The Oakland International Airport-BART Connector Project

Douglas Mansel*, Kristi McKenney**, and Dennis Gillespie***

*Aviation Planner, Port of Oakland, 530 Water Street, Oakland, CA 94607; PH 510-627-1335; FAX 510-835-0178; dmansel@portoakland.com
**Aviation Planning Manager, Port of Oakland, 530 Water Street, Oakland, CA 94607; PH 510-627-1178; FAX 510-835-0178; kmckenne@portoakland.com
***Vice President/Director of Planning, HOK Aviation, 1425 Clay Street, Oakland, CA; PH 510-287-8461; FAX 510-287-8462; dennis.gillespie@hok.com

Abstract

The Port of Oakland (Port), which owns and operates Oakland International Airport, and the San Francisco Bay Area Rapid Transit District (BART) have undertaken an effort to improve the transit connection between Oakland International Airport and the Coliseum BART Station, replacing the existing AirBART shuttle bus service. This improved transit connection, envisioned to be an automated people mover (APM) system, would interface with the proposed new terminal complex at the Airport, which is currently in the planning and schematic design phase.

The paper discusses possible APM station locations in the proposed new terminal complex and evaluates each from a customer service perspective (walking distances, level changes, indoor versus outdoor/covered stations, etc.). The paper also discusses other planning considerations, such as airport security issues associated with possible APM rights-of-way and station locations.

Introduction

For more than 30 years, transportation planners have envisioned some type of automated transit connection making the 4.8-kilometer (3-mile) connection between Oakland International Airport and the Coliseum BART Station. AirBART shuttle buses have served the route since 1980. The Alameda-Contra Costa Transit District also operates local buses along the route (Line 58). BART, in association with the Port, is currently in the planning and preliminary engineering stages of the Oakland International Airport-BART Connector (the Connector), and is preparing an Environmental Impact Report/Statement for the project.

Simultaneously, the Port is undertaking planning and engineering for a major terminal expansion program, including a new consolidated terminal building, 12 new aircraft gates, an elevated departures roadway, and other passenger amenities. While planning and design of the terminal expansion program is underway, Port and BART staff have been working together to integrate the Connector’s Airport Terminal Station with the proposed new terminal complex.

Overview of Oakland International Airport

Oakland International Airport is located in Oakland, California, in the heart of the San Francisco Bay Area. It is owned and operated by the Port. In calendar year 2000, the Airport served 10.6 million annual passengers (enplanements plus deplanements, including connecting passengers),
97% of which were originating or terminating passengers. In calendar year 2001, the Airport is expected to serve well over 11 million annual passengers. As shown in Figure 1, the Airport has two terminals, with 22 aircraft gates (with two additional gates under construction) and 7,950 on-Airport parking spaces. The Airport has four runways and is currently served by 12 airlines.

Figure 1. Aerial perspective, Terminals 1 and 2, Oakland International Airport

Figure 2 shows the existing terminal area in plan view in more detail. Buildings M-101, M-102, M-103, and M-114 form Terminal 1 and its concourse; building M-130 forms Terminal 2 and its concourse. Building M-152 connects Terminals 1 and 2. Buildings M-112 and M-106 form an air cargo complex, and building M-104 is the central utility plant.

Proposed Terminal Expansion Program

The existing terminal complex at the Airport (Terminals 1 and 2) was originally designed to accommodate about 7 million annual passengers at a reasonable level of service. (Level of service for airport terminal buildings is a relative measure of comfort in various queuing/waiting areas and in walking corridors. For example, the International Air Transport Association (IATA) has developed relationships between level of service (A, B, C, D, E, and F) and occupancy (square meters per occupant) for various components of an airport terminal building, such as ticketing lobbies, gate holdrooms, baggage claim areas, etc.) As described above, Terminals 1 and 2 are currently accommodating in excess of 10 million annual passengers at a significantly reduced level of service. (For example, the ticketing lobbies in Terminals 1 and 2 currently function at level of service F, with an average of only 0.3 square meters (3.2 square feet) per passenger during peak periods. According to IATA level of service relationships, 2.3 square meters (25 square feet) per passenger would be required to provide a level of service B during peak periods.)
To meet the growing airline passenger demand, the Port has undertaken a terminal expansion program. The Port and its prime consultant, the Master Architect Joint Venture (which includes HOK, KPa Consulting Engineers, Kwan/Henmi Architecture/Planning, and Powell & Partners) studied over 10 concepts to expand and consolidate the Airport passenger terminals. Although the Board of Port Commissioners has not yet made a final decision, the recommended scheme, which is still under refinement, is illustrated in Figure 3. Note that the concourse of Terminal 1 (M-103) and Terminal 2 (M-130) is proposed to remain (in a remodeled and/or reused condition) under the proposed scenario.
Transit Access to Oakland International Airport

