ENSCO

TEST PLAN FOR X2000 EVALUATION

SEPTEMBER 28, 1992

Approvals:

_____	_____
FRA	**Amtrak**
_____	_____
ABB	**SwedeRail**

TEST PLAN FOR THE EVALUATION OF THE X2000

PART ONE

Introduction

The purpose of this document is to provide a single reference source for the technical aspects of AMTRAK's planned evaluation of the X2000 trainset. In concept this plan is to be a "Living Document" in that it will be regularly updated as new information and better definition of the tests become available. This approach to test planning is considered essential because of the diversity of organizations and people who are likely to have an interest in and perhaps contribute to the test planning process.

After each revision, the test plan will be distributed to the following recipients for further review and comment. It is intended that the final test plan will be approved by all parties prior to the commencement of tests.

Name	Organization
T. Edwards	ABB
R. Nilsson	ABB
J. Silien	ABB
L. Kloow	SJ
E. Lombardi	AMTRAK
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W. O' Sullivan	FRA Office of Safety
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TEST PLAN FOR THE EVALUATION OF THE X2000
18 SEPTEMBER 1992

SECTION CONTENTS

1.1. TEST OBJECTIVE

The objective of this test is to determine the suitability of the X2000 trainset for operation at elevated cant deficiencies and speeds in AMTRAK's Northeast Corridor. Ultimately the results of the technical tests will be used to support AMTRAK's request for FRA approval to run the X2000 in a revenue service demonstration.

1.2 OVERVIEW OF EVALUATION PROGRAM

The evaluation program for the X2000 trainset, as currently planned, involves a series of different technical tests to be followed by one or more simulated or demonstration revenue service operations. Each test in sequence is dependent upon successful completion and analysis of performance from previous tests.

The overall test sequence will be as follows:

1- **Commissioning-** to confirm operational readiness.
2- **Cant Deficiency-** to establish safe curving limits.
3- **High Speed Stability-** to establish maximum safe speed.
4- **Pre-Revenue Test Runs-** to demonstrate the safety of the intended revenue service operation.

A test report, documenting the procedures, events and results from the overall test program, will be used to support AMTRAK's request for FRA approval for demonstration in revenue service.

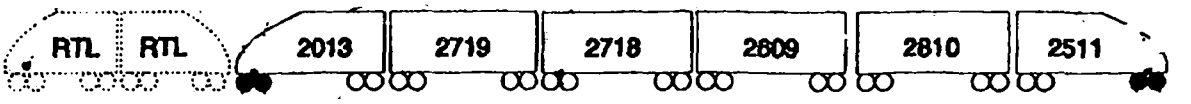
Current plans for revenue service type operations include approximately four months of limited revenue service between Washington, DC and New Haven (or New York City), and New York City (or New Haven) to Boston.

1.3 TEST CONSIST/ROLLING STOCK TO BE TESTED

X2000 trainset - (including locomotive X2-2013; three intermediate coaches UA2-2718, UA2-2719, UA2-2810, and a first-class buffet UAR2-2609; and driving trailer UA2X-2511).

Two RTL turbo power cars - (used for motive power in nonelectrified territory between New Haven and Boston only).

CAR TYPE	CAR CLASS	CAR NUMBER
Locomotive	X2	2013
Coaches	UA2	2719
	UA2	2718
	UA2	2810
First-Class Buffet	UAR2	2609
Driving Trailers	UA2X	2511



1.4 TEST ZONES AND SEQUENCE

1.4.1 Commissioning Tests in Northeast Corridor- (see Commissioning Test Plan)

The purpose of the commissioning tests are to confirm operational readiness, up to 125 mph, with particular interest in:

1) propulsion systems,
2) safety appliances (i.e.- lights, horns, etc.),
3) brake systems, and
4) cab signals.

Operational checkout will also be performed for:

- tight switch/curve negotiation,
- clearances,
- ride quality of a coach and locomotive,
- basic vehicle stability,
- stop distance,
- EMI (including during regeneration braking),
- pantograph uplift forces, and
- acceleration/current draw and transformer in-rush current.

(NOTE: interior and wayside sound level stop distances and wheel and disc temperatures will be assessed using data provided by ABB).

1.4.2 Cant Deficiency Tests -

5" to 12" cant deficiency runs conducted over a test zone between Harrisburg and Philadelphia (curves between MP 13 to MP 95 have been identified as potential test candidates. See Appendix C for a list of curves).

7" to 12" cant deficiency tests between Philadelphia and New York City.

1.4.3 High Speed Stability Tests -

Tests of high speed stability will be conducted east of Philadelphia between MP28 to MP70 on the Northeast Corridor. Tests will be conducted at a maximum speed of 150 mph (see Appendix A for the test speed profile).

1.4.4 Pre-Revenue Test Run - Round Trip Washington to New York City -

A recommended revenue speed profile run between Washington and New York City will be submitted by Amtrak to the FRA. Following the above tests, two round trips will be made between Washington and New York City, one at the proposed revenue service cant deficiency/speed profile and the second at a speed profile 5 mph faster.

1.4.5 New York to Boston Demonstration -

Following the successful completion of the above tests and approval by the FRA, the X2000 will be operated on one or more demonstration runs at a maximum of seven inches of cant deficiency on Metro North and eight inches of cant deficiency elsewhere. This consist will be powered by two RTL turbo locomotives, between New Haven and Boston.

1.4.6 Revenue Service Operation -

Following successful completion of the above and approval by the FRA, the X2000 will be placed in limited service in the Northeast Corridor from New Haven (or New York City) to Washington and from New York City (or New Haven) to Boston for approximately four (4) months.

1.5 TEST SCHEDULE

The following is a chronological sequence of the tests as currently planned. The schedule is reflected in days after the test consist leaves the shop ready to test (schedule assumes Day 1 is a Monday). **Only tests run under dry (no rain) conditions will be used to assess cant deficiency and high speed stability performance.** If possible some limited testing under wet rail conditions will be conducted to quantify the effect of wet rail.)

Interface X2000 with RTL	**Day 1-8**
Commissioning (without use of instrumented wheelsets)	**Day 9-20**
Contingency day - Saturday	**Day 21**
Sunday (no tests)	**Day 22**
Move to Philadelphia	**Day 23**
Cant Deficiency Tests between Phil & Harrisburg	**Day 24-27**
Contingency day - Saturday	**Day 28**
Sunday (no tests)	**Day 29**
Cant deficiency tests - Phil - NYC	**Day 30-33**
150 mph run	**Day 34**
Contingency day - Saturday	**Day 35**
Sunday (no tests)	**Day 36**
Simulated revenue roundtrip between DC & NYC	**Day 37**
Simulated revenue roundtrip between DC & NYC	**Day 38**
Remove instrumented wheelsets & related instrumtn	**Day 39-40**
Run to NYC at proposed revenue profile, then 4" to New Haven	**Day 41**
Contingency day (Saturday)	**Day 42**
Sunday (no test)	**Day 43**
Roundtrip New Haven to NYC at 5"	**Day 44**
Roundtrip New Haven to NYC at 7"	**Day 45**
Mate RTL to X2000 at New Haven	**Day 46**
Run between New Haven to Boston at 7"	**Day 47**
Roundtrip Boston to New Haven at 8"	**Day 48**
Start removal of instrumentation & prepare for revenue service	**Day 49**

CANT DEFICIENCY AND HIGH SPEED STABILITY TESTS
TEST PROCEDURES

PART TWO

2.1 GENERAL

At the beginning of each test day, all instrumentation will receive daily calibration. The attendance log, tape log and Test Events Log will be initiated for the day. A pre-test briefing will be held informing all participants of the test plan for the day, and reviewing all critical safety procedures. The Test Director will review the planned speed profile with the Engineer and the Transportation Supervisor. When the calibrations are complete, the strip charts are annotated and the chart monitors are ready, the Lead Test Engineer will advise the Test Director that the system and test personnel are ready to test. Once the Test Director has confirmed all personnel are onboard, he will advise the conductor to proceed according to the test speed profile.

2.2 CALIBRATIONS

The results of all calibrations will be recorded in a calibration test log. Any instrumentation failures and corrective action will be noted in the log.

2.2.1 Initial Calibrations

Initial calibrations, including shunt calibrations with a resistor applied at each of the wheelsets, will be performed during and following instrumentation installation. Where practical, a physical calibration and an electrical calibration will be performed on all data channels. Accurate calibration of the speed measurement is critical. The same speed signal will be displayed in the data system and in both control cabs.

Calibration of all volt meters, strip chart recorders and data equipment will be confirmed to be current.

2.2.2 Daily Calibrations

Shunt calibrations will be performed on all instrumented wheelset data channels at the beginning and end of each test day as a minimum. As required, the balance of the force measuring bridges will be confirmed to eliminate drift and centrifugal effects. An electrical calibration signal will be placed on all data acquisition channels at the beginning and the end of each test day. Each individual strip chart record will have a zero and step calibration signal at the beginning and end of the record.

2.3 TEST LOGS AND STRIP CHART ANNOTATION

The following test logs will be maintained (see Appendix C for examples and sign-up sheet):

- Initial Calibration Log (by Lead Test Engineer)
- Daily Attendance Log (by Test Director)
- Daily Calibration Log (by Lead Test Engineer)
- Data Tape Log (which test runs are on each tape by Lead Test Engineer)
- Test Events Log (indicating the time and location of all test events by Lead Test Engineer)
- Daily Checklists (by Lead Test Engineer)

All strip charts will be annotated with the date, channel assignments, scale factors, calibration values, and start/stop time/location. The location from which peak data values are extracted will be marked on each strip chart and the values as interpreted will be noted on the chart.

2.4 SPEED PROFILES AND TRAIN OPERATION

A list of the speed profiles, indicating speed and milepost/location for each planned run will be provided to the Locomotive Engineer, the Transportation Supervisor, and the Test Director prior to each test run. The Test Engineer and the Transportation Supervisor will initial and date the speed profile copy to be used in the cab. The planned speed profiles, for each of the planned test zones based on currently available track geometry data, is contained in **Appendix A.** A Transportation Supervisor will ride with the Engineer in the cab to interpret the speed profile for the Engineer and confirm the speeds to be run. The Test Director will be responsible for providing accurate speed profiles to the Transportation Supervisor and the Locomotive Engineer prior to each run. Each speed profile will be uniquely and clearly labeled with the test date and Run ID (Run ID Format - Date-Cant Deficiency-Direction-Lead End (Loco or Trailer) i.e. 01/20-06-W-L).

2.5 MEASUREMENT/INSTRUMENTATION/DATA DISPLAY/DATA ACQUISITION REQUIREMENTS

2.5.1 Pre-Test Track Geometry Measurements

Within one month prior to the tests, the track geometry for the test zones will be measured using the 10002 Track Geometry Measurement Car and the limiting speeds for each curve will be calculated for each cant deficiency level.

2.5.2 Pre-Test and Post Test Equipment Measurements

Before and after the test series and following the revenue demonstration, the following physical measurements and wear assessments are required. (These inspections are in addition to the normal required operating inspections).

- Wheel profiles
- Suspension clearances (i.e.- distance to stops)
- Inspect dampers for signs of wear or leakage
- Inspect trucks for damage due to shock or impact
- Inspect bearings for leakage
- Inspect all wear surfaces (i.e.-slides, pivots)
- Inspect hydraulic system for leakage

2.5.3 Vehicle Response/Performance Measurements

The data channels necessary for analysis of the safe performance of the X2000, including real time assessment of the stop test criteria (see section 2.7.1) will be measured and recorded. The data channels to be measured, recorded and displayed in real time will include:

- For both axles in the lead and trail trucks in the consist

  Left and Right Lateral W/R (Wheel/Rail) force
  Left and Right Vertical W/R force
  Left and Right L/V ratio
  Net Axle lateral force
  Net Axle L/V ratio
  Truck Side L/V
  Net Truck Lateral force

- For the locomotive, a coach, and the driving trailer

  Vertical carbody acceleration
  Lateral carbody acceleration
  Truck lateral acceleration
  Lateral Axlebox Acceleration (one axle only)
  (Note: The above are required for ride quality assessment and to correlate the measured accelerations with wheel/rail forces for future use in monitoring performance without instrumented wheelsets.)

2.5.4 Other Data Requirements

Other test data to be logged includes the outside temperature, the wind velocity/direction and precipitation. See **Appendix B** for full definition of parameters, channel

assignments, filter corners and sampling rates. (Primary tests should not be run in the rain or in the event that winds in excess of 45 mph are forecasted).

Pantograph position will be monitored with a video camera during the test.

2.6 ANALYSIS

2.6.1 Pre-Test Analysis

The anticipated performance of the X2000 trainset will be determined by analysis prior to conducting the field tests. Measured track geometry data, of typical 'worst case' conditions from the test zones, will be used as input for dynamic simulations of the X2000. The dynamic simulation was developed and validated by ABB.

XY plots of projections of the key performance parameters will be produced. These projections will be made versus speed for response to a typical 'worst case' tangent track anomaly. For curve performance, projections will be made versus cant deficiency for 1) idealized steady state curving and 2) a typical 'worst' case curved track anomaly. (Need to assess effect of wet vs. dry rail conditions prior to testing).

The response parameters to be evaluated are those identified in the Stop Test Criteria (Section 2.7.1).

2.6.2 Verification/Validation of Modeling Results

Comparisons of test data with model predictions will be performed for validation. XY Plots of the above or similar data, based on field test results will be produced to verify that the model results are reasonable indicators of actual performance.

2.6.3 Real Time Data Analysis-(for all test series)

During test operations, real time strip charts will be used to display each of the parameters required for safety monitoring. **If any parameter exceeds the criteria or if any of the safety parameter data channels fail, the test will be halted** as described in Section 2.7.1 'Stop Test Criteria and Procedures.'

2.6.4 Field Data Analysis-(for all test series)

At the conclusion of each days' test run, XY plots of cant deficiency vs the safety parameters will be made for each curve in the test zone. For any curve on which any response parameter exceeds 75% of the stop test criteria and which are planned to be run at a higher speed, projections from

these plots will be used to determine if the next planned increment in speed, for that curve, can be obtained without exceeding the safety criteria.

Locations in tangent track, for which the safety related channels exceed 75% of the Stop Test Limit, will be logged and XY plots of performance in those locations will be plotted and projected.

2.6.5 Reporting

2.6.5.1 Preliminary Report to FRA

Following the cant deficiency and high speed stability tests a report documenting the procedures, events, results, and conclusions from the technical tests will be prepared and submitted to the Federal Railroad Administration along with recommendations and justifications for a revenue speed profile to be run during the pre-revenue test run.

The report should summarize the performance of the X2000 under all test conditions and should recommend limits for demonstration in revenue service. It should include a recommended maximum cant deficiency speed profile for revenue service indicating the probable W/R forces and carbody accelerations which are likely to be generated.

2.6.5.2 Final Report to FRA

The preliminary report will be updated with the results of the pre-revenue test run and presented to the FRA.

2.7 Test Safety

During the test, it is likely that the number of test participants and observers will be large. It is therefore critical that all persons boarding the train during the test period be advised of the General Safety Requirements (see Section 2.7.2) and the responsibilities of the Test Director, relative to safety.

2.7.1 Stop Test Criteria and Procedures

The following parameters and limits will be used to monitor all test operations:

- **Net axle lateral force**
  Safety Issue - Track Panel Shift
  -Limit 0.5 * Static Vertical Axle Load
  (High rail minus low rail lateral wheel force)

- **Maximum axle sum L/V ratio (Lateral/Vertical force)**
  Safety Issue - Wheel Climb
  -Limit 1.3
  (The absolute value of the left wheel L/V ratio plus the absolute value of the right wheel L/V ratio)

- **Minimum vertical W/R (wheel/rail) force**
  Safety Issue -Vehicle Overturning - Limit 10% of static
  (Low rail vertical force - worst case vehicle)

- **Maximum Truck side L/V**
  Safety Issue - Rail rollover - Limit 0.5
  (summation of left (or right) lateral wheel forces for a truck side divided by the summation of the left (or right) vertical forces)

- **Truck Frame Acceleration**
  Safety Issue - Truck Hunting
  -Limit +/- 0.8g (for more than 6 cycles)

- **Lateral Carbody Acceleration (RTL Power car only)**
  -Safety Issue - Vehicle overturning
  -Limit - .23g (steady state) .37g (transient)
  (measured at carbody floor over the leading truck)

Notes:

1- All accelerations displayed with a 10Hz 4 pole filter.
2- All wheel force related channels displayed with a 25Hz 4 pole filter.
3- Record each single wheel- lateral force, vertical force, and L/V ratio for diagnostic/analytical purposes (see Appendix B).
4- X2000 carbody and axle box accelerations not considered safety critical. (See Appendix B for complete listing of non-safety critical data channels).
5- Net Truck Lateral Force and Vector Intercept have been moved to non-safety critical status (see Appendix B).

If, during any test run, any of the safety criteria exceeds the above limits **or** any of the safety critical data channels fails, the Test Director will be notified immediately and he will stop the test. An assessment of how to proceed will be made. Since data projections are used to minimize the likelihood that the safety limit is exceeded, after the test is stopped, steps should be taken to assure that the instrumentation is functioning properly, and that the projections made for the location are sound. If no errors are found the test speed at that location should be limited to the next lowest safe speed for all subsequent runs. Prior to each run above five inches of cant deficiency, the track will be visually inspected by Amtrak from the rear of the train.

2.7.2 General Safety Requirements

To assure safety during the test, the following procedures will be followed.

a) No one will leave or board the test consist without the knowledge of the Test Director except at planned station stops.

b) No one is permitted to work under the test consist unless given current authorization by the Test Director and all AMTRAK safety rules are complied with.

c) Hardhats, safety glasses and safety vests will be worn by all persons while in AMTRAK shops or on the track (except while onboard the train).

d) AMTRAK trains approach very quickly and quietly. Always look both ways before leaving a train between stations. The AMTRAK conductor should always be the first one off and the last one on when stopping for instrumentation checks.

e) The personnel in the data recording area are performing safety critical functions. Distractions (i.e.- crowding, excess/loud conversations) in this area should be minimized. The Test Director is responsible for eliminating distractions as required.

2.8 RESPONSIBILITIES

Test Director-Ed Lombardi_____(AMTRAK)

FRA Test Monitor-Al MacDowell_____(FRA)

Instrumentation/Data Reduction_____(SJ)

Vehicle maint/prep_____(ABB)

Data Analysis-Thomas Edwards_____(SJ/ABB)

Analysis Oversight_____(FRA/TSC)

Reporting-Ed Lombardi/Thomas Edwards_____(Amtrak/ABB)

2.9 NOTES

1. Consist to be shipped with instrumented wheelsets installed.

APPENDIX A

SPEED PROFILES AND TRAIN OPERATION

National Railroad Passenger Corporation, 30th and Market Streets, Philadelphia, PA. 19104

Amtrak

July 27, 1992

Mr. J. Kevin Kesler
Manager - Rail Programs
ENSCO, Inc.
Applied Technology and Engineering Division
5400 Port Royal Road
Springfield, VA 22151

Dear Kevin:

Attached are test speed tables for the NEC Mainline (Newark, NJ to North Philadelphia, PA) and the Harrisburg Line (Paoli, PA to Lancaster, PA). Please include these in the Test Plan for the X2000 train set. Curving speeds were calculated using April 1992 geometry data from our Track Geometry Car (TGC). Average curvature and super-elevation rounded to the nearest 0.25" were used for the calculations. As noted in the draft of the Test Plan, the speeds will be updated with data from the TGC one month prior to the test.

Also included are graphical representations of the test runs. They show Maximum Test Speed, Curving Restrictions, and Generated Cant Deficiencies for each test run from 3" to 12" unbalance inclusive.

Please call me with any questions you may have about this data.

Sincerely,

Conrad J. Ruppert, Jr.
Manager Field Engineering

attachment:X-2000 Speed Tables & Graphs

NATIONAL RAILROAD PASSENGER CORPORATION

X-2000 TEST PROGRAM

Speed Tables & Graphs

Prepared by: Conrad J. Ruppert, Jr.
Mgr.Field Engineering

July 1992

NATIONAL RAILROAD PASSENGER CORPORATION

X-2000 TEST PROGRAM

Summary of Proposed Speeds for High Cant Deficiency & High Speed Tests

BLOCK LOCATION	APPROXIMATE MILEAGE [miles]	MAXIMUM TEST SPEED [mph]
WESTBOUND - NEC MAINLINE		
Newark Station to Hunter Interlocking	1.5	90
Hunter Interlocking to Elmora Interlocking	4.5	110
Elmora Interlocking to Milepost 27.0	12.0	125
Milepost 27.0 to Milepost 70.0	43.0	150
Milepost 70.0 to Holmes Interlocking	7.0	125
Holmes Interlocking to Shore Interlocking	5.0	100
Shore Interlocking to North Philadelphia Station	3.0	90
TOTAL	**76.0**	
EASTBOUND - NEC MAINLINE		
North Philadelphia Station to Shore Interlocking	3.0	90
Shore Interlocking to Holmes Interlocking	5.0	100
Holmes Interlocking to Milepost 70.0	7.0	125
Milepost 70.0 to Milepost 27.0	43.0	150
Milepost 27.0 to Elmora Interlocking	12.0	125
Elmora Interlocking to Hunter Interlocking	4.5	110
Hunter Interlocking to Newark Station	1.5	90
TOTAL	**76.0**	
WESTBOUND - HARRISBURG LINE		
Paoli Interlocking to Milepost 63.0	42.5	110
Milepost 63.0 to Lancaster Station	5.0	90
TOTAL	**47.5**	
EASTBOUND - HARRISBURG LINE		
Lancaster Station to Paoli Interlocking	47.5	110
TOTAL	**47.5**	

WESTBOUND - NEC MAINLINE

Newark, NJ to North Philadelphia, PA

Westbound

X-2000 TEST PROGRAM
NEC MAINLINE SPEEDS

Track No.3

CV.#	TIMETABLE DESCRIPTION	MILEPOST LOCATION		CURVE GEOMETRY			CALCULATED CURVING SPEEDS										PROPOSED MAXIMUM TESTING SPEED
		East	West	DEGREE [decimal]	RADIUS [feet]	S.E. [inches]	3"UB [mph]	4"UB [mph]	5"UB [mph]	6"UB [mph]	7"UB [mph]	8"UB [mph]	9"UB [mph]	10"UB [mph]	11"UB [mph]	12"UB [mph]	[mph]
248		9.20	9.30	0.95	6,031	1.000	78	87	90	90	90	90	90	90	90	90	90
249	Curve at Hunter	10.24	10.56	0.97	5,927	2.750	90	90	90	90	90	90	90	90	90	90	"
250		12.28	12.56	0.32	18,094	1.250	110	110	110	110	110	110	110	110	110	110	110
251		13.05	13.10	0.20	28,648	0.500	110	110	110	110	110	110	110	110	110	110	"
252	Curves between Elizabeth & Elmora Block Station	14.05	14.29	1.95	2,938	4.250	73	78	82	87	91	95	99	102	106	109	"
253	Curves between Elizabeth & Elmora Block Station	14.29	14.70	2.40	2,387	4.500	67	71	75	79	83	86	90	93	96	99	"
254		18.20	18.48	0.20	28,648	0.500	125	125	125	125	125	125	125	125	125	125	125
255		18.85	18.95	0.20	28,648	0.250	125	125	125	125	125	125	125	125	125	125	"
256		19.25	19.45	0.20	28,648	0.500	125	125	125	125	125	125	125	125	125	125	"
258		19.75	19.85	0.20	28,648	0.500	125	125	125	125	125	125	125	125	125	125	"
259		20.39	20.71	0.48	11,854	1.500	115	125	125	125	125	125	125	125	125	125	"
260		20.74	20.80	0.28	20,222	1.000	125	125	125	125	125	125	125	125	125	125	"
261		21.67	21.85	0.70	8,185	4.000	120	125	125	125	125	125	125	125	125	125	"
262		21.89	22.06	0.70	8,185	3.000	111	120	125	125	125	125	125	125	125	125	"
263		22.47	22.84	0.65	8,815	3.500	120	125	125	125	125	125	125	125	125	125	"
264		22.87	23.57	0.82	7,016	4.500	115	122	125	125	125	125	125	125	125	125	"
265	First curve east of MP 24.0	23.66	23.92	1.42	4,044	6.000	95	100	105	110	115	119	123	125	125	125	"
266	First curve west of MP 24.0	24.15	24.59	1.50	3,820	5.500	90	95	100	105	109	113	118	122	125	125	"
267	Curve at MP 25.0	24.73	25.52	1.20	4,775	4.750	96	102	108	113	118	123	125	125	125	125	"
268	First curve west of Lincoln	26.39	26.66	1.93	2,964	6.000	82	86	90	94	98	102	105	109	112	115	"
269	Second curve west of Lincoln	26.76	27.18	1.43	3,997	6.000	95	100	105	109	114	118	122	125	125	125	"
270	Third curve west of Lincoln	27.46	27.68	0.77	7,473	3.750	112	120	128	135	142	148	150	150	150	150	150
271		28.86	29.07	0.20	28,648	1.500	150	150	150	150	150	150	150	150	150	150	"
272		30.27	30.66	0.43	13,222	2.750	138	149	150	150	150	150	150	150	150	150	"
273		31.13	31.33	0.45	12,733	3.000	138	149	150	150	150	150	150	150	150	150	"
274		33.77	34.22	0.45	12,733	3.000	138	149	150	150	150	150	150	150	150	150	"
275		39.08	39.37	0.30	19,099	1.500	146	150	150	150	150	150	150	150	150	150	"

