Maintenance Design Group

State-of-the-Art Transit Maintenance Facilities

Just a little more than a hundred years ago, America's public transit was animal-powered. More than 100,000 horses and mules pulled 18,000 street cars over 3,000 miles of track. Maintaining those street car fleets included oiling wheels, keeping the cars brightly painted, and providing plenty of hay, oats, and water for the horsepower. Fleet managers faced the problem of disposing of manure and debated the merits of different types of horseshoes. The cars and horses were serviced and housed in what was not surprisingly called a "barn."

Even as internal combustion engines and electricity replaced animal power in transit systems, transit maintenance facilities continued to be known as "barns." Dim cavernous structures, they simply provided a roof to shelter mechanics from the weather. Machinery and vehicle parts were strewed about on oil-soaked floors. Work pits were crude gashes in the floor with lights. As buses and street cars changed and grew in size, the barns were remodeled and updated, but the old buildings simply hadn't been designed to accommodate modern vehicles and their servicing needs.

Those old street car barns are now mostly gone-replaced by a new breed of transit maintenance facility, a sleek, efficient, environmentally friendly operation that is as far removed from its ancestor as a contemporary compressed natural gas engine is from old Dobbin.

Modern maintenance facilities are likely to be clean, well-lit, highly functional buildings with a comfortable working environment. Every activity, from dispensing transmission fluid to rebuilding an engine, has been considered in the building design. Buildings are configured for efficient workflow, taking into account the daily servicing of vehicles, regular preventive maintenance inspections, and major repairs. Potential environmental problems, like storm water pollution or air emissions, are nipped in the bud with sophisticated technology.

"A number of factors have contributed to this make-over of transit maintenance operations," says Don Leidy, managing principal of Maintenance Design Group (MDG). "In the 1970s, when the federal government began providing funding for capital improvements such as maintenance facilities, part of the package was a requirement to design state-of-the-art facilities. The government felt that investing capital dollars in the most modern technology would help transit operators reduce long-term operating costs."

At the same time, transit vehicles were changing. Buses became longer and lower. Vehicle technology shifted from mechanical and electrical to electronic, as microchips began to operate destination signs, fare boxes, and engine controls. Repairing electronic technology demanded an entirely new level of sophistication and cleanliness. And major environmental laws enacted in the 1970s, followed by extensive EPA regulations in the 1980s, had two important consequences-pollution prevention and control are now an integral part of facility design, and most new facilities are designed to use or accommodate future use of alternative fuels such as compressed natural gas (CNG).

Providing for Alternative Fuels

The Clean Air Act Amendments (CAAA) of 1990 required that urban transit buses achieve aggressive reductions in air emissions. Because these requirements, which get more stringent year by year, will be difficult to meet with a fleet of diesel-powered buses, transit agencies must seriously consider converting some or all of their fleet to alternative-fuel buses, which produce far fewer harmful emissions.

Alternative fuels range from CNG, liquefied natural gas (LNG), "clean" diesel, and methanol to electricity. Switching to alternative fuels has major effects on facility design due to significant changes in fueling and fuel storage systems. Because CNG and LNG are invisible and difficult to detect, and methanol is more flammable than other fuels, safely accommodating alternative-fuel buses can call for completely different fuel handling technology, vapor venting, explosion-proof fixtures, and special sensing devices to warn of leaks. And because fueling with CNG, for example, takes twice as long as with diesel, a facility servicing a large number of CNG-powered buses may have to include more fueling lanes.

Most transit agencies constructing new facilities are providing for a future shift over to alternative fuels, even if it is not clear which alternative is likely to be chosen. For example, the Clark County, Nevada, Regional Transportation Commission's (RTC) new $31 million Integrated Bus Maintenance Facility has been designed to accommodate CNG- and future LNG-powered buses. The project consists of a 250-bus fixed route facility side by side with a 150-bus paratransit facility. The paratransit fleet, which provides rides-on-demand for disabled citizens and seniors, is entirely CNG fueled.

"In designing the new facility, we had to anticipate what kinds of alternative fuels would be available in the future and how much of our fleet would be converted," says RTC Director Kurt Weinrich. "Flexibility was key. We have the space to expand to CNG or even to store fuel cells for electric, zero-emission vehicles. We also oversized the gas main so we could draw more CNG if needed. Even now, we are the largest consumer of compressed natural gas used in transportation in the state of Nevada."

The Impact of Regulations

A growing and changing body of regulations has made designing a modern transit maintenance facility a complex task. Among others, new facilities must comply with the CAAA of 1990 and regulations designed to achieve the goals of the Clean Water Act. Particularly important for transit facilities are regulations dealing with underground fuel storage tanks (USTs).

