Fleet Strategies Memo

January 4, 2021

TAMC

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1. INTRODUCTION

The Transportation Agency for Monterey County (TAMC) has commissioned an analysis to identify potential fleet strategies as part of the Rail Network Integration Study for the Monterey Bay Area/Central Coast. This technical memorandum summarizes the results of this analysis, and describes fleet size needs, technical operating requirements, and fleet procurement strategies for each of the three service concepts (Initial, Phased, and Vision) for the region's future rail network.

Section 2 provides information on the six major goals of this effort and a high-level summary of the methodology for developing fleet strategies. Section 3 describes the fleet needs assessment for Initial Service, Phased Service, and Vision Service. Section 4 describes what technology options are available and the associated opportunities and tradeoffs. Section 5 concludes with a series of recommendations and next steps for implementation.

2. GOALS AND METHODOLOGY

2.1 Goals

There are six major goals of this effort, as described below.

- **Service integration:** The recommended fleet strategies should help establish and strengthen the key travel markets that will serve as the backbone of the region's rail network (e.g., commuter travel to/from Silicon Valley and San Francisco). Train equipment must also meet the technical specifications required for integrated service, including maintaining train slots on shared track without causing disruptions to other services.

- **Emissions reduction:** To minimize the environmental impacts of train operations, train equipment must also meet state emissions goals and standards. In line with State Executive Order N-19-19's goal to achieve a zero-emissions vehicle fleet by 2035, emerging technologies allowing zero-emissions operations without the need for overhead catenary should be monitored for consideration.

- **Regulatory compliance:** Train equipment must meet regulatory requirements, such as crashworthiness specifications issued by the Federal Railroad Administration (FRA).

- **Cost reduction:** The recommended fleet strategies should focus on minimizing capital expenditures to deliver the rail network as efficiently as possible. This includes leveraging procurements with other entities and coordinating procurement strategies with Caltrans.
- **Cost-effective maintenance:** The recommended fleet strategies should ensure that necessary equipment maintenance can be performed in a cost-effective manner. This includes considering how a state of good repair will be maintained throughout equipment life.
- **Phased implementation:** The recommended fleet strategies should also acknowledge that there is no single answer across all planning horizons and functions. This includes aligning fleet strategies with the approach to governance and operations under each service concept (Initial, Phased, and Vision).

2.2 Methodology

The approach to devising fleet strategies consists of five basic steps or components:

- **Service vision:** The service vision describes how service will be established and expanded over time to meet the overall goals and planning parameters. It includes specific service development phases—blueprints of what the service will look like at key stages in its evolution—as well as an associated implementation timeline. This work is documented in the *Future Service Vision Memo*.
- **Technical operating requirements:** Minimum performance specifications and other critical design factors are identified for each service development phase. Potential technology / vehicle options are then evaluated against these requirements to identify areas where there is alignment, as well as any key gaps that would need to be addressed in later stages of implementation.
- **Fleet needs assessment:** Each service development phase is evaluated to determine the minimum number of trainsets required to operate the service (based on assumed frequency and travel time). An additional spare ratio is applied to estimate the total size of the fleet for each phase (per FRA guidelines, 20 percent rounding up to a whole number is generally calculated).
- **Fleet procurement strategies:** For each phase, potential strategies are identified for securing the fleet needed to operate the service. This may include leveraging existing equipment already in service, secondhand purchases, new orders, or coordinating on a joint order with other operators. Key tradeoffs and constraints for each strategy are also identified during this process.

