NEW YORK - ALBANY

(Hudson line)

Study of speed increases for Turboliners

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STUDY OF SPEED INCREASES FOR TURBOLINERS ON THE NEW YORK - ALBANY OR HUDSON LINE (State of NEW YORK - USA)

SUMMARY :

SUMMARY OF CONCLUSIONS

This Report indicates the existing track condition as found on JUNE 1986. On that basis, the top speed to be authorized for Turboliners may be raised by 10 to 25% over more than 75% of the New York/Albany line, the rate of increase of speed being related to local circumstances and made possible by track engineering works incumbent on day-to-day maintenance.

The Turboliners'speed could be further increased by an additional 5 to 10% should more substantial track engineering works be implemented, without infringing on the limits of the existing subgrade.

To make the above findings and achieve the expected running times calculated by ANF and included in Part II of this Report, SNCF used a standard French Rail speed increase approach which naturally met :

- the existing standards applicable in US railroad administrations, especially AAR standard related to the permissible lateral acceleration resulting from superelevation deficiency, set at 0.10g for adequate levels of comfort.

- the values derived from :

  . the above standards
  . special features of track equipment
  . equipment characteristics

  Therefore, the maximum superelevation deficiency was set at 130 mm for the whole line.

- the critical points (curves, turnouts, structures) currently requiring speed restrictions as shown by the papers emanating from US administrations.

SNCF relied on an on-line record of acceleration measurements kindly undertaken by Amtrak on the fleet of Turboliners.

1 - Aim of the study

Following a request made by ANF Industrie to SNCF's International Cooperation Department at the beginning of 1986, a study at diagnosis level was carried out in order to identify the possible speed increases for Turboliner services provided by Amtrak on the Hudson Line.

This report summarizes the conclusions of the study taking into account :

- US standards applicable to track geometry, track maintenance, safety and comfort.
- The geometry characteristics of the line in its June 1986 condition.
- SNCF rules and practice in terms of speed increases which have been changed to allow for the above mentioned items and namely for the AAR standards applicable to comfort and track equipment features : spikes ...

2 - Resources implemented

The study is based on documents related to safety and comfort rules, track geometry and maintenance standards available at SNCF or supplied by ANF and its agent Allied Corporation which also provided various track-charts and working time-tables regarding the Hudson Line.

SNCF's study is also based on the results of the projected high speed rail link between Montreal and New York (december 1984).

In June 1986, ANF and Allied Corporation organized a mission with SNCF representatives during which a series of recordings were made by means of portable accelerometers - which are in use on SNCF - and a large number of fruitful discussions were held with Albany's DOT concerning the existing line, and the schemes applicable to it, as well as with Amtrack, the FRA and Metronorth concerning US standards above all.

- SNCF's experts in Civil Engineering and in charge of studying speed increases on the French system were involved i.e. :

. the Track Research Department set up the limitations (cant deficiency etc) compatible with the characteristics of gas turbine trainsets in order to avoid rail overturning, track shifting etc.

. the Department for Studies and Projects was represented in ANF's mission and analysed accelerometer data, worked out the potential speed increases and determined the technical requirements to implement them on to the track.

- The Track Maintenance Department quantified the amount of works required and their costs.

Despite requests made to the effect that track geometry analog records and Integrated track geometry records should be examined in detail, they were not made available. Indeed a comparison between those graphs and others plotting acceleration measurements would have contributed to the completion and reinforcement of the conclusions of the study.

3 - Limitations of the study

It was based on the track condition as derived from the behavior of standard Turboliner train sets. It does not therefore apply to speed increases attainable by all types of equipment assuming the elimination of some special points in the track layout (enlarged radius for some/ all curves). However curve straightening has been considered easy to perform in various locations and especially where 2 tracks could be shifted on a subgrade wide enough to accomodate 4 tracks. Generally the curve straightening works - which were reported on to the D.O.T. - are extremely costly compared to time gains and whith reference to the technical solutions put forward in the second scenario of the study.

However those conclusions can be regarded as theoretical for the following reasons :

1) Prior to authorizing the equipment to run at higher speeds in revenue service, SNCF would make a point of going through a series of test runs at the future speed plus a safety margin. This is common practice on SNCF's main lines which are constantly being upgraded. These tests and preliminary checks are clearly more than recommendable in this case considering that June 86 recordings only concerned track number 1 and 3 (track 3 between the GLENWOOD and CROTON-HARMON Interlockings, track 1 was undergoing third rail replacement at the time). As a result conclusions for track 1 were extrapolated onto track 2.

2) Amtrak express trains and suburban services operated by Metronorth are provided on the same lines over half the New York - Albany section. Both Amtrak and Conrail freight trains are worked on the other half. Amtrak does not own the railroad premises and pays Metronorth and Conrail for the incremental cost of track maintenance operations required to keep a given speed level.

The operating conditions of the Hudson line are such that a close cooperation between the concessionary/owner and the operator is required with regard to the implementation of speed increases with their inherent technical requirements and the stringent application of jointly agreed operating principles. SNCF have acquired a vast experience on the operation of miscellaneous traffic flows at different speeds and in an already remote past, they developed operating principles accounting for such a traffic mix, ie :

- Lines were specialized according to traffic flows,

- Traffic flows were concentrated on specific time intervals,
- Signaling was readjusted for critical zones (for the stopping at commuter stations),
- Equipment capacity was improv ed to relieve traffic density,
- Traction performance was improved in accordance with the mix of traffic flows.

The above principles often have to be implemented concurrently, thus requiring an optimum co-ordination between the SNCF's Departments involved :

. Civil Engineering, Equipment and Operating

This co-ordination is assumed to be feasible for optimizing the investigated Corridor.