According to the Port’s November 2000 airline passenger survey, about 11% of airline passengers use public transportation modes to access Oakland International Airport (including privately-operated scheduled buses and vans, shared-ride door-to-door vans, Alameda-Contra Costa Transit District buses, and AirBART buses). According to Port data for calendar year 2000, almost 5.4% of airline passengers used AirBART buses to travel between the Coliseum
BART Station and the Airport. In January 2001, almost 6% of airline passengers used AirBART. Of all U.S. airports with shuttle bus to regional rail connections, only Boston-Logan International Airport has a higher shuttle bus to rail ridership (approximately 7.1%, based on a 1999 airline passenger survey) than AirBART. AirBART buses operate on 15-minute headways from 6 AM to 12 AM on weekdays and from 8 AM to 12 AM on weekends. One-way travel times vary between 10 and 20 minutes, depending on time of the day and associated traffic conditions.

While AirBART ridership continues to grow (at a faster rate than airline passengers), the bus system faces serious challenges as traffic congestion grows along the route between the Coliseum BART Station and the Airport, including Interstate 880 and Hegenberger Road. Further, during peak periods at the Coliseum BART Station and Airport, the number of riders that accumulate between consecutive buses often exceeds the capacity of a single bus (i.e., riders must wait for the next bus). Although the Port adds buses to the AirBART route during peak periods (reducing headways), demand may still exceed capacity (i.e., passengers may still have to wait for the next bus) because of the volume of passengers that exit a 10-car BART train (with a capacity of 1,080 riders) or arrive on flights at the Airport in the same general period.

**Proposed Oakland International Airport-BART Connector Project**

The Connector, which is envisioned to be an APM system without vehicle and pedestrian at-grade crossings, would bypass traffic congestion along the route between the Coliseum BART Station and the Airport, providing airline passengers and employees quicker and a more reliable travel time. One-way trip time (assuming no intermediate stops between the Coliseum BART Station and the Airport, which is discussed below) is anticipated to be approximately 7.8 minutes (including in-vehicle plus average waiting time).

**Ridership.** BART and the Port anticipate the Connector will transport over 10% of airline passengers to and from the Airport due to factors such as (1) reduced travel time between the Airport and Coliseum BART Station, (2) increased travel time reliability, and (3) the anticipated ease of use provided by “seamless” transfers at the Coliseum BART Station (to/from BART trains) and Airport (to/from the terminal building). For comparison purposes, the U.S. airport with the largest share of rail ridership is Reagan Washington National, where approximately 14% of passengers use rail (based on a 1997 airline passenger survey). At both Hartsfield Atlanta International and Midway (Chicago) airports, about 8% of passengers use rail (based on 1997 and 1994 airline passenger surveys, respectively).

**APM System Procurement.** To achieve a reasonable level of competitiveness during procurement, BART is planning the Connector alignment and stations with enough flexibility so that the system can be procured under a design, build, operate, and maintain (DBOM) arrangement. Some components of the project, such as the interface between the Connector’s Airport Terminal Station and the new parking garage, may need to be designed and/or constructed outside of the DBOM arrangement. In these cases, the designs would be flexible enough to accommodate a wide range in APM technologies.

**Guideway and support facilities.** The planning for the Connector at the Airport assumes that the system will be configured as a dual-lane, pinched-loop shuttle between the Coliseum BART
Station and the Airport. For the majority of the right-of-way, it is assumed that two elevated tracks will be combined along their entire length in one guideway structure, two beams supported on a single center column, except for a short tunnel section under Doolittle Drive (State Route 61) and an at-grade portion (without at-grade vehicle or pedestrian crossings) along the east side of Airport Drive. (Along this portion of the route, elevated guideway would violate height limitations imposed by airspace requirements for flight operations on Runway 27 Left and Runway 27 Right.) At Connector stations, the tracks will divide on either side of a center passenger load/unload platform. The guideways will include crossover sections at selected locations to allow for shifting of APM cars from one track/beam to the other (i.e., to allow for pinched-loop and bypass operations).

