

# Construction the Specifier

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## Escalator Design in Transit Applications

Partnering for performance drives optimal results

by David Evans

**W**hen specifying escalators for airports, subway stations, rail/bus terminals, and other transit projects, an early partnership between vertical transportation specialists and the larger architectural/engineering community is beneficial. This is not only due to the design intricacy and funding constraints involved, but also because of the longer expected project lifecycle.

Escalators intended for transit applications can be more complex than their shopping center and movie theater brethren. They must often be larger, deal with heavier (and more constant) traffic, operate for longer periods, and, in some cases, be able to endure exterior weather conditions.<sup>1</sup>

Unfortunately, when it comes to these projects, the support of Division 14 original equipment manufacturers (OEMs) is frequently sought only after the specification has been released for tender. Optimal results are usually achieved when the vertical transportation OEMs are invited to participate in the earliest planning discussions. A partnership forged before a project is even defined often yields a better design solution. Manufacturers can offer the design team technical leadership, creative problem solving, and perspective on lifecycle costs to help ensure a long-term, economical solution.

### Offering design solutions

Due to the complexity of transit applications, escalator design tends to require customization or extensive editing of any pre-existing specifications. When basic boilerplate escalator documentation is used as a starting point, there is the danger for mismatches between what is needed and what was specified. Unfortunately, by this time, the building layout has already been firmed up.

The American Public Transport Association (APTA) has recognized specific requirements for transit application in its publication RT-RP-FS-007-02, *Heavy Duty Transportation System Escalator Design Guidelines Vol. 5: Fixed Structures*. This provides recommended practices for specifying heavy-duty escalators for use in a transit environment. However, the APTA document is only a guideline; the design team still needs to review the requirements and adapt/adjust them according to the performance parameters. Again, a partnership with a qualified supplier can help with the proper assessment.

While each transit application for elevators and escalators is different, all project teams want to get the most out of the equipment for the available budget. Partnering and consulting early in the design process with an escalator manufacturer can help realize potential savings by optimizing the design. In fact, some companies now offer a 'modular' approach in the heavy-traffic applications that allows designers to select the correct equipment for the specific transit project.

Proper sizing of the escalator equipment is probably one of the most complicated design decisions. Designers will consider variables such as passenger flow studies, expected loads, operating hours, maintenance requirements, and escalator layout considerations.

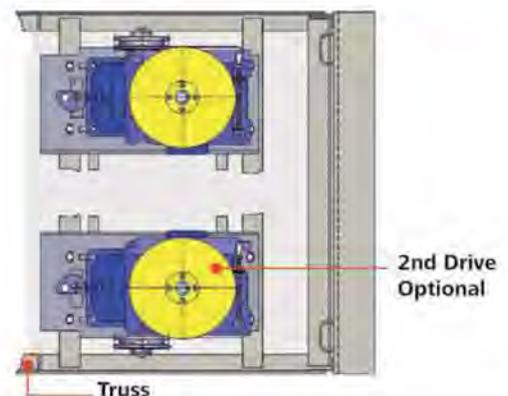
Escalator equipment layout must balance the building design requirements—including aesthetics—with the manufacturer's minimum requirements. Fortunately, some companies offer flexibility in equipment layout. For example, depending on space limitations, the escalator drive can be positioned within or outside the truss.

As shown in Figure 1, if the drive is placed inside the truss, an optional second drive can be installed to accommodate the larger spans and heights often encountered in transit applications. For some



*While specifying Division 14 always requires attention to detail, escalators intended for transit applications can be more complex than conveying systems intended for malls or theaters. Not only must they often be larger and deal with heavier traffic, but they may also need to contend with outdoor weather conditions.*

**Figure 1**



*When the escalator drive is placed inside the truss, an optional second drive can be installed to accommodate the larger spans and heights often encountered in transit applications.*

projects, this is simply not an option. For example, in a few cases, the required motor might be too large to be accommodated within the truss, or maintenance access could be an issue. In these circumstances, the motor(s) can be installed in a cage under the main truss or installed in a separate machine room (Figures 2 and 3).