Westbound

X-2000 TEST PROGRAM
NEC MAINLINE SPEEDS

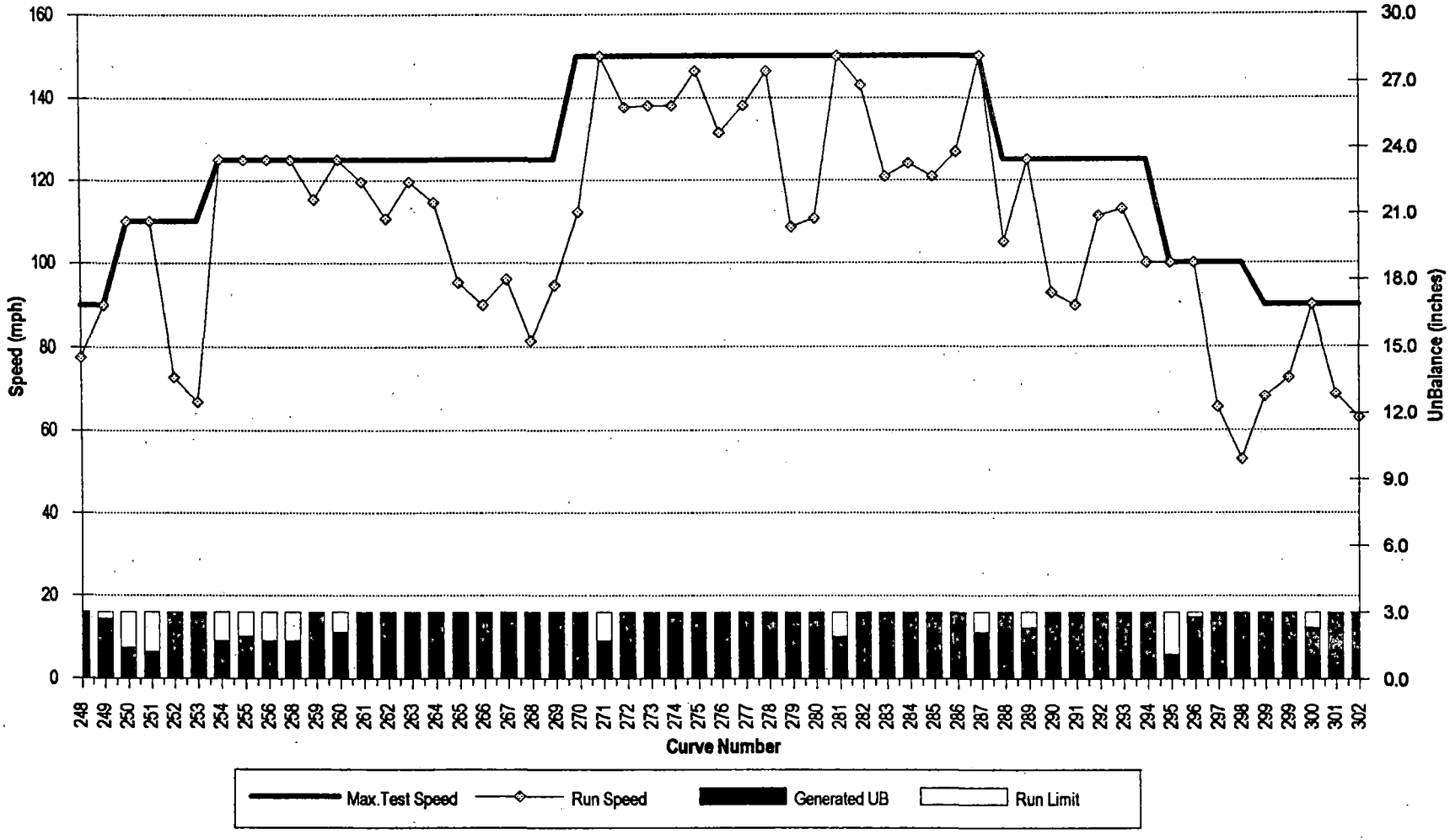
Track No.3

CV.#	TIMETABLE DESCRIPTION	MILEPOST LOCATION		CURVE GEOMETRY			CALCULATED CURVING SPEEDS										PROPOSED MAXIMUM TESTING SPEED
		East	West	DEGREE [decimal]	RADIUS [feet]	S.E. [inches]	3"UB [mph]	4"UB [mph]	5"UB [mph]	6"UB [mph]	7"UB [mph]	8"UB [mph]	9"UB [mph]	10"UB [mph]	11"UB [mph]	12"UB [mph]	[mph]
276		39.49	40.26	0.52	11,090	3.250	131	142	150	150	150	150	150	150	150	150	150
277		50.38	50.50	0.30	19,099	1.000	138	150	150	150	150	150	150	150	150	150	"
278		56.13	56.35	0.27	21,486	1.000	146	150	150	150	150	150	150	150	150	150	"
279	First curve west of Trenton	56.99	57.12	0.67	8,594	2.500	109	118	127	135	143	150	150	150	150	150	"
280	First curve west of Morris	58.42	59.09	0.82	7,016	4.000	111	118	125	132	139	145	150	150	150	150	"
281		59.50	59.70	0.17	34,378	0.750	150	150	150	150	150	150	150	150	150	150	"
282		60.24	60.57	0.37	15,626	2.250	143	150	150	150	150	150	150	150	150	150	"
283	Curve between MP 61.0 and MP 62.0	61.40	61.94	0.73	7,813	4.500	121	129	136	143	150	150	150	150	150	150	"
284	Curve east of Grundy	64.62	64.95	0.65	8,815	4.000	124	133	141	148	150	150	150	150	150	150	"
285	Curve west of Grundy	65.63	66.33	0.73	7,813	4.500	121	129	136	143	150	150	150	150	150	150	"
286		66.72	67.68	0.47	12,278	2.250	127	138	149	150	150	150	150	150	150	150	"
287		68.60	68.70	0.17	34,378	0.500	150	150	150	150	150	150	150	150	150	150	"
288	Curve west of Croydon	70.03	70.59	1.17	4,911	6.000	105	111	116	121	125	125	125	125	125	125	125
289		72.21	72.60	0.35	16,370	1.500	125	125	125	125	125	125	125	125	125	125	"
290	Reverse curves between MP 74.0 and MP 75.0	74.08	74.49	1.45	3,951	5.750	93	98	103	108	112	116	121	125	125	125	"
291	Reverse curves between MP 74.0 and MP 75.0	74.64	75.11	1.42	4,044	5.000	90	95	100	105	110	115	119	123	125	125	"
292	First curve west of MP 75.0	75.14	75.41	0.75	7,640	3.500	111	120	125	125	125	125	125	125	125	125	"
293		76.14	76.46	0.70	8,185	3.250	113	122	125	125	125	125	125	125	125	125	"
294		76.70	77.04	1.00	5,730	4.000	100	107	113	120	125	125	125	125	125	125	"
295		78.21	78.50	0.33	17,189	1.250	100	100	100	100	100	100	100	100	100	100	100
296		79.23	79.73	0.62	9,291	1.500	100	100	100	100	100	100	100	100	100	100	"
298	Curve between Shore and Ford	81.39	81.75	4.07	1,409	5.000	53	56	59	62	65	68	70	73	75	77	"
299	Curve MP 84.0 to 2nd Street overhead bridge	83.14	83.83	2.47	2,323	5.000	68	72	76	80	83	87	90	90	90	90	90
299	Curves at east and west ends of N. Phila. station pl	84.74	84.81	1.08	5,289	1.000	73	81	89	90	90	90	90	90	90	90	"
300	Curves at east and west ends of N. Phila. station pl	84.88	85.01	0.80	7,162	2.250	90	90	90	90	90	90	90	90	90	90	"
301		85.07	85.14	1.37	4,192	1.500	69	76	82	89	90	90	90	90	90	90	"
302		85.38	85.49	1.90	3,016	2.250	63	69	74	79	83	88	90	90	90	90	"

X2000NEW.XLS

AMTRAK ENGINEERING

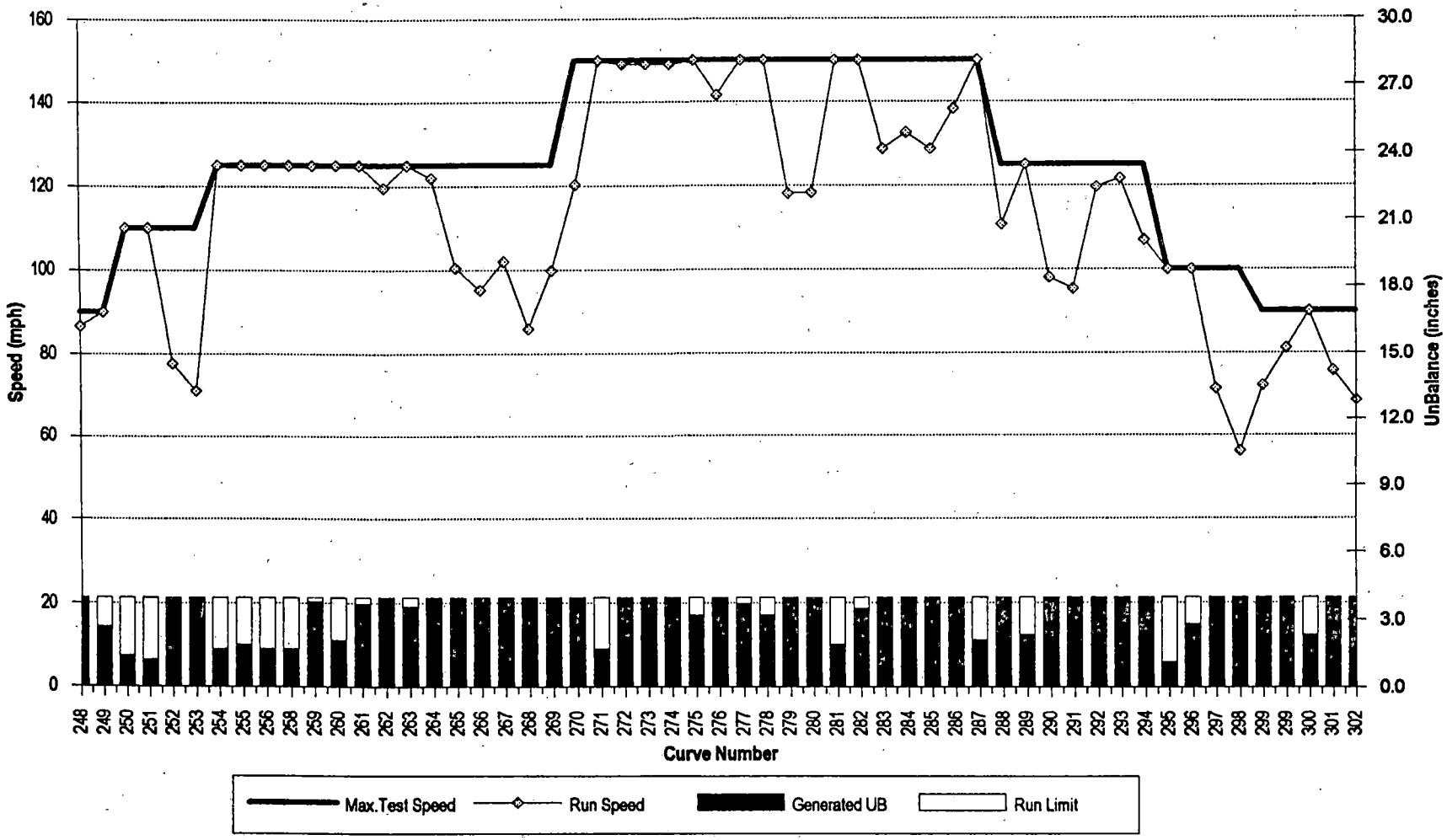
X-2000 TEST PROGRAM
NEC Mainline - Westbound - 3" UnBalance



X2_NEW03.XLC

AMTRAK ENGINEERING

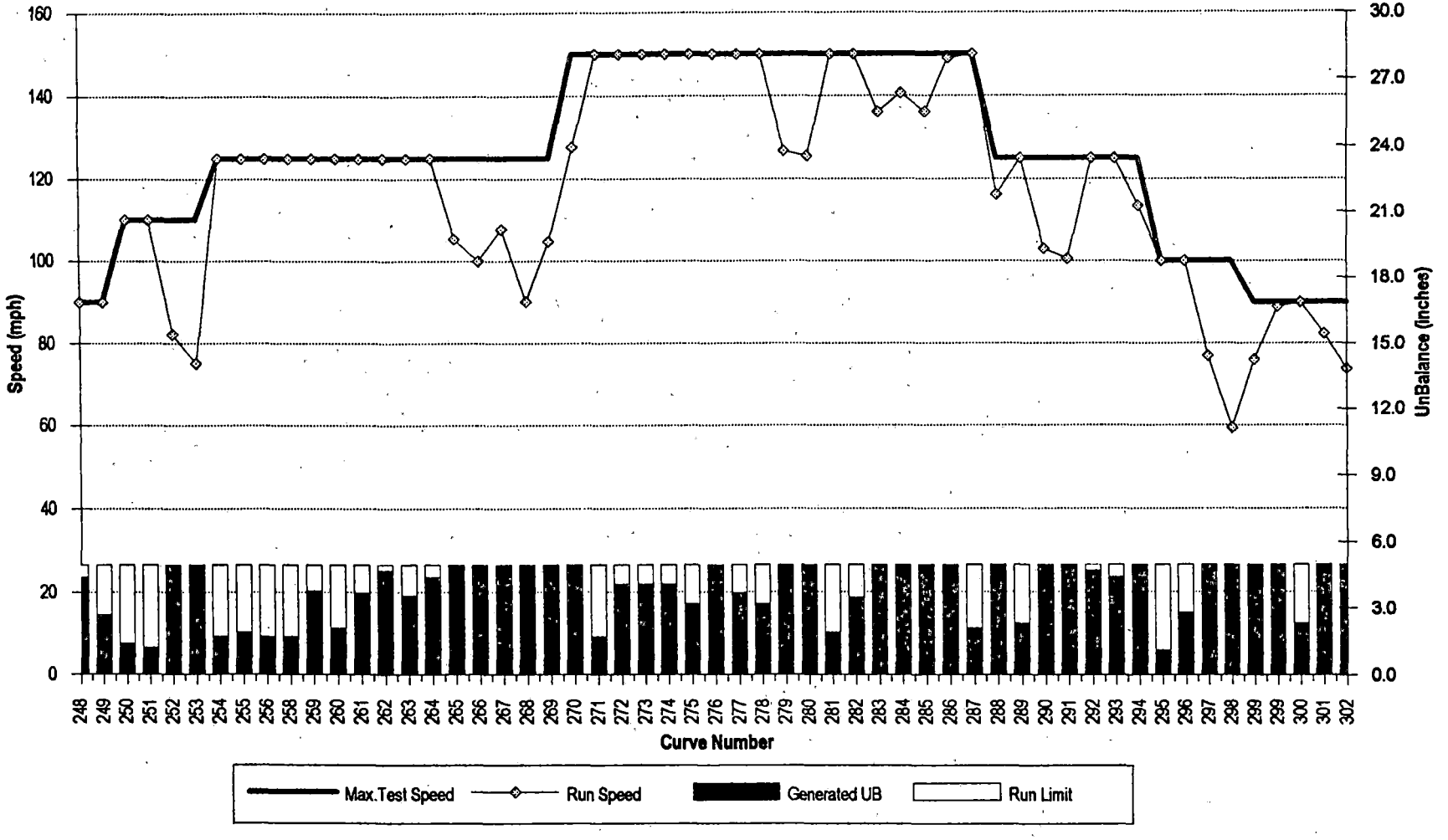
X-2000 TEST PROGRAM
NEC Mainline - Westbound - 4" UnBalance



X2_NEW04.XLC

AMTRAK ENGINEERING

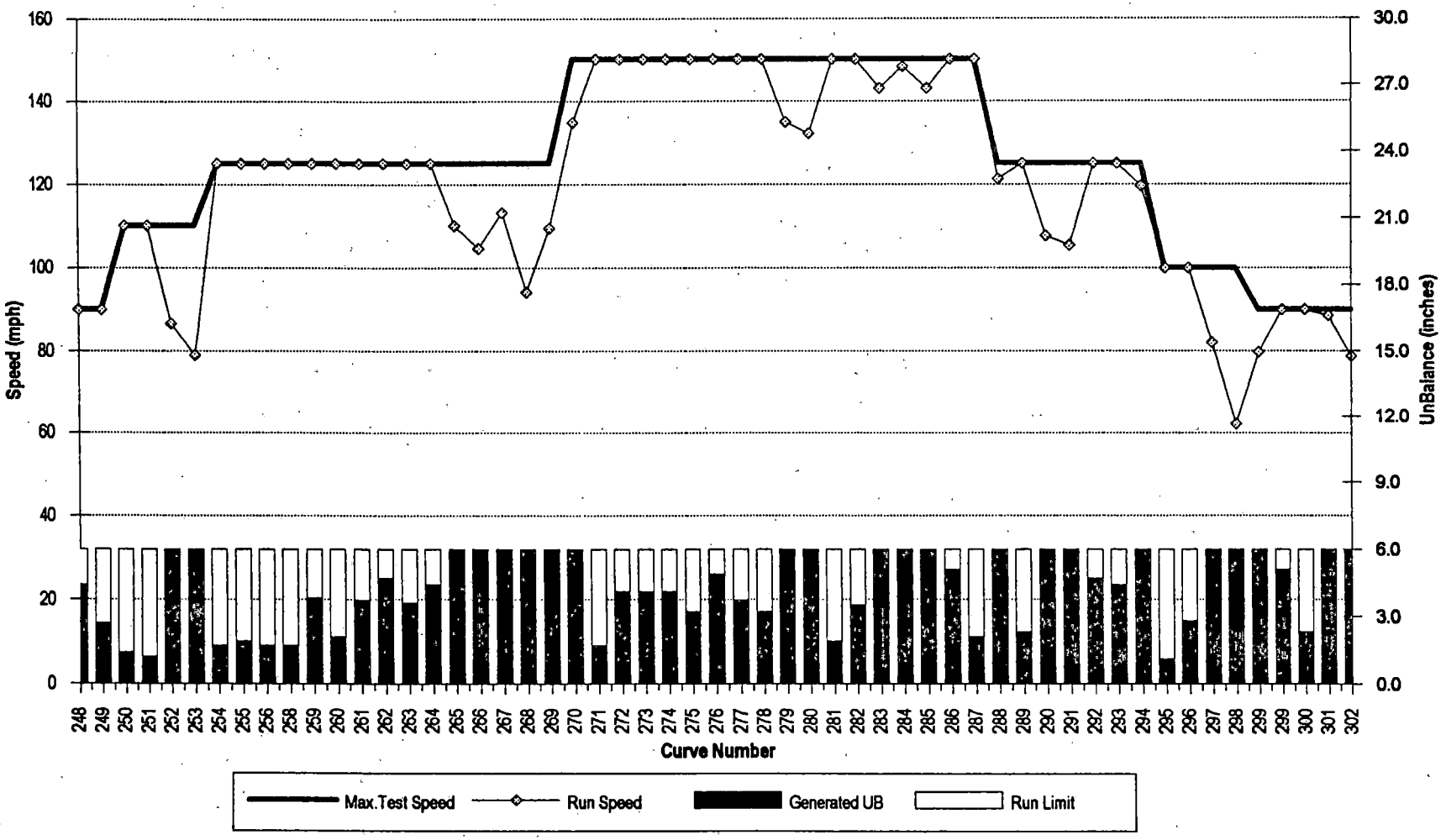
X-2000 TEST PROGRAM
NEC Mainline - Westbound - 5" UnBalance



X2_NEW05.XLC

AMTRAK ENGINEERING

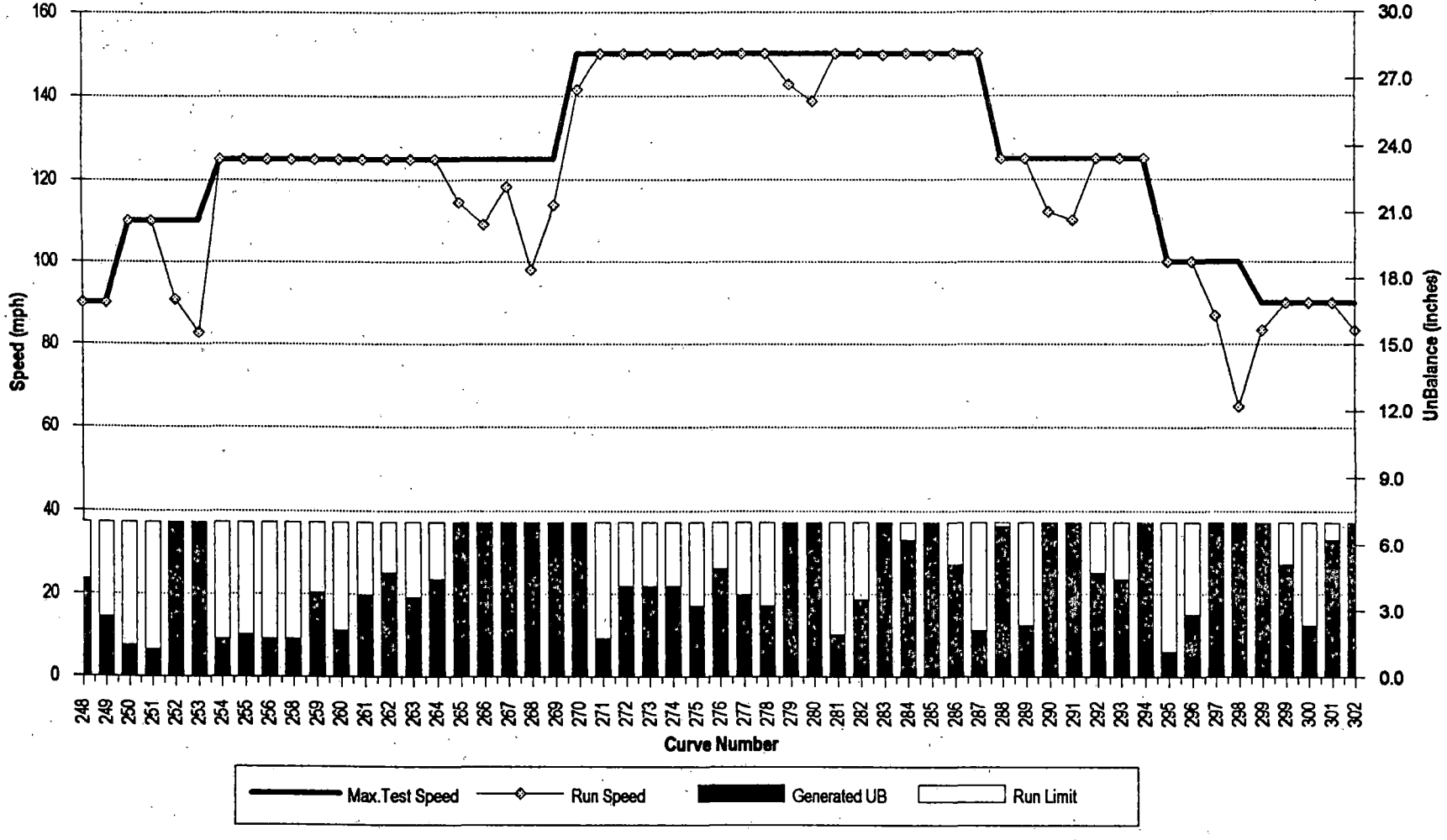
X-2000 TEST PROGRAM
NEC Mainline - Westbound - 6" UnBalance



X2_NEW06.XLC

AMTRAK ENGINEERING

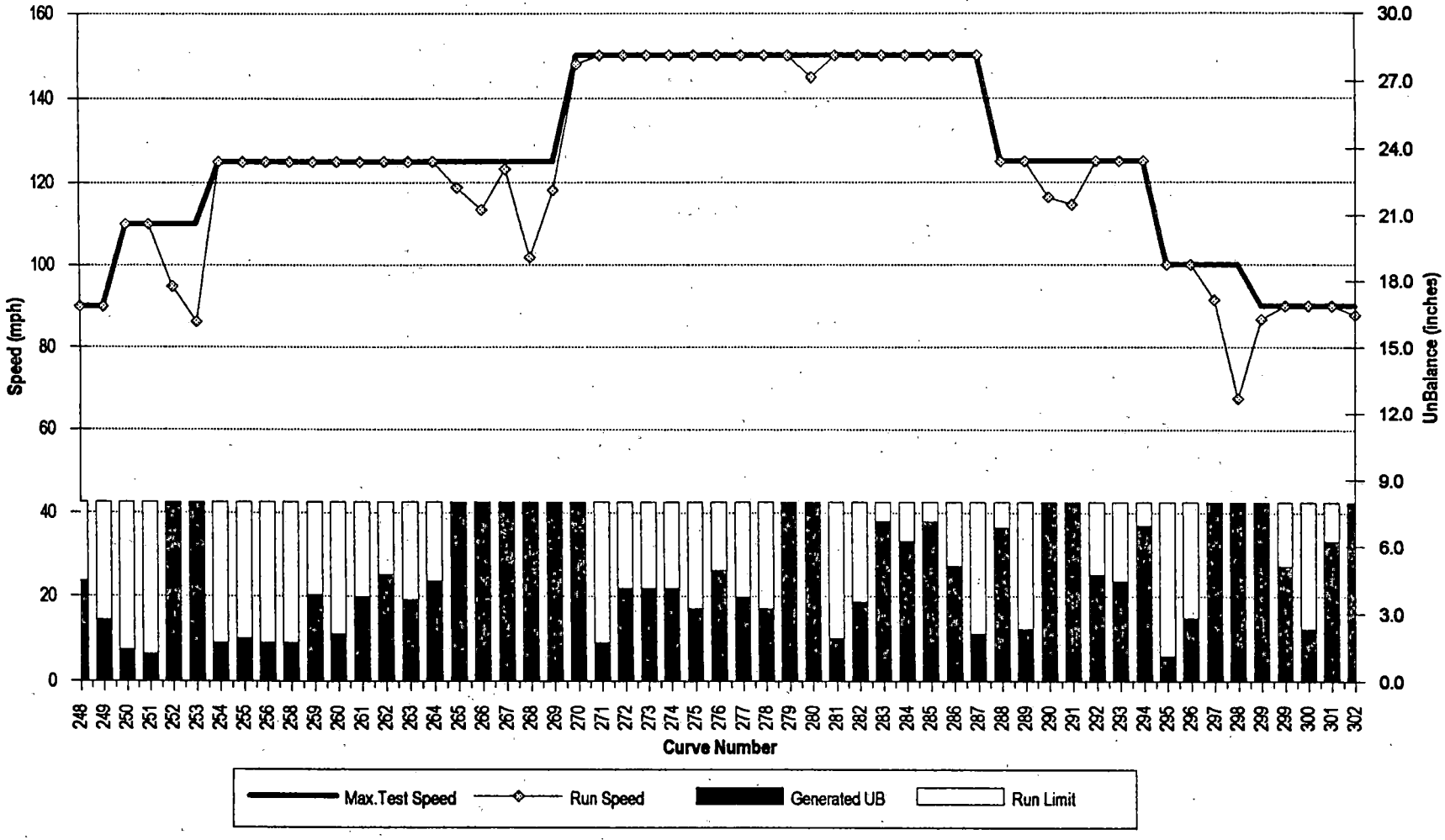
X-2000 TEST PROGRAM
NEC Mainline - Westbound - 7" UnBalance



