

### "AN UPDATED ASSESSMENT OF THE ECONOMICS OF ADVANCED TURNOUTS"

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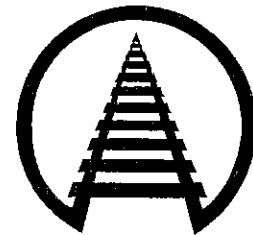
#### Summary

The Association of American Railroads (AAR) recently made an economic assessment of advanced turnout designs which indicated that there is a large market for an "intermediate" turnout design. Such a design would offer better performance than the standard turnout at a lower cost premium than that of the advanced turnout. The AAR made this assessment using field performance data collected from member railroads and the Facility for Accelerated Service Testing in Pueblo, Colorado. Guidelines for applying advanced turnouts in service, which were developed using this field performance data, confirm the conclusions of a 1993 study (TD93-014) that very high tonnage rates are needed to justify advanced designs.

There appears to be a large market for an intermediate turnout design which offers better performance than the standard turnout at a low-cost premium (i.e. 20 - 50 percent vs 100 - 200 percent cost premium for advanced designs.) The key to this type of turnout is to extend frog life and reduce frog life cycle costs while avoiding the additional expenses of signaling and control devices required of the moveable point frog. This type of turnout has potential use on mainlines with annual tonnage of 25 to 100 MGT. The advanced design turnout, on the other hand, is competitive on lines with annual tonnages of 100 MGT or more. How train delay costs are treated can affect the economic ranges of these turnouts.

Advanced design (i.e., tangential geometry, moveable point frog) turnouts show improved performance and have longer lives than standard (non-tangential, fixed point frog) designs. However, the high initial costs of these turnouts limit their application to very high tonnage lines. The life improvements wrung out of standard turnouts only exacerbate this situation, driving advanced turnouts into a smaller niche.

The standard mainline turnout, used extensively on North American freight railroads, is a non-tangential geometry lateral design with a fixed point frog. This type of turnout has shown great improvements in component lives over the last few years. In fact, use of selected premium components on most railroads has blurred the distinction between standard and advanced turnouts.

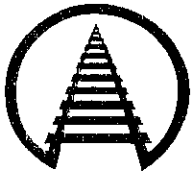


#### Suggested Distribution:

- Maintenance of Way
- Research and Development
- Track Maintenance
- Maintenance Planning

Association of American Railroads  
Research and Test Department

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## INTRODUCTION AND CONCLUSIONS

Recent experience with both standard and advanced design turnouts at the Facility for Accelerated Service Testing (FAST) and in revenue service confirms the conclusions of the 1993 study (TD93-014) that very high tonnage rates are needed to justify the high initial cost of advanced designs.

There appears to be a large market for intermediate turnout design, however, which offers better performance than the standard turnout at a low-cost premium (i.e. 20 - 50 percent vs 100 - 200 percent cost premium for advanced designs.) The key to this type of turnout is to extend frog life and reduce frog life cycle costs while avoiding the additional expenses of signaling and control devices required of the moveable point frog. This type of turnout has potential use of mainlines with annual tonnage of 25 to 100 MGT. The advanced design turnout is competitive on lines with annual tonnages of 100 MGT or more.

The major improvements of advanced design turnouts — tangential geometry points and a moveable point frog — provide better performance and longer component life in heavy freight service. As the new field data shows, AAR estimates for switch point and moveable point frog lives (700 to 800 MGT) are reasonable. Furthermore, the amount of maintenance performed on advanced turnouts has been less than originally estimated. Compared to standard fixed point frogs, minimal frog maintenance is required.

## FIELD PERFORMANCE

The expected lives of the major components in advanced turnouts are approaching the life of the adjacent mainline rail. With rail life at 700 to 1,500 MGT, switch point and frog life of 700 MGT allows the turnout to be replaced with the surrounding rail. Rail life that is a low (1 or 2) multiple of turnout life is ideal. Both the rail and turnout can be maintained at one pass, thus reducing additional labor.

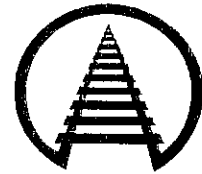
Improvements in conventional frog technology have resulted in great improvements in Rail Bound Manganese (RBM) frog life. Average life on mainline service, for example, has increased from 100-150 MGT to 200-300 MGT. This increase has paralleled the rail life increase so that the ratio of lives has remained the same at 4 to 5.

## ECONOMIC ANALYSIS

Exhibit 1 lists the characteristics of the standard, intermediate, and advanced design turnouts. For this analysis, the intermediate turnout is defined as a standard turnout with a high integrity frog, elastic fasteners, and improved plate work. Other intermediate turnouts could include improved switch geometry or alternative frog designs and materials.

Maintenance costs were determined from industry experience as well as AAR field test experience for each type of turnout. Exhibit 2 lists the maintenance savings provided by using an advanced design turnout on a 100 MGT/year line. These savings would help to offset the higher initial cost of the advanced turnout. The intermediate turnout, however, would yield smaller maintenance savings because of reduced frog savings and the eliminated switch point savings.

Cost comparisons were done on an Equivalent Uniform Annual Cost basis. Purchase and maintenance costs were annualized so that the three turnouts with different lives could be compared on the same basis. Exhibits 3 and 4 show the results of the analysis for three tonnage rates, with and without train delay costs. Exhibit 5 replots without train delay analysis costs in normalized form. The percent savings for intermediate turnouts may be seen more easily. They range from 8 to 22 percent over the 25 to 100 MGT/year tonnage rates.