Besides its indirect effect in prompting a switch to alternative fuels, the CAAA directly regulates protection of workers from toxic air emissions. This means careful attention to design of indoor parking facility HVAC so that exhaust fans are sufficiently sized to remove engine exhaust fumes, particularly during pull-out hours when a number of buses may be starting engines simultaneously. In addition, many new facilities incorporate flexible piping that can be attached to the bus tail pipe so that fumes from engine tests can be directly vented to the exhaust system.

"The RTC facility has flexible hoses at each repair bay to remove engine exhaust," says Fred Ohene, RTC project manager for the facility. "Another design feature to protect workers from air emissions is our enclosed bus paint booth, which prevents paint fumes from mixing with air in the rest of the facility."

The federal Clean Water Act does not directly regulate maintenance facilities, but it establishes water quality standards for the EPA and the states to enforce. Meeting water quality standards affects many areas of facility design. All floors in areas where vehicles travel, are repaired, or are fueled must have drains so that any spills are captured. Drainage flows into an oil/water separator before being discharged into the sewer system. The storage and distribution of oils, fluids, and lubricants must also be carefully considered.

At the RTC facility, all vehicle fluids are distributed to repair bays from a central storage area by visible overhead piping and are dispensed from pull-down hoses. This minimizes the potential for spills as well as saves money due to bulk purchasing of engine oils and fluids.

Bus washing is another activity that needs controls because both the cleaning agents and grime on the bus are potential pollutants. At the RTC facility, the bus wash is housed in a separate building tailored to the needs of that operation. Cleaning solvents are environmentally friendly. Wash water drains to a trench located in the center of the wash bay and from there to a water reclamation system, which separates greases, oils, and solvents before returning the water for reuse. "By reclaiming over 80 percent of our wash water, we are reducing both water consumption and our water bill," says Ohene.

The area of greatest concern for maintenance facilities is tank storage of fuel or other hazardous fluids. Facilities have typically stored diesel fuel and other fluids in underground storage tanks, but recently regulations governing USTs have become more stringent. To avoid the problems associated with USTs, many new facilities are shifting to above-ground tanks. "It's much easier to detect and stop leaks in tanks that are accessible to inspection, so tanks at the RTC facility are above-ground," says Tony Loyd, Carter & Burgess associate principal and project manager for the RTC facility. "To add extra protection, the outdoor fuel tanks are double-walled and concrete-encased. Also, all tanks are equipped with electronic detectors, which notify operators if there are any leaks."

Efficiency

"A key benefit of any new or retrofitted facility should be to help reduce day-to-day operating costs," says MDG's Leidy. "This can be accomplished by designing for the functional requirements of the facility, as well as improving worker productivity through better lighting and improved repair bay design-what is called human engineering."

Studies show that unscheduled repairs are several times more expensive to perform than scheduled, preventive maintenance. So designing for a workflow that allows more routine inspections saves money by catching mechanical problems before they take a bus out of service. Also, if buses spend fewer hours in the repair bay, that reduces the need for purchasing spare buses, a substantial savings.

"Creating a new maintenance facility gives you the opportunity to determine what should be the logical flow of work," says Bill Whitbred, program manager of commuter rail for DART (Dallas Area Rapid Transit). "For example, in Phase II of our Commuter Rail Maintenance Facility, we will implement the in-consist technique in which a group of cars operate together and are also inspected and repaired as a group. Because they experience the same amount of wear-and-tear, it's likely they will require the same services at the same time, which is more efficient."

"One of the major issues we considered in the design concept for our new facility was the workflow, particularly for daily processes such as emptying fare boxes, washing, fueling, and cleaning," says RTC's Weinrich. "We even involved the future site operator (RTC contracts with a private firm that operates the facility) in the design concepts as well as the Federal Transit Administration (FTA). The resulting site layout is based on the most efficient flow of vehicles."

New Technology

Computers are making maintenance facilities intelligent. Computerized systems track vehicle locations and fuel consumption. Motion sensors turn off lights when no one is occupying occasionally used rooms. Paperless work order systems track repairs and keep a database on each vehicle. The Transportation Research Board, an agency of the National Research Council, lauds this trend, noting that the use of advanced electronic systems to collect data on various maintenance functions can "reduce the time, materials, and money required to maintain transit buses."

"We have a very sophisticated computerized fuel and fluid management system at the RTC facility," says RTC's Ohene. "It tracks the usage of every kind of fluid, by bus. Sensors on the nozzles at the fueling facility identify which bus they are fueling by means of transponders on the bus, which are constantly broadcasting an identification signal. So there's a database record, for example, that a particular bus received so many gallons of fuel at a particular time. This enables us to spot buses that are using too much fuel-or engine oil."

For many decades, transit has competed with the private automobile. To attract and retain riders, transit vehicles must be clean, comfortable, and safe-and get passengers to their destination on time. The responsibility of keeping buses, trolleys, and rail cars in top shape rests with the maintenance facility. "Maintenance facilities are absolutely crucial to the successful operation of our agency," says DART's Whitbred. "High marks in cleanliness, reliability, safety, and on-time service all result from a first-class maintenance facility."