One advantage to a separate machine room is that other support equipment, such as electrical panels and control equipment, can easily be inspected without having to block passenger access to the escalator. Although walking on a stationary escalator is not recommended, when the drive equipment is located in a 'pit' at the base of an escalator, any maintenance means the escalator cannot be used—even as a temporary stairway.<sup>2</sup>

Expected passenger loads, use, and operating hours directly affect the escalator's drive sizing. This is perhaps one of the most misunderstood criteria in escalator design. The challenge is to have the equipment to adequately handle the expected load requirements and not 'over-design' to the point where operating efficiencies are compromised.

Understanding passenger flow and loading is part science, part conjecture. APTA uses a design factor of 145 kg (320 lb) for each step of the escalator. (Step dimension limits are dictated by code.) This theoretical value may not reflect simple observation or what some studies have shown. Even at peak passenger traffic, there are usually empty steps on escalators, reducing design capacity. For some people, the natural slight hesitancy to board an escalator means there is an empty step separating passengers. For others, there is simply a desire to maintain a more comfortable amount of personal space. Industry experience points to a more realistic passenger loading of 40 to 50 percent of the theoretical load. Still, high volumes of commuters exiting a subway station during rush hour are more likely to cram on to the steps, than mall shoppers doing some relaxed window browsing.

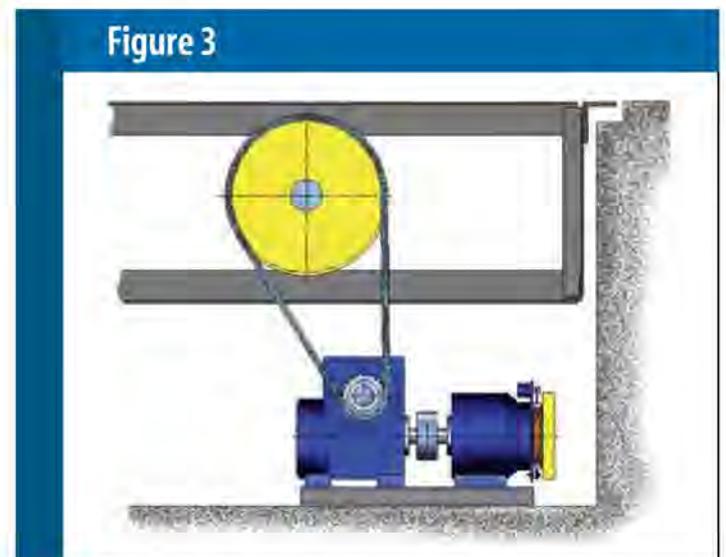
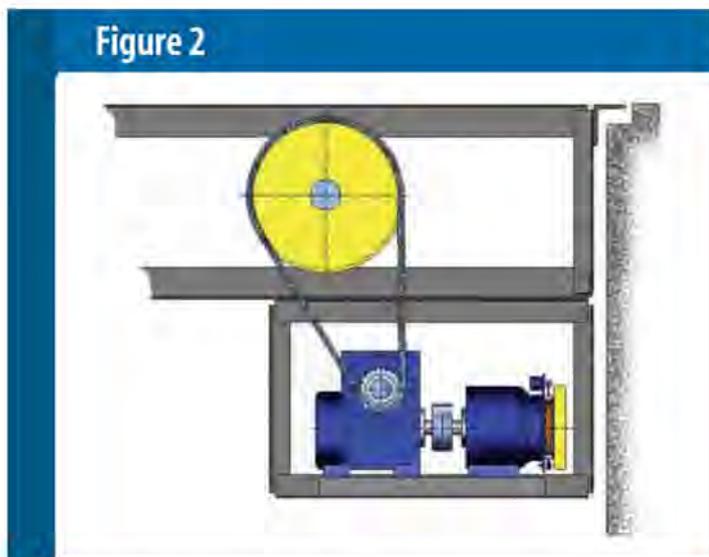
Using the inflated design load directly affects equipment selection and can lead to longer-term maintenance issues. For example, APTA requires a high life requirement and duty cycle for transit equipment. To meet this demand, escalator manufacturers must size gear boxes to resist wear at these higher use levels, although they may be overstated by up to 50 percent. Sizing gear boxes two to three times bigger than the associated drive means the equipment is never run to its maximum efficiency. In other words, while the drive efficiencies may be quoted at more than 85 percent, the actual efficiency could be closer to 60 percent.

The design team should understand what it is getting since lower efficiencies mean higher operating costs and the possibility for increased maintenance expenses. By partnering early with the escalator manufacturer, time can be spent to determine the actual versus theoretical loading to ensure correct equipment sizing.

