CALIFORNIA AIR RESOURCES BOARD

PROPOSED IN-USE LOCOMOTIVE REGULATION

COMMENTS OF WABTEC CORPORATION

Westinghouse Air Brake Technologies Corporation (**Wabtec**, or the "**Company**") respectfully provides the following comments to the California Air Resources Board (**CARB**) on the proposed In-Use Locomotive Regulation, Title 13, California Code of Regulations, Chapter 9, Article 8, Section 2478 (Proposed Regulation). As a global leader and manufacturer of technologically advanced locomotives, Wabtec understands the importance of California and national air quality and energy efficiency goals. Wabtec appreciates CARB's acknowledgement of certain alternative propulsion technologies in its Locomotive Technology Feasibility Assessment and its discussion of the challenges to commercial adoption. Wabtec's comments herein focus on the Company's perspective in developing the world's first 100% battery-electric line-haul locomotive, as well as the technical feasibility, cost, infrastructure needs, and other considerations for adoption of that technology, along with other technological advancements, for locomotives.

Wabtec designs, manufactures, and services freight rail and marine transportation products, logistics, and digital solutions that move people and goods across the globe. Headquartered in Pittsburgh, PA, Wabtec operates in over 50 countries with 27,000 employees worldwide, including over 12,000 in the U.S. With more than 23,000 locomotives in its global installed base, Wabtec moves more than 20% of the world's freight in over 100 countries.

I. WABTEC'S HISTORY OF INNOVATION FOR THE LOCOMOTIVE INDUSTRY

Throughout its history, Wabtec has successfully demonstrated its ability to design and manufacture best-in-class locomotives that meet industry requirements. Over the last few decades, Wabtec pioneered freight diesel electric locomotives with advanced emissions reduction technologies. In 2015, Wabtec's developed its ET44AC locomotive model to meet the U.S. Environmental Protection Agency's (**EPA**) most stringent Tier 4 emissions standard. This first-of-its-kind locomotive has more than 1,000 in service today and delivers a 76 percent reduction in nitrogen oxide (**NOx**) emissions and a 70 percent reduction in particulate matter emissions.[1]

[1] Railway Age, *Wabtec delivers 1,000th Tier 4 locomotive*, (Apr. 25, 2019), https://www.railwayage.com/mechanical/locomotives/wabtec-delivers-1000th-tier-4-locomotive/.

A. FLXdrive Battery-Electric Locomotive Pilot

Wabtec took a bold step toward a zero to near-zero emission locomotive future in 2021 with the demonstration and pilot of the world's first heavy-haul 100-percent battery-electric locomotive – called FLXdrive™. The FLXdrive was designed at Wabtec's Erie Campus, a 111-year-old site considered the backbone of innovation for the rail industry. In partnership with a grant from CARB, the locomotive was tested in revenue operation with BNSF Railway, the largest U.S. railroad, across the challenging environment of the San Joaquin Valley in California. Throughout this three-month technology demonstration pilot, the FLXdrive successfully reduced fuel consumption by more than 11 percent across the train consist. This fuel reduction is the equivalent of over 6,200 gallons of diesel fuel saved and approximately 69 tons of CO2 emissions reduced.[2] The FLXdrive 1.0 prototype successfully demonstrated that battery technology is safe to use in certain rail operations and has the potential to deliver emissions reductions through improved efficiency and fuel savings.

Building upon the success of the FLXdrive 1.0 Pilot, Wabtec is currently developing FLXdrive 2.0 and FLXswitch 2.0. FLXdrive 2.0 has a nameplate battery capacity up to 8.1 Megawatt hours (**MWH**) and is designed for mainline operations. FLXswitch 2.0 has a nameplate battery capacity up to 2.7 MWH and is designed for yard operations. Wabtec designed FLXdrive 2.0 and FLXswitch 2.0 to be easily customizable and fit the needs of different operating environments. It is anticipated that it would take up to 3 years to continue to develop, test and pilot battery-electric technology for line-haul operations. To date, Wabtec has received orders to be delivered in the next two years from Union Pacific Railroad and Canadian National Railway for 10 FLXswitch and 1 FLXdrive,[3] respectively, as well as 7 FLXdrive locomotives to be delivered to mining customers in Australia.[4]

Wabtec also is in active discussions with transit agencies regarding the application of battery-electric locomotive technology for the commuter rail systems. Wabtec is keen to partner with California and its transit agencies to demonstrate the technology and further support decarbonization efforts in passenger transit. While various commuter routes could implement battery technology to reduce diesel use and associated emissions, the implementation of this technology would require a demonstration period and the introduction of charging infrastructure. It is anticipated that it would take up to 3 years to develop, test and pilot battery-electric technology for passenger rail.

