

"FIELD EVALUATION OF AN ADVANCED DESIGN TURNOUT"

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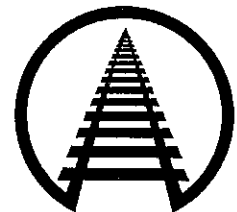
Summary

Field evaluation of an advanced design turnout, with tangential geometry and a moveable point frog, showed that improvements in performance over standard turnouts, with non-tangential geometry and fixed point frogs, are possible. These findings are from field tests conducted on the Burlington Northern Santa Fe and Union Pacific's (former Chicago & Northwestern's) Powder River Subdivision coal lines (the "joint" coal line) in Wyoming. The data is being used as part of the Association of American Railroad's Advanced Turnout Evaluation and Heavy Axle Load Revenue Service Evaluation programs. Results of testing show:

- ▶ The turnout survived over 450 MGT of unit train coal traffic. The switch points, stock rails, and closure rails all survived the duration of the test. The moveable point frog failed at 375 MGT due to a large crack. A life of 375 MGT is longer than the typical rail bound manganese (RBM) frog in similar service. However, the CNW/UP is currently averaging about a 350 MGT life with high integrity RBM frogs under portions of the same traffic, but with different operating patterns.
- ▶ Static measurements of track geometry show that the turnout is performing well under the severe, high tonnage rate traffic. Unloaded gage and crosslevel are fairly stable. The deterioration rates are very low at 0.02 and 0.11 inch per 100 MGT, respectively. Alignment deviations are present in front of and at the switch.
- ▶ Performance has degraded significantly in terms of maximum forces produced by a typical 100-ton car operating through the turnout over the 315 MGT monitoring period. The maximum force levels measured are approaching the levels found in standard AREA (e.g. non-tangential, fixed point frog) turnouts.
- ▶ The amount of maintenance performed on the turnout has been quite low compared to standard AREA turnouts in similar service. In particular, frog maintenance, such as repair welding and grinding to remove metal flow, is a small percentage (i.e. 15 percent) of what would be expected on a standard frog.

Suggested Distribution:

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



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INTRODUCTION AND CONCLUSIONS

Advanced turnout designs submitted to the Association of American Railroads (AAR) under the Advanced Turnout Evaluation Project have undergone a preliminary technical analysis. The analysis suggests that significant reductions in maximum forces (as compared to standard AREA designs) applied by vehicles traversing these turnouts are possible. Monitoring the performance of the turnouts in track, to date, has proven to be viable in terms of maintenance required and shows that the turnouts provide the life benefits suggested.

Turnouts and crossing diamonds, the vital links in the track system, are key components in train operations, because they affect more than one track. They are also the most expensive and complicated track components used. And, they consume a disproportionately large part of the track maintenance budget. About \$98 million is spent on turnout maintenance annually. Additionally, 6,800 frogs are replaced at a cost of \$120 million per year. Because the load environment on these components is quite severe, they are also the shortest-lived track in the system. In order to improve system reliability and efficiency, improved performance is needed from special trackwork.

The test turnout is a tangential geometry, moveable point (i.e. swingnose) No. 20 frog turnout built by Nortrak-VAE. It was purchased and installed by Burlington Northern at East Nacco, Wyoming, in June 1993. The turnout, located at the end of a section of double track, receives almost exclusively unit trains of coal and empties. Only loaded trains make facing point moves through the turnout, and nearly two-thirds make a diverging move.

The annual traffic has been quite high on this line for many years. In the mid-1980s, it was 100-150 MGT/year. Recently, it has increased rapidly, from about 200 MGT/year in 1993 to an estimated 240 MGT/year in 1994. A sample of wheel loads measured on the CNW line "downstream" of the turnout

showed that approximately 10 percent of the current traffic is in 110-ton cars. (TD95-005)

Findings and Conclusions to Date:

- ▶ The turnout survived over 450 MGT of unit train coal traffic. The switch points, stock rails, and closure rails all survived the duration of the test. The moveable point frog failed at 375 MGT due to a large crack. A life of 375 MGT is longer than the typical rail bound manganese (RBM) frog in similar service. However, the CNW/UP is currently averaging about a 350 MGT life with high integrity RBM frogs under portions of the same traffic, but with different operating patterns.
- ▶ Static measurements of track geometry show that the turnout is performing well under the severe, high tonnage rate traffic. Unloaded gage and crosslevel are fairly stable. The deterioration rates are very low at 0.02 and 0.11 inch per 100 MGT, respectively. Alignment deviations are present in front of and at the switch.
- ▶ Performance has degraded significantly in terms of maximum forces produced by a typical 100-ton car operating through the turnout over the 315 MGT monitoring period. The maximum force levels measured are approaching levels found in standard AREA (e.g. non-tangential, fixed point frog) turnouts.
- ▶ The amount of maintenance performed on the turnout has been quite low compared to standard AREA turnouts in similar service. In particular, frog maintenance, such as repair welding and grinding to remove metal flow, is a small percentage (i.e. 15 percent) of what would be expected on a standard frog.

RESULTS

In August 1993 and November 1994, a special test consist made a series of runs across the test turnout and selected standard turnouts at various speeds. The test consist had a loaded 100-ton car and a loaded 110-ton car (in 1994) with load measuring strain-gaged wheelsets. All four train movements (i.e. facing point



straight, facing point diverging, trailing point straight, and trailing point diverging) were made. This time series of wheelset tests shows how the turnout has deteriorated in performance with tonnage. Lateral performance, especially on the straight moves, has shown the most significant changes. The peak loads measured with a 100-ton hopper car have increased significantly over the 285 MGT interval between measurements. Exhibit 1 shows the measured peak forces at 30 MGT and 315 MGT.