### Short-term versus long-term focus

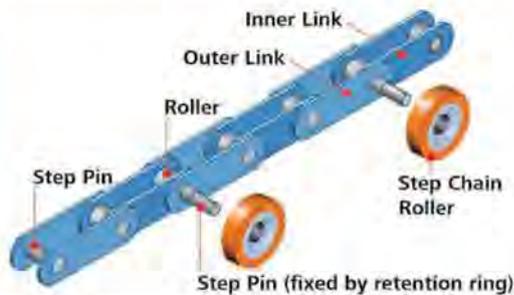
Maintaining a long-term focus is often a challenge when selecting equipment. Sometimes any savings realized in the initial cost of an escalator solution can be quickly eradicated by potentially hefty maintenance costs over the conveying system's life. APTA RT-RP-FS-007-02 recognizes the potential conflict between selecting initial equipment based on lower costs versus the long-term maintenance expenses:

It is expected that some manufacturers will be quick to tell us that these requirements will "add to the cost of the procurement." We all know, from past experience, the high lifecycle maintenance costs associated with the manufacturer's "standard" product when used in a transportation environment. Paying "more up front" will be more than compensated for by the overall reduced life cycle costs. Most importantly, it will improve customer safety, satisfaction, and convenience. The results can only be an increase in the public's confidence in a transportation system's ability to meet their needs, and thus, an increase in ridership.



*In certain escalator applications, the required motor might be too large to be accommodated within the truss (or maintenance access could be an issue). In these cases, the motors can be installed in a separate machine room or placed in a cage under the main truss.*

Figure 4



*In heavy-duty transit installations, the step chain roller of the escalator is typically placed outside the chain. The rollers are on every step connection link outside the step chain, which means they do not have to transmit force from their sprockets.*

With so many moving parts in an escalator, along with the high passenger loads and typical round-the-clock use associated with transit projects, a regular maintenance program is critical for durability and high duty cycle requirements. Something as simple as proper lubrication to the step chain—an expensive but critical component—can mean extended life. Escalator manufacturers offer various lubrication methods, including an option where the lubricants are encapsulated for maintenance-free operation.

In heavy-duty transit installations, the step chain roller is typically placed outside the chain (Figure 4). The rollers are positioned on every step connection link outside the step chain, which means they do not have to transmit the force from their sprocket. These larger-diameter rollers (as compared to in-line step rollers) have an extended life due to lower loads and revolutions.

Manufacturers typically offer a one-year warranty on escalator equipment after final installation signoff. Although extended warranty and service options are available, many transit authorities

prefer to perform their own maintenance programs. Often negotiated as part of the initial contract, maintenance training and support documentation can be provided to help ensure a smooth transition to the transit authority after the warranty expires. As the equipment becomes more complicated, especially with network connections, this type of partnership becomes increasingly important.

Using a lifecycle approach to the escalator equipment, a properly designed and maintained truss and framework typically have an indefinite life. Special design elements are required for external escalator installations to help ensure additional protection. For example, the truss may require additional primer and finishing coats, hot dip galvanizing or metalizing (*i.e.* thermal spray coating). Other measures include using stainless steel step axles and double-sealed bearings for both the chain and step wheels. Additional protection measures may include stainless sheet steel motor and drive chain covers, along with galvanized sheet steel step chain covers.

## Buy American Act

Since 1933, the *Buy American Act* has mandated the preference for purchasing domestically produced goods over their foreign counterparts for federal government purchases, with certain exceptions. The requirements are extremely stringent and the penalties for non-compliance can be severe.

Since many transit system purchases have a federal-funding component, it is critical any people-moving equipment meet the Buy American Act requirements. For escalators, both the manufacturing and assembly of the major components must be completed in the United States, while subcomponents, such as electronics, can be sourced elsewhere. ♡

## Looking for Technical Leadership

When partnering with a vertical transportation supplier, it is important to look for one that can provide current, accurate, and timely technical leadership, in addition to offering design solutions. Ideally, the manufacturer should demonstrate a sincere interest and willingness to support the design community—this should be a part of a manufacturer's philosophy of doing business.