X2_NEW07.XLC

AMTRAK ENGINEERING

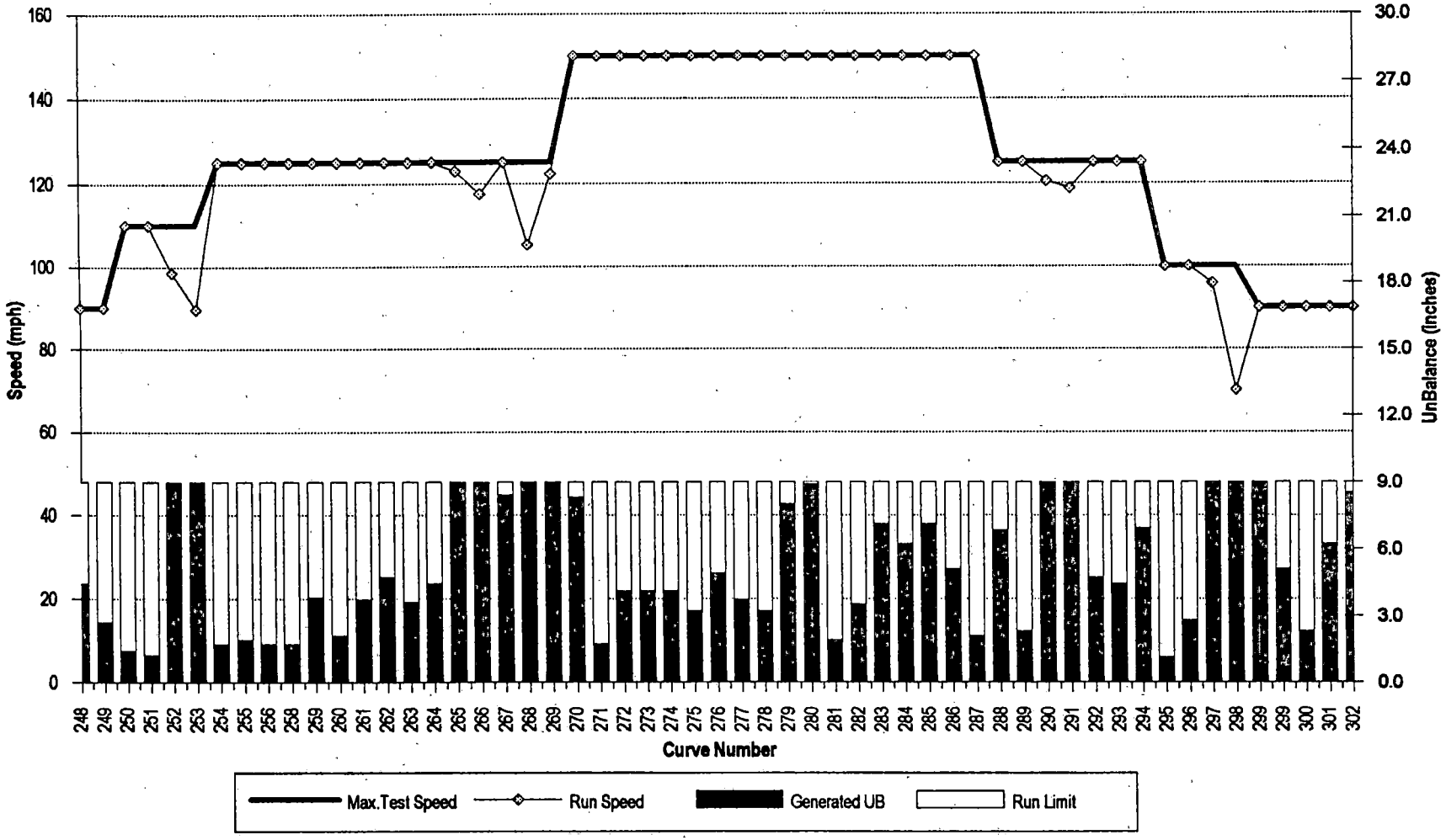
X-2000 TEST PROGRAM
NEC Mainline - Westbound - 8" UnBalance



X2_NEW08.XLC

AMTRAK ENGINEERING

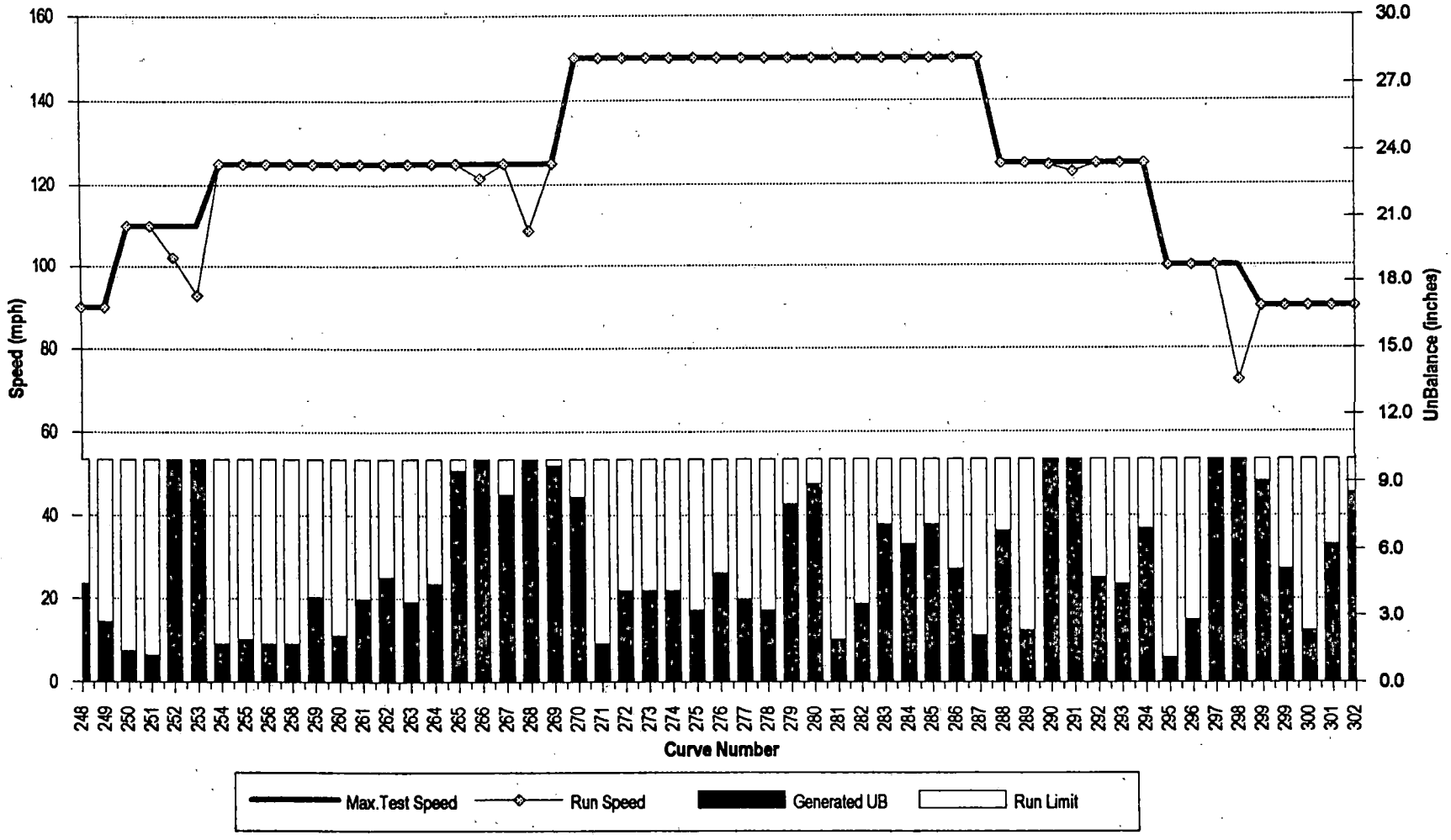
X-2000 TEST PROGRAM
NEC Mainline - Westbound - 9" UnBalance



X2_NEW09.XLC

AMTRAK ENGINEERING

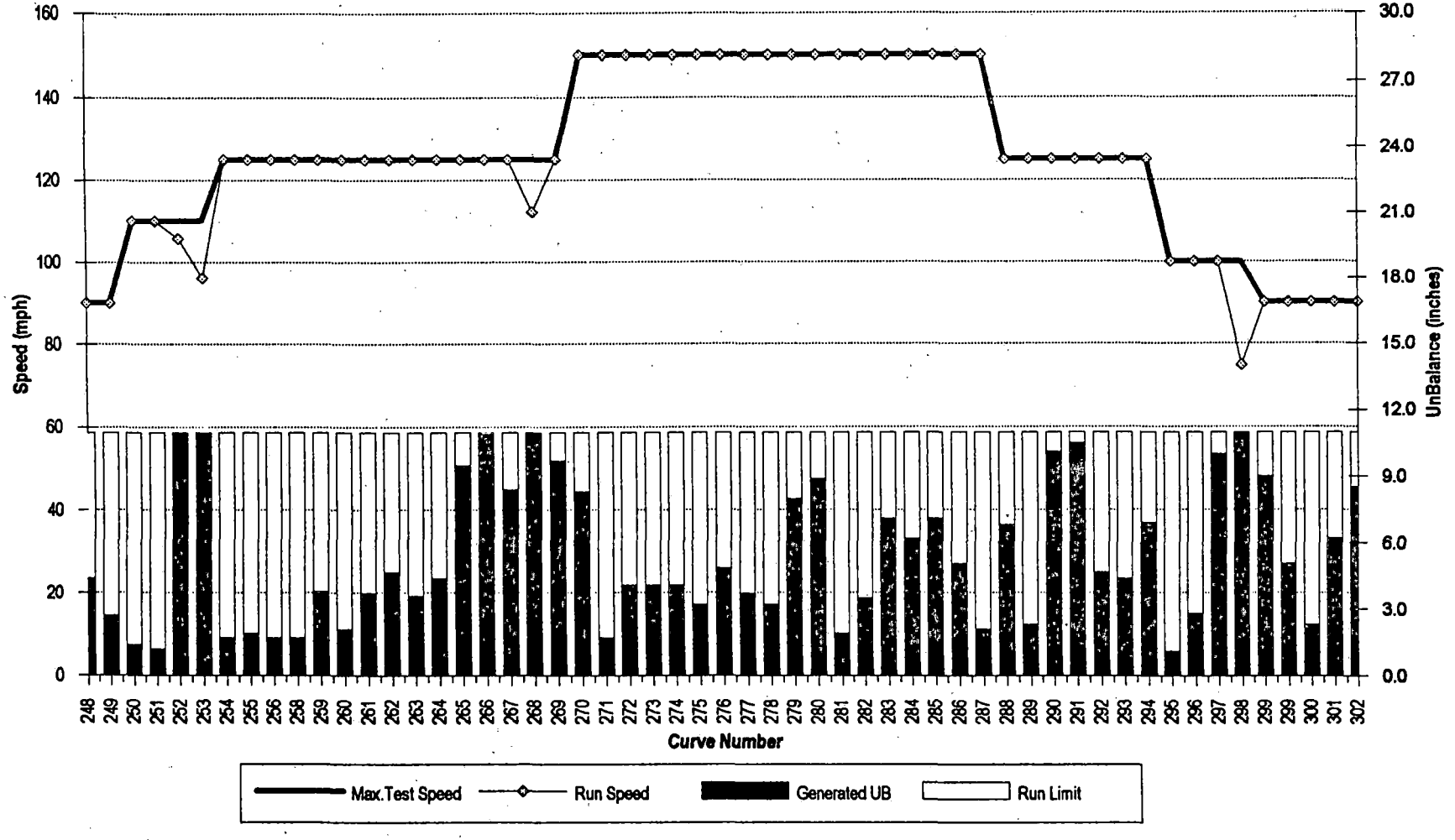
X-2000 TEST PROGRAM
NEC Mainline - Westbound - 10" UnBalance



X2_NEW10.XLC

AMTRAK ENGINEERING

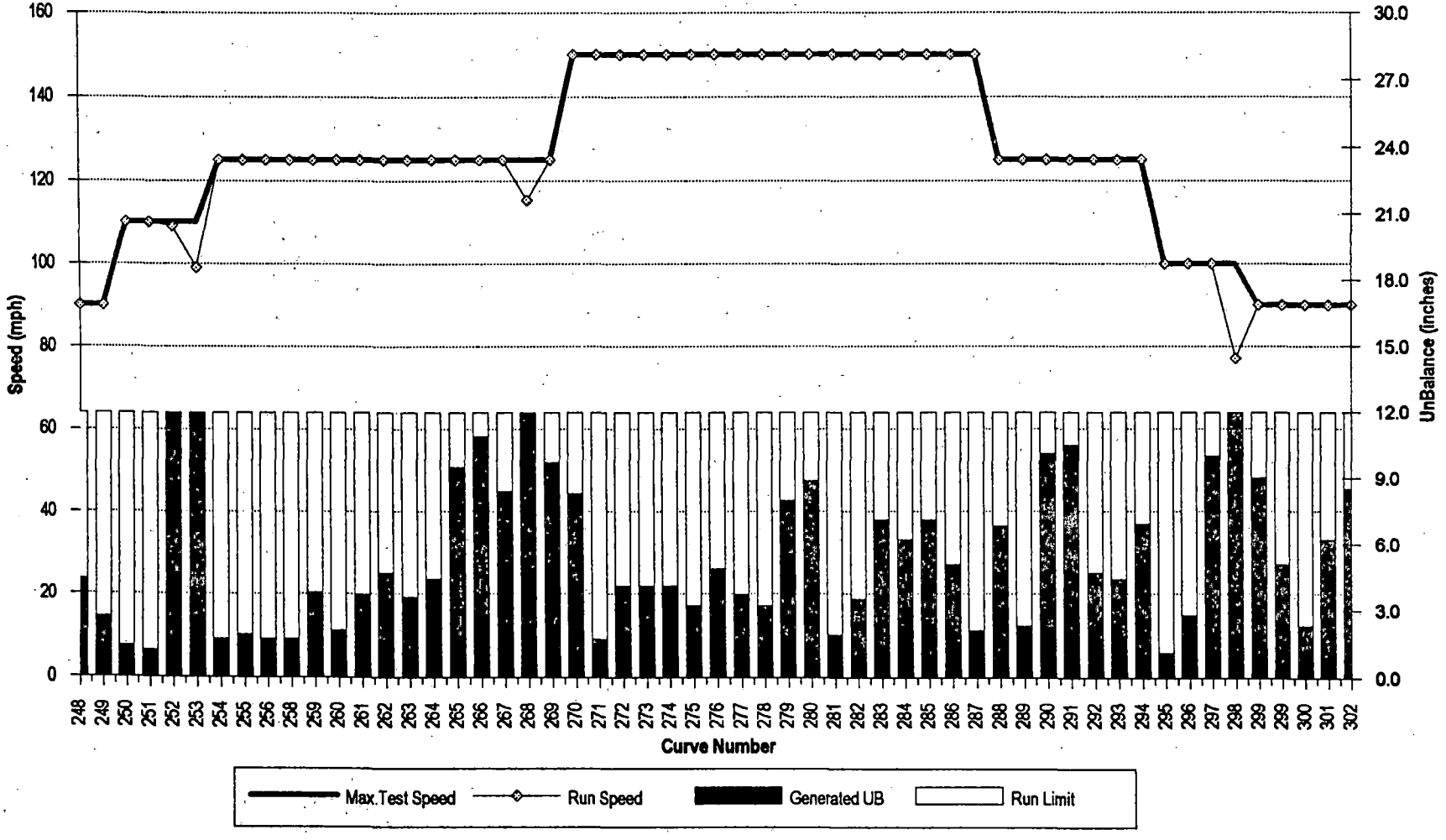
X-2000 TEST PROGRAM
NEC Mainline - Westbound - 11" UnBalance



X2_NEW11.XLC

AMTRAK ENGINEERING

X-2000 TEST PROGRAM
NEC Mainline - Westbound - 12" UnBalance



X2_NEW12.XLC

EASTBOUND - NEC MAINLINE

North Philadelphia, PA to Newark, NJ

Eastbound

X-2000 TEST PROGRAM
NEC MAINLINE SPEEDS

Track No.2

CV.#	TIMETABLE DESCRIPTION	MILEPOST LOCATION		CURVE GEOMETRY			CALCULATED CURVING SPEEDS										PROPOSED MAXIMUM TESTING SPEED
		West	East	DEGREE [decimal]	RADIUS [feet]	S.E. [inches]	3"UB [mph]	4"UB [mph]	5"UB [mph]	6"UB [mph]	7"UB [mph]	8"UB [mph]	9"UB [mph]	10"UB [mph]	11"UB [mph]	12"UB [mph]	[mph]
302		85.40	85.30	1.98	2,889	2.00	60	66	71	76	81	85	89	90	90	90	90
301		85.06	85.00	1.47	3,907	1.75	68	75	81	87	90	90	90	90	90	90	"
300	Curves at east & west ends of N. Phila. sta. pltfrm.	84.93	84.84	0.83	6,876	2.00	90	90	90	90	90	90	90	90	90	90	"
299	Curves at east & west ends of N. Phila. sta. pltfrm.	84.78	84.70	1.03	5,545	1.25	77	85	90	90	90	90	90	90	90	90	"
299	Curve MP 84.0 to 2nd Street overhead bridge	83.82	83.08	2.52	2,277	5.00	67	71	75	79	83	86	89	90	90	90	"
298	Curve between Shore and Ford	81.75	81.38	4.02	1,426	5.50	55	58	61	64	67	69	72	74	77	79	100
297	Curve eastward from Ford	81.30	80.89	1.80	3,183	2.00	63	69	75	80	85	89	93	98	100	100	"
296		79.68	79.18	0.60	9,549	2.25	100	100	100	100	100	100	100	100	100	100	"
295		78.51	78.20	0.32	18,094	1.50	100	100	100	100	100	100	100	100	100	100	"
294		77.04	76.68	1.00	5,730	4.75	105	112	118	124	125	125	125	125	125	125	125
293		76.47	76.11	0.68	8,385	3.25	114	123	125	125	125	125	125	125	125	125	"
292	First curve west of MP 75.0	75.40	75.08	0.75	7,640	4.00	115	123	125	125	125	125	125	125	125	125	"
291	Reverse curves between MP 74.0 and MP 75.0	75.08	74.62	1.55	3,697	5.75	90	95	100	104	108	113	117	120	124	125	"
290	Reverse curves between MP 74.0 and MP 75.0	74.47	74.07	1.47	3,907	5.25	90	95	100	105	109	114	118	122	125	125	"
289		72.57	72.17	0.33	17,189	1.75	125	125	125	125	125	125	125	125	125	125	"
288	Curve west of Croydon	70.61	70.06	1.18	4,842	5.75	103	108	114	119	124	125	125	125	125	125	"
287		68.70	68.60	0.17	34,378	0.50	150	150	150	150	150	150	150	150	150	150	150
286		67.89	66.72	0.47	12,278	2.25	127	138	149	150	150	150	150	150	150	150	"
285	Curve west of Grundy	66.33	65.62	0.72	7,995	4.75	124	132	139	146	150	150	150	150	150	150	"
284	Curve east of Grundy	64.94	64.60	0.65	8,815	3.75	122	131	139	146	150	150	150	150	150	150	"
283	Curve between MP 61.0 and MP 62.0	61.93	61.39	0.72	7,995	4.25	120	128	136	143	150	150	150	150	150	150	"
282		60.54	60.22	0.35	16,370	1.25	132	146	150	150	150	150	150	150	150	150	"
280	First curve west of Morris	57.13	57.00	0.57	10,111	2.00	112	123	133	142	150	150	150	150	150	150	"
279	First curve west of Trenton	56.33	56.05	0.67	8,594	2.25	106	116	125	133	141	148	150	150	150	150	"
278		50.46	50.36	0.30	19,099	1.00	138	150	150	150	150	150	150	150	150	150	"
277		40.24	39.48	0.30	19,099	1.50	146	150	150	150	150	150	150	150	150	150	"
276		39.36	41.94	0.52	11,090	3.25	131	142	150	150	150	150	150	150	150	150	"

X2000NEE.XLS

Eastbound

X-2000 TEST PROGRAM
NEC MAINLINE SPEEDS

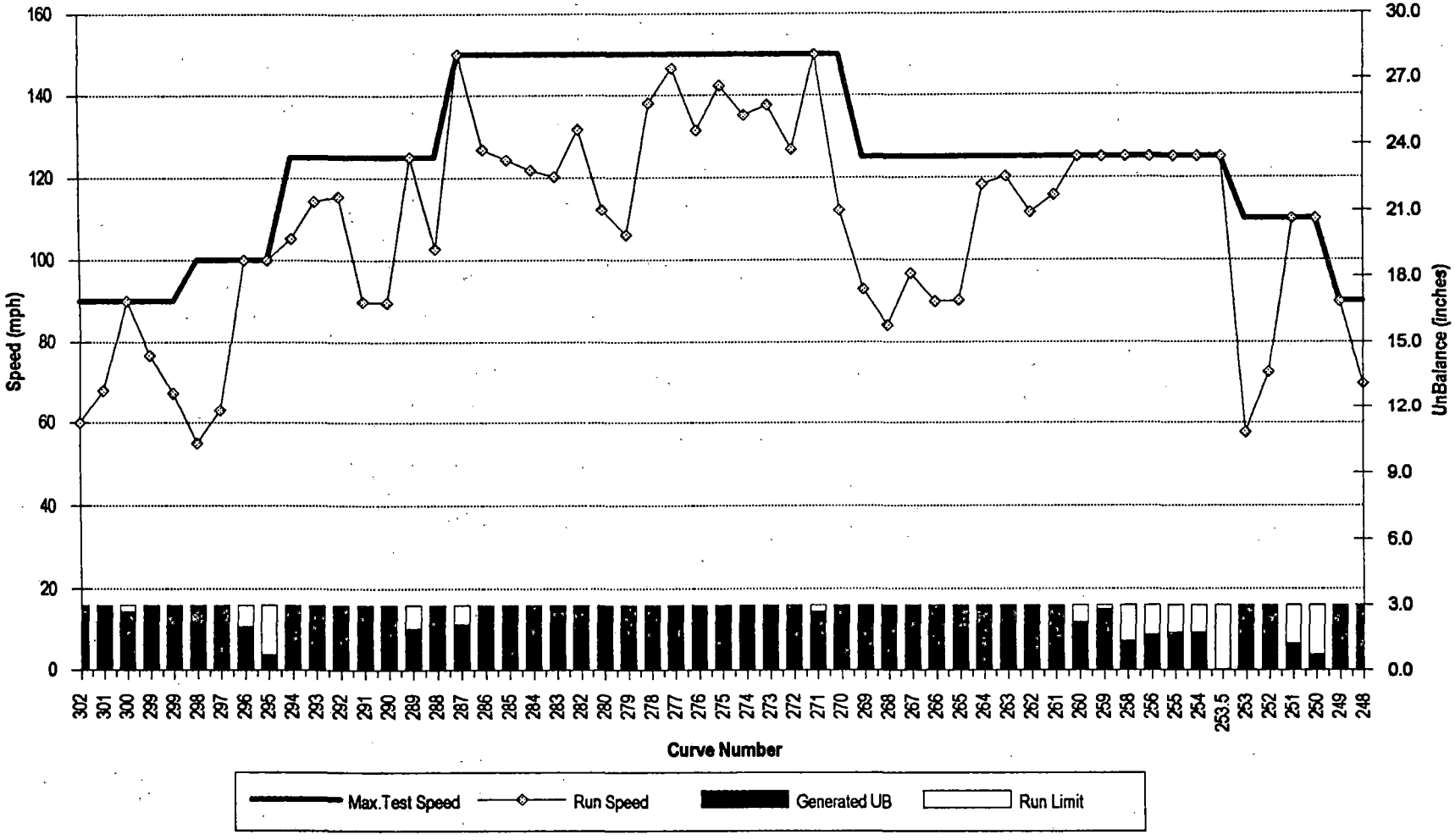
Track No.2

CV.#	TIMETABLE DESCRIPTION	MILEPOST LOCATION		CURVE GEOMETRY			CALCULATED CURVING SPEEDS										PROPOSED MAXIMUM TESTING SPEED
		West	East	DEGREE [decimal]	RADIUS [feet]	S.E. [inches]	3"UB [mph]	4"UB [mph]	5"UB [mph]	6"UB [mph]	7"UB [mph]	8"UB [mph]	9"UB [mph]	10"UB [mph]	11"UB [mph]	12"UB [mph]	[mph]
275		34.21	33.75	0.30	19,099	1.25	142	150	150	150	150	150	150	150	150	150	150
274		31.34	31.12	0.45	12,733	2.75	135	146	150	150	150	150	150	150	150	150	"
273		30.65	30.25	0.43	13,222	2.75	138	149	150	150	150	150	150	150	150	150	"
272		28.97	28.85	0.47	12,278	2.25	127	138	149	150	150	150	150	150	150	150	"
271		27.65	27.43	0.28	20,222	1.75	150	150	150	150	150	150	150	150	150	150	"
270	Third curve west of Lincoln	27.17	26.74	0.77	7,473	3.75	112	120	128	135	142	148	150	150	150	150	"
269	Second curve west of Lincoln	26.65	26.38	1.45	3,951	5.75	93	98	103	108	112	116	121	125	125	125	125
268	First curve west of Lincoln	25.54	24.68	1.87	3,069	6.25	84	89	93	97	101	104	108	112	115	118	"
267	Curve at MP 25.0	24.53	24.11	1.18	4,842	4.75	97	103	108	114	119	124	125	125	125	125	"
266	First curve west of MP 24.0	23.88	23.61	1.55	3,697	5.75	90	95	100	104	108	113	117	120	124	125	"
265	First curve east of MP 24.0	23.51	22.86	1.45	3,951	5.25	90	95	100	105	110	114	118	123	125	125	"
264		22.81	22.45	0.77	7,473	4.50	118	125	125	125	125	125	125	125	125	125	"
263		22.04	21.88	0.72	7,995	4.25	120	125	125	125	125	125	125	125	125	125	"
262		21.84	21.68	0.72	7,995	3.25	112	120	125	125	125	125	125	125	125	125	"
261		20.80	20.71	0.67	8,594	3.25	116	125	125	125	125	125	125	125	125	125	"
260		20.69	20.39	0.25	22,919	0.50	125	125	125	125	125	125	125	125	125	125	"
259		19.74	19.64	0.42	13,751	1.75	125	125	125	125	125	125	125	125	125	125	"
258		19.41	19.28	0.28	20,222	1.75	125	125	125	125	125	125	125	125	125	125	"
256		18.94	18.84	0.42	13,751	3.00	125	125	125	125	125	125	125	125	125	125	"
255		18.50	18.20	0.20	28,648	0.50	125	125	125	125	125	125	125	125	125	125	"
254		15.10	14.70	0.20	28,648	0.50	125	125	125	125	125	125	125	125	125	125	"
253	Curves between Elizabeth & Elmora Block Station	14.26	14.03	2.37	2,421	2.50	58	63	67	72	76	80	83	87	90	94	110
252	Curves between Elizabeth & Elmora Block Station	13.10	13.05	1.97	2,913	4.25	73	77	82	86	90	94	98	102	105	109	"
251		12.54	12.29	0.20	28,648	0.50	110	110	110	110	110	110	110	110	110	110	"
250		10.49	10.21	0.32	18,094	2.00	110	110	110	110	110	110	110	110	110	110	"
249	Curve at Hunter	9.24	9.18	1.02	5,636	2.75	90	90	90	90	90	90	90	90	90	90	90
248		9.20	9.30	1.47	3,907	2.00	70	76	83	88	90	90	90	90	90	90	"

