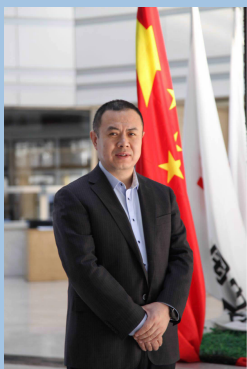


## 科技部项目“下一代”地铁车辆 ——从“技术引进”到“技术引领”的历史性跨越

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我国自开展城市轨道交通车辆技术研究以来,国内相关的整车制造企业相继都遵循着“引进、消化、吸收、再创新”的技术路线,逐步缩小了与国外先进技术的差距。随着将近六十年的技术积累,特别是近十年伴随着中国城市轨道交通建设的高速发展,国内轨道交通相关企业不断地投入研发和开展技术创新,取得了丰硕的成果。研发的相关技术和产品也都经过了长时间的验证,成熟可靠。但是,毋庸置疑,无论从车辆产品还是相关技术研发方面,还摆脱不了对国外先进技术的依赖。

正是在此背景下,国家科技部为了更好地发展国内的轨道交通产业,积极响应国家智能制造的政策方针,下达了“十二五”国家科技支撑计划,以进一步深入开展面向未来的城市轨道交通车辆相关技术自主化研究。2015年6月,中车长春轨道客车股份有限公司正式成为该计划“下一代地铁车辆技术研究及示范应用”项目(编号2015BAG13B00)的承担方。该项目本着“安全、智能、绿色、高效”的设计理念,以实现“技术引领”为目标,从顶层规划开始,重点突破车体、转向架、牵引传动、列车网络和制动核心系统等关键技术,对车辆的智能化、安全舒适、绿色环保、综合节能等方面进行系统性研究和设计,全力打造面向未来的城市轨道交通车辆,引领市场需求。

在智能化方面:列车采用全自动无人驾驶技术,车辆上电、自检、出库、运营、回库等一系列过程均采用无人驾驶控制模式,实现智能行车;以故障预警与健康管理局为核心,提供故障预警报警、故障精确定位和故障分析诊断,确保行车安全及运营秩序,并提供运维决策建议,实现故障智能专家诊断以及预测性智能化维修;以人为本,搭建了智能旅客信息服务平台,增加乘客的乘车体验,为乘客提供增值服务。

在安全性方面:4辆编组列车整车监控点有1200余处,可全面监控车辆关键零部件的运行状态,特别是障碍物及脱轨检测、走行部在线检测等一系列主动安全保障技术的研发应用,确保故障能够被及时发现和处理;同时,对重点部位和安全设备采用双通道冗余监控和冗余设计,全面、系统地保障列车运行安全。

在舒适性方面:采用开放性驾驶室设计,使乘客有更多的活动空间;客室整体设计简洁大方,通透性强,座椅、扶手、吊环等设计符合人机工程学,简单舒适;此外,照明采用冷暖双色控制,车窗采用抗紫外线及变色技术,客室空气采用净化装置及温湿度均匀控制技术,还配置了针对残疾人的助听系统,等等,为乘客提供更好的乘车体验。

在绿色环保方面:应用最新环保材料和技术,进一步降低车内外噪声,避免产生摩擦制动带来的粉尘污染。

在综合节能方面:首次开发全碳纤维复合材料轻量化车体,整车质量比标准B型车减重14.85%;同时,综合利用锂离子动力电池、高压直进、辅助高频及永磁牵引传动等相关节能技术,实现整车能耗降低15.4%。

2017年6月,科技部项目“下一代”地铁车辆正式下线。2018年9月27日,科技部高新司在长春组织召开了国家科技支撑计划“下一代地铁车辆技术研究及示范应用”的验收会。验收专家组现场查验并添乘了“下一代”地铁车辆,听取了项目汇报,审阅了验收资料,经质询和讨论,验收专家组一致认为,项目完成了立项批复的考核指标,同意通过项目验收,并对科技部项目“下一代”地铁车辆给予高度的评价。

“下一代”地铁车辆代表了目前中国城市轨道交通车辆产品的最高水平,引领城市轨道交通车辆向安全、可靠、绿色、智能方向发展,对于建设高质量综合交通具有重要意义,具有可观的产业化推广应用前景。中车长春轨道客车股份有限公司通过多年车辆技术的积累和不断创新,实现了车辆产品从“技术引进”向“技术引领”的历史性跨越,使其车辆产品更加具备国际竞争力和市场影响力。

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(1) 根据车顶结构确定扣车顶时先落一位端还是二位端,防止因工序错误造成车顶损坏。

(2) 扣车顶时,要保证车顶和侧墙左右平行,与侧墙边梁形成一条直线,防止两侧出现误差,如图 12 所示。

(3) 扣车顶后,车内对角线会发生变化,所以需要调整对角线后再进行段焊,防止扣车顶后先段焊后调整对角线,以免造成车体焊后扭曲。车顶落入如图 13 所示。

(4) 调整车内各部位尺寸,主要是车内的高度和宽度尺寸,防止各部位尺寸超差。

端墙的组装应注意组装和研配方面的问题,因为端墙的宽度是定型的,而高度是可以调整的,所以要在研配端墙时控制好高度尺寸。研配前要试



图 12 调整侧墙对角线



图 13 车顶落入

吊端墙一次,观察端墙外形是否与车体外形相符,可根据实际情况研配,走正负公差。端墙组装时要控制好端墙门口宽度、高度和前后倾斜度。组对连接条时要调整并保持车体外形与端墙外形一致,确保连接条组焊不错口和端墙前后的垂直度。

