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打造系列化、智能化市域列车平台

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市域列车的最高速度可达200 km/h，同时还能兼顾地铁列车的快起快停和快速乘降，对提高市域（郊）铁路运输效率、提高城市公共交通效率具有重要作用。中车南京浦镇车辆有限公司全新研制的市域C、D型车列车基于城际动车组设计理念，车体结构采用动车组设计规范，可实现1 500 kN车体压缩强度性能和36 km/h的相对速度碰撞性能；应用了综合气密性设计技术，采用了高性能阻尼隔声材料，可有效提升列车隔音性能，全面提升乘坐舒适性；应用了包括智能照明、智能PIS（乘客信息系统）、智能检测、智能运维等智能化技术，以及多网融合、多屏融合、智能检测系统融合、主机融合等新技术。通过一系列智能化、数字化、轻量化、低碳化等设计，将市域C、D型列车打造成了智能化市域列车平台。该平台具有以下特点：

1）互联互通。动态限界满足国铁干线、城际铁路线以及市域（郊）铁路C线和D线等多种线路要求，可共享多种通道资源；采用双信号主机，共同的信号采集源，满足CBTC（基于通信的列车控制）与CTCS（中国列车控制系统）信号系统制式线路互联互通需求；控制器设置了3条制动指令线，组合成了7级制动，有助于长三角地区实现统一的区域救援制动方案，满足采用不同制动系统的不同制式列车在救援时的互联互通要求。

2）节能环保。优化了司机室、开闭机构和裙板气动外形，与既有城际铁路动车组相比，其空气阻力系数和阻力分别降低了6.5%和4.7%；采用永磁电机、轻量化结构和空调智能控制等技术，综合能耗降低12%；采用可回收、可降解材料替代非环保材料，材料可回收率超过了95%；采用水性漆和PC（塑料板材）板等环保材料，提高了车内空气质量，整车甲醛和TVOC（总挥发性有机化合物）释放量比标准要求降低约10%。

3）安全可靠。车体满足1 500 kN压缩载荷和1 000 kN拉伸载荷；4节编组时，可实现36 km/h的相对速度碰撞性能，提升了整车被动安全；可对动车组整车和关键零部件的运行状态进行实时监测，提高了动车主动安全。牵引、制动和网络等关键系统均采用冗余设计，单点故障不影响动车组整体功能；重联动车组的从控动车组无任何司乘人员，针对该运用模式，实现了视频联动监控、防火联动控制和疏散；采用自适应侧疏散装置，可保证在疏散平台、曲线段以及高架段等不同疏散工况下的快速疏散；采用基于高原“复兴号”改进的应急通风活动窗，满足跨省互联互通运营时应急通风时间长的需求，提升了应急处置能力。

4）智能引领。采用高实时以太网控制技术、FAO/ATO（全自动运行/列车自动运行）自动驾驶、多屏融合和主动障碍物检测等技术构建动车组智能行车体系；采用实时弓网监测、走行部监测和空调监测等技术实现动车组智能监测；采用智能送风、冷暖车厢智能调节、无级智能调光和乘客智能分流等技术打造智能服务动车组；以构型为主，实现产品全生命周期的数据整合和数据管理，实现列车智能运维；整套系统采用一个主机，融合了主动障碍物检测、弓网监测、走行部及脱轨监测、失稳及平稳监测、司乘行为分析、能耗记录、PIS、烟火报警及车载智能运维9个检测子系统，主机采用统一的设备规格，简化了系统集成的复杂度。

中车南京浦镇车辆有限公司系列化、智能市域列车平台具有智慧、绿色、低碳、舒适等特点，可为促进长三角地区轨道交通高质量发展提供强大的技术支撑，可在我国构建“四网融合”的轨道交通系统和建设国家综合立体交通网中发挥重要作用。同时，有利于带动我国轨道交通产业的技术进步，提升国家核心竞争力，推动国家交通强国建设和“双碳”战略的实施。

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Commentary

Building Serialized and Intelligent City Railway Train Platform

LI Dingnan

(CRRC Nanjing Puzhen Co., Ltd., Secretary of Party Committee, Chairman of the Board)