X2000NEE.XLS

AMTRAK ENGINEERING

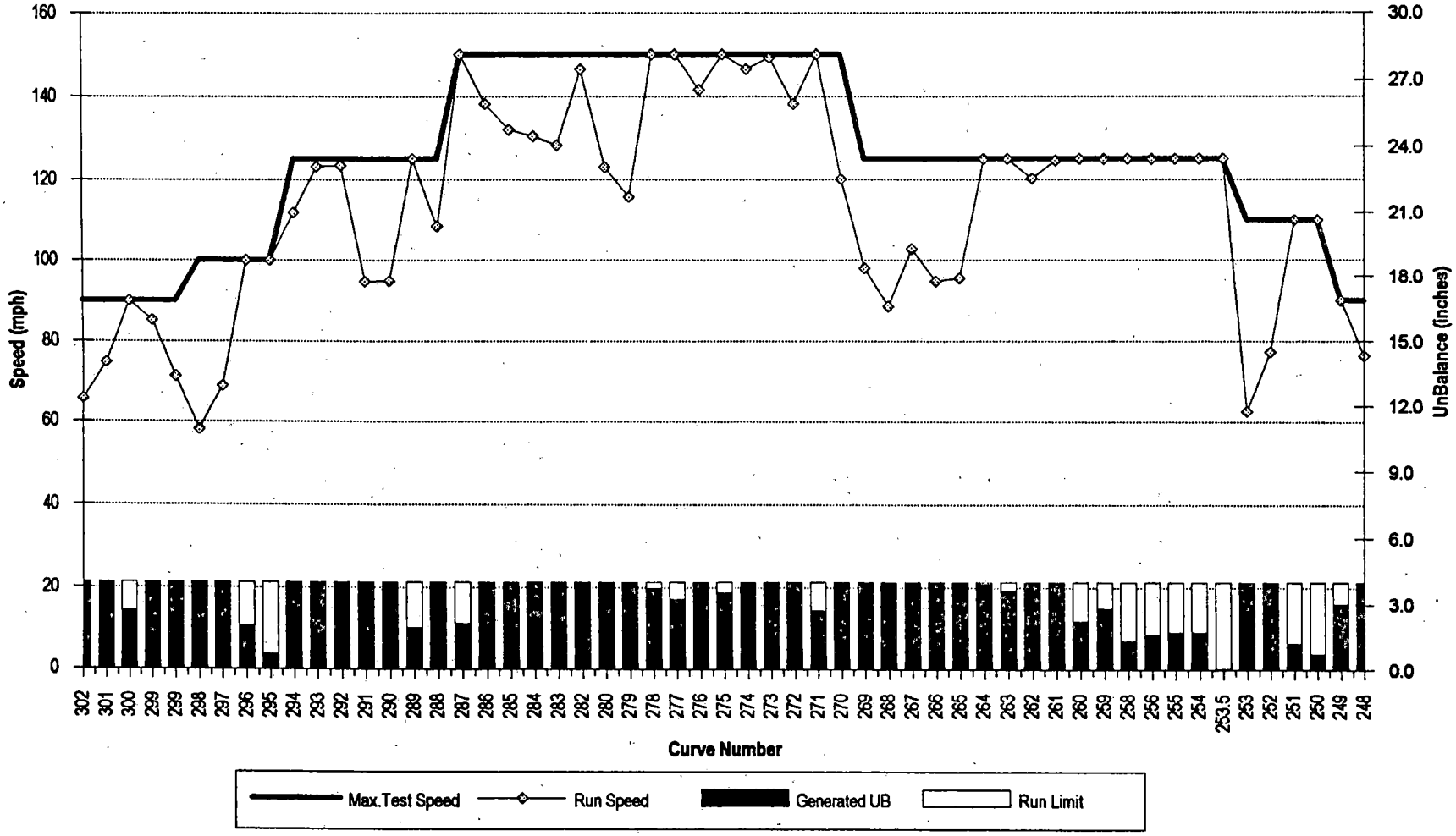
X-2000 TEST PROGRAM
NEC Mainline - Eastbound - 3" UnBalance



X2_NEE03.XLC

AMTRAK ENGINEERING

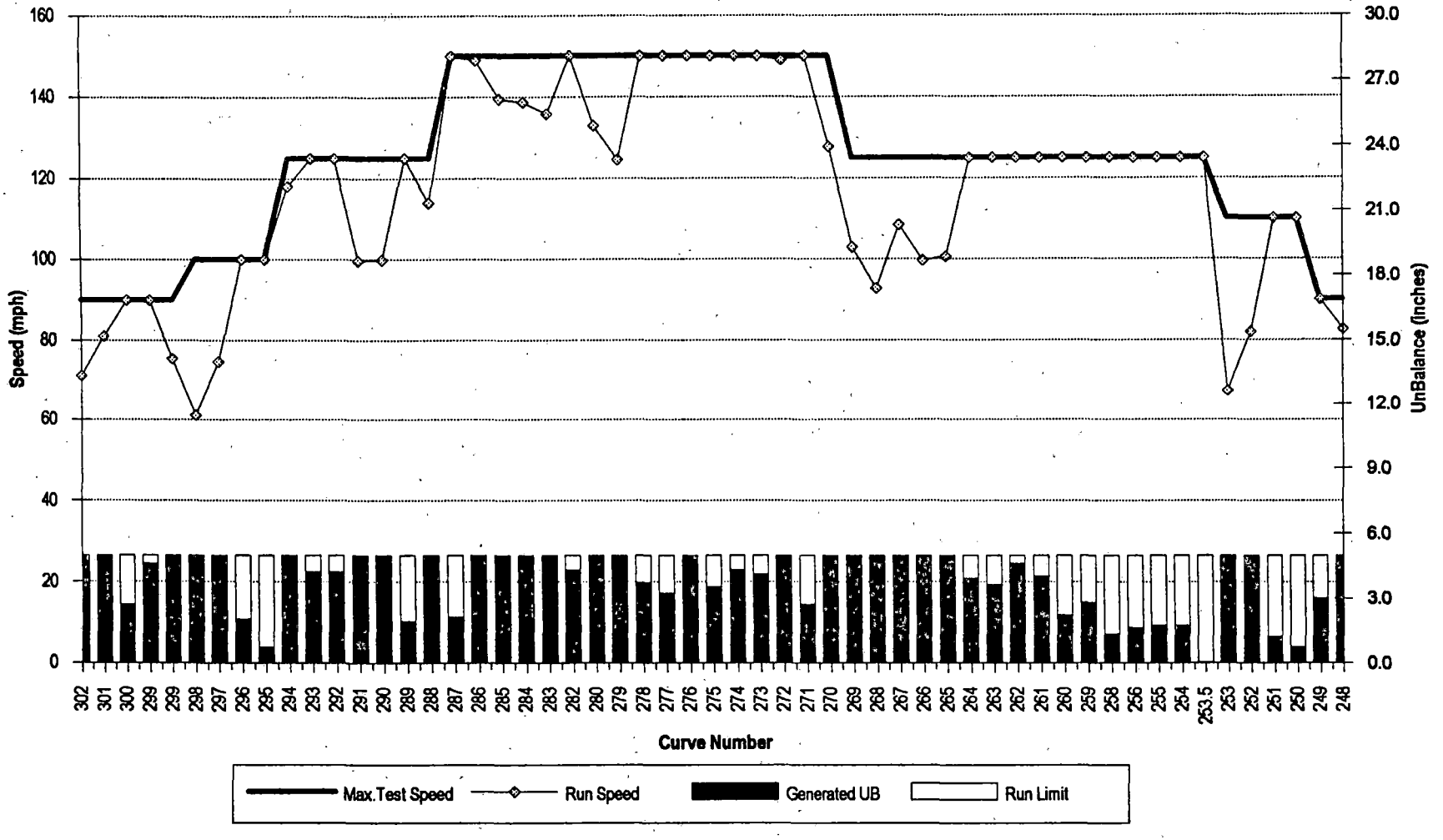
X-2000 TEST PROGRAM
NEC Mainline - Eastbound - 4" UnBalance



X2_NEE04.XLC

AMTRAK ENGINEERING

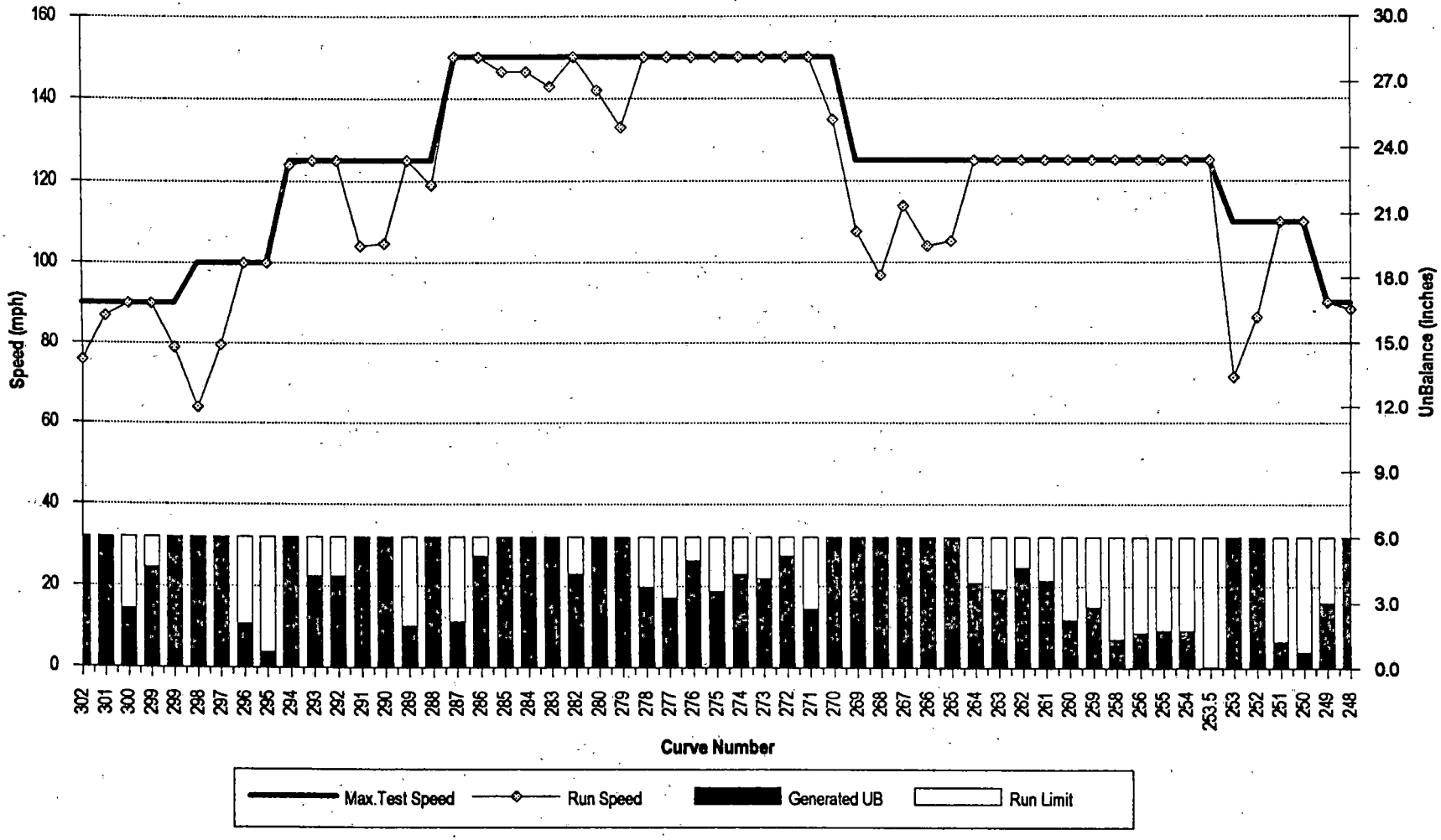
X-2000 TEST PROGRAM
NEC Mainline - Eastbound - 5" UnBalance



X2_NEE05.XLC

AMTRAK ENGINEERING

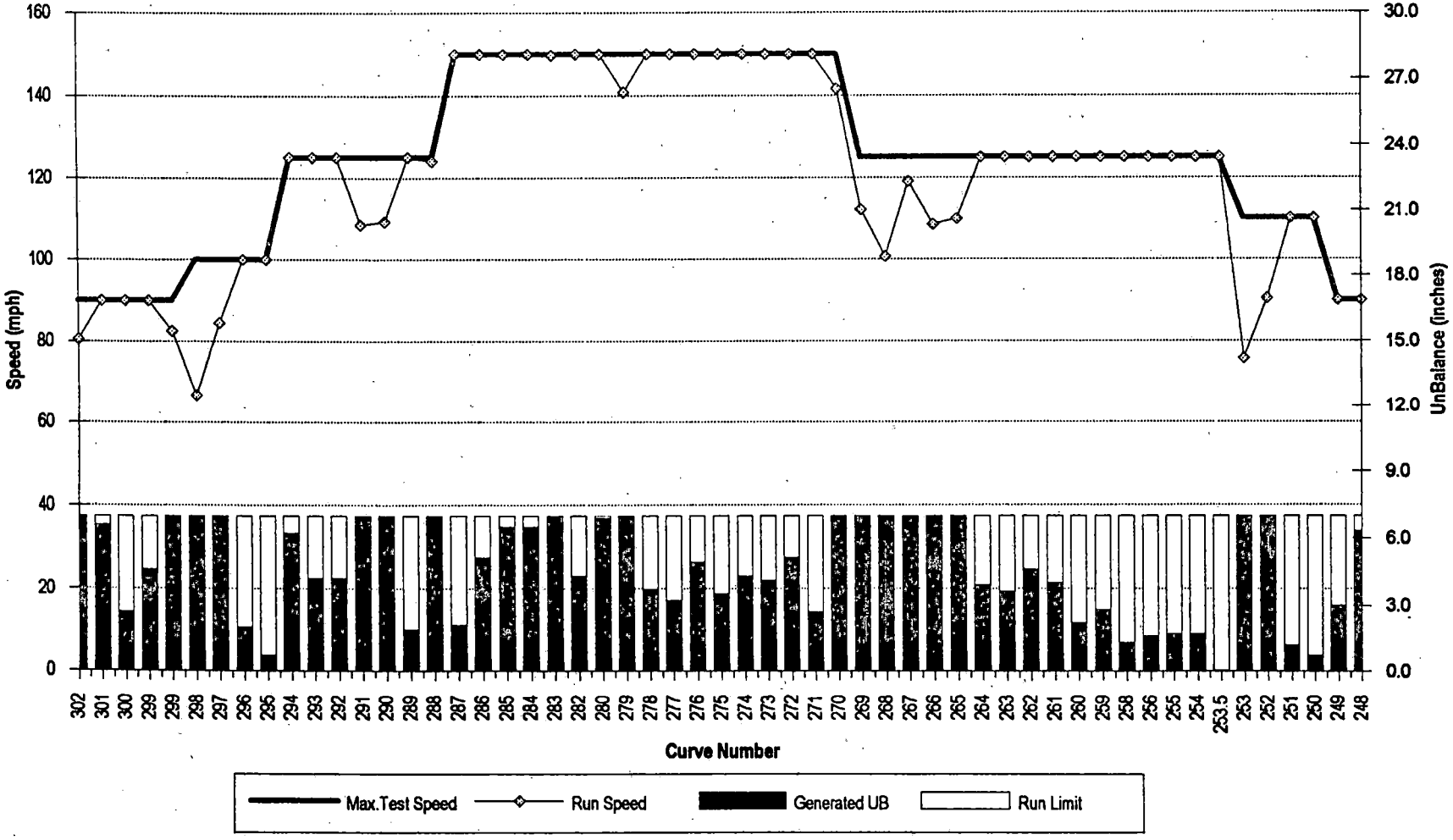
X-2000 TEST PROGRAM
NEC Mainline - Eastbound - 6" UnBalance



X2_NEE06.XLC

AMTRAK ENGINEERING

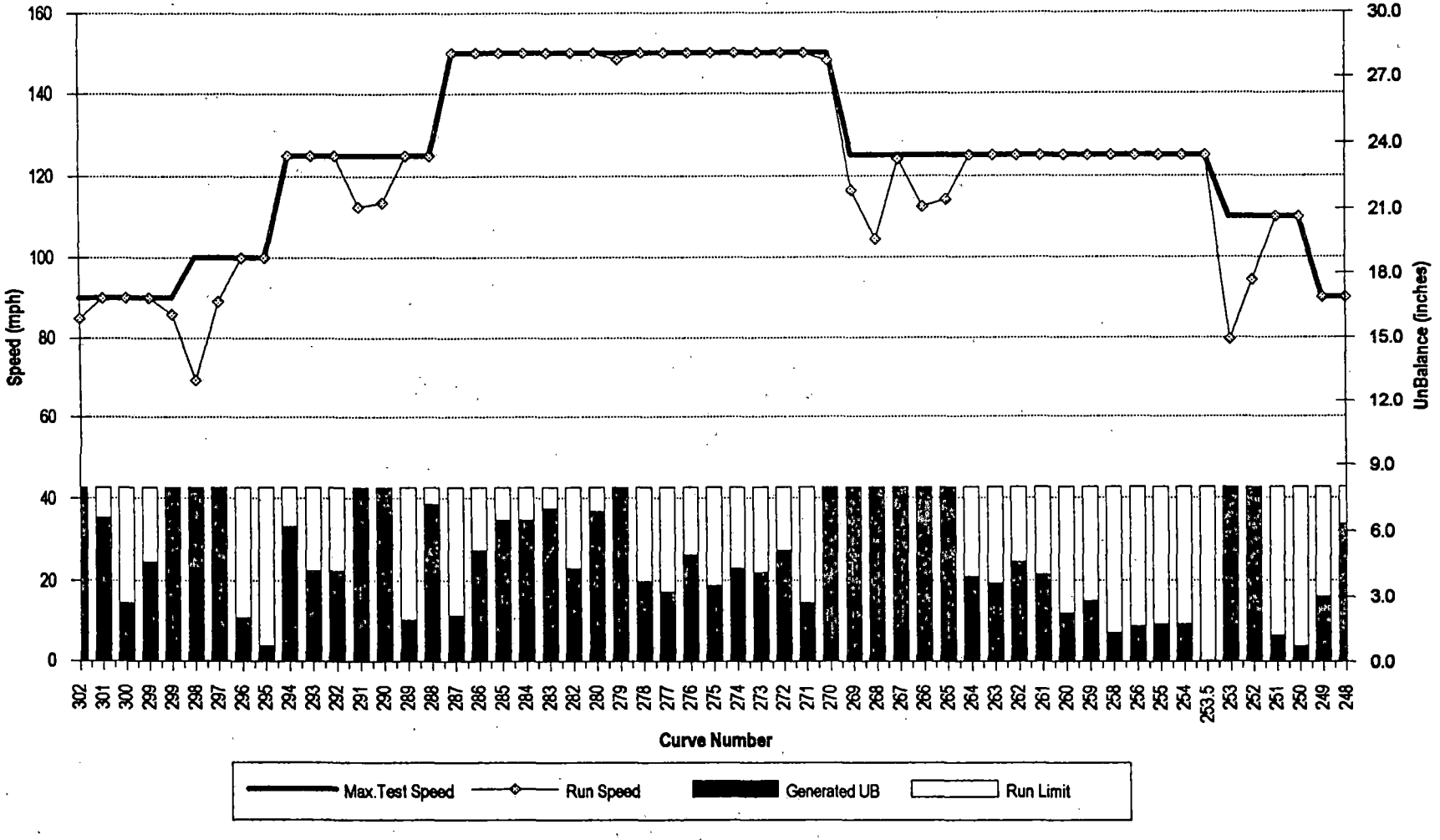
X-2000 TEST PROGRAM
NEC Mainline - Eastbound - 7" UnBalance



X2_NEE07.XLC

AMTRAK ENGINEERING

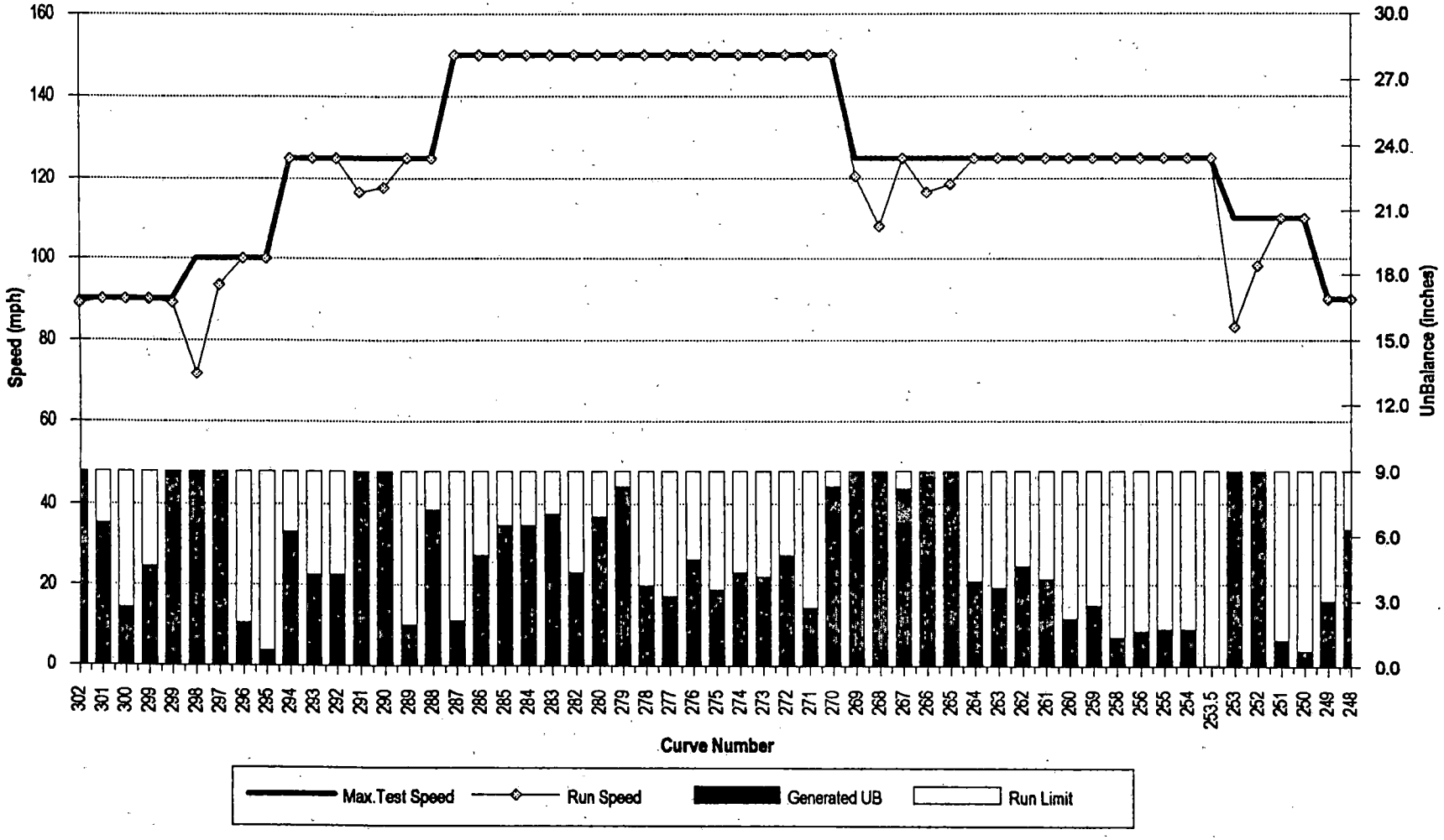
X-2000 TEST PROGRAM
NEC Mainline - Eastbound - 8" UnBalance