To make the Connector system more affordable, BART is exploring options to initially construct a single-lane, bypass shuttle system, with the ability to add a second track/beam as ridership and the need for additional capacity grow. Other options for expanding the capacity of a single-lane, bypass shuttle system, were explored and rejected. For example, one method to increase capacity of a single-lane, bypass shuttle system is to add cars to APM trains. However, due to the space constraints in the Airport terminal area and along the Connector route, longer station platform lengths cannot be accommodated for longer APM trains.

System maintenance facilities and additional APM car storage is assumed to occur at or near the Coliseum BART Station end of the Connector system.

**Horizontal and Vertical Alignment.** During the design of the Airport Drive improvement project (the main entrance/exit roadway to/from the Airport), the Port established a 10.7-meter (35-foot) wide Connector right-of-way, parallel and east of Airport Drive between Doolittle Drive (State Route 61) and the planned new Air Cargo Road/Airport Drive interchange. At the time that this Connector right-of-way was established, the exact location and layout of the future terminal complex was not known. The Connector right-of-way was intentionally terminated at the Air Cargo Road interchange to provide flexibility for the future alignment from Air Cargo Road to the final location of the proposed station within the terminal expansion program.

Horizontal alignment is controlled by the desired design speed and required turning radii for the specific APM system selected. BART provided general guidance that (1) a turn radius of 259.1 meters (850 feet) was desired for the guideway on approach to the terminal where APM cars would be traveling at full design speed, and (2) a minimum turn radius of 76.2 meters (250 feet) was desired near the station where APM cars would be either decelerating for entry into or accelerating for exit from the station. Turn radii shorter than those desired can be accommodated if necessary, but would result in a reduction in design speed, which would affect the travel time between the Coliseum BART Station and the Airport, degrading overall level of service and possibly reducing ridership.

Vertical alignment is controlled by the vertical curve requirements of each individual APM system design. If possible, vertical and horizontal transitions should not be combined. That is, all vertical transition in the guideway should occur on tangent sections of guideway, not on horizontal curves; all horizontal curves should occur on a level datum. A general criterion guiding the planning is that the underside of structure for the Connector guideway should maintain 5.2 meters (17 feet) clear where the guideway passes over any roads or parking lots, in order to provide full accessibility for trucks and emergency vehicles that need access throughout the Airport. Most APM systems require approximately 1.5 to 2.1 meters (5 to 7 feet) vertical depth for the guideway structure; therefore, the top of guideway should maintain a vertical height
of approximately 6.7 to 7.3 meters (22 to 24 feet) above the ground surface within the terminal area, in order to not restrict flexibility for vehicular movement below the guideway.

Intermediate Stations. The Port, BART, and the City of Oakland are examining the possibility of constructing two intermediate stations between the Coliseum BART Station and the Airport Terminal Station: one near the intersection of Hegenberger Road and Edgewater Drive, and the other near the intersection of Hegenberger Road and Doolittle Drive (State Route 61). The one-way trip time between the Coliseum BART Station and the Airport Terminal Station with these two intermediate stations is estimated to be approximately 9.5 minutes (in-vehicle plus average waiting time), assuming a dual-lane, pinched-loop APM system (1.7 minutes longer than without stops at the intermediate stations). These intermediate stations would serve business and hotel developments along Hegenberger Road. They would be full BART stations with BART fare collection equipment, restrooms, and station agent booths, allowing a direct platform-to-platform transfer to and from the larger BART trains at the Coliseum BART Station without further fare collection.

Airport Terminal Station. The Airport Terminal Station is envisioned to be an outdoor, open-air station with a pedestrian canopy covering the platform and BART fare collection plaza, similar to other mainline stations within the BART system. The station is intended to accommodate two berthed trains. Each train could include up to three APM cars, each approximately 10.7 meters (35 feet) in length. The minimum outside dimensions for the station plan are approximately 16.8 meters (55 feet) wide by 76.2 meters (250 feet) long.

A traction power substation would be required in the vicinity of the Airport Terminal Station. APM propulsion power will likely be provided by BART and carried within the guideway structure, while electric power and other utilities serving the Airport Terminal Station will likely be connected to the Airport’s utility network.