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[2] Wabtec Newsroom, *Wabtec's All-Battery Locomotive, FLXdrive, Lowers Freight Train's Fuel Consumption by More than 11 Percent in California Pilot*, May 17, 2021, https://www.wabteccorp.com/newsroom/press-releases/wabtec-s-all-battery-locomotive-flxdrive-lowers-freight-train-s-fuel-consumption-by-more-than-11.

[3] Wabtec Newsroom, *Union Pacific Railroad Makes Largest Investment in Wabtec's FLXdrive Battery-Electric Locomotive*, Jan. 28, 2022, https://www.wabteccorp.com/newsroom/press-releases/union-pacific-railroad-makes-largest-investment-in-wabtec-s-flxdrive-battery-electric-locomotive; Railway Age, *CN Orders Wabtec FLXdrive,* (Nov. 4, 2021), https://www.railwayage.com/news/cn-orders-wabtec-flxdrive/.

[4] CleanTechnica, *Wabtec's 100% Electric Locomotive Trickle Suddenly Becomes International Flood*, (Jan. 17, 2022), https://cleantechnica.com/2022/01/17/wabtecs-100-electric-locomotive-trickle-suddenly-becomes-international-flood/.

B. Other Railroad Industry Technology Investments

The recent interest in Wabtec's FLXdrive technology is just one example of the rail industry's substantial steps to reduce emissions. The rail industry is using digital technologies to improve the efficiency of its operations, testing more sustainable fuels like biodiesel and renewable diesel, and continuing to modernize its existing fleet. All of these efforts are important levers to improve local air quality, reduce emissions, and combat global climate change.

Wabtec's railroad customers have embraced digital technologies and solutions to optimize the rail network and train performance, as well as to achieve substantial fuel savings and emissions reductions. For example, Wabtec's Trip Optimizer™ smart cruise control system, which can be added to existing locomotives, helps improve fuel usage and reduces emissions.[5] It is installed on 11,000 locomotives globally and has saved 400 million gallons of fuel since 2009. The fuel savings translate to a reduction in CO2 emissions by more than 500,000 tons per year, the equivalent of taking 100,000 cars off the road worldwide. In addition, Wabtec's network solutions, from Movement Planner to Precision Dispatch, help railroads handle the complexity of busy rail networks, using movement planning and automation to improve network velocity and reduce dwell time. Brought together, these digital solutions help railroads achieve significant fuel and carbon reductions.

Wabtec also is partnering with Union Pacific Railroad (UP) to use a higher biodiesel blend in Wabtec locomotives used by the railroad.[6] This new collaboration supports UP's ambitions to increase the percentage of low-carbon fuels consumed to 10 percent of its total diesel consumption by 2025 and 20 percent by 2030. Union Pacific has begun testing with B20 biodiesel and R80 renewable diesel on trains powered by Wabtec FDL engines operating in California. As testing progresses, it is anticipated that higher percentages of biofuels will be used. We also partnered with BSNF Railway with a new biofuel project aimed at quantifying the impact of alternative fuels on emissions, durability, and performance in Wabtec locomotives. This project will demonstrate the performance of biodiesel (B20) and renewable diesel (R80) in revenue service on Wabtec Tier 3 and Tier 4 Evolution Series locomotives in California between Barstow and Los Angeles.[7]

Lastly, Wabtec's railroad customers are determined to support the circular economy by maximizing and extending the capabilities of their locomotive fleets. Earlier

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[5] Railway Age, *Trip Optimizer Tops 500MM Miles,* (July, 28, 2020), https://www.railwayage.com/news/trip-optimizer-tops-500mm-miles/.

[6] UP News Releases, *Wabtec and Union Pacific Railroad Partner to Reduce Emissions with Higher Biodiesel Blends,* (Mar. 8, 2022), https://www.up.com/media/releases/wabtec-higher-biodiesel-nr-220308.htm.