X2_NEE08.XLC

AMTRAK ENGINEERING

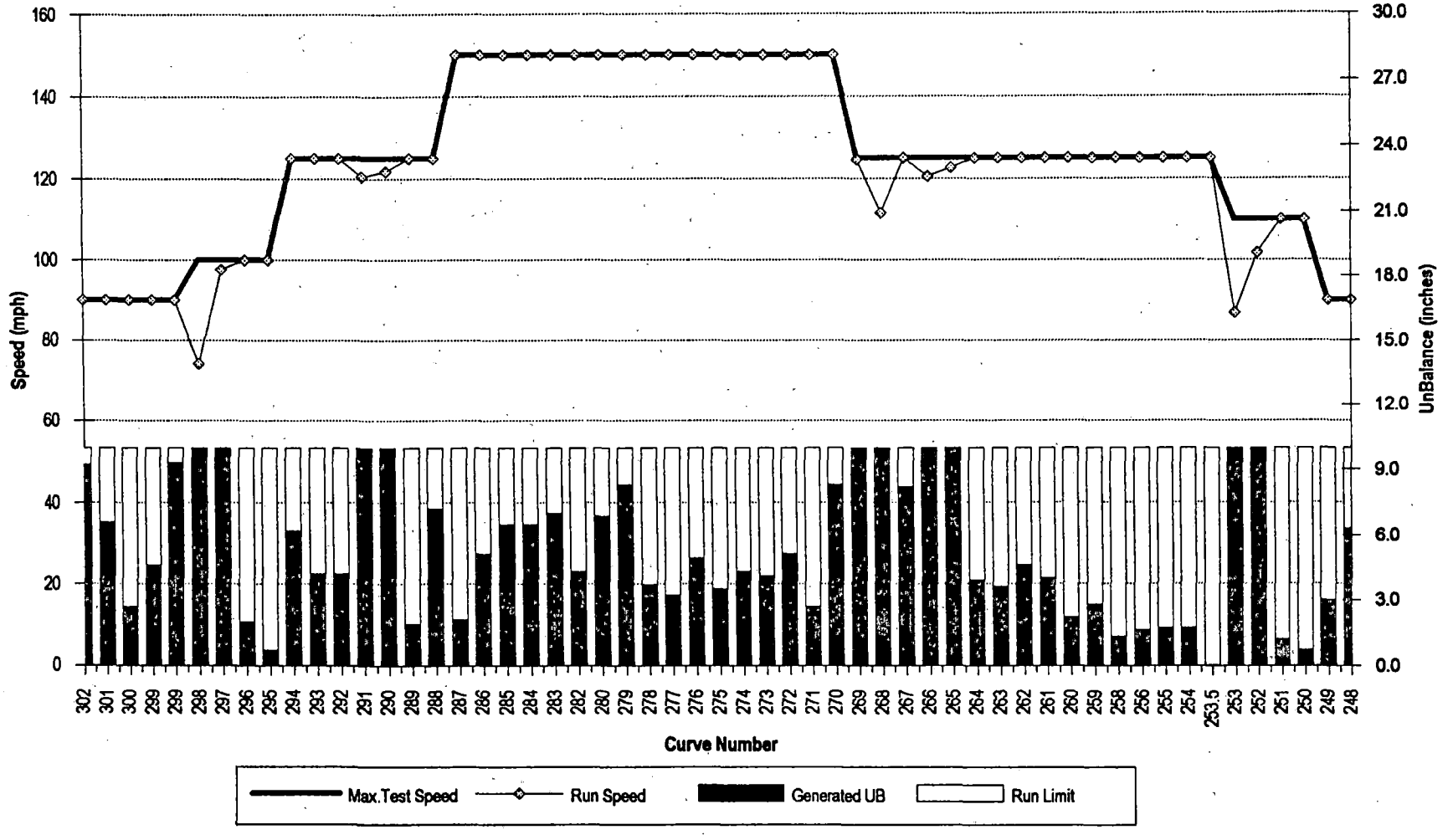
X-2000 TEST PROGRAM
NEC Mainline - Eastbound - 9" UnBalance



X2_NEE09.XLC

AMTRAK ENGINEERING

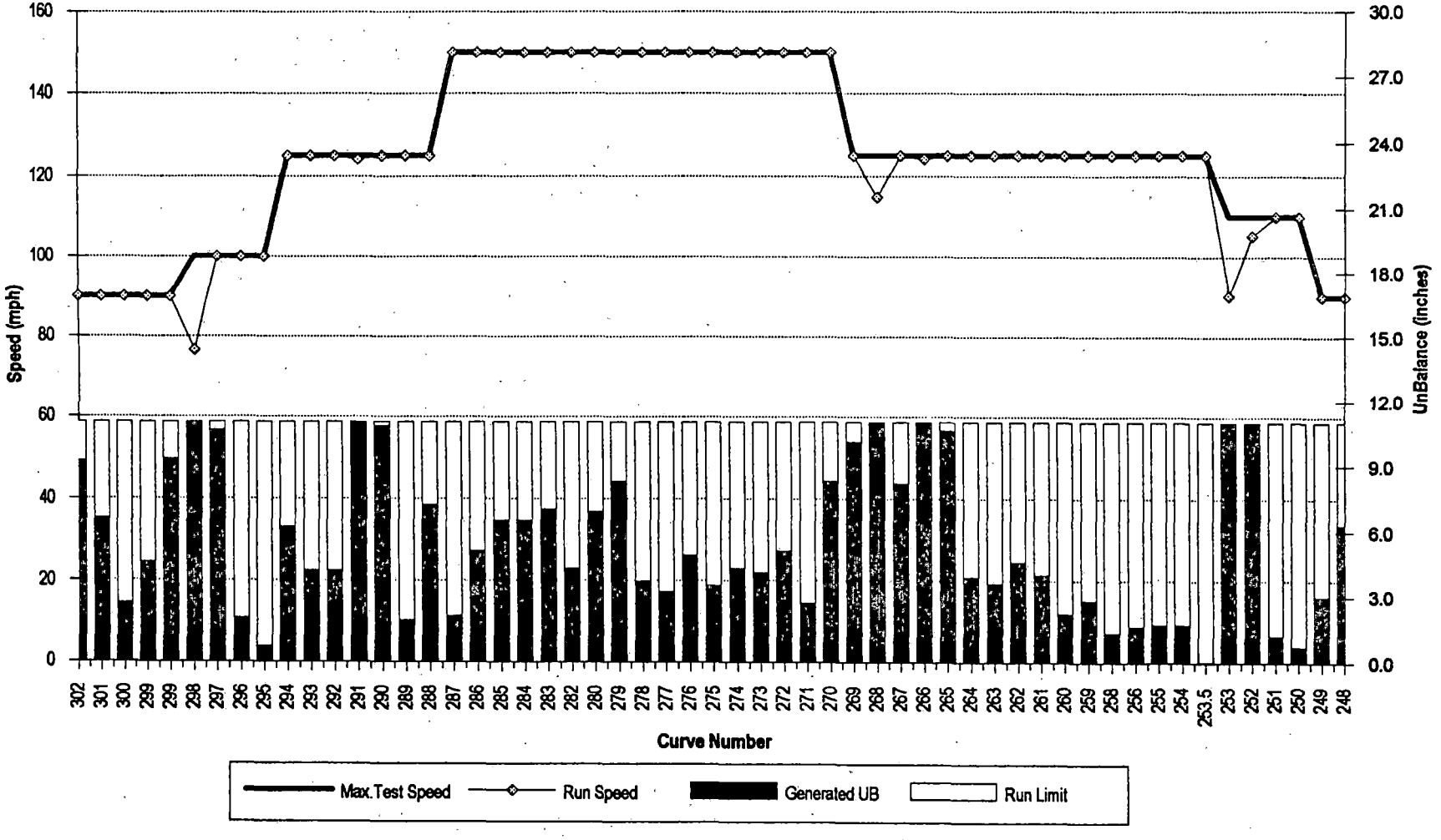
X-2000 TEST PROGRAM
NEC Mainline - Eastbound - 10" UnBalance



X2_NEE10.XLC

AMTRAK ENGINEERING

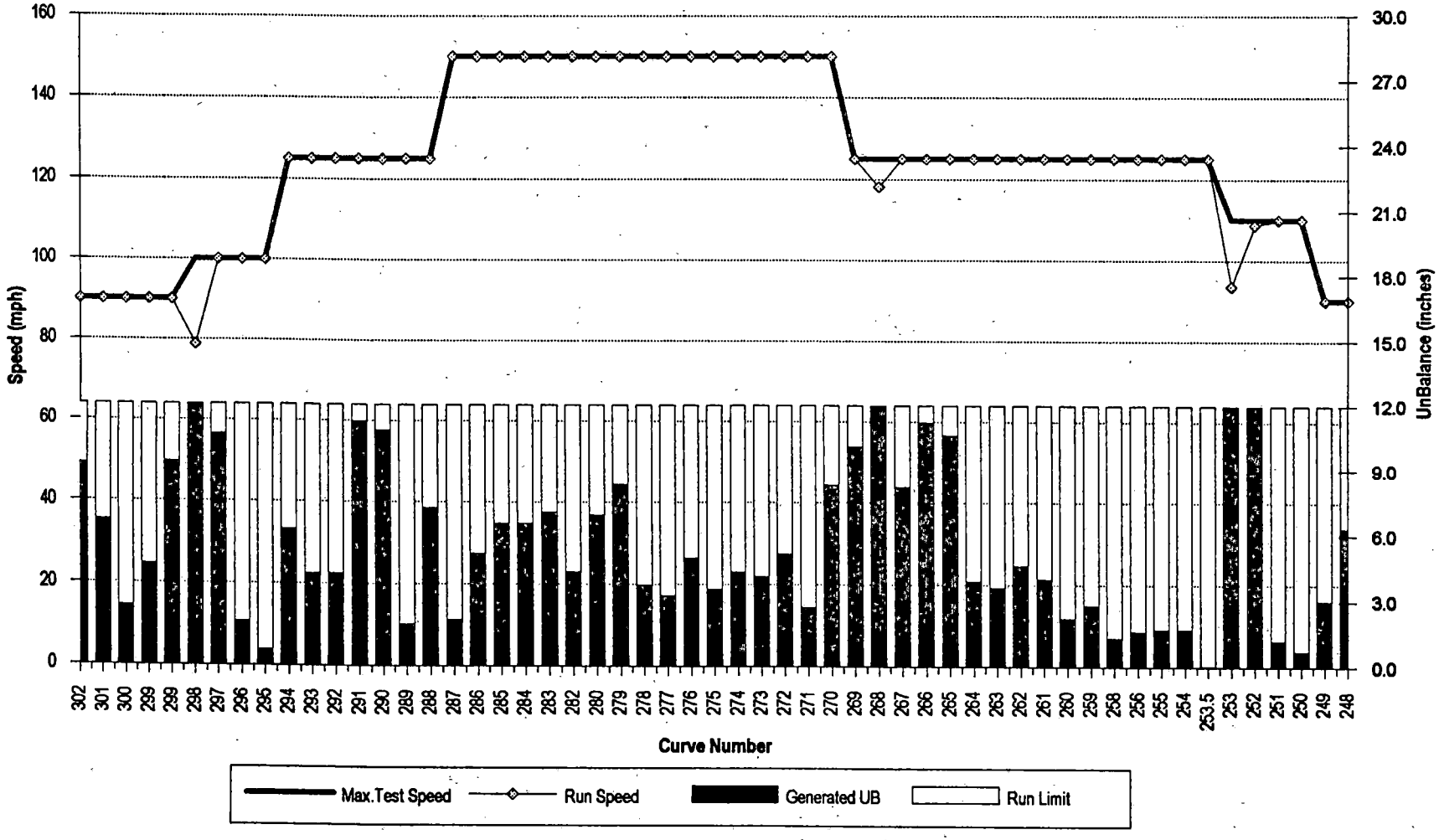
X-2000 TEST PROGRAM
NEC Mainline - Eastbound - 11" UnBalance



X2_NEE11.XLC

AMTRAK ENGINEERING

X-2000 TEST PROGRAM
NEC Mainline - Eastbound - 12" UnBalance



X2_NEE12.XLC

WESTBOUND - HARRISBURG LINE

Paoli, PA to Lancaster, PA

Westbound

X-2000 TEST PROGRAM

HARRISBURG LINE SPEEDS

Track No. 4/2

CV.#	TIMETABLE DESCRIPTION	MILEPOST LOCATION		CURVE GEOMETRY			CALCULATED CURVING SPEEDS										PROPOSED MAXIMUM TESTING SPEED
		East	West	DEGREE [decimal]	RADIUS [feet]	S.E. [inches]	3"UB [mph]	4"UB [mph]	5"UB [mph]	6"UB [mph]	7"UB [mph]	8"UB [mph]	9"UB [mph]	10"UB [mph]	11"UB [mph]	12"UB [mph]	[mph]
628	First 3 curves west of MP 21	21.64	21.88	2.13	2,686	5.750	77	81	85	89	92	96	99	103	106	109	110
629	First 3 curves west of MP 21	22.01	22.32	2.10	2,728	5.750	77	81	86	89	93	97	100	104	107	110	"
630	First 3 curves west of MP 21	22.37	22.76	2.03	2,818	5.750	78	83	87	91	95	98	102	105	109	110	"
631		23.30	23.60	0.20	28,648	1.000	110	110	110	110	110	110	110	110	110	110	"
632		24.63	24.85	1.17	4,911	4.125	93	100	106	110	110	110	110	110	110	110	"
633		25.25	25.40	0.43	13,222	0.750	110	110	110	110	110	110	110	110	110	110	"
634		25.53	25.75	0.42	13,751	1.625	110	110	110	110	110	110	110	110	110	110	"
635		26.30	26.39	0.22	26,445	0.875	110	110	110	110	110	110	110	110	110	110	"
636		26.47	26.53	0.27	21,486	1.000	110	110	110	110	110	110	110	110	110	110	"
637		28.20	29.20	0.20	28,648	1.250	110	110	110	110	110	110	110	110	110	110	"
638	1st & 2nd curve 1200' west of Signal 295	29.81	30.25	3.07	1,868	5.625	63	67	70	74	77	80	83	85	88	91	"
639	1st & 2nd curve 1200' west of Signal 295	30.32	30.81	2.35	2,438	5.625	72	77	80	84	88	91	94	98	101	104	"
640		31.22	31.56	1.55	3,697	5.875	90	95	100	105	109	110	110	110	110	110	"
641		32.16	32.55	0.93	6,139	3.500	100	107	110	110	110	110	110	110	110	110	"
642		32.87	33.15	0.82	7,016	3.500	107	110	110	110	110	110	110	110	110	110	"
643		33.57	33.87	0.27	21,486	1.250	110	110	110	110	110	110	110	110	110	110	"
644		34.23	34.61	0.32	18,094	1.125	110	110	110	110	110	110	110	110	110	110	"
645		35.06	35.19	0.55	10,418	1.375	107	110	110	110	110	110	110	110	110	110	"
646		35.88	36.04	0.38	14,947	1.250	110	110	110	110	110	110	110	110	110	110	"
647		36.11	36.25	0.37	15,626	1.500	110	110	110	110	110	110	110	110	110	110	"
648		36.79	37.31	1.00	5,730	3.250	95	102	109	110	110	110	110	110	110	110	"
649		37.34	37.93	0.98	5,827	3.375	96	104	110	110	110	110	110	110	110	110	"
650		38.43	39.12	0.47	12,278	1.375	110	110	110	110	110	110	110	110	110	110	"
651		39.45	39.90	0.75	7,640	2.500	102	110	110	110	110	110	110	110	110	110	"
652		40.85	41.05	0.73	7,813	2.500	104	110	110	110	110	110	110	110	110	110	"
653		41.33	41.65	0.73	7,813	2.375	102	110	110	110	110	110	110	110	110	110	"
654		43.60	43.71	0.42	13,751	0.500	110	110	110	110	110	110	110	110	110	110	"
655		45.13	45.34	0.45	12,733	0.750	109	110	110	110	110	110	110	110	110	110	"
656		46.76	46.87	0.37	15,626	0.000	108	110	110	110	110	110	110	110	110	110	"
657	Curve west of Atglen	47.41	48.21	2.02	2,841	5.500	78	82	86	90	94	98	101	105	108	110	"
658		48.26	48.65	0.97	5,927	3.000	94	102	109	110	110	110	110	110	110	110	"
659		48.76	49.08	1.02	5,636	3.375	95	102	109	110	110	110	110	110	110	110	"
660		49.73	50.10	0.88	6,486	2.750	96	105	110	110	110	110	110	110	110	110	"

X2000HBW.XLS

Westbound

X-2000 TEST PROGRAM

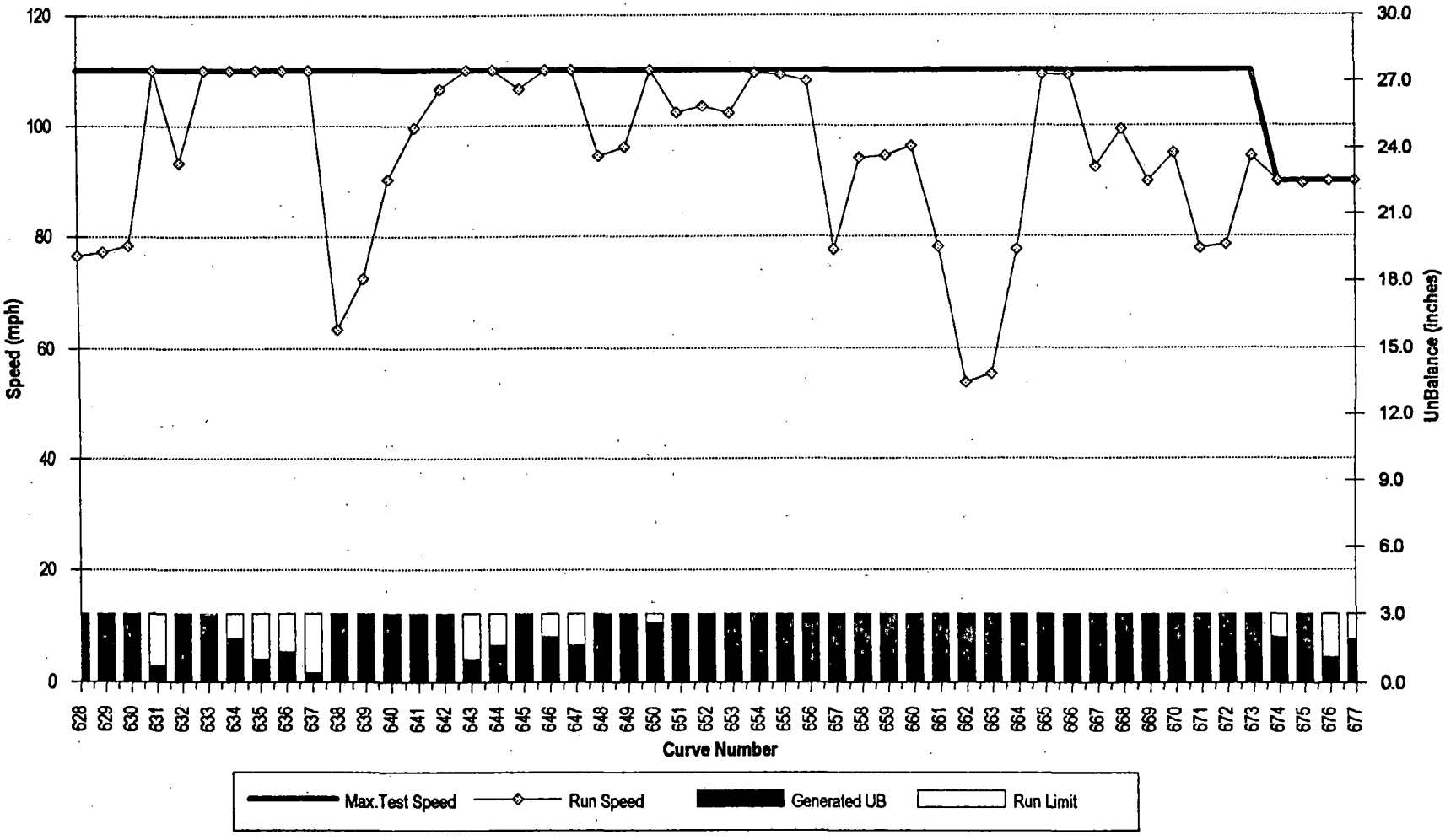
HARRISBURG LINE SPEEDS

Track No. 4/2

CV.#	TIMETABLE DESCRIPTION	MILEPOST LOCATION		CURVE GEOMETRY			CALCULATED CURVING SPEEDS										PROPOSED MAXIMUM TESTING SPEED
		East	West	DEGREE [decimal]	RADIUS [feet]	S.E. [inches]	3"UB [mph]	4"UB [mph]	5"UB [mph]	6"UB [mph]	7"UB [mph]	8"UB [mph]	9"UB [mph]	10"UB [mph]	11"UB [mph]	12"UB [mph]	[mph]
661	Curve east of Gap	50.22	50.64	2.05	2,795	5.750	78	82	87	91	94	98	101	105	108	110	110
662	Curve at Gap	50.79	51.70	4.05	1,415	5.250	54	57	60	63	66	68	71	73	76	78	"
663	Curve west of Gap	52.02	52.46	4.13	1,386	5.875	55	58	61	64	67	69	72	74	76	79	"
664	Curve at MP 53	52.77	53.27	2.02	2,841	5.500	78	82	86	90	94	98	101	105	108	110	"
665		53.69	54.02	0.45	12,733	0.750	109	110	110	110	110	110	110	110	110	110	"
666		54.41	54.60	0.45	12,733	0.750	109	110	110	110	110	110	110	110	110	110	"
667		55.82	56.65	1.00	5,730	3.000	93	100	107	110	110	110	110	110	110	110	"
668		57.39	57.65	0.65	8,815	1.500	99	110	110	110	110	110	110	110	110	110	"
669		58.43	58.99	1.50	3,820	5.500	90	95	100	105	109	110	110	110	110	110	"
670		59.54	59.69	0.97	5,927	3.125	95	103	110	110	110	110	110	110	110	110	"
671	Curve west of MP 60	59.97	60.61	2.03	2,818	5.625	78	82	86	90	94	98	101	105	108	110	"
672	Curve west of MP 61	60.96	61.48	2.00	2,865	5.625	79	83	87	91	95	99	102	106	109	110	"
673		61.63	62.11	1.00	5,730	3.250	95	102	109	110	110	110	110	110	110	110	"
674		62.98	63.22	0.43	13,222	0.500	90	90	90	90	90	90	90	90	90	90	90
675		63.53	63.87	1.00	5,730	2.625	90	90	90	90	90	90	90	90	90	90	"
676		64.85	65.51	0.33	17,189	0.750	90	90	90	90	90	90	90	90	90	90	"
677		66.36	66.59	0.85	6,741	2.875	90	90	90	90	90	90	90	90	90	90	"