**Exhibit 1. Turnout Characteristics**

	<b>BASE</b>	<b>INTERMEDIATE</b>	<b>ADVANCED</b>
Frog Type	STD RBM	Hi Int. RBM	Moveable Point
Frog Life (MGT)	103	284	700
Switch Geometry	AREA	AREA	AREA
Standard Switch Point Life (MGT)	337	371	1000+
Curved Switch Point Life (MGT)	800+	800+	1000+
Diverging Route Traffic (%) Load	5	10	10
Empty	25	50	50
Welding Interval (MGT)	25	70	350
Installation Cost (\$1,000)	59	70	120, 150, or 180

**Exhibit 2. Major Savings from Advanced Design Turnouts Relative to Standard Turnouts(100 MGT Line)**

<b>Maintenance Activity</b>	<b>Unit Cost</b>	<b>Approx. Yearly Savings</b>
Guard Rail Adjustment	\$150	\$150
Hand Grind Points	300	200
Hand Grind Frog	300	1,800
Weld Frog	550	1,400
Replace St. Sw> Pt.	2,200	375
Replace Frog	9,000	9,000

The high initial cost of additional signaling, control, and switch machine(s) for advanced turnouts limits their application to

very high tonnage lines. The analysis shows that tonnage rates of 100 MGT/year or higher are needed to justify advanced turnouts.

Train delay due to turnout maintenance becomes a significant cost component at tonnage levels above 50 MGT/yr. As Exhibits 3 and 4 show, consideration of train delay costs is needed to justify advanced designs over an intermediate design, even at the highest tonnage rates. Turnouts with initial cost premiums above 200 to 300 percent would require unrealistically long lives (e.g. 5,000-10,000 MGT) to justify their use.

**CAVEATS**

There are several factors, conservatively considered, which may greatly affect the results of the analysis. Among them are:

- ▶ Train delay
- ▶ Operating speed
- ▶ Line capacity

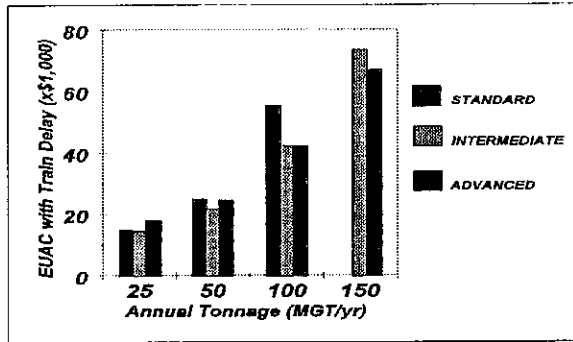
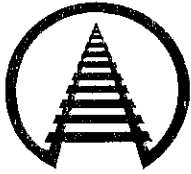


Exhibit 3. Turnout Life Cycle Cost Comparison (with Train Delay Costs)

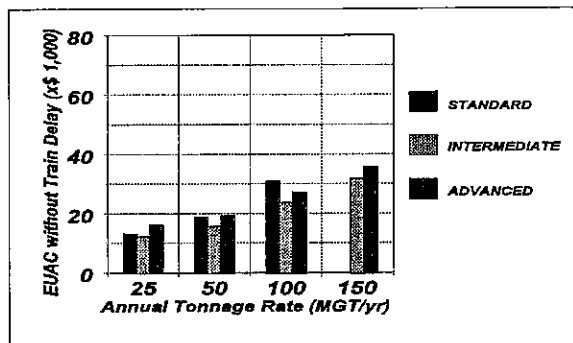


Exhibit 4. Turnout Life Cycle Cost Comparison (without Train Delay Costs)

Train delay can be a major factor in turnout economic analysis, especially on single track high tonnage lines. Train delay costs attributable to turnouts can easily equal turnout maintenance costs. How to properly quantify and attribute these delay costs is a key issue. Further work on ways to minimize delay costs should be conducted under the Special Track Work Research Program.

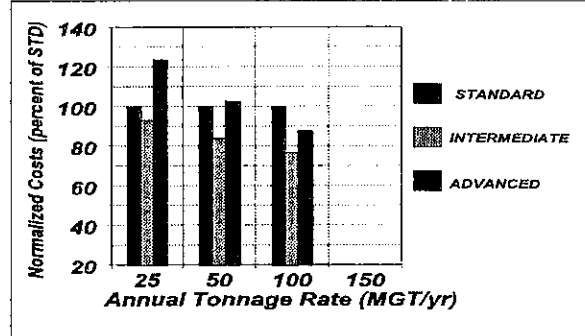


Exhibit 5. Normalized Turnout Life Cycle Cost Comparison (without Train Delay Cost)

Train delay was assumed to be the only delay resulting from turnout maintenance. There is no consideration of train delay from trains slowing down to operate through the diverging side of the turnouts.

Advanced turnouts can be operated at higher speeds than AREA designs without increasing dynamic forces. The Federal Railroad Administration speed restrictions (for curve superelevation), however, limit the speed increase that can be obtained.

Where line capacity has been reached, increasing operating speeds through turnouts may be a cost effective way to slightly increase capacity. In such cases, while the advanced turnout may reduce overall costs, it may be more costly to build and maintain than the standard turnout.

Contact David D. Davis at (719) 584-0754 with questions or comments about this document.

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