DATA SHEET

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Title:	**TRAIN SPEEDS**
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INTRODUCTION

Scale model motive power is generally capable of running at high speed rates which, if scaled up to prototype speed, would be extremely high. This sheet is presented to provide some understanding of railroad speed limitations. If observed in model practice, prototypical speeds can improve the appearance of a model train in motion.

Railroad speed limits are complex. Some are imposed by statutes and regulations, others by the railroads themselves, and many by right-of-way characteristics and qualities inherent in motive power and rolling stock. Complexity requires that broad, general terms be used in this sheet.

GENERAL LIMITATIONS

Some railroads set overall maximum speeds system-wide or by divisions. Many establish rulebook definitions which are uniformly applied, even in temporary slow orders. The New York Central defined train speeds in these words:

Normal Speed - The maximum authorized speed.
Limited Speed - A speed not exceeding fifty mph.
Medium Speed - A speed not exceeding thirty mph.
Slow Speed - A speed not exceeding fifteen mph.
***Restricted* Speed** - A speed not exceeding that which will enable a train to stop short of train, obstruction, or switch not properly lined, look out for broken rail, and not exceeding slow speed.

On other roads, different specific values may be assigned to limited and slower speeds. The terms will be used in various places in this sheet. Note the use of the term "not exceeding" in the definitions; crew discretion determines how much ***slower*** trains should be run under any restrictions. Train speed restrictions generally apply to entire trains. Acceleration should not begin until the last car has passed any point of restricted speed.

STATUTORY PROVISIONS

Since 1946, train speeds in the U.S. have been subject to an I.C.C. regulation which relates normal speeds to the type of train control and signal protection in use:

	No block signals	Automatic block signals
Freight trains	49 mph	69 mph
Passenger trains	59 mph	79 mph

Higher speeds are authorized only when signal protection is reinforced by automatic train stop or cab signal equipment. State and municipal speed limits may be applied to trains. A heavily-traveled street crossing, or the rare situation in which a railroad operates directly in a city street, may evoke a stringent local ordinance. In Ada, Oklahoma, Santa Fe trains are held to ten mph. Employee timetables indicate other in-town speed limits ranging from 15 to 45 mph.

SIGNAL SYSTEM LIMITATIONS

Regardless of I.C.C. speed, block lengths impose practical speed limits. On one straight, level branch line in the Detroit area, signal blocks are comparatively short and the railroad imposes a normal speed of 70 mph. Shortened blocks reduce both unrestricted running space and stopping distance.

Many signal aspects call for speed restrictions. The ***Approach Medium*** (Rule 282) aspect suggests speed reduction so that the next signal will be passed at medium speed. ***Approach*** (Rule 285) indicates that the signal may be passed at medium speed. In multiple-track territory, a red block signal is Rule 290 on some roads--pass at the restricted speed and Rule 291 on others--stop, then proceed at the restricted speed. Within single-track territory or interlocking limits a red board or block is always Rule 292 -- stop.

TRACK, TERRAIN AND STRUCTURES

Straight, level mainline trackage permits the highest prototype train speeds. Grades, curves, crossings, bridges and turnouts impose varying restrictions. Some examples have been selected for information.

Grades: Upgrades automatically reduce prototype running speeds, and downgrades require control through braking. On Sherman Hill (Union Pacific) lightweight passenger trains are permitted 30 to 60 mph. in both directions, while standard-weight passenger trains are held to 25 - 50 mph. and freight trains 20 - 40 mph. Exact speed varies according to grade and curve conditions.

Curvature: A ten degree curve, quite sharp on the prototype, is 79" radius in HO scale, 143" radius in O scale -- quite generous. On the prototype, such a curve would call for slow speed, whereas these radii are run at normal speed on model railroads.

Secondary Track and Branch Lines. Roadway conditions determine speed limits. Denver to Cheyenne on the Union Pacific is normal speed territory. Its Umatilla Branch is medium speed to limited speed, and the Heppner Branch calls for slow to medium speed. Such secondary tracks as switching leads are usually operated at slow to medium speed.

Bridges: Limits vary with structures, their conditions, and engine weights. Culverts and most overpasses are built for normal speed running as are many mainline truss bridges. An old, light-loading-table truss bridge might be run in the 20 to 40 mph range. Some movable spans permit normal speeds, while older bascule and swing spans may require reduced speeds. High trestles invariably call for restricted speed; a 156' high steel trestle on the Fort Dodge, Des Moines & Southern was operated in the neighborhood of ten mph and a timber trestle of like proportion would probably be run at six mph.

Railroad Crossings*:* Speed depends on construction and condition of crossing. The Pennsylvania Railroad established a limit of 30 mph for crossing the Rock Island at Englewood, near a station, while the NYC-C&O crossing at Wayne Junction was run at normal speed.

SIGNAL SYSTEM LIMITATIONS - continued

Turnouts: Most main line turnouts are run at normal speed in the straight-through position. Speeds on diverging routes vary directly with turnout numbers. The #30 high-speed turnout permits a diverging speed of 50-70 mph. On some roads, a #20 is taken at 30 mph, whereas a #14 requires 20-25 mph, and smaller ones 10-15 mph. Trains trailing straight through spring switches are usually limited to 15-20 mph if the points are to move under the trains.

Interlocking Plants: Speeds vary with local conditions. Some plants call for reduction to slow speed. The model operator could use the turnout or crossing limit, whichever might apply.