AMTRAK ENGINEERING

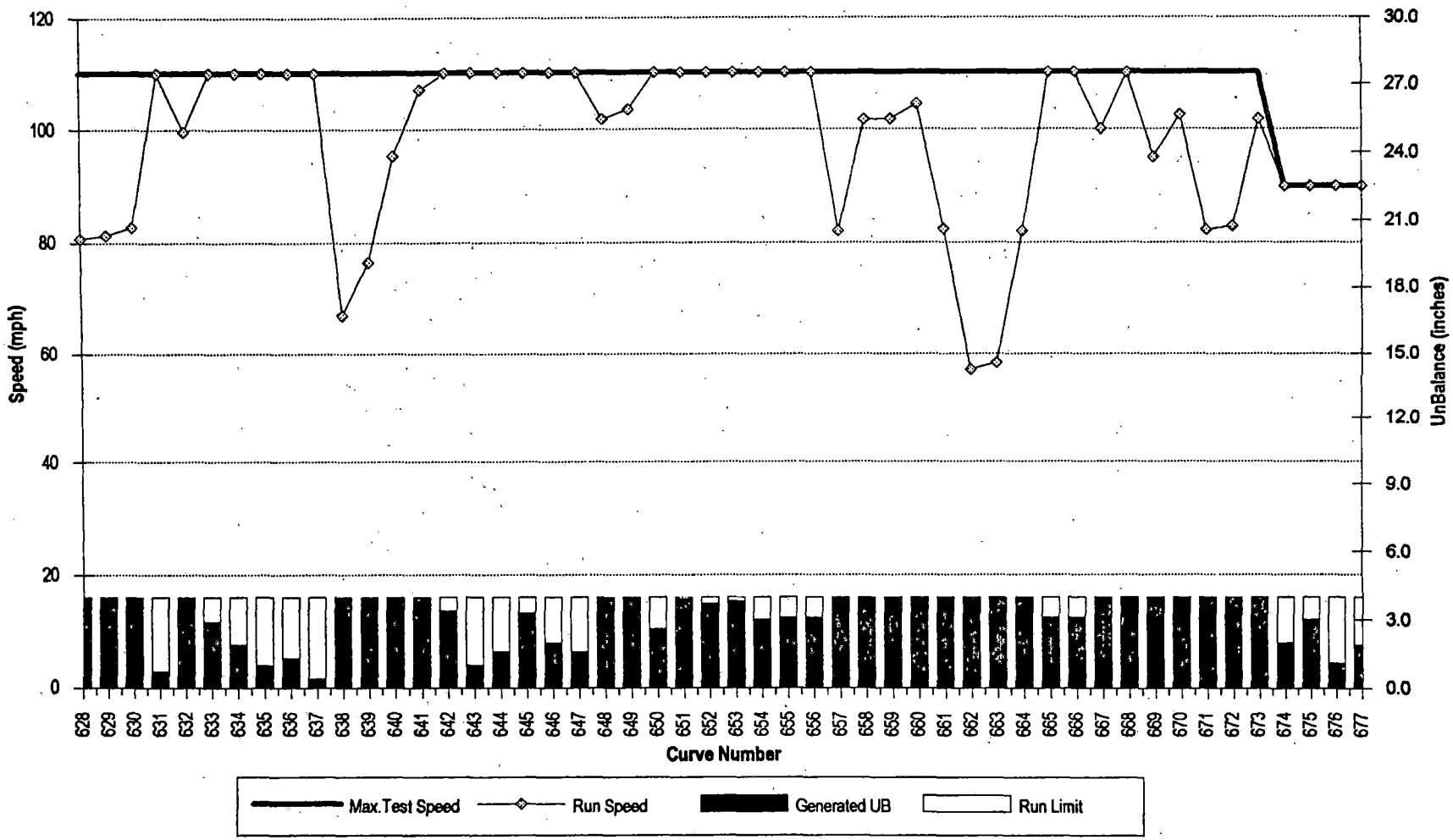
X-2000 TEST PROGRAM
Harrisburg Line - Westbound - 3" UnBalance



X2_HBW03.XLC

AMTRAK ENGINEERING

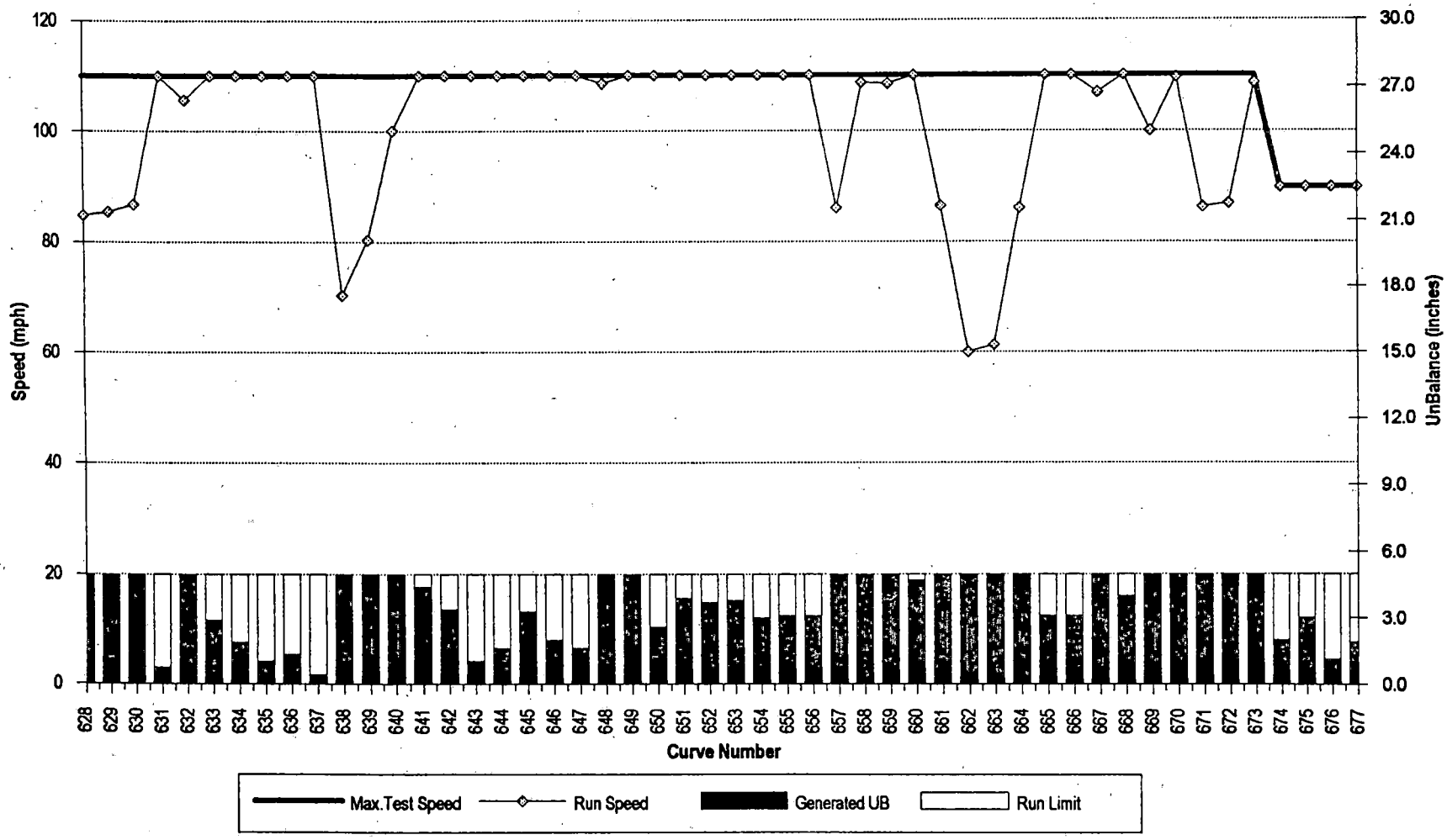
X-2000 TEST PROGRAM
Harrisburg Line - Westbound - 4" UnBalance



X2_HBW04.XLC

AMTRAK ENGINEERING

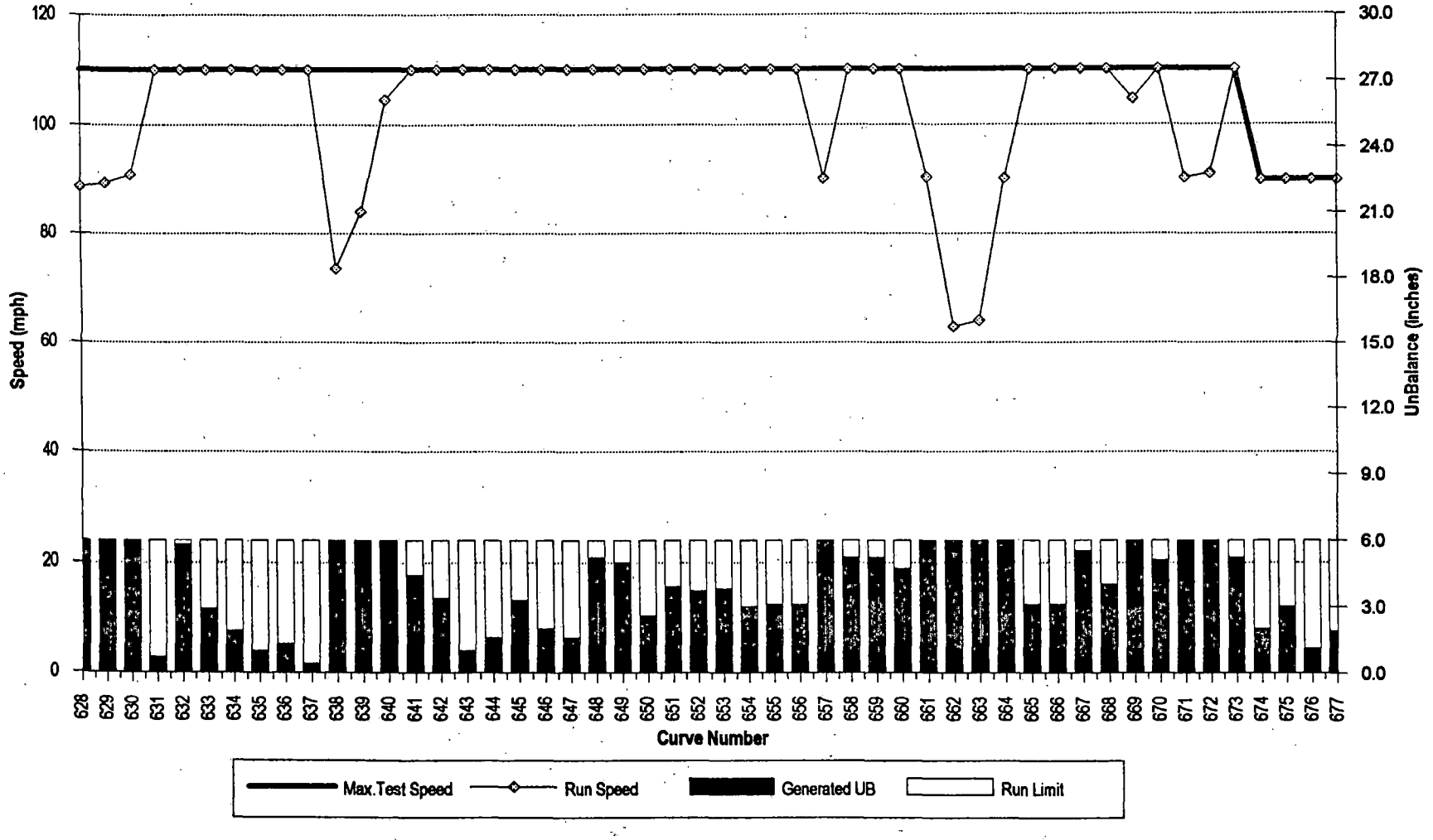
X-2000 TEST PROGRAM
Harrisburg Line - Westbound - 5" UnBalance



X2_HBW05.XLC

AMTRAK ENGINEERING

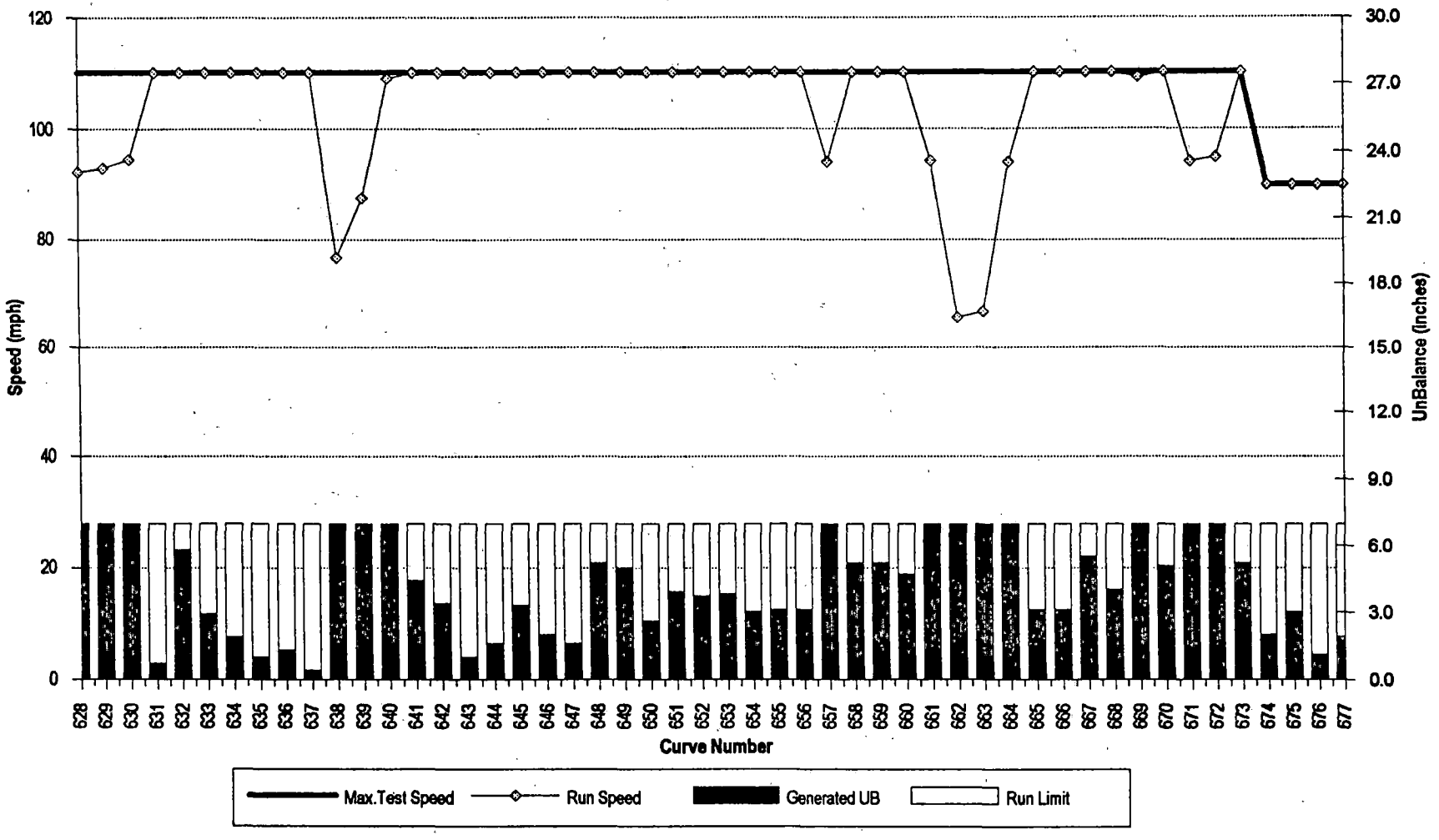
X-2000 TEST PROGRAM
Harrisburg Line - Westbound - 6" UnBalance



X2_HBW06.XLC

AMTRAK ENGINEERING

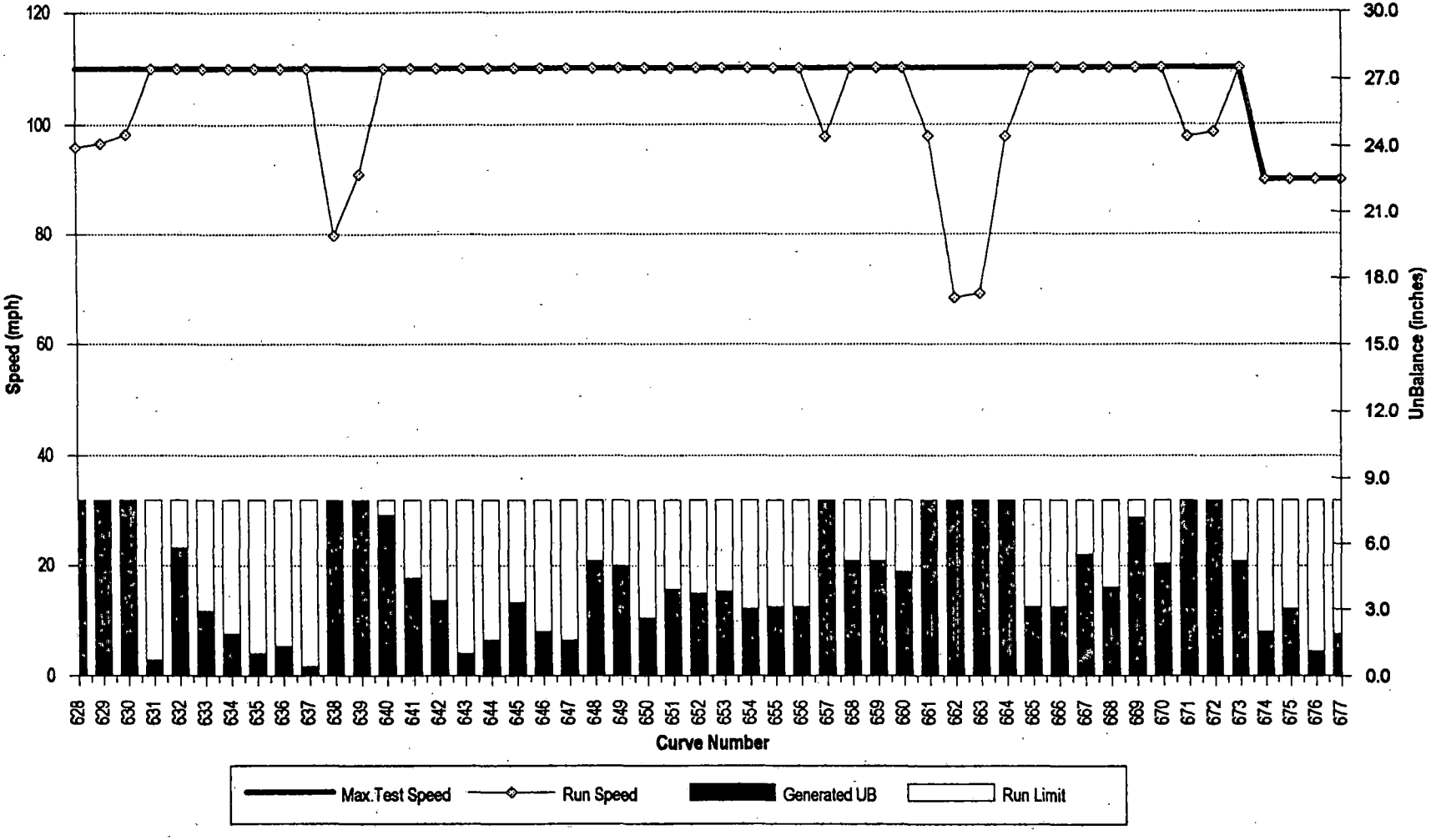
X-2000 TEST PROGRAM
Harrisburg Line - Westbound - 7" UnBalance



X2_HBW07.XLC

AMTRAK ENGINEERING

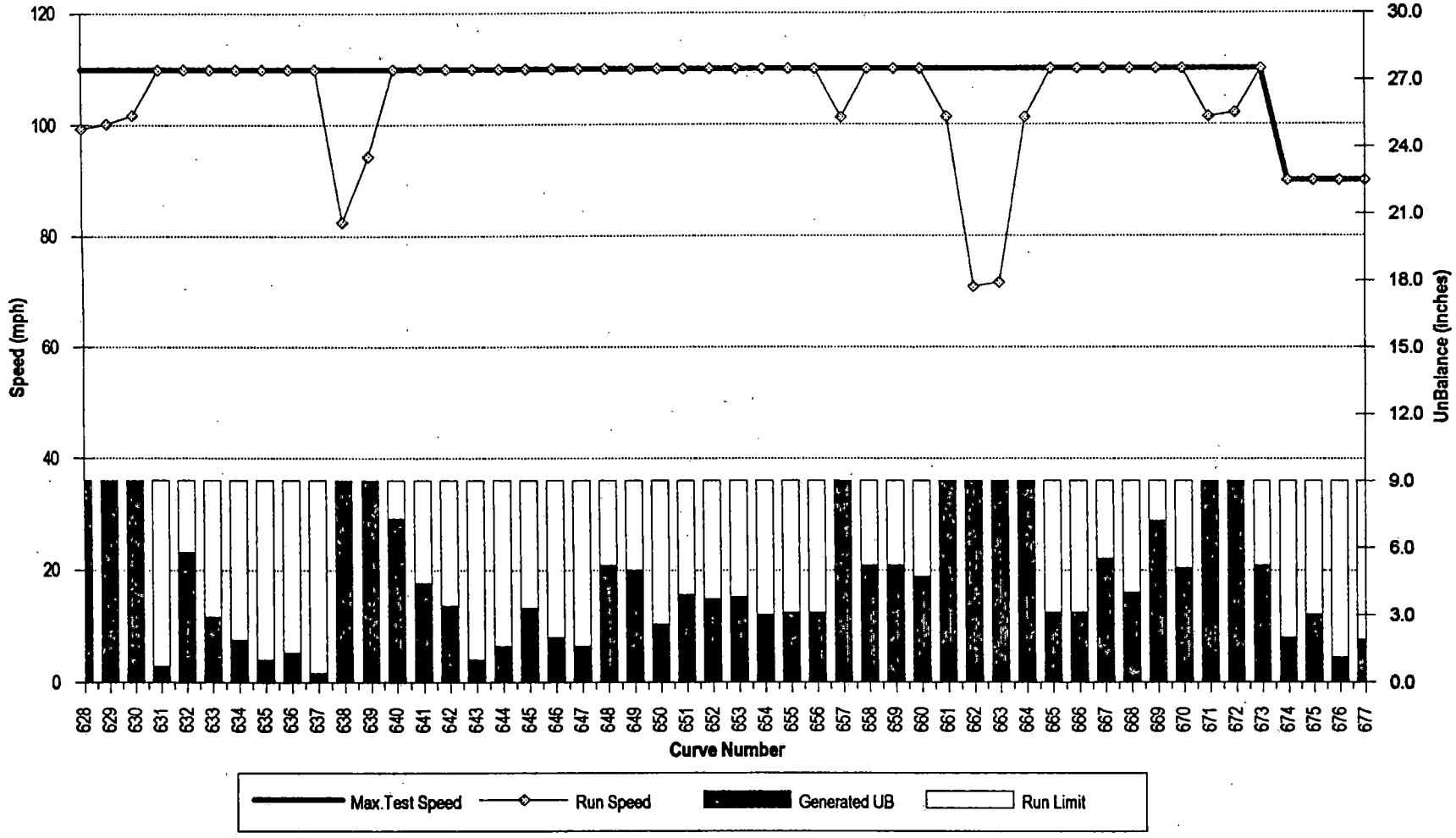
X-2000 TEST PROGRAM
Harrisburg Line - Westbound - 8" UnBalance



X2_HBW08.XLC

AMTRAK ENGINEERING

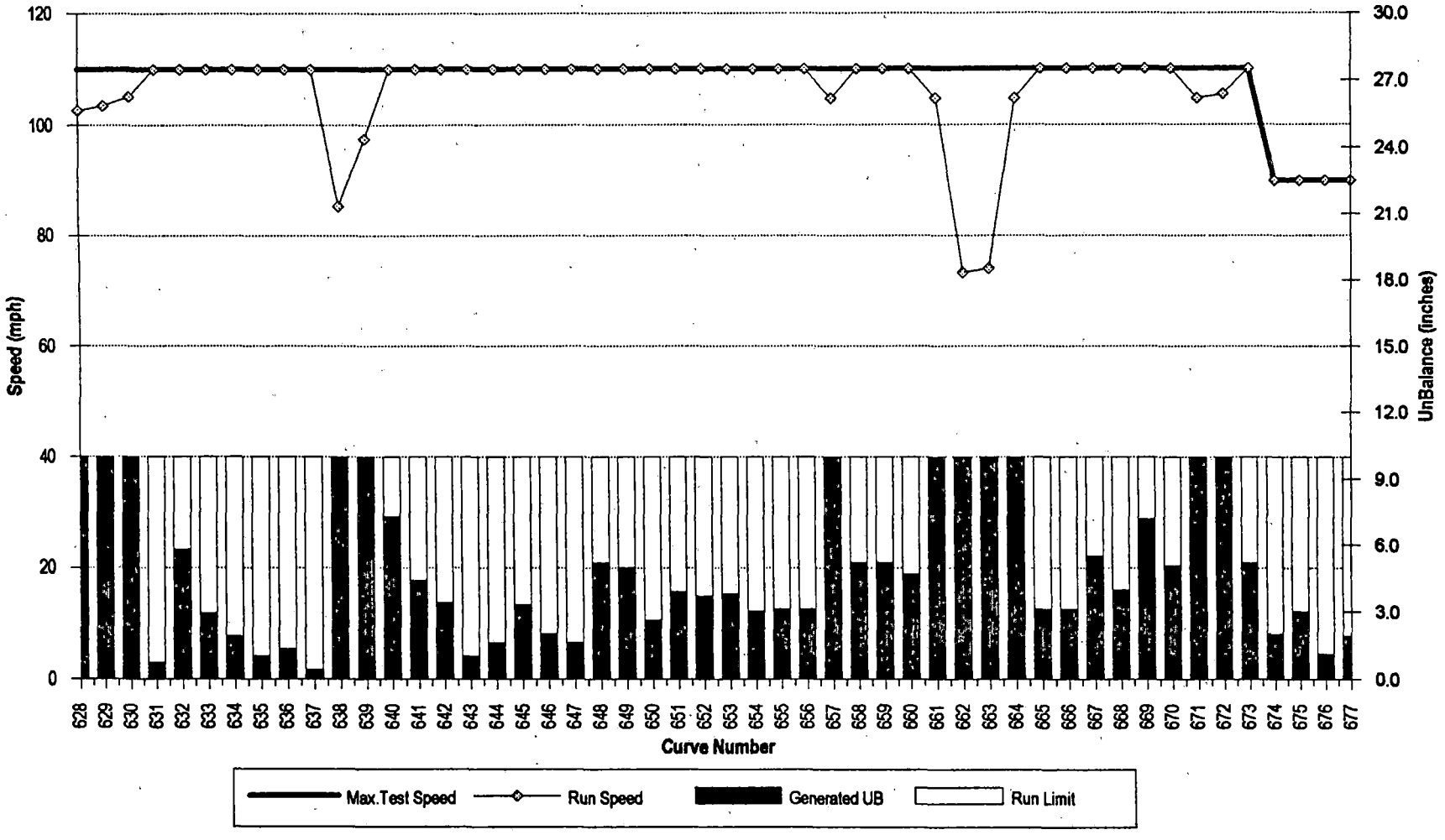
X-2000 TEST PROGRAM
Harrisburg Line - Westbound - 9" UnBalance



