## Commission Background Paper 8A-03

# Federal Standards Regarding the Functional and Physical Design Lives of Surface Transportation Infrastructure

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### Introduction

This paper is part of a series of special gap analyses to be prepared for the National Surface Transportation Policy and Revenue Study Commission authorized in Section 1909 of SAFETEA-LU. These analyses are intended to address issues that are relevant to the Commission's charge outlined in Section 1909 that were not fully explored in an initial set of briefing papers that were prepared for the Commission. These papers will serve as background material in developing the analyses to be presented in the final report of the Commission. This particular paper correlates to Module 4J, "Future Infrastructure Design Policies and Standards".

The intent of this paper is to inform the Commission on the role that Federal standards and guidance play in establishing the functional and physical design lives of surface transportation infrastructure, particularly with regard to perceived restrictions on the maximum life eligible for Federal funds. The paper also discusses the eligibility for Federal and State funding of design features that enhance project quality beyond standards. Finally, the paper discusses a new Federal Highway Administration (FHWA) pilot program, called Highways for LIFE, that demonstrates innovative technologies and practices that can be used to build projects that will, among other benefits, result in longer lasting highways, thereby achieving a higher level of user satisfaction.

### Background and Findings

There appears to be a misperception by some in the surface transportation community that facilities built using Federal dollars must be limited to functional and physical design lives of 20 years, and that any functional or physical life beyond this 20 year mark is not eligible for Federal funds. This perception—possibly resulting from aggressive cost-cutting measures implemented to construct the Interstate System in the 1960s and 1970s within available budgets—is not accurate. In fact, functional and physical design lives significantly in excess of 20 years are eligible for Federal funding if justified. In the case of bridges, physical design lives of 75 years are now the standard, although 100-year lives can be expected with the use of high performance materials. Tunnels generally have a useful life of 100 to 120 years.

The eligibility of extended physical and functional design life in transit projects for Federal funding is not limited by design standards, but major capital investments that are candidates for funding under the Federal Transit Administration's New Starts program must rate well in cost effectiveness. These ratings rely on estimates of project benefits 20 or 25 years in the future, so there is some incentive to limit project scope (and cost) to match the demands forecast over the 20- or 25-year planning cycle. However, most of the components of a fixed guideway system, such as rapid rail (Metro) or commuter rail have a life cycle of between 75 and 100 years, with rolling stock having a useful life of 25 to 35 years. The rating process uses an annualized capital

costs as the basis for calculating cost-effectiveness, so that project benefits can be appropriately balanced with project costs.

Another misunderstanding pertaining to design standards is the conventional wisdom that States and localities may not spend additional moneys of their own to add quality beyond standards to a project. This misunderstanding may result from the Federal requirement that certain large projects on the National Highway System, as well as major transit capital investment projects, must be subjected to Value Engineering, which some view as a method to "cheapen" a project. In fact, value engineering, if applied correctly, will support features designed to add quality to a project if the features lengthen the project's life or lower its lifecycle maintenance cost. States and local governments are always free to fund such quality enhancements in highway and transit projects with their own funds, although these enhancements are generally eligible for Federal funding as well. Furthermore, when transit projects face the likelihood of cost overruns or significant project delays, value engineering (which also addresses processes) has been used to restore the projects to on-time, on-budget performance.

In the case of a design feature deemed not necessary for a project by the Federal Government, the State or local government could still fund it with its own funds, but this cost would not count toward the project cost eligible for Federal funds nor would the State funds invested in it count toward the State's match of the Federal funds for the project. Such costs would also not be included in the cost-effectiveness calculation for transit projects, to the extent that they represented enhancements beyond the basic transportation project (such as streetscape and pedestrian improvements, or architectural design elements).

The FHWA has recently implemented a pilot program, called Highways for LIFE, to demonstrate innovative technologies and practices that can be used to build projects safely and quickly and will result in longer lasting highways. More about this program and its objectives is described below.

