到设计的标准及参数。所有参与此项目的团队紧密合作，最终完成了我们认为目前世界上最为先进的架线设备。

Tesmec facilities allow to perform complete calibration and performance tests. In particular these machines required a long hardware set-up and software debugging process in order to reach the designing criteria and parameters. All the teams participate to this project collaborate intensively to reach what we consider today the most advanced stringing machine worldwide.



运输 The Transportation 2008 - 06-07

设计一款具有革新技术的设备是一项庞大而耗时的工程，尽管泰斯美克公司从一开始就竭尽全力，希望按照合同的交货期交货，但是如此复杂的设计制造周期是无法准确估计的。因此，为了尽量缩短供货周期，泰斯美克公司毅然决定采用空运的方式将此批设备从意大利运至中国，运输设备总量达12台，总重量达57吨。这是泰斯美克公司历史上的第一次，为此，泰斯美克公司做出了巨大的努力。

The time available to develop such sophisticated machines appeared not enough since the beginning of designing issue and despite the huge effort all Tesmec staff to respect the lead time given in the purchasing contracts, some delay was accumulated. Therefore Tesmec in order to reduce the final delivery time to the job sites decided, for the first time in its history, to deliver the machine by air. A total number of 12 machines, for a total weight of over 57.000 kg, were send by planes from Italy to china with a very huge effort by Tesmec logistic department.





现场设备调试启动 The Site Start-Up 2008 - 06 ~ 07

当设备及相关附件运抵施工现场后，泰斯美克公司立即派出了技术支持团队，不同的技术团队在现场对设备及附件进行了再次的测试，以确保所有设备的状态良好，并随时可以开始操作。

One upon the time all the machines and relative accessories arrived on job sites, different Tesmec technical teams retested all the machines and accessories equipment, in order to re-confirm that all the items were in good order and ready to operate.



架线操作 The Stringing Operation 2008 - 06 ~ 07

最终，泰斯美克设备顺利在工程中开始使用。三个施工现场中有两个现场至今还在施工中。

Finally at work ! Three different job sites prepared and two of them are still now running.

湖北荆门汉江大跨越 The Jingmen Han River Crossing Job Site 由湖南省送变电工程公司承担 Performed by the Hunan Transmission and Transformation Corporation

汉江大跨越是1000kV试验示范工程中最重要的一段大跨越之一，线路为三相单回六分裂线路，两根地线中的一根为OPGW光缆地线。

导线类型：AACSR 截面积：630mm² 导线直径：33mm
牵引绳：直径20mm的钢丝绳用于牵引导线，直径13mm的钢丝绳用于牵引光缆地线。

Han river big crossing is one of the two big crossing for 1000kV Line project of China, while the other is the Yellow river one. The line is a three phases one, composed by 6 conductors for each phase, plus 2 earth wire (1 OPGW).

Conductor type: AACSR Section: 630sqmm
Diameter: 33 mm

Earth wire (including OPGW in one of the two lines): 19 mm;
Pulling Rope: Diameter 13 mm for OPGW and 20 mm for conductors





河南南阳唐河现场

The Tanghe Job Site

由湖南省送变电工程公司承担

Performed by the Hunan Transmission and Transformation Corporation

该段线路为三相单回八分裂线路，两条地线中一根为OPGW光缆地线。

导线类型：AACSR 截面积：500mm² 导线直径：30mm
地线直径（其中包括一根光缆地线）：19mm

牵引绳：直径18mm的牵引绳用于牵引导线，直径13mm的牵引绳用于牵引光缆地线

The line is a three phases one, composed by 8 conductors for each phase, plus 2 earth wire (1 OPGW).

Conductor type: AACSR Section: 500sqmm Diameter: 30 mm

Earth wire (including OPGW in one of the two lines): 19 mm;

Pulling Rope: Diameter 13 mm for OPGW and 18 mm for conductors



湖北襄樊现场

The Xianfang Job Site

由北京送变电工程公司承担

Performed by the Beijinng Transmission and Transformation Corporation

该段线路为三相单回八分裂线路，两条地线中一根为OPGW光缆地线。

导线类型：AACSR 截面积：500mm² 导线直径：30mm
地线直径（其中包括一根光缆地线）：19mm

牵引绳：直径18mm的牵引绳用于牵引导线，直径13mm的牵引绳用于牵引光缆地线

The line is a three phases one, composed by 8 conductors for each phase, plus 2 earth wire (1 OPGW).

Conductor type: AACSR Section: 500sqmm Diameter: 30 mm

Earth wire (including OPGW in one of the two lines): 19 mm;

Pulling Rope: Diameter 13 mm for OPGW and 18 mm for conductors





成功完成任务 The Successful Job 2008 - 07

泰斯美克公司最新设备所具备的高精度同步功能，使得整个现场从项目经理到机手的工作都得以大大简化。随着使用经验的积累，湖南和北京两家送变电公司使用泰斯美克公司最新机器及架线技术的信心也在与日俱增，效率也在

逐日提高。如今，这种先进的施工工艺已经被证实是十分有效的，并对国内以后的特高压多分裂导线工程都是具有指导意义的。

The performance and the simplicity of use of these synchronized machines enchanted all the people present at the Job site from Project Leaders to the machine operators. More and more days passing the Stringing teams of the two construction companies are taking confidence with the use and the process of this innovative technology and systems becoming more and more efficient. It the now a common conclusion that this system is valid and become a new standard for the future UHV power line with high number of conductors per bundle.