3) In these conclusions, are also shown potential speed increases of Turboliners on the WEST SIDE CONNECTION, without suburban traffic from PENN STATION to SPUYTEN DUYVIL, the commissioning of which should eliminate some of the major operating constraints mentioned above (joint leg for metro-North/AMTRAK, from Grand Central Terminal to Spuyten Duyvil). Assumption was made that Turboliners would be self-propelled from che 30th Street Freight Yards and as on SNCF, the transit through the Riverside Park Tunnel would not impede the use of turbines.

4) The possible changes required by speed increases were not included in the cost evaluation :

- changes on the signalling system and cab signal,
- lengthening of the distance covered between the treadle actuating the warning device and the grade crossing.

It is clearly difficult at this stage to describe the detailed works required with sufficient accuracy.

4 - Basic data and assumptions

4.1 - Basic documents

* TRACK CHART NEW YORK/ALBANY and dated January 1982, which includes :

. Number of lines, their respective localization,

. Track lay-out, curve radii and superelevations.

It is noteworthy that in terms of superelevations, the value of 4" is never exceeded, which corresponds to grade 4, while some sections are categorized under grade 5 and 6.

* RECORDINGS of the vehicle structure's lateral and vertical accelerations measured first at the front truck, then at the rear one, for two turbo-train sets.

- The recordings were made on revenue-service trains having faced all the contingencies related to operations : speed restrictions, running on slow-speed transitions, stops, and so forth. Recording only refer to track 1.

* JANUARY 1983 TABLE FOR MAXIMUM PERMISSIBLE SPEEDS (Amtrak) :

. Line speeds

. Singular speed restrictions.

This paper is not fully reliable, especially for singular speed restrictions which do not always reflect the actual speeds operated by trains. It is expected and quite likely that these tables are changed for each operating service with the relevant seasonal variations (track subsidence and condition, engineering works under planning, etc...).

Some speed enhancements may have taken place since this paper was published (see. L. ROSSI's letter dated 6.14.83); as far as possible, our proposed speed rises have considered the current and future patterns.

* PARAMETERS OF THE STUDY

Track maintenance classes 1983 Track safety standard Document					Maximum permissible superelevation deficiency $\left(\frac{0.118\ V^2}{R} - D\right)$	
Class	Max. Speed miles	km/h	Maximum superelevation inches	mm	Spiked track mm	Track with modern fastenings
4	80	129	4	102	90	140
5	90	145	5 (1)	127	130	160
6	110	177	6 (2)	152	140	160 (2)

(1) These two values are not under use on New York/Albany, but could be adopted as the proposed speed increases are implemented.

(2) 180 mm if $V \leq 170$ km/h (106 mph).

- The superelevation deficiency values were worked out to account for the relative lighweight of turbotrains and also US track standards.

Limits are set for rail overturning on spiked sections, track lateral displacement on modern tracks with fastenings. The Prud'homme's Formula gives $HL < 0.85 \left(\frac{1 + P}{3}\right)$

HL = lateral force (expressed in tons)
P = axleload.

4.2 - <u>General comments</u>

- There were many sources of data for US papers (for maximum permissible speeds, in particular).

- The recordings were performed on line 1 only and at the maximum commercial speed or at a lesser speed (our test trains operate at the target V + 10 khp).

- No track condition recordings were available (such as Mauzin, the French Railroads'track inspecting vehicle).

4.3 - <u>Equipment</u>

. Run on 2. June 86 Front-cab recording

Primary suspension fitted with new springs, redesigned, secondary suspension (silent block) with excellent overall condition.

Mileage, since the last overhaul : 244.447 miles.

. Run on 5. June 86 Recording on the rear cab.

Redesigned primary suspension, 4 new dampers, good overall condition.

Mileage since the last overhaul : 332.411 miles. Given the locomotives' mileage, the condition of these locomotives, may be considered as average.

For the assessment of the theoretical values related to lateral accelerations induced by superelevation deficiency, we have considered the sway applicable to turboliners.

As to the second study with maximum speeds achievable after works, the US railroads should provide :

. Either an allowance for superelevation standards applicable with reference to maintenance classes.

. Or rating some sections on a higher class.

. Or, and this would be the best approach to the project, to allow higher superelevation deficiencies than the usual ones applicable to ordinary trains, the Turboliners having a more favorable sway, smaller axleloads and a lightweigh driving truck.

We have restricted in our proposals the value for superelevation deficiency to $\leqslant$ 130 mm, whereas on the French Railroads' lines, the Turboliners have a normal superelevation deficiency of 160 mm (ie 6" 3/8) and an exceptional superelevation deficiency of 180 mm (ie 7").

4.4 - Permanent way

During the tape analysis, we noted the highest vertical acceleration levels that do not jeopardize safety, but which are good comfort indicators.

. The first phase of the study (without work) considered these levels with accuracy and of course the lateral accelerations due to maintenance defects.

. The second phase of the study was less restrictive, since it took for granted that the required works would be completed for overall improvements, especially on interlocking zones.

Classes of runs on New York/Albany route :

. New York central (MP 00) Poughkeepsie (MP 73) class 4, class 5 envisaged, or possibly 6 ? From MP 16 to MP 25
MP 51 to MP 72

. Poughkeepsie (MP 73) - Hyde Park (MP 79) class 4

. Hyde Park (MP 79) - Barryton (MP 94) class 5

class 6 possibly envisaged ? From MP 90 to MP 98

. Barryton (MP 94) - North Newton Hook (MP 124) class 5

. North Newton (MP 124) - MP 140 class 6

. MP 140 (Port Road) - Albany (MP 142) class 4 ?