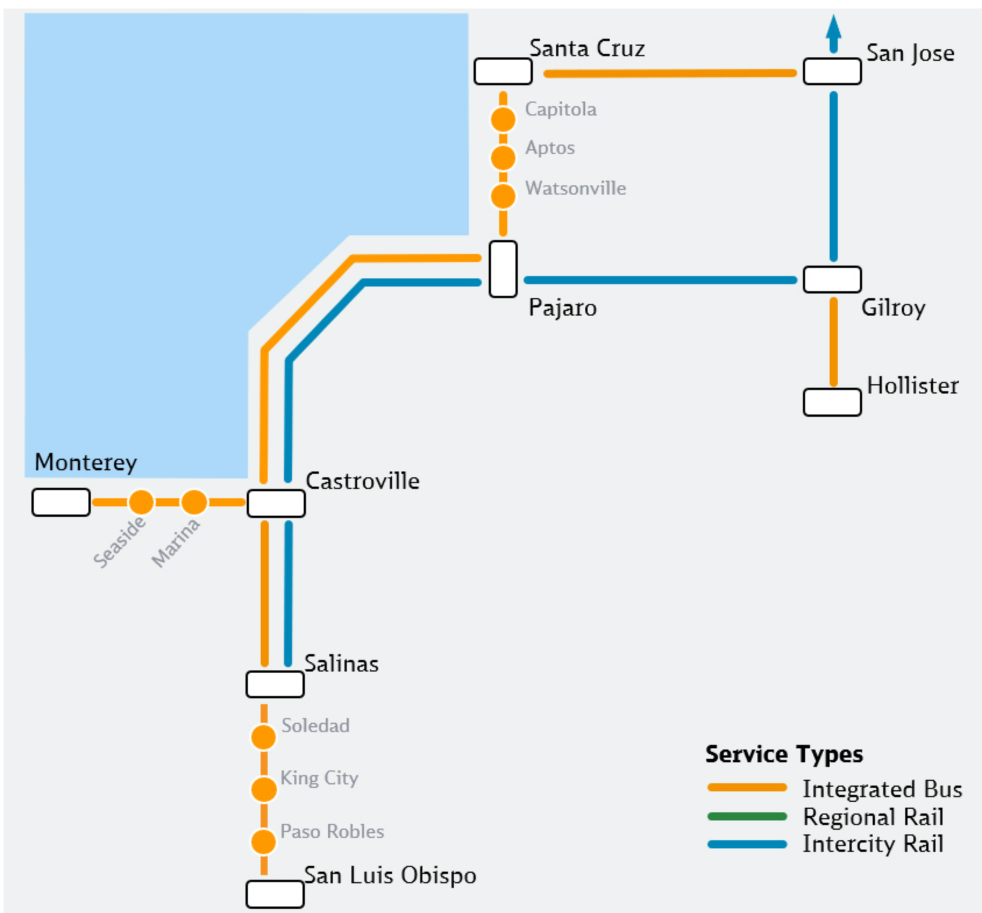
- **Recommendations and next steps:** A final series of recommendations and next steps are identified for moving the implementation plan forward. This may include more detailed analysis in later stages of the project to narrow down preferred options and strategies and to incorporate evolving technologies. Coordination with Caltrans is also identified, where appropriate.

3. FLEET NEEDS ASSESSMENT

3.1 Initial Service

The Initial Service concept is illustrated in **Figure 3.1.1**, which extends current Caltrain service from Gilroy to Salinas.

Figure 3.1.1 – Initial Service Concept



Fleet Size

Prior to the COVID-19 pandemic, Caltrain operated three commute-oriented round trips to and from Gilroy each weekday. The Initial Service concept is achieved by extending these round trips to Salinas. Fleet investment for the Initial Service concept can be minimized through use of existing Caltrain equipment. An operations agreement with Caltrain's governing body—the Peninsula Corridor Joint Powers Board (PCJPB)—would be needed to address funding / reimbursement, operations and maintenance protocols, and other details.

Technical Operating Requirements

Operations must comply with FRA requirements, similar to current Caltrain operations on the San Jose to Gilroy segment, which is owned by Union Pacific Railroad (UPRR) and shared with freight trains.

Maintenance Requirements

Fleet maintenance would be addressed in the operations agreement with PCJPB. As part of utilizing existing Caltrain equipment, general maintenance would be performed by Caltrain at its existing facilities, such as the Centralized Equipment, Maintenance and Operations Facility immediately north of San Jose Diridon Station.

The Initial Service concept also specifies the need for overnight storage tracks for three trainsets at Salinas, similar to the current storage accommodations at Gilroy. TAMC's current Monterey County Rail Extension Phase 1: Kick Start Project includes a six-train layover facility in Salinas that would meet this need.