City railway train has a maximum speed reaching 200 km/h and caters to the rapid start-up/stop and quick boarding/alighting of metro trains, playing a crucial role in improving the efficiency of city (suburban) railway transportation and urban public transport. The newly developed city railway C and D type trains by CRRC Nanjing Puzhen Co., Ltd. are based on the design concept of intercity EMUs (electric multiple units), with the carbody structure designed according to EMU design specifications, capable of delivering 1 500 kN carbody compression strength performance and 36 km/h relative speed collision performance. The application of comprehensive airtight design technology and high-performance damping and sound insulation materials effectively enhances the sound insulation performance of the train and comprehensively improves passenger comfort. Intelligent technologies such as smart lighting, intelligent PIS (passenger information system), intelligent detection, and intelligent operation-maintenance are applied, along with new technologies such as multi-network integration, multi-screen integration, intelligent detection system integration, and host integration. Through a series of intelligent, digital, lightweight, and low-carbon designs, the city railway C and D type trains are transformed into an intelligent city railway train platform. The platform features:

1) Interoperability: Dynamic clearances meet the requirements of various lines such as the national railway trunk lines, intercity railway lines, and city (suburban) railway lines C and D, allowing for the sharing of multiple channel resources. With dual-signal hosts and a common signal acquisition source, the demand of interoperability between CBTC (communication-based train control) and CTCS (China train control system) signaling system format lines is fulfilled. The controller is equipped with three braking command lines, combining to form 7 levels of braking, facilitating the implementation of a unified regional rescue braking plan in the Yangtze River Delta region while meeting the interoperability demands of different format trains using different braking systems during rescue operations.

2) Energy-saving and environmental protection: The driver's cabin, the opening and closing mechanisms, and the skirt plate aerodynamic shapes are optimized, compared to existing city railway EMUs, the air resistance coefficient and resistance are reduced by 6.5% and 4.7% respectively. By adopting technologies such as permanent magnet motors, lightweight structures, and intelligent air-conditioning control, the comprehensive energy consumption is reduced by 12%. Non-environmental protection materials are replaced by recyclable and degradable materials, with the material recyclability rate exceeding 95%. Environmental protection materials such as water-based paint and PC (polycarbonate) boards improve indoor air quality, reducing formaldehyde and TVOC (total volatile organic compounds) emissions by approximately 10% of the entire train compared to requirements in standards.

3) Safety and reliability: The carbody can afford 1 500 kN compression load and 1 000 kN tensile load. With 4-car formation, a relative speed collision performance of 36 km/h can be achieved, enhancing the passive safety of the entire train. Real-time monitoring of the operation status of the entire EMU train and key components improves the active safety of the EMU. Key systems such as traction, braking and networking adopt redundancy design, ensuring that a single-point failure does not affect the overall functionality of the EMU. In the case of multi-coupled EMUs, the subordinate EMUs board no passengers or crew, targeting which, video-linked monitoring, fire-linked control and evacuation are enabled. The adoption of adaptive side evacuation devices ensures rapid evacuation under different evacuation conditions such as evacuation platforms, curved sections, and elevated sections. Based on the emergency ventilation movable windows improved from 'Fuxing' for plateau, the long emergency ventilation duration for inter-provincial interoperation is satisfied, enhancing emergency response capabilities.

4) Intelligent leadership: Technologies including high real-time Ethernet control technology, FAO/ATO (fully automatic operation/automatic train operation) automatic driving, multi-screen integration, and active obstacle detection are adopted to build an intelligent driving system for EMUs. Technologies such as real-time pantograph-catenary monitoring, running gear monitoring, and air-conditioning monitoring technologies are used to achieve intelligent monitoring of EMUs. Technologies of intelligent air supply, cold and warm compartment intelligent adjustment, stepless intelligent dimming, and intelligent passenger diversion are utilized to create intelligent service EMUs. Based on configuration, data integration and data management of product full lifecycle as well as train intelligent operation-maintenance are realized. The entire system adopts a single host, integrating 9 detection subsystems including active obstacle detection, pantograph-catenary monitoring, running part and derailment monitoring, instability and stability monitoring, driver/passenger behavior analysis, energy consumption recording, PIS, fire/smoke alarm and on-board intelligent operation-maintenance. The unified equipment specifications of the host simplify the complexity of system integration.

The serialized and intelligent city railway train platform of CRRC Nanjing Puzhen Co., Ltd. features intelligence, greenness, low carbon, and comfort, providing strong technical support for promoting high-quality development of rail transit in the Yangtze River Delta region and contributing significantly to the construction of China's 'four-network integration' rail transit system and the national comprehensive three-dimensional transportation network. Moreover, it facilitates technological advancement in China's rail transit industry, enhances national core competitiveness, and promotes the implementation of national strategies for building transportation power and dual-carbon 'initiative'.

(**Translated by ZHANG Liman**)