X2_HBW09.XLC

AMTRAK ENGINEERING

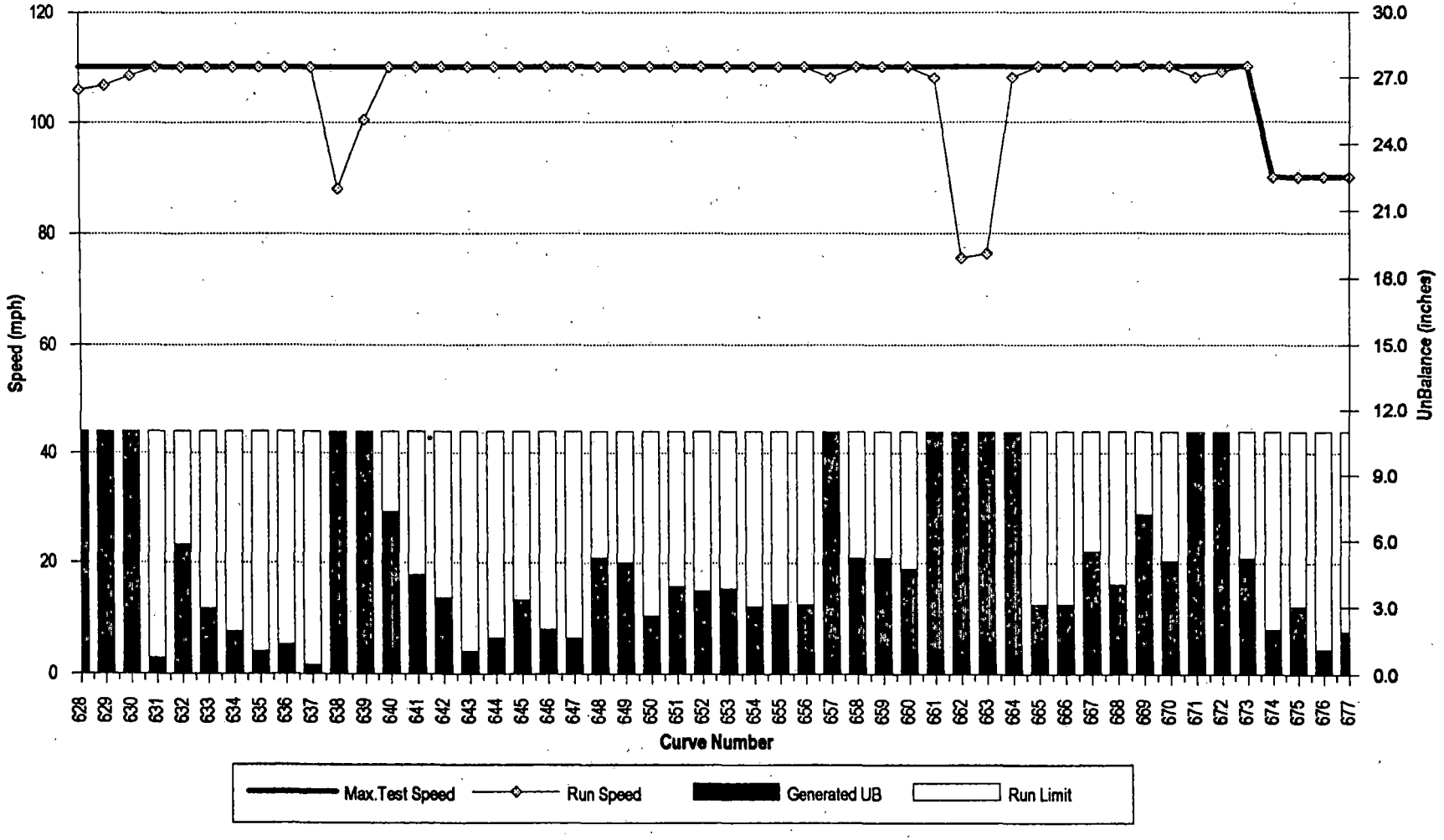
X-2000 TEST PROGRAM
Harrisburg Line - Westbound - 10" UnBalance



X2_HBW10.XLC

AMTRAK ENGINEERING

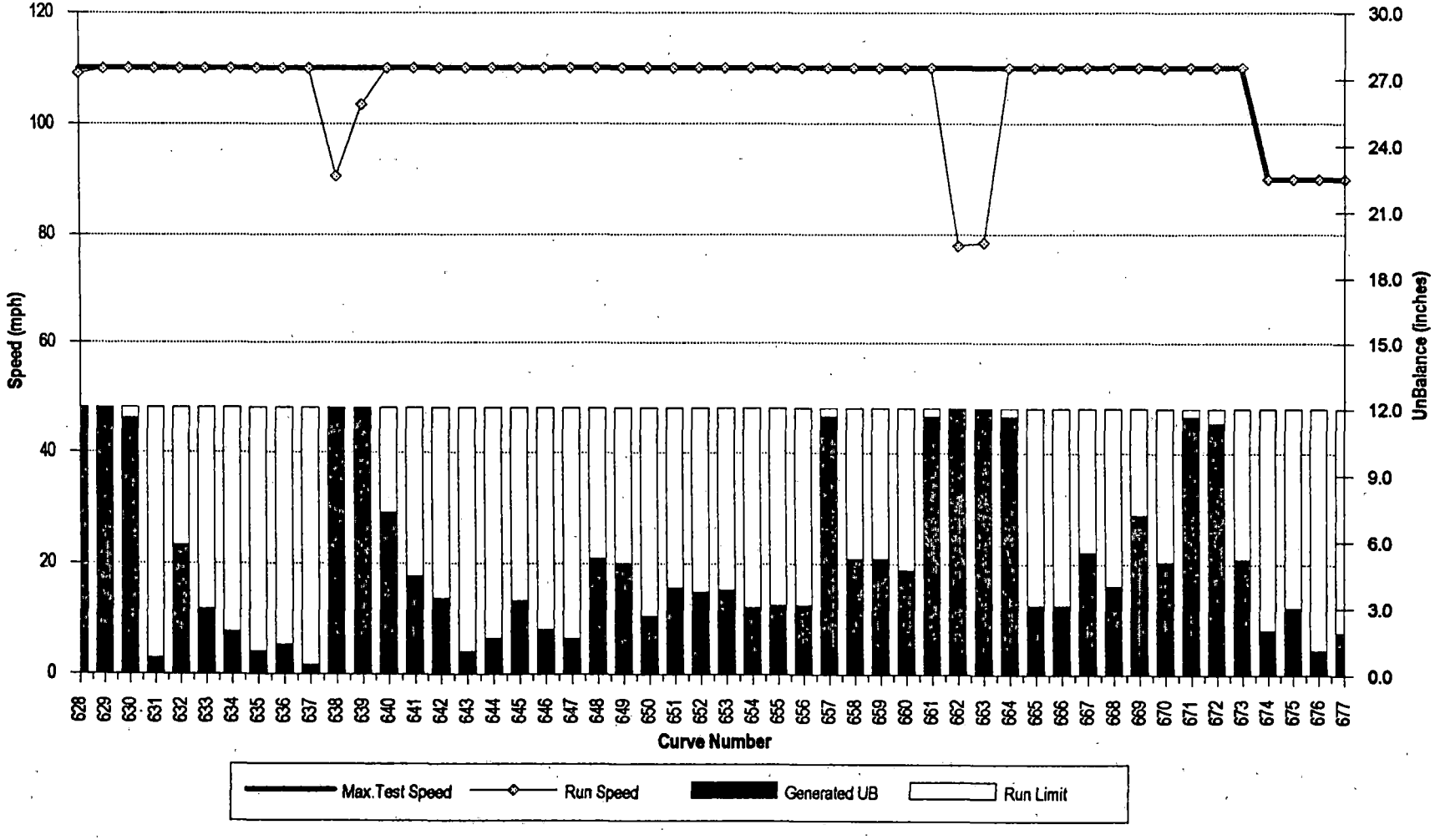
X-2000 TEST PROGRAM
Harrisburg Line - Westbound - 11" UnBalance



X2_HBW11.XLC

AMTRAK ENGINEERING

X-2000 TEST PROGRAM
Harrisburg Line - Westbound - 12" UnBalance



X2_HBW12.XLC

EASTBOUND - HARRISBURG LINE

Lancaster, PA to Paoli, PA

Eastbound

X2000 TEST PROGRAM

HARRISBURG LINE SPEEDS

Track No. 1

CV.#	TIMETABLE DESCRIPTION	MILEPOST LOCATION		CURVE GEOMETRY			PROPOSED CURVING SPEED FOR X-2000 TEST										PROPOSED MAXIMUM TESTING SPEED
		West	East	DEGREE [decimal]	RADIUS [feet]	S.E. [inches]	3"UB [mph]	4"UB [mph]	5"UB [mph]	6"UB [mph]	7"UB [mph]	8"UB [mph]	9"UB [mph]	10"UB [mph]	11"UB [mph]	12"UB [mph]	[mph]
677		66.58	66.26	0.60	9,549	1.875	108	110	110	110	110	110	110	110	110	110	110
676.1		66.22	66.17	0.37	15,626	0.750	110	110	110	110	110	110	110	110	110	110	"
676		65.52	64.79	0.32	18,094	0.750	110	110	110	110	110	110	110	110	110	110	"
675		63.87	63.51	1.00	5,730	3.375	95	103	109	110	110	110	110	110	110	110	"
674		63.21	62.97	0.45	12,733	0.500	105	110	110	110	110	110	110	110	110	110	"
673		62.10	61.64	1.02	5,636	3.250	94	101	108	110	110	110	110	110	110	110	"
672	Curve west of MP 61	61.48	60.97	2.03	2,818	5.250	76	81	85	89	93	97	100	104	107	110	"
671	Curve west of MP 60	60.62	59.97	2.00	2,865	5.500	78	82	87	91	95	98	102	105	109	110	"
670	Curve west of MP 59	59.69	59.53	1.10	5,209	3.000	88	95	102	108	110	110	110	110	110	110	"
669		58.99	58.42	1.52	3,778	5.500	90	95	99	104	109	110	110	110	110	110	"
668		57.64	57.36	0.65	8,815	1.250	97	107	110	110	110	110	110	110	110	110	"
667		56.64	55.79	0.98	5,827	2.250	87	95	103	110	110	110	110	110	110	110	"
666		54.58	54.38	0.45	12,733	0.875	110	110	110	110	110	110	110	110	110	110	"
665		53.99	53.66	0.47	12,278	0.875	109	110	110	110	110	110	110	110	110	110	"
664		53.25	52.74	2.05	2,795	5.625	78	82	86	90	94	97	101	104	108	110	"
663	Curve west of Gap	52.44	52.00	4.03	1,421	5.750	56	59	62	65	67	70	72	75	77	79	"
662	Curve at Gap	51.63	50.77	4.20	1,364	5.625	54	57	60	63	66	68	71	73	75	77	"
661		50.61	50.19	2.00	2,865	5.875	80	84	88	92	96	100	103	107	110	110	"
660		50.06	49.81	1.00	5,730	3.375	95	103	109	110	110	110	110	110	110	110	"
659		49.16	48.84	1.00	5,730	3.375	95	103	109	110	110	110	110	110	110	110	"
658		48.72	48.36	1.00	5,730	3.125	94	101	108	110	110	110	110	110	110	110	"
657	Curve west of Atglen	48.29	47.50	2.00	2,865	5.750	79	84	88	92	95	99	103	106	109	110	"
656		46.86	46.77	0.33	17,189	0.375	110	110	110	110	110	110	110	110	110	110	"
655		45.34	45.24	0.40	14,324	0.750	110	110	110	110	110	110	110	110	110	110	"
654.1		44.81	44.61	0.45	12,733	0.875	110	110	110	110	110	110	110	110	110	110	"
654		43.79	43.65	0.32	18,094	0.750	110	110	110	110	110	110	110	110	110	110	"
653.1		43.97	43.96	0.37	15,626	0.750	110	110	110	110	110	110	110	110	110	110	"
653		41.63	41.32	0.65	8,815	2.250	107	110	110	110	110	110	110	110	110	110	"
652		41.03	40.84	0.75	7,640	1.875	96	106	110	110	110	110	110	110	110	110	"
651		39.90	39.42	0.67	8,594	2.250	106	110	110	110	110	110	110	110	110	110	"
650		39.09	38.39	0.50	11,459	1.625	110	110	110	110	110	110	110	110	110	110	"
649		37.92	37.33	1.02	5,636	3.375	95	102	109	110	110	110	110	110	110	110	"

Eastbound

X2000 TEST PROGRAM

HARRISBURG LINE SPEEDS

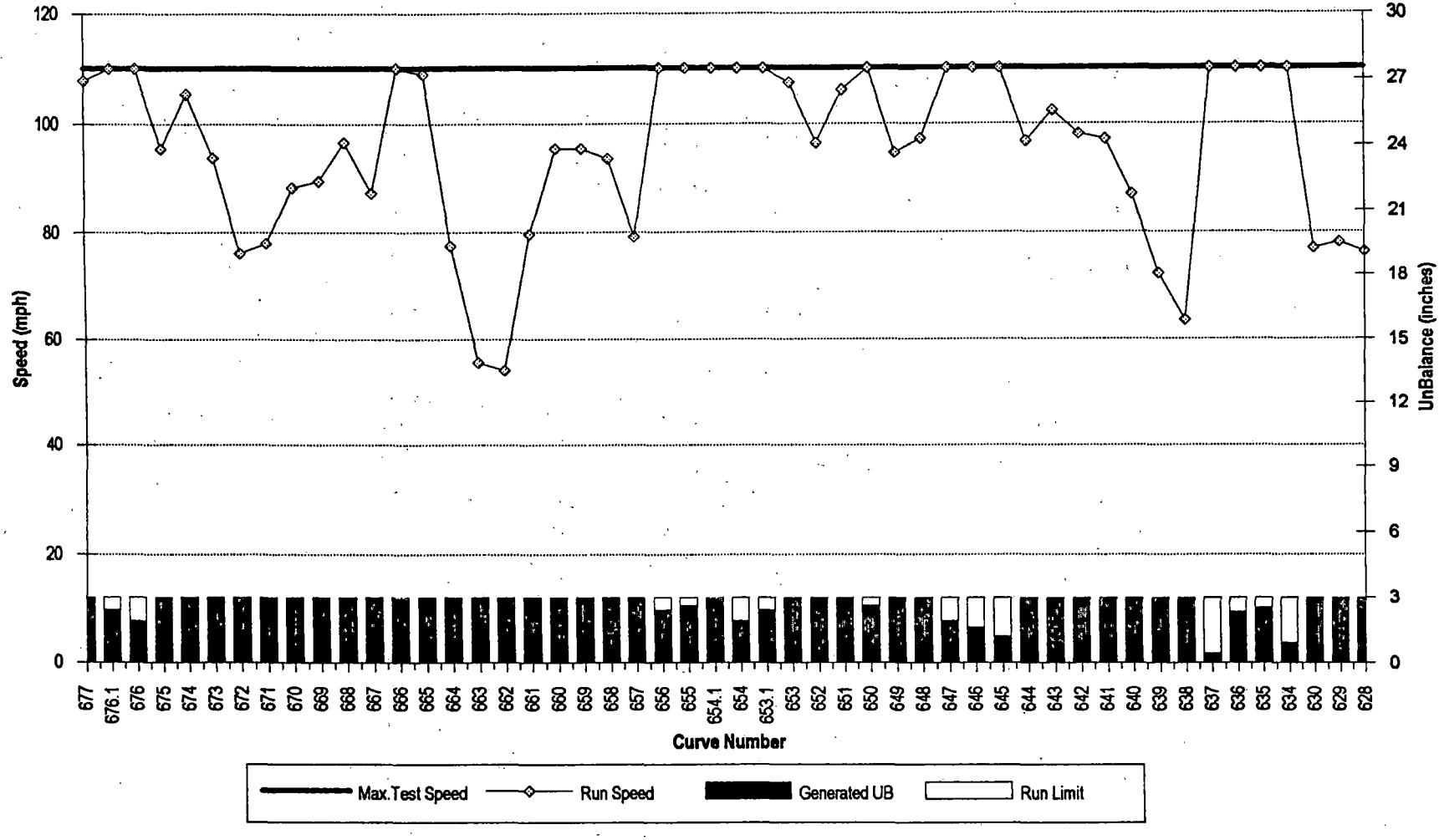
Track No. 1

CV.#	TIMETABLE DESCRIPTION	MILEPOST LOCATION		CURVE GEOMETRY			PROPOSED CURVING SPEED FOR X-2000 TEST										PROPOSED MAXIMUM TESTING SPEED
		West	East	DEGREE [decimal]	RADIUS [feet]	S.E. [inches]	3"UB [mph]	4"UB [mph]	5"UB [mph]	6"UB [mph]	7"UB [mph]	8"UB [mph]	9"UB [mph]	10"UB [mph]	11"UB [mph]	12"UB [mph]	[mph]
648		37.30	36.77	0.98	5,827	3.500	97	104	110	110	110	110	110	110	110	110	110
647		35.87	35.70	0.37	15,626	1.250	110	110	110	110	110	110	110	110	110	110	"
646		35.55	35.43	0.32	18,094	1.125	110	110	110	110	110	110	110	110	110	110	"
645		35.13	34.84	0.32	18,094	1.500	110	110	110	110	110	110	110	110	110	110	"
644		34.58	34.10	0.92	6,251	3.000	97	104	110	110	110	110	110	110	110	110	"
643		34.04	33.55	0.72	7,995	2.250	102	110	110	110	110	110	110	110	110	110	"
642		33.16	32.88	0.82	7,016	2.500	98	107	110	110	110	110	110	110	110	110	"
641		32.56	32.18	0.97	5,927	3.375	97	104	110	110	110	110	110	110	110	110	"
640		31.58	31.27	1.70	3,370	6.000	87	92	96	100	105	109	110	110	110	110	"
639	1st & 2nd curve 1200' west of Signal 295	30.84	30.34	2.37	2,421	5.625	72	76	80	84	87	91	94	97	100	103	"
638	1st & 2nd curve 1200' west of Signal 295	30.28	29.81	3.00	1,910	5.500	64	67	71	74	77	80	83	86	89	91	"
637		29.20	28.20	0.20	28,648	1.250	110	110	110	110	110	110	110	110	110	110	"
636		25.71	25.50	0.45	12,733	1.500	110	110	110	110	110	110	110	110	110	110	"
635		24.50	24.15	0.50	11,459	1.750	110	110	110	110	110	110	110	110	110	110	"
634		23.60	23.30	0.20	28,648	0.750	110	110	110	110	110	110	110	110	110	110	"
630	First 3 curves west of MP 21	22.74	22.35	2.05	2,795	5.500	77	81	86	90	93	97	101	104	107	110	"
629	First 3 curves west of MP 21	22.31	21.97	2.05	2,795	5.750	78	82	87	91	94	98	101	105	108	110	"
628	First 3 curves west of MP 21	21.85	21.60	2.12	2,707	5.625	76	81	85	89	92	96	99	103	106	109	"

X2000HBE.XLS

AMTRAK ENGINEERING

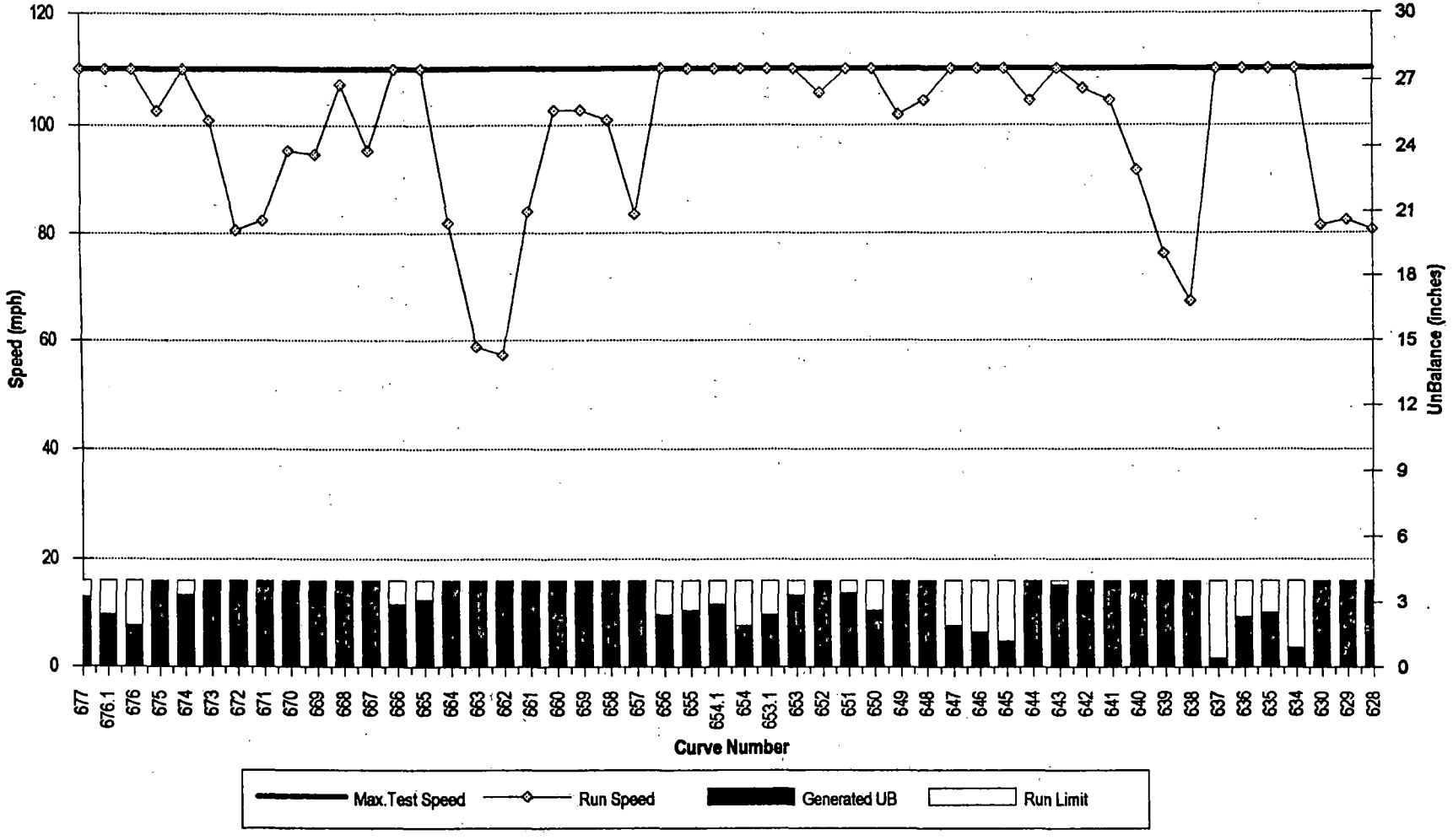
X-2000 TEST PROGRAM
Harrisburg Line - Eastbound - 3" UnBalance



X2_HBE03.XLC

AMTRAK ENGINEERING

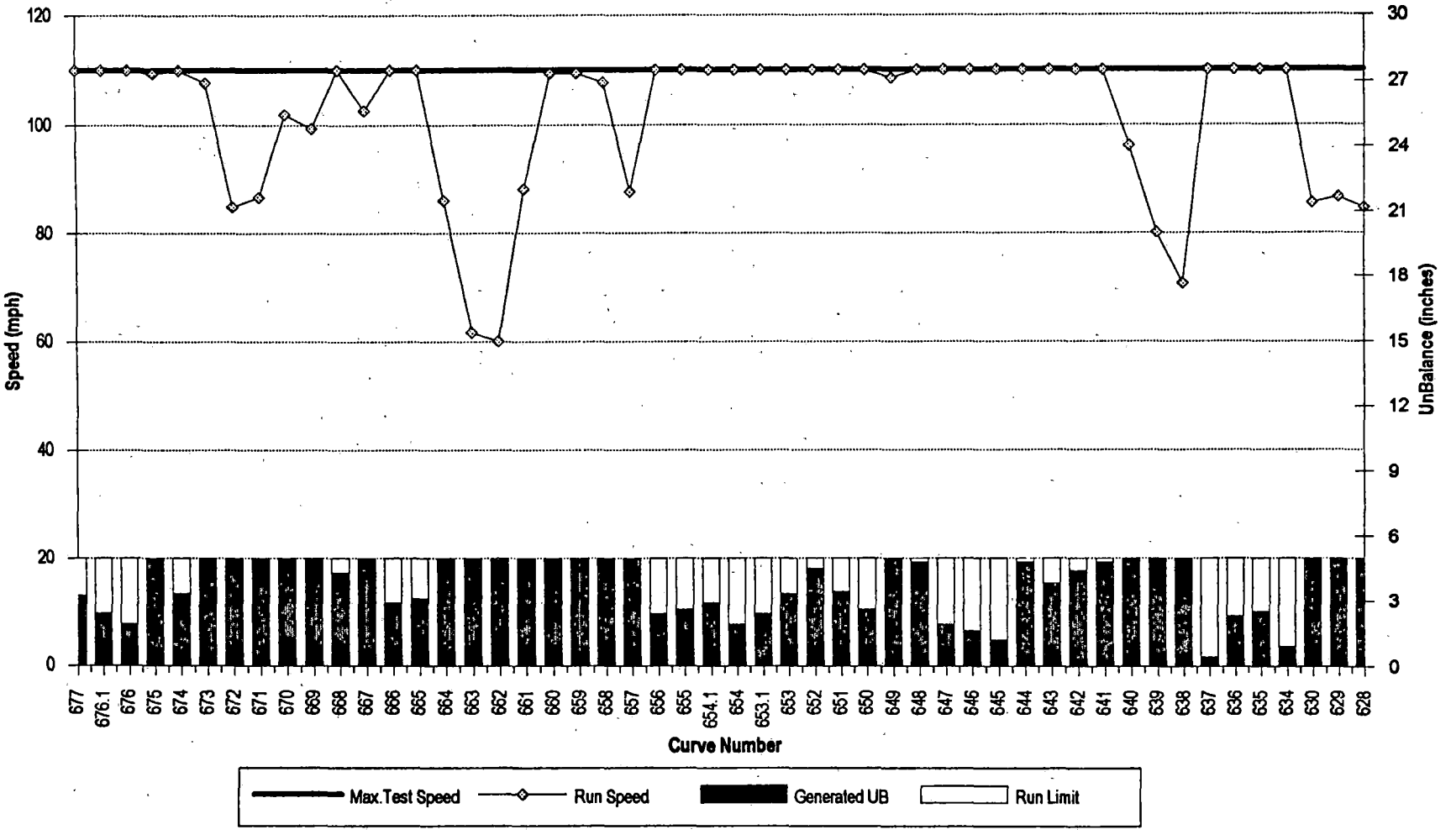
X-2000 TEST PROGRAM
Harrisburg Line - Eastbound - 4" UnBalance