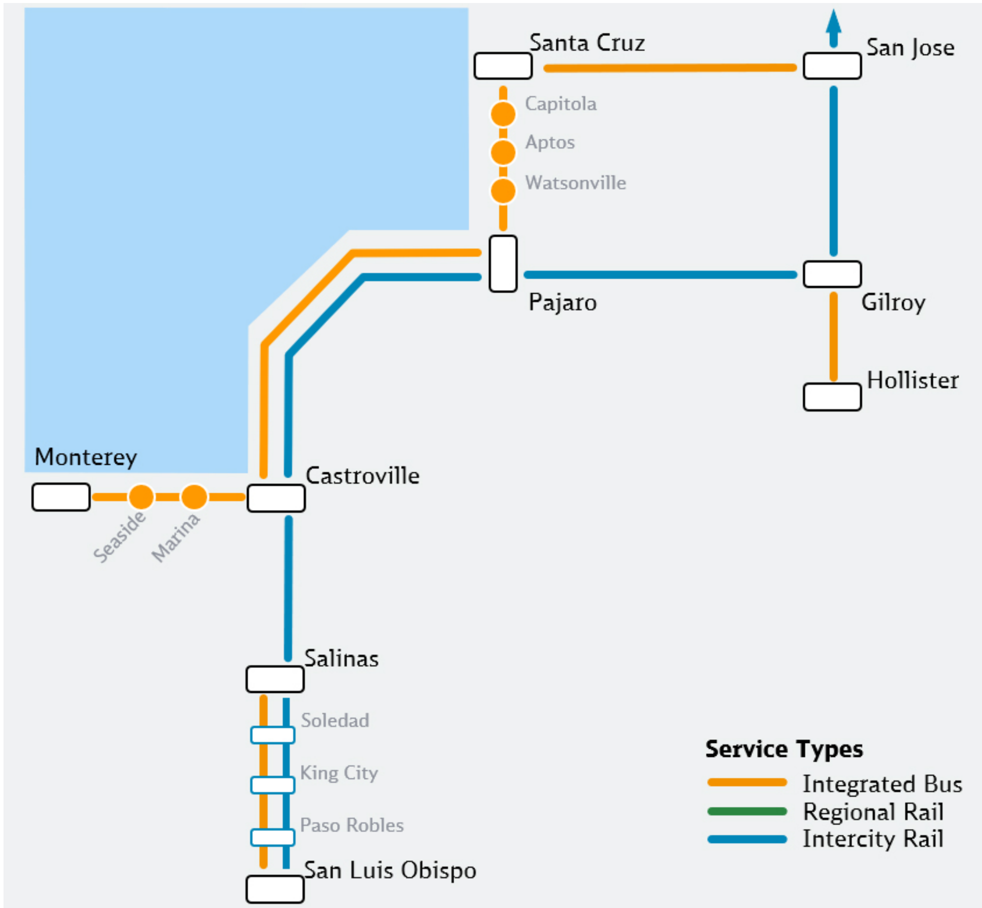
3.2 Phased Service

The Phased Service concept is illustrated in **Figure 3.2.1**, which implements hourly service between Salinas and San Jose, and extends service from Salinas to San Luis Obispo four times daily.

Fleet Size

The Phased Service concept requires a total of six trainsets for day-to-day operations, with an additional two trainsets to provide spares. The number of passenger coaches in each trainset would be determined based on ridership demand. To maximize interoperability and capitalize on economies of scale, the fleet would be shared between service north of Salinas and south of Salinas.

Figure 3.2.1 – Phased Service Concept



Technical Operating Requirements

The Phased Service concept reflects regional policy goals not to force transfers at Gilroy, but rather to allow for blended operations with high-speed rail (HSR) trains between Gilroy and San Jose. As part of future planning and stakeholder coordination, electrification of the Peninsula Corridor, currently underway, could allow blended operations to continue north between San Jose and San Francisco. This strategy identifies equipment needs that will not preclude blended service from future planning conversations. For compatibility, trainsets for the Phased Service concept must therefore be able to maintain identified technical operating slots, which conventional diesel-hauled equipment is incapable of achieving. South of Gilroy, however, the Coast Subdivision is assumed to continue to remain unelectrified, meaning that train equipment would also need to be able to operate on diesel power (or an alternative energy source such as batteries or hydrogen fuel cells) and comply with relevant FRA requirements.