BART’s objective is to operate the Airport Terminal Station as an entry into the BART regional rail transit system, requiring BART fare collection systems at the Airport, allowing direct platform-to-platform connection to the larger BART trains at the Coliseum BART Station without further fare collection. Requiring BART fare collection at the Airport would provide a seamless connection to the BART regional rail transit system, but limits the flexibility to use the Connector for transport of airline passengers free-of-charge between the new terminal building and other on- or off-airport facilities such as remote parking lots or rental car facilities.

Integrating an APM station into the Terminal Expansion Program

Integrating an APM station into the terminal expansion program presents significant challenges. Both the Port and BART want the Airport Terminal Station to be conveniently located so that the Connector is competitive with other ground transportation modes serving the Airport (e.g., private automobiles, taxicabs, shared-ride door-to-door vans, etc.). Additionally, the Port requires that the station and guideway structures not restrict other necessary Airport functions and objectives, such as flexibility for future terminal expansion. Objectives for integrating the station with the terminal expansion program included:

- Minimizing the need for passengers to make vertical transitions (via escalators, elevators, and/or stairs)
- Eliminating the need for passengers to cross active roadways (at-grade)
- Minimizing walking distances
- Locating the station with a direct connection to the terminal’s security checkpoint (given that approximately 48% of airline passengers using the Airport have only carry-on baggage, and upon arriving at the Airport, would bypass the ticket counter lobby and proceed directly through the security checkpoint to the aircraft gates)
- Locating the station as close or closer to the entrance to the new terminal building as the most convenient parking space in the adjacent parking garage

Early concepts for the terminal expansion program showed the Airport Terminal Station abutting the new terminal building at the ticketing lobby level (Figure 4). However, the Port (through an airport peer review process) identified that this placement restricts future expansion of the new terminal building towards Terminal 2 (M-130). More recent terminal expansion concepts show the Airport Terminal Station abutting the parking garage at its fifth level, adjacent to the pedestrian bridge over the upper/departures level roadway (Figure 5). This pedestrian bridge connects with the new terminal building one level above the ticketing lobby in the vicinity of the security checkpoint. Although the Airport Terminal Station is shown adjacent to the parking garage in Figure 5, Port and BART staff will continue to explore and refine its location, taking into account many considerations, as the terminal expansion program proceeds through design.

**Figure 4. Airport Terminal Station Abutting New Terminal Building**
Figure 5. Airport Terminal Station Abutting Parking Garage
Other considerations for integrating the Airport Terminal Station with the terminal expansion program included the following items.

**Structural Separation.** Elevated APM stations in California have structural and seismic design requirements that are different from parking garage structures. So as not to burden the design of parking garage with additional seismic stability requirements (and additional cost) not otherwise required, an important objective of planning for the Connector was to provide physical separation between the structures. In addition, building design code requirements consider transit stations to be a different occupancy classification than parking garages, and require physical fire separations between the two types of occupancy, if combined within the same structure. Physical separation of the proposed open-air Airport Terminal Station from the parking garage allows each structure to be designed to meet its specific requirements in the most cost-efficient manner possible.

**Construction Phasing Coordination.** Another key consideration for locating the Airport Terminal Station and guideway alignment at the Airport was the recognition that two separate public agencies are responsible for implementing the terminal expansion program and the Connector system construction, the Port and BART respectively. Each agency has separate governing authorities, funding sources, project implementation schedules, and risks that could result in project delay. It was determined early in the planning for the Connector that a location for the station and alignment for the guideway should be developed that would allow the Connector to be implemented completely separately from the new terminal complex and other Airport construction projects. While the objective of both agencies is to integrate the two projects into a common implementation schedule, the development of the terminal complex could not be dependent on the Connector’s planning, funding, design, or construction schedule.

Since the Airport Terminal Station is located between the parking garage and curbside roadways, and because the Connector guideway must cross the outbound roadway system, it may be difficult to construct the Airport Terminal Station and portions of the guideway subsequent to the garage and roadway system (should constructing the Connector at a later time ultimately be required). Certain elements, such as footings and piles, may need to be constructed as part of the garage and/or roadway system, separately from BART’s DBOM contract.