EQUIPMENT CHARACTERISTICS

The equipment handled in a train may limit its overall speed. On the Union Pacific, passenger trains of plain-bearing equipment were held 10 mph slower than passenger trains of roller bearing equipment. A passenger train handling a freight car may be held to 50 mph in some cases. Trains handling trailer flats, however, may be permitted 5-10 mph higher speed than other freight trains. In general, freight trains must observe limits of the sort listed below when handling various

TYPE OF CAR	LIMIT (mph)
Bunk cars	40
Rail detector cars	40
Cars with K brakes	40
Wrecking cranes	35
Clearance cars	35
Air dump cars	30
Circus trains	30
Ore cars	30
Cranes, shovels, etc. loaded on cars	30
Scale test cars	25
Spreaders and ditchers	25
Cranes, shovels, etc. moving on own wheels	20

special cars and loads.

MOTIVE POWER	GENERAL LIMIT (mph)	PASSENGER SERVICE	FREIGHT SERVICE
Steam Engines Backing Yard engines 2-8-0 & 4-6-0	 20 (UP) 20 (IC) 35 (UP)		
2-8-2, 57" drivers 2-8-2, 63" drivers 2-10-4, 74" drivers	35 (UP) 60 (ATSF)	55 (UP)	50 (UP)
4-4-2, 79" drivers 74" drivers 4-6-4, 84" drivers	100 (ATSF) 90 (ATSF) 100 (ATSF)		
4-8-4 4-12-2	70 (ATSF) 50 (UP)		
4-12-2 heading through turnout 4-12-2 backing through turnout	10 (UP) 6 (UP)		
Heavy Mallet 4-6-6-4, 3900 class 4-8-8-4	35 (UP) 50 (UP)	65 (UP)	50 (UP)

MOTIVE POWER

This tabulation is incomplete. A rule of thumb is that modern (1936 and later) steam power was rated at approximately 1.25 mph, per inch of driver diameter, while older power was rated at most 1 mph, per inch of driver diameter. High motive power speed ratings do not confer authority to exceed other speed regulations. Of the timetables studied, only three indicated speed limits of 100 mph, a rate which was regularly exceeded on many railroads between 1934 and 1946.

MOTIVE POWER	GENERAL LIMIT (mph)	PASSENGER SERVICE	FREIGHT SERVICE
Diesel-Electric Engines Backing Yard engines in road service	 40 (UP) 35 (UP)		
Freight and road switcher Freight engines Passenger Engines	 65 (ATSF) 100 (ATSF)	65 (UP)	50 (UP)
Electric Engines Heavy Light	 100 (PRR, GG1) 70 (PRR, P5a) 45 (CSS&SB)		
Multiple-Unit Cars Motor Cars RDC Cars: Single Multiple	65 (IC) 65 (ATSF) 50 (PRR) 80 (PRR)		

GAUGING MODEL TRAIN SPEEDS

Elapsed Time (seconds)	Scale
9	N
5	HO
3½	S
2½	O

A quick and fairly accurate estimate of the scale speed of a model train may be made by observation, using this formula: Train speed in scale miles per hour equals actual inches

traveled in the "Elapsed Time" given in the adjacent table.

The car length is a handy unit to employ in making observations of this sort. For O scale and S scales, it may be convenient to run time observations for 5 and 7 seconds, respectively, dividing distance by two to establish train speed.

A method of approximating train speeds is to use 5 seconds as the time standard and to calculate on the basis of car lengths, adding these values for each car passing during the five-second period:

For each 25' car - 4 mph
For each 32' car - 5 mph
For each 40' car - 6 mph
For each 50' car - 7½-8 mph
For each 60' car - 9 mph
For each 70' car - 10 mph
For each 75' car - 11 mph
For each 80' car - 12 mph

Each increment of 7' in five seconds equals one mph in the calculation. This method is effective for prototype as well as model speed calculations.

SPEED TABLE

A table of this sort, relating running time per mile to train speed in miles per hour, is found in almost every employee time table.

Time/Mile Min.	Sec.	MPH	Time/Mile Min.	Sec.	MPH	Time/Mile Min.	Sec.	MPH	Time/Mile Min.	Sec.	MPH	Time/Mile Min.	Sec.	MPH	Time/Mile Min.	Sec.	MPH
0	36	100	0	47	76.6	0	58	62.1	1	18	46.1	1	40	36.0	2	5	28.8
0	37	97.3	0	48	75.0	0	59	61.0	1	20	45.0	1	42	35.3	2	10	27.7
0	38	94.7	0	49	73.5	1	0	60.0	1	22	43.9	1	44	34.6	2	15	26.7
0	39	92.3	0	50	72.0	1	2	58.0	1	24	42.9	1	46	34.0	2	30	24.0
0	40	90.0	0	51	70.6	1	4	56.2	1	26	41.9	1	48	33.3	2	45	21.8
0	41	87.8	0	52	69.2	1	6	54.2	1	28	40.9	1	50	32.7	3	0	20.0
0	42	85.7	0	53	67.9	1	8	52.9	1	30	40.0	1	52	32.1	3	30	17.1
0	43	83.7	0	54	66.6	1	10	51.4	1	32	39.1	1	54	31.6	4	0	15.0
0	44	81.8	0	55	65.5	1	12	50.0	1	34	38.3	1	56	31.0	5	0	12.0
0	45	80.0	0	56	64.2	1	14	48.6	1	36	37.5	1	58	30.5	6	0	10.0
0	46	78.3	0	57	63.2	1	16	47.4	1	38	36.8	2	0	30.0			