Maintenance Requirements

The six-train Salinas layover facility included in the Kick Start Project would accommodate the additional capacity required for Phased Service. Overnight storage capacity would also be needed for one train in San Luis Obispo. The expanded operating requirements would necessitate new or leased equipment, from an operator or from the State, which would require a new or expanded maintenance facility.

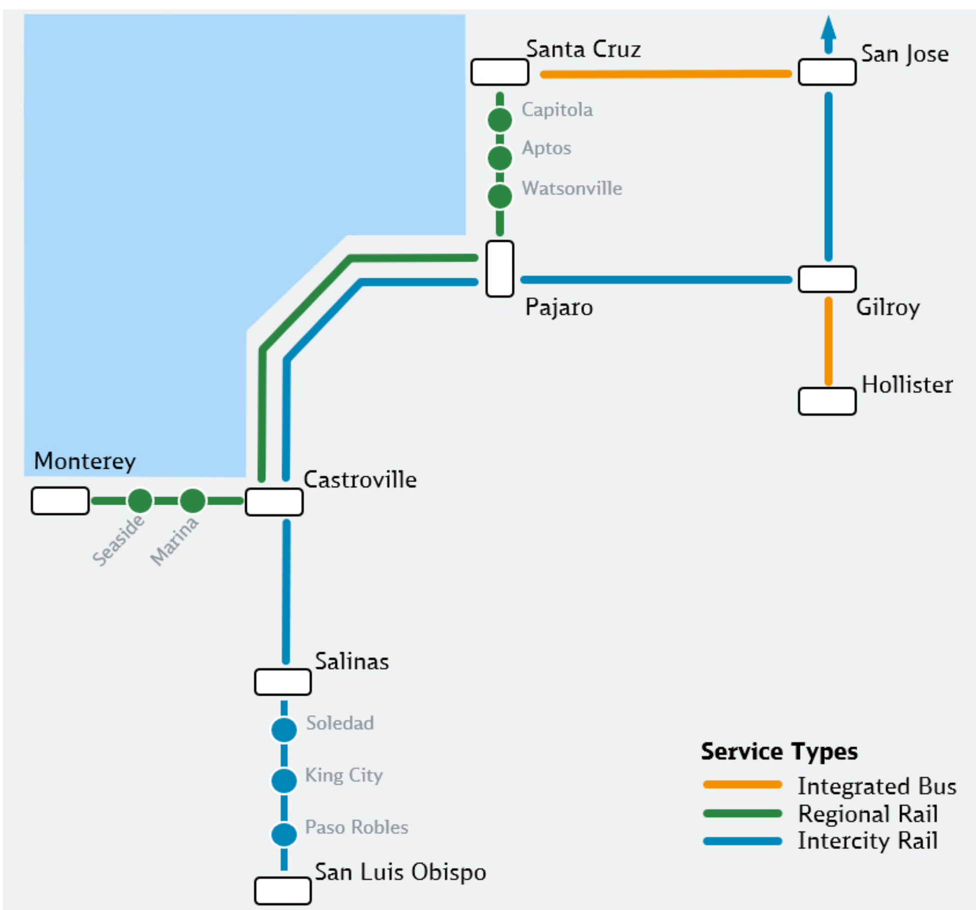
Fleet Procurement Strategy

Given the relatively small size of the Phased Service fleet, joint procurement opportunities should be explored to maximize cost efficiencies.

3.3 Vision Service

The Vision Service concept is illustrated in **Figure 3.3.1**, which increases intercity service between Salinas and San Luis Obispo to eight daily round trips and introduces hourly regional rail service between Santa Cruz and Monterey.