The track was assumed to be entirely spiked throughout the route.

5 - Results

A first study shows the potential speed increases to be achieved without modification to :

- the track lay-out
- the existing maintenance classes

and thus without additional expenses in the short and medium terms, save a few minor adjustments that could be considered as part of the day-to-day Maintenance.

A second study conducted on similar basic data and parameters considers other alternatives for speed increases which could lead to :

- improved track standards and possibly upgrading in the maintenance class
- the replacement of points and crossings
- increased superelevations to minimize deficiency and to remain close to the US standards, whilst taking advantage of the Turboliner's sway (flexibility coefficient) :

  $(\gamma nc < \frac{1}{1500} \ (1 + 0.25) \ )$

  γnc = uncompensated acceleration.

The results are shown hereafter in the tables :

Table 1 : Diagram for existing and projected speeds

Table 2 : Lay-out characteristics and analysis of accelerometer-recordings (3 sheets)

Table 3 : Amount of work to be carried out between phase 1 and phase 2 (2 sheets)

Table 4 : Broad evaluation of work required between phase 1 and phase . (6 sheets)

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TABLE I

NEW YORK-ALBANY : Turboliner diagnosis

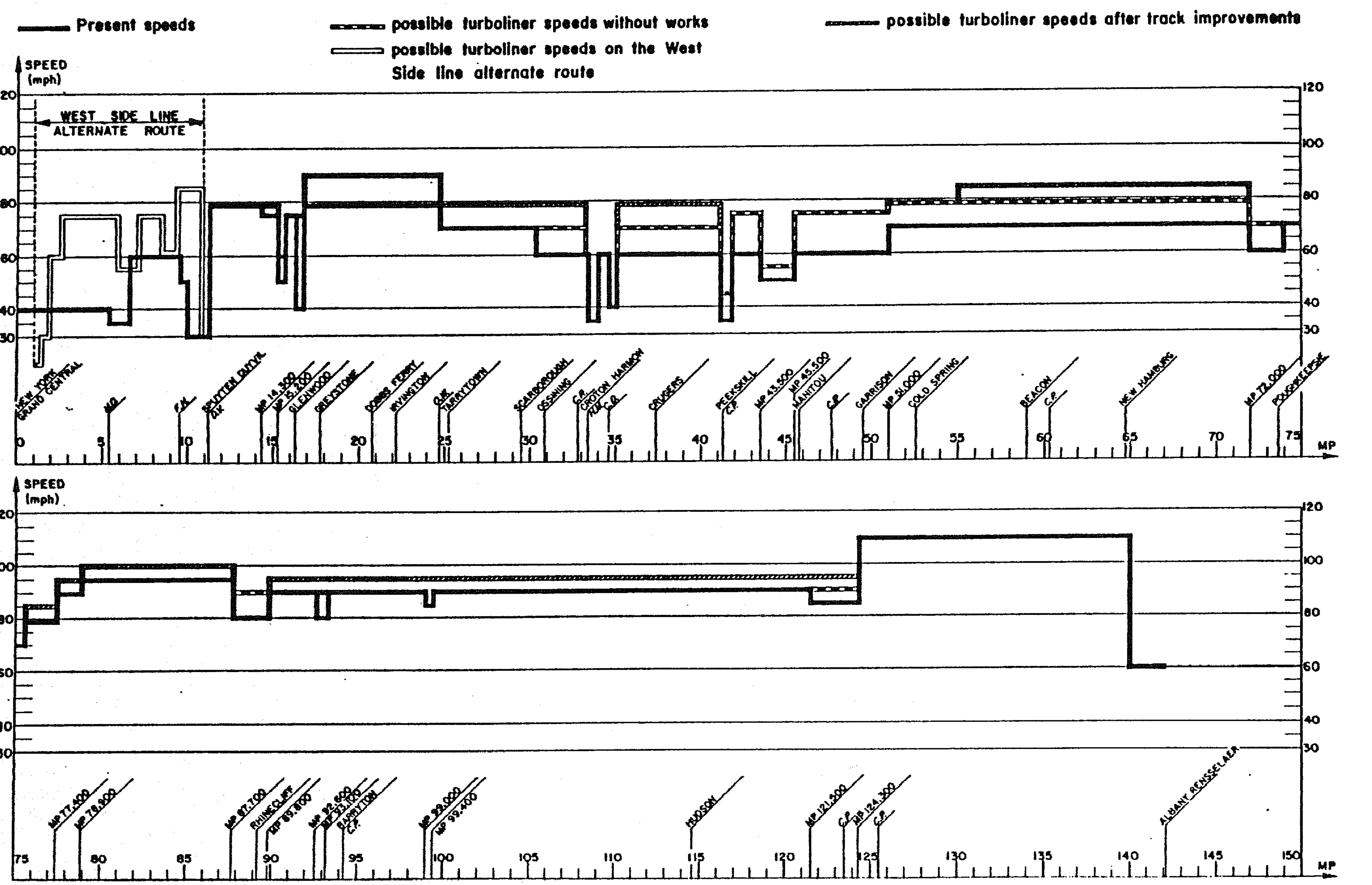

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TABLE 2 1/3

ROUTE		RADIUS		CANT		CLASS OF LINE	THEORE-TICAL SPEED	TRIAL SPEED	γ_v	γ_t			Ivth	PROPOSED TURBO SPEED		PARTICULARS
MILEAGE	LOCATION	degrees	m	inches	mm		mph	mph	ft/s²	γ_t ft/s²	γ_{nc} ft/s²	γ_r ft/s²	inches	WITHOUT WORKS mph	WITH WORKS mph	
0+000	GRAND STATION															
		–	–	–	–	4	40	40	0.85	–	–	–	–	40	–	
5+400	M.O. INTERLOCK	–	–	–	–		40	35	1.05	–	–	–	–			JUNCTION WITH HARLEM LINE
		–	–	–	–	4	60	59						60	–	
		–	–	–	–											
						4	50	?					–	50	50	
9+100		7°	250	3	76	5 ?	30	30		0.66	0.33	0.33	1 11/32	30	30	
10+000		6°15'	280	2 1/2	63	5 ?	30	30	0.82	0.95	0.13	0.16	1 3/8	30	30	TURNOUT: DIVERTED BRANCH
13+500		1°18'	1343	4	102	4	79	66	–	0.26	0.13	0.13	1 9/16	79	79	
14+000		1°06'	1588	3	76	4	79	66	–	0.39	0.16	0.23	1 23/32	79	79	
14+600		1°51'	944	4	102	4	75	66		0.46	0.26	0.20	3 5/32	75	79	
		2°17'	765	1 1/2	38	4	50	50	0.52	0.20	0.13	0.07	2 7/16	50	60	
16+300	GLENWOOD INTERLOCK	1°25'	1233	4	102	4	75	50	0.66	–	–	–	1 15/32	75	79	
16+500		–	–	–	–	4	40	19	–	–	–	–	–	40	79	
18+900		1°40'	1048	4	102		79	70						79	90	