## Highway and Bridge Design Lives

Design standards for Interstate highway construction are specified in *A Policy on Design Standards Interstate System* (AASHTO January 2005), implemented in 23 CFR 625.4. The guide helps to ensure safety, permanence, utility, and flexibility of the infrastructure to meet expected growth in traffic. Supported by statute (23 USC 109), new construction and complete reconstruction of Interstates should be designed to meet the types and volumes of traffic 20 years beyond the year in which the plans, specifications, and estimate for construction of the section are approved. Traffic volumes for the design shall be the 30th highest hourly volume of the design year. In practice, however, the 20-year traffic design year is treated as a minimum design standard. State and local designers may construct and size highway facilities to meet the needs of more distant time horizons, provided there is adequate justification for doing so. The FHWA could object, however, to over-sizing a facility if the future traffic need could not be documented, were viewed by experts as unrealistic, or could be met more efficiently by staged future additions to capacity. For instance, it would not make sense to build 10 lanes for a facility today that would not need more than 8 lanes of capacity for 30 years; rather, steps could be taken to preserve access to necessary right-of-way so that future lanes could be added when needed.

The Interstate standards do not set a timeframe for how long an Interstate facility should be built to last. Different components of a highway will last longer than others. For instance, the sub-grade and base courses of a highway section can last several decades, whereas the surface pavement course may last less than 20 years, depending on climate conditions, maintenance practices, traffic loadings, and pavement materials. Clearly, the overall facility should last at least until the 20-year traffic design year that the facility is built to accommodate—an absolute minimum for most facilities. In fact, States and localities are encouraged to design facilities to have longer design lives, provided it is cost effective to do so (as might be shown using Value Engineering).

*A Policy on the Geometric Design of Highways and Streets* applies to non-Interstate roads on the National Highway System (NHS). Called the Green Book, it is implemented by 23 CFR 625.3 and 625.4. Deviations from these standards must be approved by the FHWA (23 CFR 625.3(1)(f)). Federal-aid projects not on the NHS are to be designed, constructed, operated, and maintained in accordance with State laws, regulations, directives, safety standards, design standards, and construction standards (23 CFR 625.3(a)(2); 23 CFR 625.4(a)(3)), but such laws are usually heavily influenced by Green Book standards. There is no traffic design year or physical life specified for facilities covered by the Green Book. Accordingly, States and localities may design roads for traffic levels and physical lives well beyond 20 years, provided such objectives are reasonable and justified.

Bridges are subject to their own set of standards. In 2001, the American Association of State and Highway Transportation Officials (AASHTO) adopted a new *Guide Manual for Condition Evaluation and Load and Resistance Factor Rating (LRFR) of Highway Bridges*. The manual reflects the most current technologies and builds on the structural reliability approach inherent in specifications for load and resistance factor design (LRFD). Under the LRFD specifications, bridges are designed to have a design life of 75 years, although lives of up to 100 years may be achieved using higher performance materials. FHWA strongly supports the use of the LRFD specifications.

With regard to designing a bridge to carry higher traffic volumes beyond a 20-year traffic projection, the FHWA would look at each bridge on a case-by-case basis. In general, with appropriate justification, designing for higher traffic levels or heavier than standard specification loads would be considered eligible for Federal funds. The FHWA, for instance, has approved many designs exceeding the HS-20 standard, such as designs built to the new HL-93 standard (generally superior to the HS-25 standard). Such approvals can be based on the use of the bridge by heavy trucks, such as those that may be permitted under grandfathered size and weight laws.

Finally, with regard to program-level planning for transportation assets, Federal long-term planning requirements do not limit planning horizons to 20 years. A metropolitan long-range transportation plan (and the State long range plan into which it will be incorporated) is required to identify transportation needs for *at least* the next 20 years. MPOs and States can and do develop plans for more than 20 years. Similarly, environmental assessments of projects are also permitted to go beyond 20 years.