Technical leadership can take many forms. It can range from offering educational and training seminars

on products to funding research and technical development. In addition, some manufacturers actively participate as a technical resource to the associated codes, guidelines, and safety standards related to vertical transportation, such as the American Public Transportation Association (APTA) and the American Society of Mechanical Engineers (ASME) A 17.1, *Safety Code for Elevators and Escalators*. This experience and 'leading edge' industry knowledge is extremely valuable to the design community. ♡



*For high-traffic locations, understanding escalator passenger flow and loading can be complex. Theoretical capacity values may not reflect simple observation or what some studies have shown. Even at peak hours, there are usually empty steps on escalators.*

### Location, location, location

Determining the maintenance interval and the type of maintenance to be conducted helps ensure the extended life of the wearing parts (e.g. step chain, rollers, gear box, and motors). When devising the maintenance interval, consideration should be given to the escalator's location. For an outdoor installation, atmospheric exposure (e.g. water, snow, ice, air pollutants) and the amount of dirt accumulation are the main factors. Dirt in the form of dust can be blown into the escalators and build up on lubricated components, such as step chains, drive chains, and track systems (due to oil runoff from the chain).

For outdoor escalators, the trusses are additionally protected either by galvanizing or metalizing processes. The components and fasteners within the unit are zinc-plated against corrosion, while the step chains are protected as much as possible by the use of covers and channel sections to drain away any water (e.g. rain, cleaning, or sprinklers). The lower end of the truss is fitted with an oil/water separator.

Since 2000, ASME A17.1, *Safety Code for Elevators and Escalators*, requires the escalator be designed for seismic conditions of Zone 2 or higher. The primary function is to ensure the conveying system remains on its support locations during seismic activity. Generally, the standard method of supporting the escalators is by the use of support angles at each end of the truss. This method lends itself to be adapted for use in seismic zones, but does have a limit of allowable movement. Consequently, consideration must be given to the story drift value at any escalator location. If the value exceeds the limit of the end support angles, then the escalator must be held at some other location (e.g. fix one end and support the other under the upper or lower escalator head). This method necessitates close coordination with the architect to ensure a support can be located as required.

A final consideration for outdoor escalators involves the possibility of the system being seen as a target for vandalism. For transit applications, the balustrade design is generally all stainless steel

with a brushed finish (vertical or inclined panel). Fasteners, if visible, should be tamper-proof.

When it comes to assessing the maintenance interval for indoor transit escalators, the operating time is the major determinant. Others include local regulations or any contractual provisions.

Although the frequency of maintenance may vary by site, escalator maintenance operations can generally be divided into two categories:



*Taking a lifecycle approach to escalators, a properly designed and maintained truss and framework typically should have an indefinite life. Partnering and consulting early in the design process with manufacturers can help yield potential savings through optimal configurations.*

- minor maintenance jobs (*i.e.* inspecting main functions, basic cleaning, and basic lubrication); and
- major maintenance jobs (*i.e.* inspection of other functions and devices, additional cleaning, and specific lubrication).

With so many maintenance considerations, it quickly becomes apparent a strong working partnership between the supplier and transit authority is necessary to maximize equipment life (regardless of who assumes the maintenance contract).

### Partnering for performance

By definition, a partnership is a relationship between individuals or groups and characterized by cooperation and responsibility—in this case, achieving a specified goal. The relationship between an escalator supplier and those involved in transit design (including transit authorities, architects, engineers, and other designers) offers

tangible short- and long-term benefits. However, success requires this partnership start early, building the necessary trust and respect to weather the inevitable challenges that occur during the project's lifecycle.

### Notes

<sup>1</sup> For more on general considerations, see “Escalators on the Move,” by Rod Lynch in the December 2005 issue of *The Construction Specifier*.

<sup>2</sup> The step rise (*i.e.* one step to the next, vertically) and depth (one edge of the step to another, horizontally) of an immobile escalator are significantly different than a fixed stairway. Additionally, the rise changes as one approaches the upper and lower landings, as steps form into a horizontal, level surface.

## Additional Information

### Author

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International Standards on Escalators. Evan is also vice chair of the American Public Transportation Association (APTA) Elevator and Escalator Technical Forum. He works out of the Clinton, North Carolina, escalator truss manufacturing facility, which is also where steps are cast and components assembled. Evans can be contacted at david.evans@us.schindler.com.

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### Abstract

Specifying escalators for transit applications can be very different from selecting a conventional conveying system for a shopping mall. The design intricacy, funding

constraints, and longer expect project lifecycle means an early partnership with vertical transportation specialists can make or break a project.

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