19+500	HASTINGS					?	79	56	0.60	–	–	–		79	90	CANT TO BE INCREASED TO 4" FOR CURVE AT MILE 22+500
22+700		1°30'	1164	4	102	4	79	74	0.72	0.33	0.13	0.20	2 7/16	79	90	
23+000		0°55'	1905	1	25	6	110	75		0.52	0.13	0.39	2 15/16	79	90	
23+100		0°55'	1905	1	25	4 or 6	79 or 110	75		0.52	0.13	0.39	2 15/16	79	90	
24+700	O.W. INTERLOCK	–	–	–	–	4	70*	50	1.31	0.26	–	0.26	–	70	79	* D.O.T. ALBANY 08.1986
28+000		2°10'	806	4	102		70		0.78	0.33	–	0.33	3 5/16	70	79	
29+800		1°57'	898	3 1/8	89	4	70	60	–	–	–	–	3 1/16	70	79	

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TABLE 2 2/3

ROUTE		RADIUS		CANT		CLASS OF LINE	THEORE-TICAL SPEED	TRIAL SPEED	γ_v	γ_t			I vth	PROPOSED TURBO SPEED		PARTICULARS
MILEAGE	LOCATION									γ_t	γ_{nc}	γ_r		WITHOUT WORKS	WITH WORKS	
		degrees	m	inches	mm		mph	mph	ft/s²	ft/s²	ft/s²	ft/s²	inches	mph	mph	
30 + 800		1°38'	1069	3 1/2	89	4	60	40	1.05				0 9/16	75	79	
32 + 900	C.R. INTERLOCK	-	-	-	-	4	60/35*	40	0.92	-	-	-	-	60	60	* ON H.M. INTERLOCK
34 + 600	C.D. INTERLOCK	1°30'	1164	0 1/2	12	4	40	33	0.50	-	-	-	1 3/16	40	40	
37 + 000		2°46'	631	3 1/2	89		60			0.20	0.07	0.13	3 11/32	70*	79*	* WITH CANT INCREASED TO 6"
38 + 800		1°15'	1397	2	51	4	60	60	0.78	0.59	-	0.59	1 3/32	70	79	
41 + 000		1°52'	936	0 1/2	12	4	60	60		0.46	0.07	0.39		70	79	
41 + 300	PEEKSKILL	5°43'	305	3 1/2	89	4	35		0.72*				1 11/32	45	45	* STRUCTURE
42 + 000		2°17'	765	0 1/2	12	4	35	35.	-	-	-	-	1 16/32	45*	45*	* ACCELERATION ZONE
42 + 900		2°17'	765	4	102	4	60		-	0.33	0.13	0.20	1 21/32	75	75	
43 + 100		2°15'	776	4	102	4	60	61	-	0.33	0.13	0.20	1 9/16	75	75	
43 + 800		3°29'	501	2 1/2	63	4	50		0.66	0.20	0.07	0.13	3 1/2	55	55	
44 + 100		3°17'	532	2 1/2	63	4	50	50	-	0.33	0.07	0.26	3 3/16	55	55	
45 + 600		1°25'	1233	0 1/2	12	4	60						3 1/32	75	75	
49 + 200		2°48'	624	4	102	4	60	60	0.52	0.39	-	0.39	2 29/32	75*	75*	* WITH CANT INCREASED TO 6"
50 + 300		2°17'	765	4	102	4	60		0.56	0.36	0.07	0.30	1 21/32	75	75	
60 + 000		1°57'	895	4	102	4?	70	70	0.59	0.33	0	0.33	0 13/16	79	85*	* WITH CANT INCREASED TO 5"
73 + 800		1°15'	1397	2	51	4?	60	60	0.78	0.26	-	0.26	1 3/32	70	70	
75 + 100		1°38'	1069	4	102	4	70	69	-	-	-	-	1 1/2	70	70	
76 + 900		1°30'	1164	4	102	5	79	76	-	0.20	0	0.20	2 7/16	79	85	NO CERTAIN ELEMENT
78 + 500		1°50'	953	4	102	5	90	86	-	0.33	0	0.33	6 7/32	90*	95*	* WITH CANT INCREASED TO 6"
84 + 300		1°24'	1247	4	102	6	95	95	0.92	0.52	0.16	0.36	4 5/16	95	100*	* WITH CANT INCREASED TO 4 1/2"
85 + 400		1°09'	1519	4	102	6	95	93	0.59	0.92	0.20	0.72	3 1/8	95	100	