**Security considerations.** The face of the parking garage structure is being planned to remain at least 91.4 meters (300 feet) away from the face of the new terminal building, respecting various security policies established by the Federal Aviation Administration (FAA) to minimize risks associated with bomb blasts emanating from parked vehicles. If the garage were to be located within the 91.4-meter (300-foot) security zone, the FAA could require extra reinforcing be included in the design of the face of the terminal building. (Alternatively, during heightened levels of security, the FAA could (1) prohibit the use of those parking spaces within the 91.4-meter (300-foot) security zone, and/or (2) require all vehicles entering the garage be thoroughly inspected.)

Ideally, the location of the Airport Terminal Station would also respect the 91.4-meter (300-foot) security zone. But due to space constraints and to minimize walking distances, the Airport Terminal Station, as currently planned, will be located within the 91.4-meter (300-foot) security zone if the terminal building should ever be expanded towards existing Terminal 2 (M-130) some time after the terminal expansion program is complete. Future terminal expansion towards Terminal 2 (M-130) will have to consider measures to protect against bomb blasts
emanating from APM trains, such as a reinforced wall between the station and outbound roadways.

**Funding.** The Port has pledged $25 million towards the planning, design, and construction of the on-Airport components of the Connector project. To fund its contribution, the Port intends to impose and use passenger facility charges (PFCs). PFCs are one source of revenue for airport improvement projects; others include (1) internally generated capital resulting from retained airport revenues (e.g., parking lot revenues and terminal building rent), (2) bond proceeds, (3) PFC revenues, (4) federal grants (Airport Improvement Program entitlement and discretionary grants), and (5) state and local grants. The U.S. Department of Transportation and FAA have established regulations and issued policy guidance regarding the eligibility of certain types of improvement projects, such as ground access projects, for funding with these sources.

In 1990, the U.S. Congress enacted legislation to allow airport operators (such as the Port) to impose and use PFCs in the amount of $1, $2, or $3 per enplaned passenger, subject to review and approval by the FAA. For a project to be eligible for PFC funding, it must (1) preserve or enhance safety, capacity, or security of the national air transportation system, (2) reduce noise from an airport, or (3) furnish opportunities for enhanced competition between or among air carriers. Signed into law on April 5, 2000, the *Wendell H. Ford Aviation Investment and Reform Act for the 21st Century*, also known as AIR-21, allows airport operators to impose and use PFCs in the amount of $4 and $4.50 per enplaned passenger, subject to meeting certain eligibility requirements on the amounts over $3. For example, the airport operator must demonstrate that the project will make significant contributions to improving safety and security, increasing competition, reducing current or anticipated congestion, or reducing the impact of noise.

Airport ground access projects, including public transportation improvements such as the Connector, are generally eligible for PFC funding if they meet the requirements described above (although certain types of projects are specifically excluded from eligibility). Additionally, the airport operator must own or acquire the right-of-way and any necessary land for the project, and the project must primarily serve the Airport. Because the Port, BART, and the City of Oakland are pursuing intermediate station stops for the Connector, the Port will propose to use PFCs to fund only those components of the Connector that primarily (or exclusively) serve Airport passengers and employees (e.g., the Airport Terminal Station).

Examples of airports where PFCs have been used to fund improved transit (specifically light rail) connections to the regional rapid transit systems include John F. Kennedy and Portland international airports. In each instance, the airport operator (the Port Authority of New York and New Jersey, and the Port of Portland, respectively) was required to demonstrate to the FAA that expending PFC funds on the project would enhance the capacity of the national air transportation system. Although each airport operator successfully demonstrated that their project enhanced the capacity of the national air transportation system, the preparing such an argument can be challenging.

**Conclusion**

As described, there are many unique challenges in integrating an APM connection to the regional rail transit system with an airport terminal expansion program. Perhaps the most challenging aspect is to balance the desire to provide a convenient interface with the terminal with the need
to maintain airport operations and allow for flexibility for future terminal expansions. Further, because the Connector is a link to the regional rail transit system (and only a portion of the overall system will be on Airport property), BART must necessarily manage the planning, design, construction, operation, and maintenance of the system. Therefore, many details, such as construction phasing and schedule, are out of the Port’s direct control, even though the Port is responsible for the overall terminal expansion program with which the Connector must interface. Many of these challenges will continue to be explored and addressed as both the Connector and terminal expansion program proceed through design.