[7] Trains Magazine, *Union Pacific, BNSF, and Wabtec move to boost biodiesel fuel use,* (Mar. 9, 2022), https://www.trains.com/trn/news-reviews/news-wire/union-pacific-wabtec-move-to-boost-biodiesel-fuel-use/.

this year, UP signed a historic deal with Wabtec to modernize 600 locomotives.[8] At more than $1 billion, this deal was the largest investment in modernized locomotives in the rail industry. The modernizations extend the locomotive's life and provide benefits, including a fuel efficiency improvement of up to 18%; more than 80% increase in reliability; and haulage ability increase of more than 55%. Moreover, the modernizations will provide approximately 350 tons of carbon reduction per locomotive per year. The total order will enable Union Pacific to realize approximately 210,000 tons in annual emission reductions. The reductions are the equivalent of removing emissions from nearly 45,000 passenger cars per year. The modernizations also support the circular economy with more than half the locomotive's weight being reused. Throughout the order, approximately 70,000 tons of steel will be reused and recycled – the equivalent of more than 51,000 passenger cars.

Wabtec is pleased to be working with its committed railroad customers on a variety of technologies and solutions to improve rail efficiency and reduce emissions, including digital solutions, cleaner fuels, and locomotive modernizations. As a difficult to decarbonize industry, it will take multiple technologies and solutions to realize the zero-emissions freight rail network of the future.

C. Wabtec's Technology Road Map

While battery-electric technology is a potential solution to deploy zero-emission locomotive technologies, it is not suitable for every operating environment throughout the rail industry. Specifically, line-haul operations demand much greater energy density and may be more suitable to alternative energy sources like hydrogen. Looking forward, if the hydrogen supply grows to meet demand, Wabtec believes hydrogen eventually will be the next step in rail innovation. Hydrogen in an internal-combustion engine (**ICE**) will allow the current installed based powered by diesel-electric ICE to leverage the benefits of hydrogen fuel. Longer term, new locomotives will be produced using a combination of battery and hydrogen fuel cell technology to provide a path to zero-emission freight movement by rail. Given the current state of the research and development for hydrogen propulsion technologies – both within the ICE and using battery and fuel cell technologies, Wabtec is unable to predict when such technologies will be ready for commercial adoption.

II. CURRENT CHALLENGES FOR COMMERCIAL ADOPTION OF ZERO-EMISSIONS LOCOMOTIVE TECHNOLOGIES

Despite being at the forefront of innovation for locomotive technologies, Wabtec acknowledges that there are several key challenges that must be addressed to enable commercial adoption of alternative propulsion technologies like battery and hydrogen. Wabtec and the railroad industry are working together to address many of these interrelated challenges. However, it is difficult to predict the time horizon necessary to

[8] Wabtec Newsroom, *Union Pacific Signs Largest Locomotive Modernization Deal in Rail Industry History with Wabtec*, (July 27, 2022), https://www.wabteccorp.com/newsroom/press-releases/union-pacific-signs-largest-locomotive-modernization-deal-in-rail-industry-history-with-wabtec.

address these various challenges given the importance of engaging diverse stakeholders, leveraging significant investment for the assets and associated infrastructure, and solving for a dynamic supply chain environment.

A. Technology Readiness

As discussed above, Wabtec's FLXdrive 1.0 pilot demonstrated the tremendous strides of battery technology over the past decade. However, as a disruptive technology, a critical path to commercializing battery-electric locomotives in the rail industry is additional testing and demonstration of this technology in day-to-day operation. By way of example, Wabtec's railroad customers typically require up to 30 to 50 locomotive years of operation before a new technology is considered fully mature and integrated into their operations.

For line-haul operations, FLXdrive is designed to either replace a diesel locomotive in the consist or add to the consist in mainline operations. This hybrid consist will be managed by FLXoptimizer, Wabtec's energy management system, to optimize FLXdrive operation for traction and braking, minimizing the total fuel consumption and maximizing emissions reductions. A train-level fuel savings and emissions reduction of up to 30% is feasible by replacing one diesel locomotive in a consist with one FLXdrive, based on the battery size, specific route, and train type. It is important to note that the FLXdrive locomotive concept, described herein, is not currently capable of zero-emissions routes for line-haul operations.

For yard operations, FLXswitch can be used to replace existing diesel electric switcher locomotives to drive total fuel savings and eliminate diesel exhaust emissions. While FLXswitch could be used to replace an existing diesel electric switcher, the FLXswitch is currently 8-10 times the capital cost of procuring an older diesel-electric switcher in the North America market. Given the challenging economics of advanced clean energy technologies like the FLXswitch, Wabtec has been working with its customers to identify possible federal, state, and local grant funding opportunities to help offset the cost of these advanced technologies.