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TABLE 2 3/3

ROUTE		RADIUS		CANT		CLASS OF LINE	THEORETICAL SPEED	TRIAL SPEED	γ_v	γ_t			Ivth	PROPOSED TURBO SPEED		PARTICULARS
MILEAGE	LOCATION									γ_t	γ_{nc}	γ_r		WITHOUT WORKS	WITH WORKS	
		degrees	m	inches	mm		mph	mph	ft/s^2	ft/s^2	ft/s^2	ft/s^2	inches	mph	mph	
89+000	•	1°50'	953	4	102	5	80	76	0.59	0.33	0.13	0.20	4 1/16	90*	90*	*WITH CANT INCREASED TO 6"
92+600		1°50'	953	4	102	5	90	76	0.39	0.13	0.13	0.13	6 7/32	90*	95*	*WITH CANT INCREASED TO 6"
92+900		1°50'	953	4	102	5	80	*75	-	0.39	0.13	0.26	6 7/32	90*	95*	*WITH CANT INCREASED TO 6"
94+900		1°24'	1247	4	102	5	90	90	0.66	-	-	-	3 25/32	90	95	
96+800						5	90	90	0.85	0.52	0	0.52				STRAIGHT
99+200		1°30'	1164	4	102	5	85	85	0.85	0.39	0.20	0.20	3 16/32	85	95	
104+300		1°50'	953	4	102	5	90	90	0.66	0.66	0.13	0.52	6 7/32	90*	95*	*WITH CANT INCREASED TO 6"
123+900		1°51'	944	4	102	5	85	85	0.52	0.52*	-	0.52	5 3/16	90	95**	*TURNOUT – **CAN UP TO 6"
134+100		1°00'	1747	4	102	6	110	106	0.98	0.66	0.07	0.59	4 11/32	110	110	
135+700		1°00'	1747	4	102	6	110	106	0.92*	0.56	0.07	0.49	4 11/32	110	110	*STRUCTURE
142+000	CP I	-	-	-	-	?	60	45 ?	-	-	-	-	?	?		
	ALBANY						15									

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TABLE 3 – 1/2

ROUTE from	ROUTE to	SPEEDS 1st phase	SPEEDS After works	WORKS TO BE DONE 1	WORKS TO BE DONE 2	WORKS TO BE DONE 3	WORKS TO BE DONE 4	1 Tamping; 2 Tamping + cant adjustment; 3 drainage; 4 replacing of turnout
0	15.000	75	79	0.5				
0	15.200	50	60		0.3			Tamping, cant + 13 mm
YONKERS CURVE								
0	GLENWOOD INTERLOCK 16.300	75	79	0.1				
GLENWOOD INTERLOCKING 16.300		40	60				6	
OOD INTERLOCK 0	O.W. INTERLOCK 24.700	79	90	2.2				If route upgraded to class 5, as planned
INTERLOCK	24.700	70	79	0.5		0.3 x 4	6	6 turnouts + tamping + drainage
INTERLOCK 0	MP 30.300	70	79	1.7				
.300	C.R. INTERLOCK 32.900	75	79	0.4				0.28 vertical at C.R. INTERLOCK, but no time gain to be expected if stop at CROTON-HARMON
INTERLOCK CD 0	CP 40 40.800	70	79	0.4				2 curves between MP 37 and MP $\frac{32}{8}$ - cant + 0.5 (13 mm)
	PEEDSKILL CURVE	70	79	0.2				
0	41.200							
0	41.800	45				0.2 x 2		I = 118 mm at 45 mph. I = 146 mm at 50 mph, so limit without upgrading to class 5 (+ structure at MP 42)
PEEKSKILL CURVE								
0	MP 43.500	75						
.500	MP 45.500	55						I = 117 mm at 55 mph
.500	MP 51.000	75	75	0.3	0.3		4	I = 141 mm seek upgrading to class 5 and cant + 13 mm
.000	MP 55.000	79	/	/	/	/	/	At 54.600 I = 128 mm at 79 mph - Seek upgrading to class 5
.000	MP 79.000	79	85	0.1 0.8	/	0.1 x 2	4*	Structure 58.000 - * INTERLOCK 58.500 Tamping but no replacing - Same at 61.500 - Seek upgrading to class 5
.000	MP 74.000	70		0.3				
.000	MP 75.500	70 79						
.500	MP 77.400							

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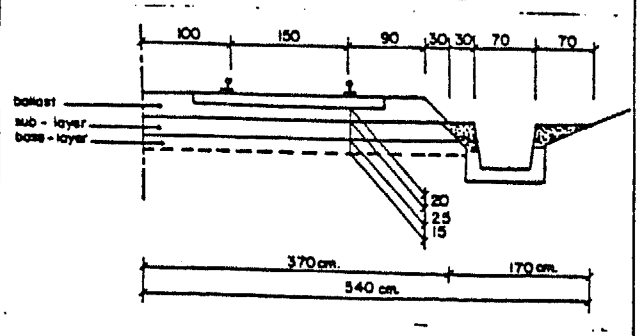
ROUTE from	ROUTE to	SPEEDS 1st phase	SPEEDS After works	WORKS TO BE DONE 1	2	3	4	1 Tamping; 2 Tamping + cant adjustment; 3 drainage; 4 replacing of turnout
.400	MP 78.900	90	95		0.4			Cant + 26 mm - Curve 78.500
.900	MP 85.400	95	100	0.5*				I max. 114 mm - * with 1 level crossing
				0.3				
.400	MP 87.700	95	100	0.4	/	/		
.700	MP 89.800	90						Rhine cliff sta. at MP 89
.800	MP 92.600	90	95		/	/		
.600	MP 93.100	90	95		0.3			I = 112 mm at 90 mph - Cant + 26 mm - I = 116 mm at 95 mph
.100	MP 99.000	90	95	3.6				I = 110 mm at 95 mph
				12.3	1.3	1.8	16	
.000	MP 99.400	85	95	1.6				I = 110 mm at 95 mph
.400	MP 103.900	90	95	2.6			2	
	G.O. INTERLOCK							
3.900	MP 107.000	90						Important works
7.000	MP 121.500	90	95	0.2		0.2 x		Structure 108.100
				4.3		2		
1.500	MP 124.300	90	95	1.6				
				0.2*				* 1 level crossing
4.300	MP 140.000	110	110	2.0	-			Comfort allowing higher speed
				12.5	0	0.4	2	
t from page 1				12.3	1.3	1.8	16	
				km 24.8 x 2	km 1.3 x 2	km 2.2 /	Ap. 18 /	