司机室组装中有许多关键尺寸需要得到保证

和控制,如整车的挠度、司机室研配等。组装时需要保证车钩面板上挠下垂、司机室内高、司机室与车体连接外形平整度、司机室蒙皮与底架连接平整度等方面的控制。因此,需要在组装时控制好以下关键尺寸:

(1) 组装司机室前,要对底架一位端 FE 施加下拉反变形,以防止组焊后上翘。

(2) 研配司机室槽型柱时要确保柱子的高度尺寸和坡口角度。

(3) 组装时要控制好边梁上平面到窗口横梁上平面的尺寸高度。

(4) 要控制好司机室内部高度尺寸,同时要保证下部蒙皮对接不产生错口。

## 4 结语

本文对中国标准动车组从部件组对到总合成的组装过程及需要掌握的技术要领和组装技术进行了总结论述。实践证明,只有了解客观规律,掌握客观规律,应用客观规律,按客观规律做事,才能提高企业员工的作业操作技能水平,提升企业产品质量,树立企业质量名片。

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## Commentary

# "Next Generation" Metro Vehicle Project of the Ministry of Science and Technology — A historic leap from "Technology Import" to "Technology Leading"

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Since the beginning of urban rail transit vehicle technology research in China, following the technical line of "Import, Digestion, Absorption and Re-innovation", all the domestic vehicle manufacturing enterprises have gradually narrowed the gap with the advanced foreign technologies. Based on technical accumulation in the past 60 years, especially following the rapid development of urban rail transit construction in China in the last decade, relevant enterprises have stuck to the investment in research and development for technical innovation and achieved fruitful results. All the developed techniques and products are mature and reliable after a long time verification. However, it has to be admitted that neither the vehicle products nor the related R & D works cannot get rid of

the dependence on foreign advanced technology yet.

Under such a background, responding positively to national policies of intelligent manufacturing and taking the Twelfth Five-year Plan subject research as an opportunity, MoST (the National Ministry of Science and Technology) has released the Project of the National Sci-Tech Support Plan, to deepen the autonomous research on relevant techniques for future urban transit vehicles, aiming at a better rail transit industry development in China. In June of 2015, CRRC Changchun Railway Vehicles Co., Ltd. officially became the bearer of the Project under the subject of *Research and Exemplary Application of Next Generation Metro Vehicle* (No. 2015BAG13B00). Based on the "safe, intelligent, green and efficient" design concept, and aiming at the "technology leading", the Project started from detailed planning by focusing on mastering key techniques in core systems such as car-body, bogie, traction and transmission, train network and brake, perform systematic research and design in the respects of intelligence, safety and comfort, green and environmental protection, comprehensive energy saving etc., strove to build the future-oriented urban rail transit vehicles and lead the market demands.

In terms of intelligence, all rail transit trains will adopt full automatic driverless techniques. The driverless control mode is used to realize intelligent operation in the whole process, including power-on, self-check, operation, out and in from service. Centered on the fault pre-warning and health management, rail transit train will provide fault pre-warning alarm, accurate fault finding and analytic diagnosis to ensure the safety operation and operational orders; advices will be provided on operation and maintenance decision making to realize fault intelligent expert diagnosis and predictive intelligent maintenance; people-oriented intelligent passenger information service platform will be created to enhance the passenger riding experiences and offer value-added services.

In terms of safety, more than 1 200 monitoring points for the four-car trainset have been set up for supervisory control of the status of key parts and vehicle components; a series of research and application of the active safety assurance techniques, such as the detection of obstructions and derailment risks, the online detection of running gears and so on, will ensure timely fault finding and handling. Meanwhile, the double-channel redundant monitoring and design adopted in key parts and critical safety equipment will completely and systematically ensure the safe train operation. In terms of comfort, the open cab design is adopted, providing passengers with more free space; the saloon design is simple and generous with strong permeability. Seats, handrails and hanger rings are designed in compliance with ergonomics, thus becoming simple and comfortable. In addition, lighting adopts cold/warm double-color control, windows adopt anti-ultraviolet and color-change techniques. While the saloons adopt air purification devices, temperature and humidity uniform control, as well as the hearing aid system for the disabled, to offer a better ride experience for passengers.

In terms of green and environmental protection, the state-of-the-art environment friendly materials and techniques are adopted, which will significantly reduce the internal noise and prevent powder pollution resulting from frictional brake.

In terms of comprehensive energy saving, full carbon fiber composite materials are developed for the lightweight car body, the mass of which is reduced by 14.85% compared with a standard Type B vehicle; meanwhile, lithium-ion power battery, high voltage DC link, auxiliary high frequency and energy saving technology of permanent magnet traction drive are comprehensively used, resulting in 15.4% of energy consumption reduction over a whole vehicle.

In June of 2017, the "next generation" metro vehicles project of MoST officially rolled off the line. On the 27th of September, 2018, the High-tech Division under MoST organized an acceptance meeting in Changchun City for the research and exemplary application of the next generation metro vehicle under the National Sci-Tech Support Plan, and accomplished evaluation of project approval. The expert team performed on-site inspection, boarded on the "next generation" metro vehicle, listened to the presentations on the project and reviewed the information supplied for acceptance. All experts agreed that the approved examination indicators for the project had been fulfilled, the project acceptance was passed and the "next generation" metro vehicle project of MoST was highly appraised.

The "next generation" metro vehicle represents the top level of urban rail vehicle products in China, which not only leads the development of urban transit vehicle in the direction of save, reliable, green and intelligent, but also plays an important role in the construction of a comprehensive high-quality rail transit with considerable prospect of industrialization promotion. With years of technical accumulation and continuous innovation, CRRC Changchun Railway Vehicles Co., Ltd. has achieved a historic leap from "Technology Import" to "Technology Leading" in terms of vehicles products, which are becoming more internationally competitive and more market-influential.