Figure 3.3.1 – Vision Service Concept



Fleet Size

For mainline intercity service, the Vision Service concept requires an additional trainset (for a total of seven) for day-to-day operations, plus the additional two trainsets to provide spares. For the regional service between Santa Cruz and Monterey, four trainsets are required for day-to-day operations, plus one spare. As for the Phased Service concept, the number of passenger compartments or coaches composing each trainset would be determined according to ridership demand.

Technical Operating Requirements

For intercity rail, technical operating requirements would be as described under the Phased Service concept. For regional rail, the vehicle type would need to satisfy a variety of requirements reflecting the diverse running environments along the route. For the mainline segment between Pajaro and Castroville, for example, the trainsets must meet UPRR requirements. For the Monterey and Santa Cruz Branch Lines, however, the trainsets would also need to be smaller-scale (such as single-level multiple-unit trains), compatible with operations through developed communities—including potential street-running (e.g., near the Santa Cruz Boardwalk)—and capable of operating without overhead catenary, which branch line communities wish to avoid.

Maintenance Requirements

For intercity rail, maintenance requirements would be as described under the Phased Service concept, except that overnight storage tracks for three trainsets would be needed at San Luis Obispo. For regional rail, a new storage and maintenance facility would be required for the new equipment.

Fleet Procurement Strategy

Similar to the Phased Service concept, the relatively small size of the fleet means that joint procurement opportunities should be explored where feasible to maximize cost efficiencies.

4. FLEET TECHNOLOGY OPTIONS

4.1 General Approach

Four potential fleet technology options have been identified for implementation of the Monterey Bay Area rail network, reflecting the operating context and technical requirements of each of the three proposed service concepts:

- Conventional diesel-hauled
- Bi-mode / hybrid
- Diesel multiple unit (DMU)
- Electric multiple unit (EMU)

Each technology option has been evaluated against a series of characteristics and criteria to identify the key opportunities and tradeoffs of each option. The following characteristics and criteria were selected for this evaluation:

- Power source
- Current operating precedent in California
- FRA compliance
- Operability without overhead catenary
- Equipment scale and compatibility with street running

The results of this assessment are summarized in matrix form in **Table 4.1.1**.

Table 4.1.1: Matrix of Fleet Technology Options

Evaluation criteria / characteristic	**Fleet Technology Option**			
	Conventional Diesel-Hauled 	**Bi-mode / Hybrid** 	**Diesel Multiple Unit (DMU)** 	**Electric Multiple Unit (EMU)** 
Power source	Diesel	Diesel, Electric	Diesel	Electric
Currently operated in California	Yes	No	Yes	Pending
FRA compliant	Yes	Depending on body type	Depending on body type	Depending on body type
Can operate without overhead catenary	Yes	Yes	Yes	No, but equipment not requiring catenary is under development
Smaller-scaled equipment / street running compatible	No	No	Yes	Depending on body type

<u>Legend</u>
= Fully meets goals and operating requirements
= Partially meets goals and operating requirements
= Does not meet goals and operating requirements

4.2 Tradeoffs Analysis

4.2.1 Conventional Diesel-Hauled

Conventional diesel-hauled equipment is the de facto technology choice for most intercity and commuter rail service in California, as well as throughout North America. Trainsets consist of a series of unpowered passenger coaches coupled to one or more diesel-powered locomotives, usually in a "push" or "pull" configuration (for a locomotive in the lead or end position, respectively). Examples within Northern California include Caltrain (as shown in **Figure 4.2.1**), Capitol Corridor, Altamont Corridor Express (ACE), and the San Joaquins.

Figure 4.2.1 – Conventional Diesel-Hauled Equipment

With low infrastructure needs, conventional diesel-hauled equipment is well-suited to mainline railways in North America, most of which are not electrified and frequently shared with freight trains. Compared to more investment-intensive options, conventional diesel-hauled equipment can be rolled out quickly by capitalizing on existing infrastructure and maintenance facilities. Within the last 15 years, there have been numerous examples of new startup service across the United States using diesel-hauled equipment, including the FrontRunner (Salt Lake City / Ogden / Provo), New Mexico Rail Runner Express (Albuquerque / Santa Fe), Trinity Railway Express (Dallas / Fort Worth), the Northstar Line (Minneapolis), the Music City Star (Nashville), SunRail (Orlando), and Tri-Rail (Miami / Fort Lauderdale / West Palm Beach).