ITEMS	UNIT	QUANTITY	FRENCH COST (1)		U.S. COST	
			Unit price $	Cost $	Unit price $	Cost $
1) MECHANICAL TAMPING						
a) Detail of cost per linear meter of track (ml)						
- Mechanical tamping with laying of ballast (0.20 m)	ml	1	1.56	1.56*		
- Ballast supply	t/ml	0.08	5.14	0.41		
- Ballast unloading	t/ml	0.08	0.62	0.05*		
-- cost january 1985 updating coefficient = 1.03	ml	1		2.02		
-- cost january 1986	ml	1	2.08	2.08		
rounded up at	ml	1	2.10	2.10		
b) Of which cost of labor						
- Quantum of cost of labor = 20 % of costs marked*						
-- total of costs marked*, january 1985 updating coefficient = 1.03				1.61		
-- total of costs marked*, january 1986				1.66		
-- quantum of cost of labor	ml	1	0.33	0.33		
c) Total cost of mechanical tamping						
- Mechanical tamping, all included	ml	49.600	2.10	104,299.00		
rounded up at				104,300.00		
2) MECHANICAL TAMPING WITH TRACK LIFTING						
a) Detail of cost per linear meter of track						
- Mechanical tamping + track lifting (cant) up to 0.15 m	ml	1	6.23	6.23*		
- Ballast supply	t/ml	1.00	5.14	5.14		
- Ballast unloading	t/ml	1.00	0.62	0.62*		
-- cost january 1985 updating coefficient = 1.03	ml	1		11.99		
-- cost january 1986	ml	1		12.36		
rounded up at				12.40		
b) Of which cost of labor						
- Quantum of cost of labor = 20 % of costs marked*						
-- total of costs marked*, january 1985 updating coefficient = 1.03				6.85		
-- total of costs marked*, january 1986				7.06		
-- quantum of cost of labor	ml	1	1.40	1.40		
c) Total cost of mechanical tamping with lifting						
- Mechanical tamping + track lifting (cant), all included	ml	2.600	12.46	32,406.00		
rounded up at				32,410.00		

ITEMS	UNIT	QUANTITY	FRENCH COST (1)		U.S. COST	
			Unit price $	Cost $	Unit price $	Cost $
3A) DRAINAGE (ROADBED)						
a) Detail of cost per linear meter of track						
						
Volume of base layer : 1 ml x 5.40 m x 0.15 m	m3/ml	0.81				
Volume of sub-layer : 1 ml x 5.40 m x 0.25 m	m3/ml	1.35				
-- total volume	m3/ml	2.16				
- Excavation for base layer	m3/ml	0.81	3.54	2.87		
- Disposal of existing sub-layer + excavated material	m3/ml	2.16	2.17	4.69		
- Placing of new base layer	m3/ml	0.81	11.96	9.69		
- Placing of new sub-layer	m3/ml	1.35	36.66	49.49		
-- cost, january 1985 updating coefficient = 1.03	ml	1	66.74	66.74		
-- cost, january 1986	ml	1	68.74	68.74		
rounded up at	ml	1	69.33	70.00		
(Note : base layer 11.95 $/m3 = 2.31 + 9.64)						
b) Of which cost of labor						
- Quantum of cost of labor = 50 % of the following costs*						
. 2.87 $* . 2.31 $ × 0.81 = 1.87* $. [2.31 $ × 36.65/11.95 = 7.09 $] × 1.35 = 9.57 $* . 4.69 $						
-- total of costs marked*, january 1985 updating coefficient = 1.03				19.02		
-- total of costs marked*, january 1986				19.59		
-- quantum of cost of labor	ml	1	9.82	9.82		
c) Total cost of drainage (roadbed)						
- Drainage works (roadbed)	ml	2,200	69.33	152,528.00		
3B) DRAINAGE NEAR STRUCTURES						
a) Detail of cost per linear meter of track						
- Laying of precast concrete ditches h = 0.70 m	ml	1	160.47	160.47		
updating coefficient = 1.03						
-- cost january 1986	ml	1	165.15	165.15		