Another alternative propulsion technology that Wabtec is exploring is hydrogen – either in the ICE or using a hydrogen fuel cell. Today's hydrogen fuel cell power density is not aligned with the power demands of locomotives, however. Fuel cell systems can be procured in units of 75 to 200 Kilowatt Hours (**KWH**) in today's market. Whereas, a standard line-haul locomotive is powered by 3,300 KWH engines. Stringing 15 to 45 fuel cell systems together is unlikely to provide sufficient reliability to a railroad operator. Thus, fuel cell technology must advance and prove to be reliable in rail operations before operators will adopt the technology.

With respect to CARB's Technology Feasibility Assessment for the Proposed Regulation, Wabtec believes that the design, development, and deployment of alternative propulsion technologies, beyond a Tier 4 diesel-electric heavy-haul locomotive, remain in various phases of pilot and demonstration programs.

B. Interoperability

Interoperability is a major barrier in the technology adoption process. Managing a locomotive fleet with multiple different energy demands (e.g. battery, hydrogen, diesel, electricity, etc.) forces rail operators to invest and maintain different infrastructure for each form of technology. Rail operators also need to ensure each technology stays within reach of the power source. The U.S. rail network moves more than a 6 billion tons of freight a year across nearly 140,000 miles of track between and among 49 states and the District of Columbia. Thus, proximity to rail yards and the associated charging and/or refueling infrastructure required for alternative propulsion technologies may constrain the rail operators ability to power certain locomotives.

C. Charging and Refueling Infrastructure

There are numerous operational variables that must be addressed to seamlessly integrate new locomotive technologies into railroad fleets. Both FLXdrive 2.0 and FLXswitch 2.0 utilize external charging and dynamic braking for battery charging. By way of example, Wabtec estimates for an average 12-hour rail yard shift, the FLXswitch locomotive will need to charge for 4 hours to complete its shift. Wabtec further envisions, in alignment with customers inputs and other suppliers, a wayside charging system for stationary charging with DC input utilizing an off-board reverse pantograph. These charging technologies and the associated infrastructure is still being developed to support battery-electric locomotives

Moreover, infrastructure for refueling of hydrogen locomotives is even more uncertain when compared to battery charging capabilities. With that said, the same operational principles – such as ensuring safe operations, reducing downtime, ensuring close proximity to necessary infrastructure, etc. – must be applied to ensure that this alternative technology is seamlessly integrated into a railroad's operations.

D. Hydrogen Supply in the United States

To support the eventual adoption of hydrogen technology in the rail industry, hydrogen production and distribution infrastructure projects need to accelerate drastically. Producing clean hydrogen from low-carbon energy is costly at the moment. IEA analysis finds that the cost of producing hydrogen from renewable electricity could fall 30% by 2030 as a result of declining costs of renewables and the scaling up of hydrogen production.[9]

In parallel with hydrogen production growth, the development of hydrogen refueling infrastructure that supports locomotive operations also needs to accelerate to ensure the safe adoption of hydrogen by the rail industry and to fully recognize the benefits of this renewable energy.

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[9] International Energy Agency, *The Future of Hydrogen* (June 2019), https://www.iea.org/reports/the-future-of-hydrogen

Considering these factors, hydrogen locomotive technology is not projected to be widely adopted within the next 8-10 years without significant investment in research and development activities by the rail industry. With that said, Wabtec believes that hydrogen powered locomotives are essential to the long-term rail industry roadmap to decarbonization, especially for line-haul operations.

E. Battery Supply Chain Constraints

Today's battery and minerals supply chain primarily depend on China. China produces three-quarters of all lithium-ion batteries and is home to 70% of production capacity for cathodes and 85% for anodes (both are key components of batteries).[10] Today, the United States has a small role in the global battery supply chain, with only 7% of battery production capacity. Most key minerals are mined in resource-rich countries such as Australia, Chile, and the Democratic Republic of Congo, and handled by a few major companies.

Considering current supply constraints in North America, Wabtec made the strategic decision to partner with General Motors (**GM**), a U.S. expert in battery-electric technologies for the transportation sector. Wabtec plans to leverage GM's advanced Ultium Battery Technology for the ruggedized rail environments.[11] The Ultium batteries will be manufactured in the U.S. and designed to handle the environmental, space, and weight considerations for rail application, while maintaining performance, durability, reliability, maintainability, and safe operation of the locomotive.

Although Wabtec's partnership with GM works to mitigate the supply chain challenges discussed above, the production speed and capacity of battery electric locomotives will be greatly affected by the supply of critical minerals impacting the broader EV market. Thus, the deployment of battery-electric locomotives can only ramp up to the threshold that the battery industry can maintain. Based on these supply chain constraints, Wabtec anticipates a potential two- to three-year lead time for new orders, which may be further contingent upon production capacity.