As such, there is an extensive market of off-the-shelf equipment from multiple manufacturers, as well as increased opportunities to purchase secondhand equipment or enter into joint procurements both within and outside of the state. In particular, services that would be integrated with the region's rail network (e.g., Caltrain, Coast Starlight), already use diesel-hauled equipment.

However, there are several key tradeoffs associated with conventional diesel-hauled equipment, such as greenhouse gas emissions. While there has been rapid advancement in low-emissions (EPA Tier 4) designs and alternative fuels (e.g., biodiesel), these technologies can only go so far in meeting the state's ambitious greenhouse gas emissions goals.

In addition, the large profile of conventional diesel-hauled equipment makes them challenging to integrate into urban settings designed for pedestrians and mixed uses. While there are some examples of street-running in operation today, such as near Jack London Square in Downtown Oakland, these are almost exclusively legacy alignments, and diesel locomotives are generally not compatible with street running operations.

4.2.2 Bi-mode / Hybrid

Bi-mode / hybrid equipment is a dual-powered solution using diesel and electric traction for services operating on both unelectrified and electrified track. Trainsets can operate on diesel by default but are also equipped with pantographs and other necessary systems to allow them to switch to electric traction where overhead catenary is installed. As electrified mainline railways are rare in North America, there are only a few examples of services currently in operation using bi-mode / hybrid locomotives—New Jersey Transit (as shown in **Figure 4.2.2**) and Montreal's Exo draw power from overhead catenary, while New York's Long Island Rail Road and Metro-North Railroad draw power from a third rail.

Figure 4.2.2 – Bi-mode / Hybrid Equipment

The primary benefit of bi-mode / hybrid equipment is the ability to provide a "one-seat ride" across both electrified and unelectrified corridors. In New Jersey Transit's case, for example, the equipment is used extensively on unelectrified branch lines to provide direct service through the electrified North River Tunnels to and from Pennsylvania Station in New York City. In the case of the Monterey Bay Area, the technology could allow trains from the Central Coast to operate to the San Francisco Bay Area using electrified high-speed rail infrastructure, avoiding a forced transfer at Gilroy.

As there are currently no electrified mainline railways in service in California, however, there is no existing experience with bi-mode / hybrid equipment within the state. As a result, procurement and maintenance may have cost and schedule implications beyond those of more conventional technology choices. In addition, FRA compliance is not a given, and waivers or special rulings may be necessary before the equipment can be operated.

Because of the limited customer base for the technology, it may also be difficult to secure competitive bids from manufacturers or take advantage of joint procurement opportunities. A lack of manufacturers and off-the-shelf models may also put the service at risk of vendor lock. The equipment used on New Jersey Transit and Exo, for example, was supplied by the same manufacturer (Bombardier).

Similar to conventional diesel-hauled equipment, the large scale of locomotives and coaches also present challenges for integration into urban settings, and bi-mode / hybrid equipment is generally not compatible with street running, potentially making them poorly suited for the Santa Cruz and Monterey Branch Lines.

4.2.3 Diesel Multiple Unit (DMU)

Like conventional diesel-hauled trains, diesel multiple units (DMUs) rely on diesel as a power source, but apply it in a distributed fashion. Each unit typically consists of one or more compartments or cars functioning as a single, self-propelled vehicle. Units can then be coupled together into larger consists. Multiple unit trains offer several advantages over locomotive-hauled trains, including better energy efficiency and acceleration (suited for lines with closely-spaced stops) and enhanced operational flexibility, with the ability to easily couple/decouple units mid-route (e.g., at branch line junctions) and tailor consist length to passenger demand.

DMUs have existed since the early 20th century but have enjoyed a recent resurgence in North America as a cost-effective alternative to light rail, as well as being suitable for commuter rail applications. Examples in California include Sonoma–Marin Area Rail Transit (SMART, shown in **Figure 4.2.3**), eBART (eastern Contra Costa County), SPRINTER (northern San Diego County), and the under-construction Arrow (San Bernardino County).