ITEMS	UNIT	QUANTITY	FRENCH COST (1)		U.S. COST	
			Unit price $	Cost $	Unit price $	Cost $
b) Of which cost of labor						
- Quantum of cost of labor = 25 % of above unit price	ml	1	41.29	41.29		
c) Total cost of drainage near structures						
- Laying of precast concrete ditches h = 0.70 m	ml	1,000	165.15	165,150.00		
3C) DRAINAGE (ROADBED) OUTSIDE RENEWED TURNOUTS						
a) Detail of cost per linear meter of track						
- Removal and relaying of track in open line	ml	1	20.10	20.10*		
- Ballast clearing	ml	1	9.35	9.35*		
- Ballast supply	t/ml	1.6	5.14	8.23		
- Ballast unloading	t/ml	1.6	0.62	1.00*		
- Levelling of the track	ml	1	6.23	6.23*		
-- cost january 1985 updating coefficient = 1.03	ml	1		44.91		
-- cost january 1986	ml	1	46.25	46.25		
rounded up at	ml	1	47.00	47.00		
b) Of which cost of labor						
- Quantum of cost of labor = 75 % of costs marked*						
-- total of costs marked*, january 1985 updating coefficient = 1.03				36.68		
-- total of costs marked*, january 1986				42.45		
-- quantum of cost of labor	ml	1	28.36	28.36		
c) Total cost of drainage outside renewed turnouts						
- Length of zones = 2,200 - (6 turnouts x 60 m) = 2,200 - 360 m = 1,840 m						
- Drainage of zones outside renewed turnouts	ml	1,840	46.74	86,000.00		
d) Total of drainage works						
- Total 3A + 3B + 3C				403,700.00		
4) RENEWAL OF TURNOUTS						
a) Detail of cost per turnout						
- Supply of single turnout tg 0.085	u	1	20,083	20,083.00		
- Removal and laying of single turnout tg 0.085	u	1	4,720	4,720.00*		
- Supply of track between 2 turnouts (interlocking)	u	1	1,201	1,201.00		
- Removal + laying of track between turnouts (interlocking)	u	1	200	200.00*		
- Ballast supply	t/u	105	5.14	540.00		
- Ballast unloading	t/u	105	0.62	65.00*		
- Levelling of turnout	u	1	2,547	2,547.00*		

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ITEMS	UNIT	QUANTITY	FRENCH COST (1)		U.S. COST	
			Unit price $	Cost $	Unit price $	Cost $
- Excavation for turnout	ml	40	22.44	897.00*		
- Excavation for ordinary track	ml	30	17.61	528.00*		
- Supply of ordinary track	ml	20	120.13	2,402.00		
- Removal and relaying of ordinary track	ml	20	17.14	343.00*		
- Ballast supply for 20 m of ordinary track (ballast = 2.1 t/ml)	t	42	5.14	216.00		
- Unloading of ballast for ordinary track	t	42	0.62	26.00*		
- Levelling of ordinary track	ml	20	6.23	125.00*		
-- cost, january 1985 updating coefficient = 1.03	u	1		33,893.00		
-- cost, january 1986	u	1	34,915	34,915.00		
rounded up at	u	1	35,000	35,000.00		
b) Of which cost of labor per turnout						
- Quantum of cost of labor = 75 % of costs marked*						
-- total of costs marked*, january 1985 updating coefficient = 1.03				9,452.00		
-- total of costs marked*, january 1986				9,737.00		
-- Quantum of cost of labor, per turnout				7,323.00		
c) Total cost of turnout renewal						
- Renewal of turnouts, all included	u	18	35,055	630,990.00		
5) RECAPITULATION OF TRACK WORKS						
- Mechanical tamping				104,210.00		
- Mechanical tamping with track lifting				32,410.00		
- Drainage				403,700.00		
- Renewal of turnouts				630,990.00		
-- cost of track works, all included, january 1986				1,171,310.00		
rounded up at				1,171,500.00		

SNCF

COSTS OF TRACK WORKS : NEW-YORK - ALBANY

ADDENDUM N° 1

TABLE 4.5/6

ITEMS	UNIT	QUANTITY	FRENCH COST (1)		U.S. COST	
			Unit price $	Cost $	Unit price $	Cost $
RENEWAL OF TURNOUTS WITH LAYING OF UIC 60 - A 74 tg 0.085						
a) Detail of cost per turnout						
- Supply of single turnout UIC 60 - A 74 tg 0.085	u	1	28,356	28,356.00		
- Removal and laying of single turnout tg 0.085 UIC 60 - A 74	u	1	5,193	5,193.00*		
- Supply of track between 2 turnouts (interlocking)	u	1	1,321	1,321.00		
- Removal + laying of track between turnouts (interlocking)	u	1	219	219.00*		
- Ballast supply	t/u		5.14	643.00		
- Ballast unloading	t/u	125	0.62	78.00*		
- Levelling of turnout	u	1	2,547	2,547.00*		
- Excavation for turnout	ml	40	22.44	897.00*		
- Excavation for track	ml	30	17.61	528.00*		
- Supply of track (UIC 60)	ml	20	132.27	2,645.00		
- Removal + laying of track (UIC 60)	ml	20	17.92	358.00*		
- Ballast supply for 20 m of track (ballast = 2.4 t/ml)	t	48	5.14	247.00		
- Unloading of ballast for track	t	48	0.62	30.00*		
- Levelling of track (UIC 60)	ml	20	7.95	159.00*		
-- cost, january 1985 updating coefficient = 1.03	u	1		43,221.00		
-- cost, january 1986	u	1	44,502	44,502.00		
rounded up at	u	1	44,500	44,500.00		
b) Of which cost of labor						
- Quantum of cost of labor = 75 % of costs marked*						
-- total of costs marked*, january 1985 updating coefficient = 1.03				10,010.00		
-- total of costs marked*, january 1986				10,314.00		
-- Quantum of cost of labor, per turnout				7,736.00		
c) Total cost of turnout renewal						
- Renewal of turnouts, all included	u	18	44,502	802,058.00		

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COSTS OF TRACK WORKS : NEW-YORK - ALBANY