## Transit Infrastructure

The Federal Transit Administration does not work with design standards comparable to those used by the FHWA. Rather, major transit investment designs are governed by standards set locally and standard industry practices. It is common practice for transit projects to be sized based on forecasts of demand looking out 20 or 25 years, however. This practice occurs because major capital investments that are candidates for funding under the FTA's New Starts program are subject to rating and evaluation of project cost effectiveness. These ratings rely on estimates of project benefits 20 or 25 years in the future (this time frame is linked to the time frame of the local Long Range Transportation Plan, and it is the time within which the new project is expected to realize its maximum intended benefits). In order for a project to meet the requirement under the New Starts process that it rate well, particularly in terms of its cost-effectiveness, it is often sized so that its costs are not excessive with respect to the benefits forecast. Thus, there is an incentive to limit project scope to match the demands forecast over the 20 or 25 year planning cycle.

However, this "sizing" of the project is usually based on the extent of the infrastructure, not its useful life. A project may be planned to an ultimate size of 100 linear miles 40 or 50 years hence, but the initial application may only be for ten miles – also known as a "Minimum Operable Segment" - the distance that could reasonably achieve the project benefits estimated for the next 20 to 25 years. The infrastructure required for the project will have much longer useful lives than 25 years. The same logic applies to the capacity of the project. A visionary plan for a small metropolis may include a rapid rail project 50 years hence, but if the 20-year projection of benefits is not sufficient to support the rapid rail, a light rail project may be advised. Nevertheless, infrastructure designs for each of these alternatives will presume useful lives of 75 to 100 years, although their project costs will be very different. The New Starts rating process does take this into account by using annualized capital costs as the basis for calculating cost-effectiveness. In this way, the costs of long-lived or heavier-scale project elements will not be over-emphasized.

## Value Engineering

Value engineering (VE) must be applied to all Federal-aid highway projects on the National Highway System with an estimated cost of $25 million or more (see 27 CFR 627). In addition, FTA requires use of VE on its major capital investment projects (see FTA Circular 9300.1A). Among other requirements, the VE team must consider the lowest lifecycle cost means of accomplishing a project. VE can assure that agencies get the most for their Federal funds. However, whether in concept or in practice, VE is sometimes mistakenly viewed as a way to reduce project costs by removing all but the most basic elements needed to get the project in place.

Properly used, VE does not need to result in a reduction in initial project cost (although this can be an outcome). It can result in the recommendation of a more expensive project that has a longer expected life or has a lower maintenance cost (in present value terms) over its lifecycle—thus adding value to the project. Under these circumstances, features designed to add value and quality to the project are fully eligible for Federal funds. Of course, State and local funds may

also be used to cover these expenses as part of the States matching share, or they could be funded without Federal-aid funding[1].

If the State or local government were to include a feature on a highway or transit project clearly not necessary for the project, such as an ornamental feature, or were to design the facility to carry loads beyond levels the FHWA or FTA thought could be justified, the State or local government could fund these features with its own funds. The cost of the features would not count toward the eligible cost of the project (the part in which the Federal government participates), nor would the State's contribution to it count toward the State's match requirement for Federal funds.

## Changing the Way Highways Are Built

The FHWA encourages States to design and build structures with longer physical lives and improved quality than have previously been targeted. The Highways for LIFE (Long-lasting, Innovative, Fast Construction of Efficient and Safe Highways), established in SAFETEA-LU, provides incentives for the use of innovative technologies and practices with the expectation that safe, efficient highways and bridges can be built faster, and with greater durability. Incentives take the form of discretionary grants to qualifying projects.

The program, as established by the legislation, reflects an understanding that the best approach to improving the quality of the highway system is made by working through the individuals and organizations charged with designing, building, and operating it. The FHWA intends to create an atmosphere that encourages and enables the rapid adoption of innovations in the design, construction and operation of highways.