Figure 4.2.3 – Diesel Multiple Unit (DMU) Equipment

The versatility of DMUs allows for adaption to many different operating environments. They are a popular choice for regional / commuter rail service on mainline railways shared with freight, with both heavier, FRA-compliant designs (e.g., SMART or WES Commuter Rail near Portland, Oregon) and lightweight, non-FRA-compliant designs (e.g., SPRINTER or TEXRail in Fort Worth). The FRA has granted waivers for non-compliant designs if there is time separation between freight and passenger trains, in combination with other operating protocols and design features. Crash energy management and other design principles can also reduce vehicle weight and track wear while maintaining crashworthiness.

With superior performance relative to locomotive setups, DMUs can also be found in more contexts with higher service frequencies and / or closer station spacing, such as eBART or New Jersey Transit's River Line, which operate as frequently as every 15 minutes. Their smaller vehicle profile also makes DMUs suited to urban environments, and there are several examples with street running (more typically found in light rail systems), including Austin's Capital MetroRail, WES Commuter Rail, and the River Line.

In recent years, DMU manufacturers have increasingly offered equipment with modular technology that allows diesel components to be replaced with battery power or hydrogen fuel cells to achieve zero-emissions operations without the need for overhead catenary. The technology has also been adapted to permit hybrid battery–catenary operations on partially-electrified routes.

4.2.4 Electric Multiple Unit (EMU)

Like DMUs, electric multiple units (EMUs) rely on a distributed power model but use electricity instead of diesel as a power source. EMUs offer many of the same benefits as DMUs when compared to locomotive-hauled trains, but also allow for zero-emissions and better energy efficiency compared to DMUs. Mainline EMUs are common outside of North America, where electrification is more widespread, but there are some examples in the United States, including legacy systems in New York (Metro-North Railroad, Long Island Rail Road, and New Jersey Transit), Philadelphia (SEPTA), and Chicago (Metra's Electric District and NICTD's South Shore Line), as well as Denver RTD's new commuter rail lines.

California's first mainline EMUs will be rolled out for Caltrain's electrification between San Francisco and San Jose (as shown in **Figure 4.2.4**). Light rail and subway / metro trains are also technically EMUs, although they are usually categorized separately from mainline EMUs.

Figure 4.2.4 – Electric Multiple Unit (EMU) Equipment

Electricity for mainline EMUs is usually supplied through overhead catenary systems, although several legacy systems use third rail technology (e.g., Long Island Rail Road, Metro–North Railroad). Overhead catenary requires a system of support masts and wires that have a visual impact, but these can be designed with a less intrusive aesthetic if desired. Recent innovations have also demonstrated the feasibility of hybrid battery-powered EMUs on routes without or with limited overhead catenary.

FRA-compliant EMUs typically feature heavier train bodies (e.g., Denver RTD) to meet crashworthiness specifications. Caltrain, however, opted for an FRA waiver for lightweight EMUs through temporal separation from freight trains. However, this equipment will not be able to operate on the unelectrified portions of the Coast Subdivision.

Because mainline railway electrification is not widespread in the United States, procurement and maintenance expertise is more limited than for conventional diesel-hauled trains or DMUs, and the market for competitive bidders and models may be smaller. Specifications may be heavily tailored to each operator, although both SEPTA and RTD use variants of the single-level Hyundai Rotem Silverliner model.

Joint procurement with or tiering from Caltrain's EMUs makes logical sense for compatibility and interoperability reasons, but the large scale of bi-level EMUs makes them challenging to integrate into urban environments and ill-suited to street running. However, smaller-scale equipment such as single-level EMUs are more similar to light rail trains and can be integrated relatively easily into urban contexts and street running (e.g., South Shore Line).