ADDENDUM N° 2

TABLE 4. 6/6

ITEMS	UNIT	QUANTITY	FRENCH COST (1)		U.S. COST	
			Unit price $	Cost $	Unit price $	Cost $
EXTRA COSTS FOR TRACKS WITH 3 RD RAIL						
1) EXTRA COST ON MECHANICAL TAMPING						
- Extra cost on mechanical tamping	ml	1	0.62	0.62		
- Extra cost on quantum of cost of labor	ml	1	0.09	0.09		
2) EXTRA COST ON MECHANICAL TAMPING WITH TRACK LIFTING						
- Extra cost on mechanical tamping + track lifting	ml	1	3.74	3.74		
- Extra cost on quantum of cost of labor	ml	1	0.42	0.42		
3) EXTRA COST OF TRACK REMOVAL AND LAYING IN ZONES WITH DRAINAGE WORKS						
- Extra cost on track removal	ml	1	0.39	0.39		
- Extra cost on track laying	ml	1	0.89	0.89		
- Removal of third rail	ml	1	1.06	1.06		
- Laying of third rail	ml	1	1.59	1.59		
-- total of extra cost, january 1979 updating coefficient = 1.51				3.93		
-- total of extra cost, january 1986	ml	1	5.93	5.93		
rounded down to	ml	1	5.90	5.90		
- Extra cost on quantum of cost of labor	ml	1	4.44	4.44		
4) EXTRA COST ON RENEWAL OF TURNOUT						
- Extra cost on removal of turnout	u	1	43.62	44.00		
- Extra cost on laying of turnout	u	1	156	156.00		
- Removal of third rail	u	1	74	74.00		
- Laying of third rail	u	1	111	111.00		
- Removal of extreme elements	u	1	9	9.00		
- Laying of extreme elements	u	1	19	19.00		
-- total of extra cost, january 1979, per turnout updating coefficient = 1.51	u	1		413.00		
-- total of extra cost, january 1986, per turnout	u	1	623	623.00		
rounded up at	u	1	625	625.00		
- Extra cost on quantum of cost of labor, per turnout	u	1	467	467.00		

(1) NOTE :

These costs have been computed on the basis of French National Rail roads' (S.N.C.F.) "Série de prix projets, 1985 édition".

They do not include :
- taxes and overhead expenses,
- transport costs and indirect costs on materials,
- site monitoring and protection costs.

Costs in US $, on the basis of 1 $ = 6.42 FF (exchange rate january 1987).

RUNNING TIMES

Computed by ANF Industrie

on the basis of SNCF's speed diagrams

ANF

NEW YORK - ALBANY

TABLE 5 1/2

Type of trainset	Level of limit speed	Traction turbines	Route	Basic running (without margin): Average on-line running time and speed (mn - mph)	Basic running (without margin): Booster time in % of on-line running time	Basic running (without margin): On-line traction consumption (trainset) (US gal/mile)	On-line running time (standard running with a 5 % regularity margin) (mn)
RTL M1+3R+M1 - gear ratio 125 mph - driving axle load : 19 t trainset mass under normal load : 302 t power to weight ratio 6.4 kW/t	Limit speeds with track works table n°1	1 turmo XII and 1 turmo III (this last one used as a booster) -- Performances and consumptions computed for "standard" weather conditions with "standard" contrary wind taken into account	New-York Croton-Harmon 33.3 miles	37.3 mn 53.5 mph	36.6	1.83	39.2
			Croton-Harmon Poughkeepsie 40.3 miles	33.9 mn 71.2 mph	51	1.74	35.6
			Poughkeepsie Rhinecliff 15.5 miles	11.9 mn 78.4 mph	67.9	2.13	12.5
			Rhinecliff Hudson 25.3 miles	18.3 mn 83.2 mph	42.4	1.74	19.1
			Hudson Albany-Rensselaer 27.7 miles	19.1 mn 86.9 mph	90.85	2.10	20.1
			New-York Albany 142.1 miles — 4 stops	120.5 mn 70.7 mph	53.2	1.87	126.5
			New-York Albany 142.1 miles — no stop	114 mn 75 mph	51.7	1.70	119.5

NEW-YORK - ALBANY
(WEST SIDE LINE ALTERNATIVE)

TABLE 5 2/2

Type of trainset	Level of limit speed	Traction turbines	Route	Basic running (without margin) Average on-line running time and speed mn - mph	Booster time in % of on-line running time	On-line traction consumption (trainset) US gal/mile	On-line running time (standard running with a 5 % regularity margin) mn
RTL M1+3R+M1 - gear ratio 125 mph - driving axle load : 19 t - trainset mass under normal load : 302 t - power to weight ratio 6.4 kW/t	Table 1 with West Side Line	1 turmo XII and 1 turmo III (this last one used as a booster) -- Performances and consumptions computed for "standard" weather conditions with "standard" contrary wind taken into account	New-York Croton-Harmon 33.3 miles	29.4 mn 66.3 mph	56.9	2.02	30.9
			Croton-Harmon Poughkeepsie 40.3 miles	33.9 mn 71.2 mph	51	1.74	35.6
			Poughkeepsie Rhinecliff 15.5 miles	11.9 mn 78.4 mph	67.9	2.13	12.5
			Rhinecliff Hudson 25.3 miles	18.3 mn 83.2 mph	42.4	1.74	19.1
			Hudson Albany-Rensselaer 27.7 miles	19.1 mn 86.9 mph	90.85	2.10	20.1
			New-York Albany 142.1 miles — 4 stops	112.6 mn 75.3 mph	59.7	1.93	118 (rounded)
			New-York Albany 142.1 miles — no stop	105.5 mn 80.4 mph	58.5	1.74	111