Exhibit 1. Maximum Dynamic Loads vs. Movement at 25 mph

Turnout Type		Tangential Design		AREA Design
		30	315	200
Facing/ Straight	Lateral	3	16	12
	Vertical	47	51	55
Trailing/ Straight	Lateral	2	6	10
	Vertical	49	47	--
Facing/ Diverging	Lateral	12	18	22
	Vertical	48	53	74
Trailing/ Diverging	Lateral	14	17	20
	Vertical	51	53	49

The large deterioration in lateral performance of the test turnout is due, in part, to the unique operating pattern of the line. The turnout is at the beginning of double track. Loaded trains move south (railroad east) from single to double track, making a facing point diverging move to get to the right hand track.

Dispatching system records for the period of the turnout test show that approximately two-thirds of the loaded trains make this facing point diverging move. The large amount of diverging traffic and infrequent surfacing have resulted in a turnout that behaves more like an equilateral turnout than a lateral turnout.

For example, the maximum lateral forces are nearly equal for the straight and diverging facing point movements. The maximum forces on both movements have increased markedly since the first wheelset test at 30 MGT. The only tangible effect of this increased lateral loading is the frequent bolt failures reported. The bolts that fasten the plates to the crossties on the straight side of the switch are the ones that have failed.

COMPONENT LIFE

The moveable point or swing nose (SN) frog survived for approximately 375 MGT (20 months) of coal unit train traffic. A comparison of the test frog to available frog life data is presented in Exhibit 2. Because of many uncontrollable variables, results of test data are unclear. The usefulness of this comparison is therefore limited without a direct comparison of turnout designs or traffic types. It does present a view of the state of practice, however.

Exhibit 2. Frog Life Data from Industry Tests

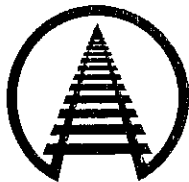
Traffic Type	Traffic Rate (MGT/Year)	Frog Type/ Avg. Life (MGT)	Data Source/# Samples	Maint Lvl
100-Ton	200+	#20 SN/375	Test /1	low
Heavy	80+	>#14 RBM/180	Survey/ Many	mixed
Heavy	80+	#20 SN/350	Survey/ Many	mixed
100-Ton	50-100	#20 RBM/129	Test/25	high
100-Ton	100-150	#20 RBM*/310	Test/37	med
125-Ton	100	#20 RBM*/350	FAST/1	high
125-Ton	100	#18.5 SN/132**	FAST/1	high

* High integrity castings

** Failure was material (not design) related

One factor that is readily apparent in these tests is that premium quality components increase life dramatically. The use of high integrity castings more than doubles the life of RBM frogs.

The level of maintenance is another factor which is difficult to assess. The moveable



point frogs require much less welding and grinding than do RBM's.

A time series of static track measurements shows how the turnout geometry deteriorates. Unloaded gage and crosslevel, measured through the diverging route of the turnout, show different trends. The unloaded gage shows little change over the 400 MGT monitoring period. The average value increased from 0.17 to 0.23 inch from 100 MGT to 400 MGT. This is a gage widening rate of 0.02 inch/100 MGT. Thus, the plate work, fasteners and concrete ties are doing an excellent job of holding gage under the lateral forces of the turnout.

Crosslevel error has increased at a faster rate. The average value increased from 0.38 inch at 100 MGT to 0.62 inch at 315 MGT. Surfacing at 375 MGT returned the average crosslevel error to 0.30 inch when measured at 400 MGT. The crosslevel deterioration rate was 0.11 inch/100 MGT during this period. Not unexpectedly, the maximum gage and crosslevel errors occur at the locations of maximum lateral and vertical loading, respectively.

MAINTENANCE

The amount of maintenance performed on the turnout was relatively small. Compared to a standard non-tangential geometry turnout with an RBM frog, the tangential switchpoints and the swingnose frog required very little grinding and welding. Standard RBM frogs "downstream" of the test turnout average eight weld repairs over a 200-300 MGT life (TD95-002).

Grinding is even more frequent than weld repairs on these RBM frog turnouts. Yet, the test turnout frog received one weld repair (at 340 MGT) and was ground three times; twice as part of the adjacent rail grinding program. The weld repair survived about 35 MGT, or 2 months. This is about 10 percent of the life of the original moveable point rail.

The welding was done to repair surface damage at the load transfer zone between

wing and point rails. The dramatic reduction in track time required for maintenance can have significant benefits in increased track reliability and capacity. The broken bolt problem previously discussed is the only other serious maintenance problem. The second surfacing at 375 MGT provides an estimate of surfacing cycle at about 300 MGT, or 15 months. Exhibit 3 lists the maintenance history for the site.

Exhibit 3. E. Nacco Turnout Maintenance History

Month	Year	Cumulative Tonnage (MGT)	Maintenance Performed
June	1993	0	Installation
August	1993	30	Profile Grinding
October	1993	63	Surfacing
April	1994	176	Profile Grinding
May	1994	196	Replace Bolts
October	1994	275	Replace Bolts
January	1995	340	Frog Point Weld Repair, Replace Bolts, Replace Plates
January-February	1995	340-355	Weld Grinding
March	1995	375	Replace Frog Point Rail
June	1995	450	End of Test

ACKNOWLEDGMENT

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

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