5. RECOMMENDATIONS

5.1 Initial Service

TAMC's fleet strategy to implement the Initial Service concept revolves around leveraging existing conventional diesel-hauled equipment already in use by Caltrain for its operations between Gilroy and San Francisco. To extend the three commute-period round trips each weekday south of Gilroy to Salinas, TAMC would pursue an agreement with Caltrain (specifically, the Peninsula Corridor Joint Powers Board) for contracted operations, allowing the Initial Service concept to be implemented relatively quickly and with minimal investment in infrastructure. Funding arrangements, operating protocols, and other details would be determined in negotiation with PCJPB.

5.2 Phased Service

For the Phased Service concept, bi-mode / hybrid equipment would be required to achieve strategic policy goals, implement all-day bi-directional service, and not force transfers at Gilroy. Hybrid or battery-powered multiple units could also achieve these goals, if the technology can support operations between San Luis Obispo and Gilroy without catenary (or in limited locations, such as at stations) and if the equipment meets FRA requirements.

Alternatively, service could be provided with conventional diesel-hauled equipment but would require transfers and additional travel time for passengers, with capacity and operating constraints north of Gilroy. In addition, the regulatory environment may become increasingly averse to diesel-based equipment, and the emissions performance of diesel-hauled trains may affect the ability of TAMC to obtain funding. For example, the Caltrans Division of Rail and Mass Transit has identified a preliminary goal to achieve a fully zero-emissions intercity rail fleet by 2035. This could be accomplished through engine upgrades and an intermediate switch to renewable diesel by 2025, followed by a final switch to hydrogen fuel cells as the primary power source (with batteries or overhead catenary as a secondary power source for hybrid trains) by 2035.

Additional analysis, discussion, and coordination is needed in the future to identify a preferred fleet strategy for the Phased Service concept.

5.3 Vision Service

For the Vision Service concept, single-level, multiple-unit trainsets—whether DMU, hydrogen fuel cell, battery-powered multiple units, or some other variant—are best suited for the "around the bay" service on the Monterey and Santa Cruz Branch Lines. Their smaller size and flexibility allows them to operate on both the Coast Subdivision mainline between Pajaro and Castroville (where they will share trackage with regional / intercity trains and UPRR's freight trains), as well as through existing communities along the branch lines, in urban contexts that may include street running, without the need for overhead catenary systems.

In late 2020, the Santa Cruz County Regional Transportation Commission identified "electric passenger rail" as the locally preferred alternative in its Transit Corridor Alternatives Analysis along the Santa Cruz Branch Line. Neither electric commuter rail nor electric light rail is recommended, deferring this decision to the preliminary engineering and environmental analysis phase to maintain flexibility for future decisions on the rail vehicle type. Therefore, similar to the Phased Service concept, additional analysis, discussion, and coordination is needed in the future to identify a preferred fleet strategy for the Vision Service concept.

5.4 Future Considerations

Given the pace of change in policy (e.g., FRA rules and regulations, state emissions goals) and technology, it is not yet necessary and would even be premature to make a decision now that may constrain future options under later service phases (i.e., Phased Service and Vision Service). For these phases, TAMC will continue to monitor the situation, undertaking additional analysis, discussion, and coordination as appropriate.

Particularly with respect to Executive Order N-19-19 to transition to zero emissions by 2035, there is still significant development and testing before non-catenary zero-emissions technology becomes widespread as a primary power source in mass-production units. For the state-owned fleet and intercity services, Caltrans' current thinking is that hydrogen offers the best chance at zero emissions, given the need to operate on unelectrified tracks. Multiple units powered by hydrogen fuel cells, such as Alstom's Coradia iLINT (as shown in **Figure 5.4.1**), are already carrying passengers in Germany. The fleet strategies in this memo, however, do not preclude the use of hydrogen or other zero-emissions technologies, but rather defer the selection of specific energy sources until such time that a final decision is appropriate.

To help lay the groundwork for a hydrogen-based fleet, TAMC could offer to participate in a pilot program with potential manufacturers to test prototype or early-production hydrogen multiple unit trainsets on the Santa Cruz and Monterey Branch Lines. Similar trials with other technologies and elsewhere in the state could serve as a catalyst in the development of mass-production zero-emissions trainsets for use in California.

Figure 5.4.1 – Hydrogen Fuel Cell MU Equipment