A significant number of proven technologies and practices currently exist to achieve safer highways, reduce congestion due to construction, accelerate highway construction, and provide longer-lasting highways. However, a great deal of this innovation and advanced technology is practiced on special projects or has not risen to the level of common practice. Without substantial changes in how the transportation community promotes, delivers, and deploys innovations and technologies, the realization of better ways of building highways could take many more years than necessary.

The Highways for LIFE program asks the question: If agencies wanted to change how highways are built and delivered, *what would it take to bring about rapid change*? Guiding principles for consideration in planning a new way of building and delivering highway projects might include:

- Do the "never been done"—by breaking out of one's comfort zone and changing attitudes from "I can't and won't" to "I can and will."
- Involve stakeholders—from the transportation community and highway users—in the development and conduct of the program.
- Utilize proven successes—technologies, materials, processes, and practices—in the financing, design, construction, and operation of highways.

[1] The State could not, however, choose to fully fund any selected component of the project to avoid Federal requirements such as the "Buy America" requirement for the Federal-aid highway or Transit program.

- Be bold and audacious—break the mold to "leap and not creep." Implementing proven technologies and innovations will result in significant benefits by producing safer highways, reducing construction congestion, and building longer-lasting highways.
- Keep the focus—on the motorists and highway users.
- Improve safety—not only during the construction phase, but also to provide a safer highway after the orange barrels are gone.
- Reduce congestion due to construction—by accelerating the onsite phases of construction process and employing the best technologies and practices in the management of work zone traffic. Note that accelerating construction does not always translate to more people, more equipment, or more overtime. Sometimes it simply means planning the project more carefully and doing more advance work, so that the project can be completed more quickly once the road closure is in place.
- Extend road life significantly—by increasing design life, using innovative materials, and practicing preservation.
- Improve highway quality—to levels that represent the best of what the transportation community produces.

One approach to bringing about such a paradigm shift is to change the focus. Rather than telling builders and suppliers *how* to build a project, they should be given a description of what the end product must "look like," in terms of performance standards. The standards should be based on the needs of motorists, such as pavement smoothness levels, safety criteria, and the like. Then, working together, the transportation agency, the contractors, and the suppliers can devise innovative ways of getting the job done. With user-focused performance standards in hand, the DOTs, the contractors, and suppliers can work together to develop solutions that show the driving public what is possible.

## Innovations on the Fast Track

State agencies adopting these practices in highway projects can qualify for funding under the Highways for LIFE program. Fostering innovations through Highways for LIFE and other, similar efforts would facilitate the implementation of innovative technologies that would enhance the safety and speed of highway construction and the safety characteristics, quality, and durability of pavements and bridges. The purpose of fostering innovations is to:

- Stimulate investment in innovation and accelerate deployment.
- Provide improved tools to facilitate achievement of performance standards.
- Provide broad access to the innovations that goes well beyond those involved in constructing a few projects.
- Provide an improved technology infrastructure to support highway safety, construction, longevity, and quality.

## Conclusion

The Federal Government encourages innovative approaches to extending the lives of such facilities so as to improve the efficiency of the surface transportation system. There are no barriers in published standards or guidance to exceeding 20 years in physical life and traffic

design capacity. Moreover, States are encouraged to look beyond 20 years, and in the case of the Highways for LIFE program, can receive discretionary grants to facilitate this goal. For transit projects, the cost-effectiveness rating system is intended to facilitate construction to current state of the practice, with value engineering being used to optimize the project's cost-benefit. Transit fixed guideway projects are expected to have lifecycles of 50 to 100 years.

## References


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"Highways for LIFE: Accelerating Innovation for the American Driving Experience" (Website), Federal Highway Administration at http://www.fhwa.dot.gov/hfl/

"Value Engineering" (Website), Federal Highway Administration at http://www.fhwa.dot.gov/ve/