F. Grid Capacity

Charging battery-electric locomotives adds new demands to the electrical grid due to the power needed and the duration of the charge. Put in perspective, the average Tesla has a battery capacity of 0.1 MWH. A single FLXdrive locomotive at 8.1 MWH is the equivalent power of 81 Tesla cars. To maximize efficiency and ensure the continuity of freight operations, locomotives will need to pull high levels of power from local grids in relatively short amounts of time. Ensuring the reliability of the power grid has been a topic

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[10] International Energy Agency, *Securing Clean Energy Technology Supply Chains*, (July 2022) https://www.iea.org/reports/securing-clean-energy-technology-supply-chains

[11] GM Newsroom, *Wabtec and GM to Develop Advanced Ultium Battery and HYDROTEC Hydrogen Fuel Cell Solutions for Rail Industry*, (Jun. 15, 2021), https://news.gm.com/newsroom.detail.html/Pages/news/us/en/2021/jun/0615-wabtec.html.

of critical importance as we discuss the FLXdrive technology with various policymakers and other stakeholders. Moreover, it is a paramount area for further evaluation and assessment as Wabtec's customers look to demonstrate battery-electric locomotive technologies in their operating environments. This evaluation must be conducted in collaboration with local utilities to ensure the compatibility and reliability of their infrastructure with the infrastructure necessary to charge battery-electric locomotives.

The Biden Administration has acknowledged that "the current electric grid was not developed with today's electrification needs in mind."[12] Independent estimates indicate that electricity transmission systems will need to expand by 60 percent by 2030 and may need to triple by 2050 to meet the country's increased renewable generation and electrification needs. In addition, more than 70 percent of the nation's grid transmission lines and power transformers are over 25 years old, creating vulnerabilities during severe weather events. Power outages from severe weather have doubled over the past two decades across the United States and the frequency and length of power failures reached their highest levels since reliability tracking began in 2013 — with U.S. customers on average experiencing more than eight hours of outages in 2020.

These realities underscore the need for further study of the electrical grid's capability to support a full fleet of battery-electric locomotives at various rail locations.

III. Authority to Regulate Locomotive Emissions

As an original equipment manufacturer subject to U.S. EPA's locomotive regulations, Wabtec is concerned that CARB's Proposed Regulation would create an untenable patchwork of state and local regulatory requirements for locomotives. Pursuant to Section 209(e) of the Clean Air Act, Congress preempted state and local governments from adopting or enforcing "any standard or other requirement relating to the control of emissions from . . . new locomotives or new engines used in locomotives."[13] Under its regulations, U.S. EPA established regulations implementing this preemption consistent with Congressional intent to prevent unreasonable burdens on interstate commerce. Moreover, U.S. EPA defined "new" locomotives to include both those newly manufactured and those existing locomotives that are remanufactured or rebuilt.[14]

The North American railroad system is a complex and interconnected network that involves over 500 railroad companies operating over 180,000 miles of track in 49 states, Canada, and Mexico. Locomotive manufacturers and rail operators need the certainty of a uniform regulatory landscape to safely, efficiently, and sustainably move people and goods. Congress and EPA recognized the benefits of a strong federal program to address manufacturing, remanufacturing and in-use compliance of locomotive emissions.

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[12] U.S. Department of Energy, *Biden Administration Launches $2.5 Billion Fund to Modernize and Expand Capacity America's Power*, (May 10, 2022) https://www.energy.gov/articles/biden-administration-launches-25-billion-fund-modernize-and-expand-capacity-americas-power

[13] *See* 42 U.S.C. § 7543(e).

[14] *See* 40 CFR § 1033.901.

Contrary to Congressional direction, U.S. EPA's implementing regulations, and the strong policy interests supporting a federal program for locomotive emissions, CARB's Proposed Regulation would create California-specific locomotive requirements. This would create an undue burden on locomotive manufacturers and rail operators.

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Wabtec appreciates CARB's consideration of the foregoing comments on the proposed In-Use Locomotive Regulation. As discussed herein, over the past several years, the rail industry has made substantial investment in advanced propulsion locomotive technologies, digital technologies to improve the efficiency of its operations, sustainable fuel testing, and modernization of its existing fleet. Wabtec believes that CARB's rulemaking efforts should collaboratively involve the rail industry and its suppliers to address the challenges presented herein. We look forward to continuing to work with CARB and the rail industry on developing the clean energy freight rail network of the future.

Respectfully submitted,

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