X2_HBE04.XLC

AMTRAK ENGINEERING

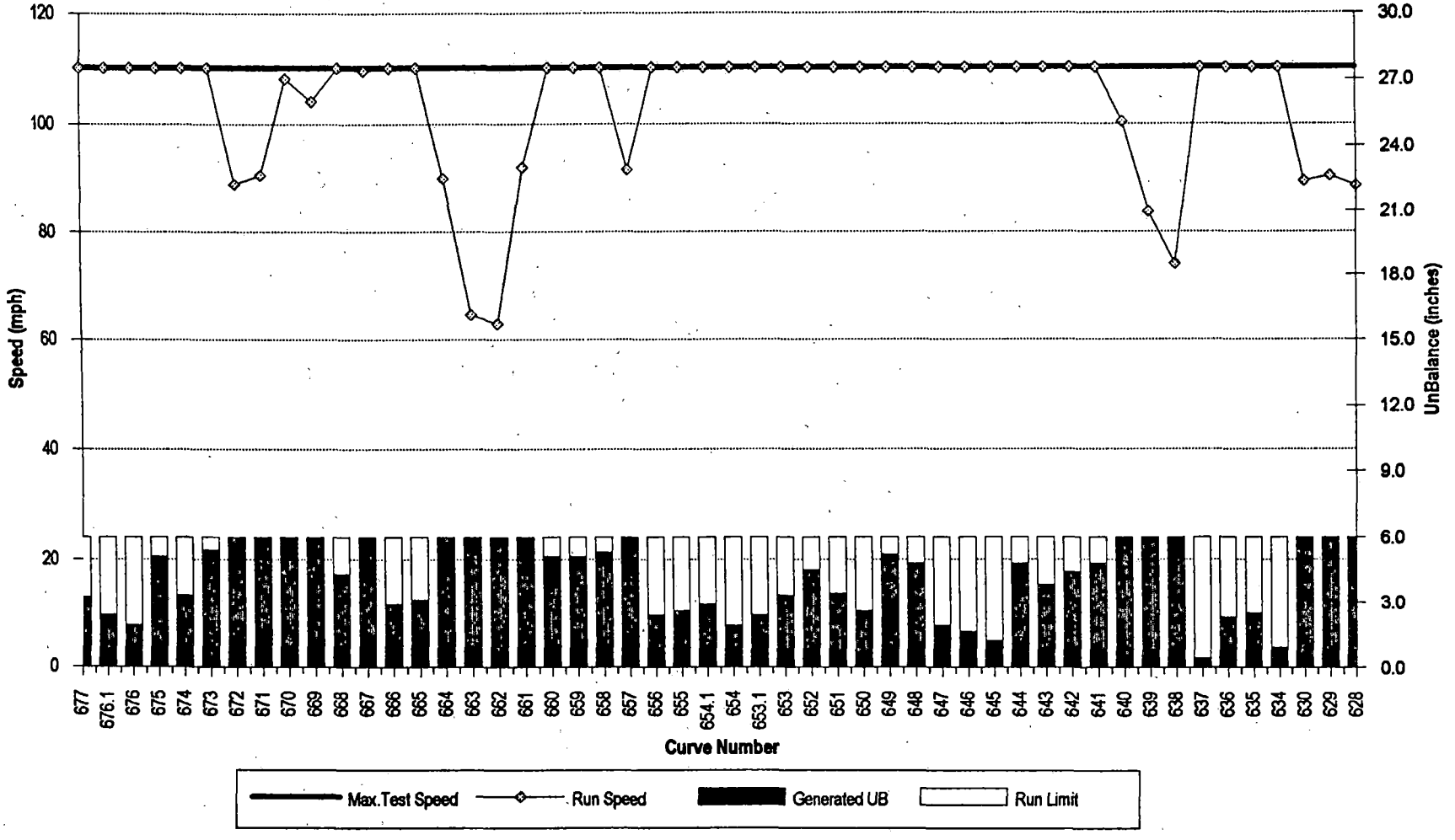
X-2000 TEST PROGRAM
Harrisburg Line - Eastbound - 5" UnBalance



X2_HBE05.XLC

AMTRAK ENGINEERING

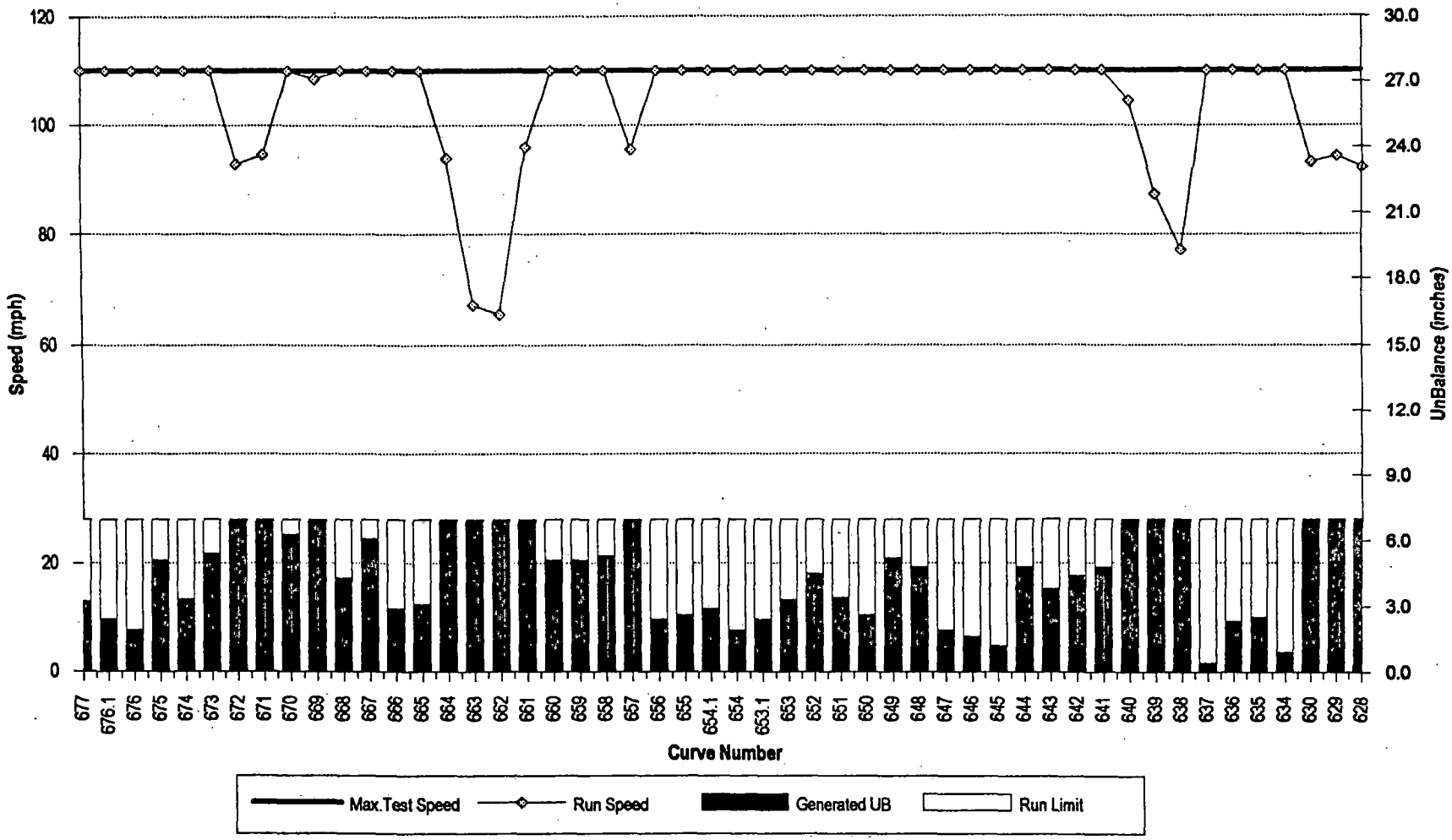
X-2000 TEST PROGRAM
Harrisburg Line - Eastbound - 6" UnBalance



X2_HBE06.XLC

AMTRAK ENGINEERING

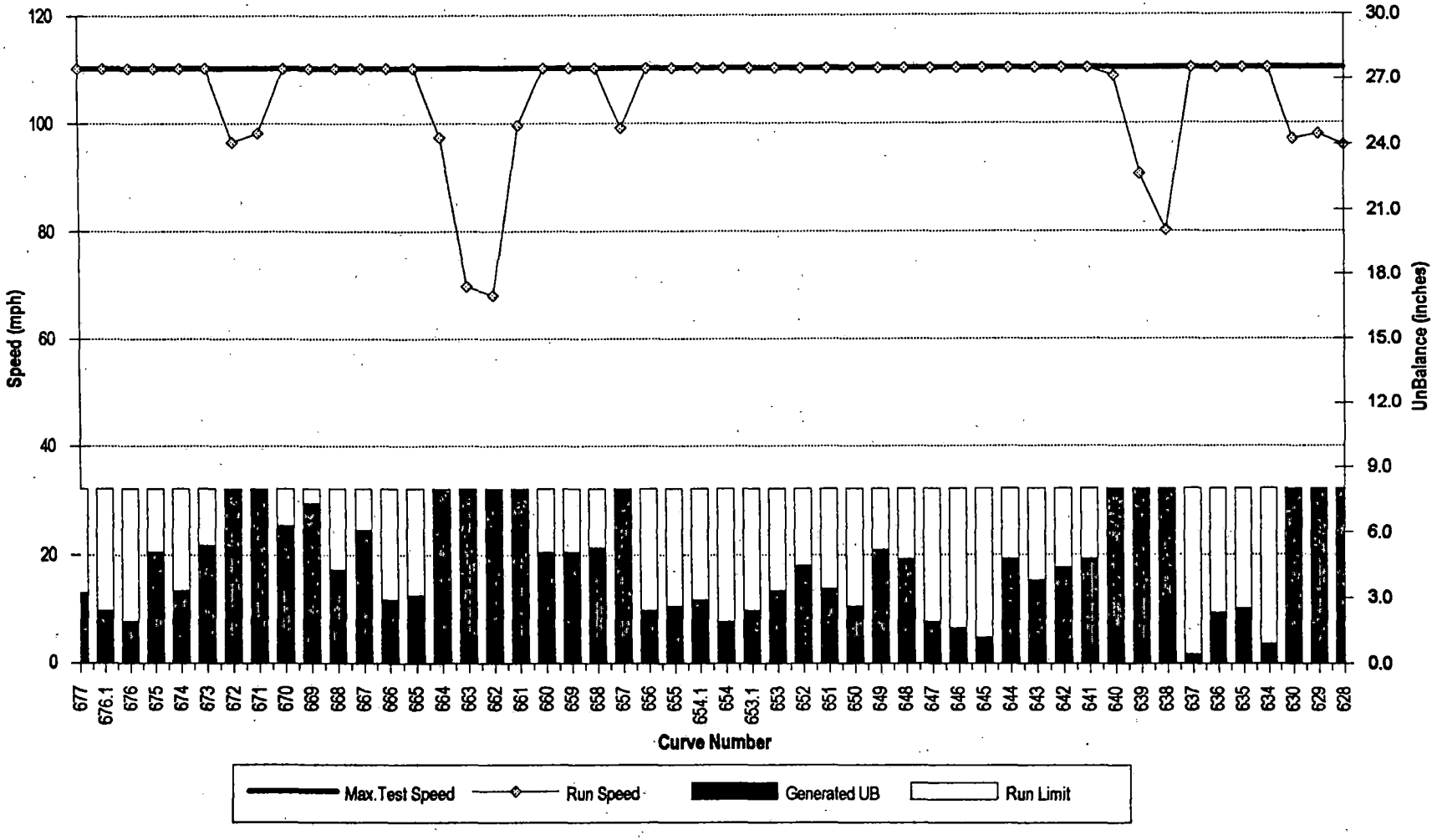
X-2000 TEST PROGRAM
Harrisburg Line - Eastbound - 7" UnBalance



X2_HBE07.XLC

AMTRAK ENGINEERING

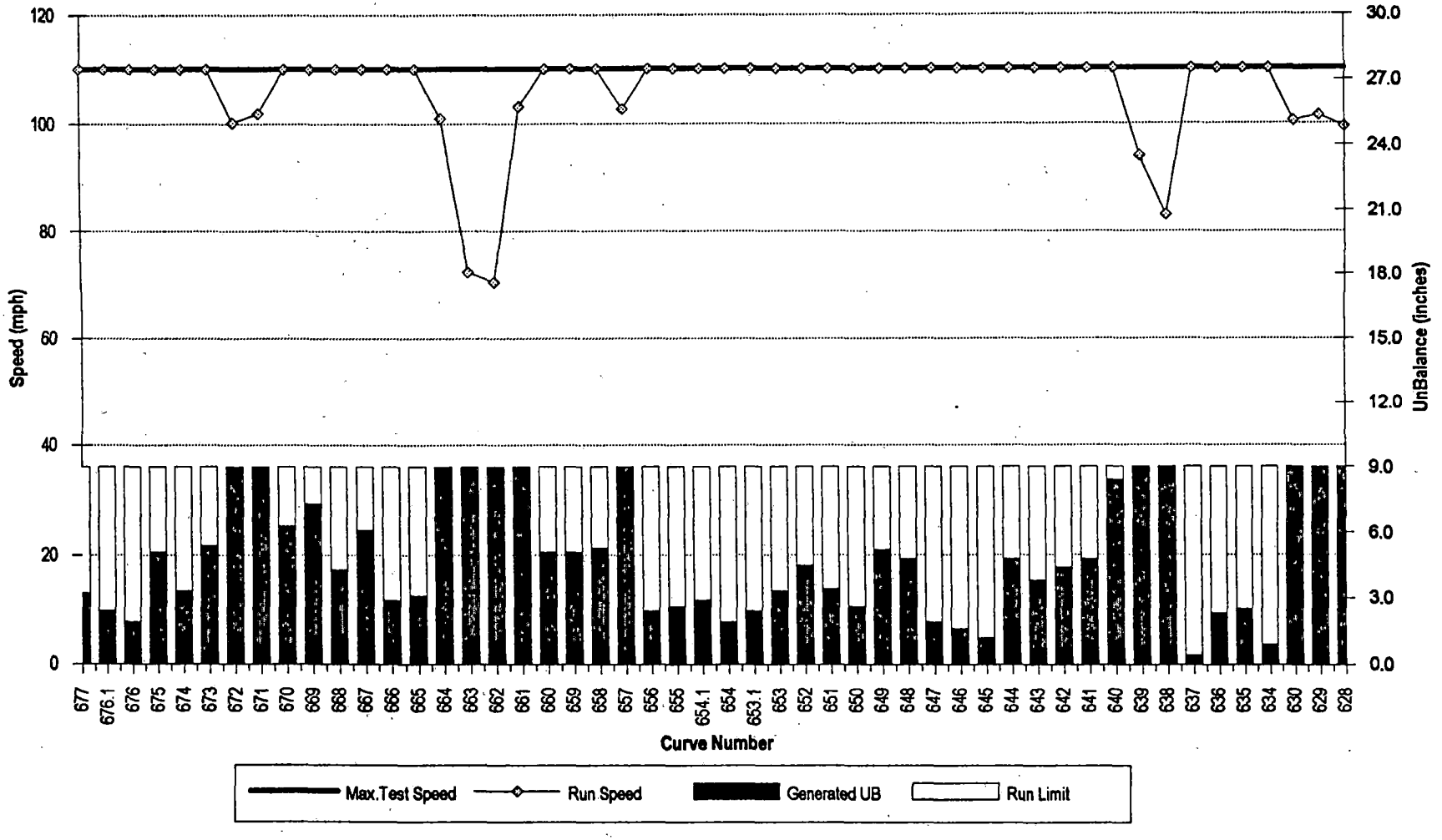
X-2000 TEST PROGRAM
Harrisburg Line - Eastbound - 8" UnBalance



X2_HBE08.XLC

AMTRAK ENGINEERING

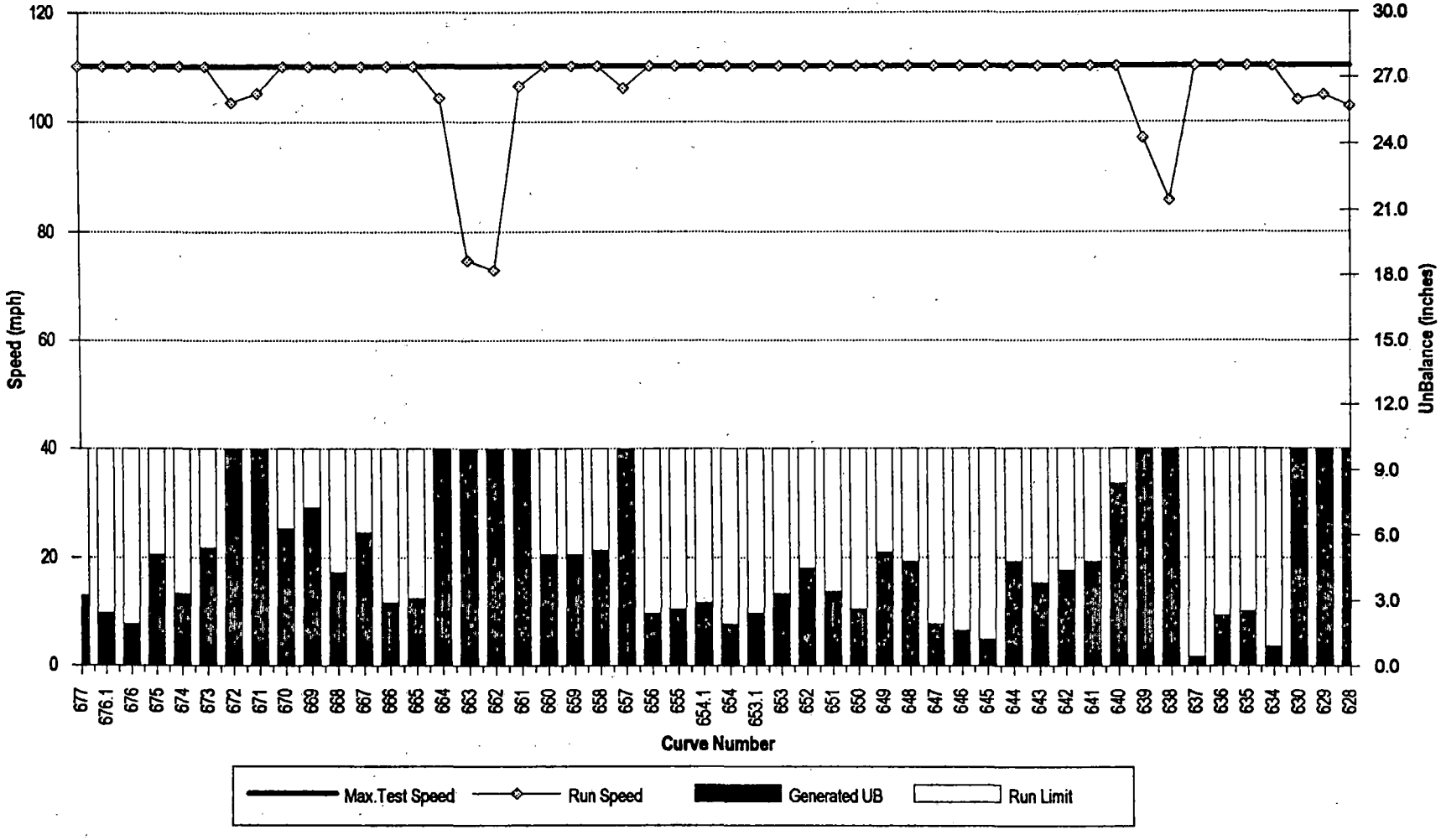
X-2000 TEST PROGRAM
Harrisburg Line - Eastbound - 9" UnBalance



X2_HBE09.XLC

AMTRAK ENGINEERING

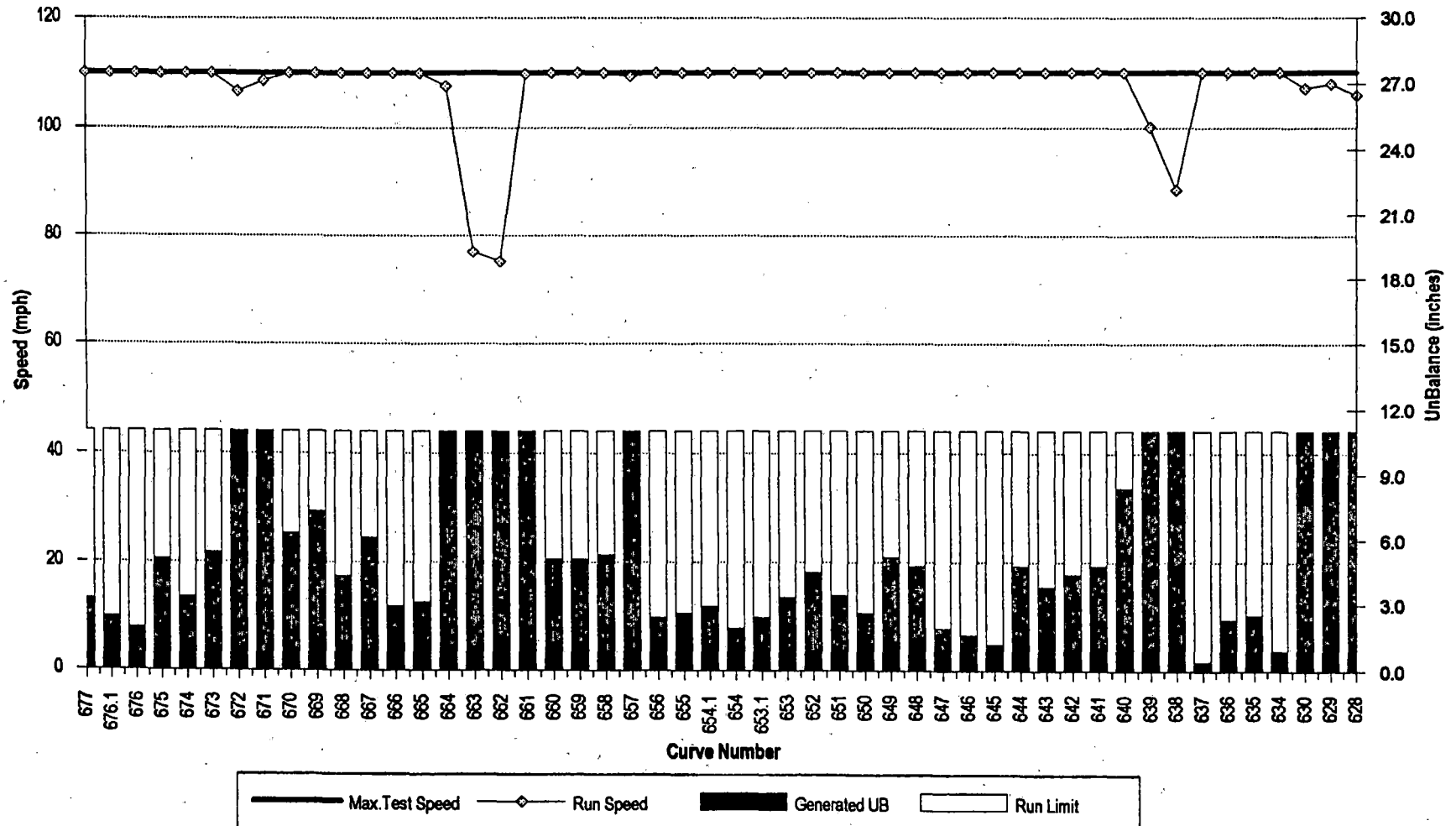
X-2000 TEST PROGRAM
Harrisburg Line - Eastbound - 10" UnBalance



X2_HBE10.XLC

AMTRAK ENGINEERING

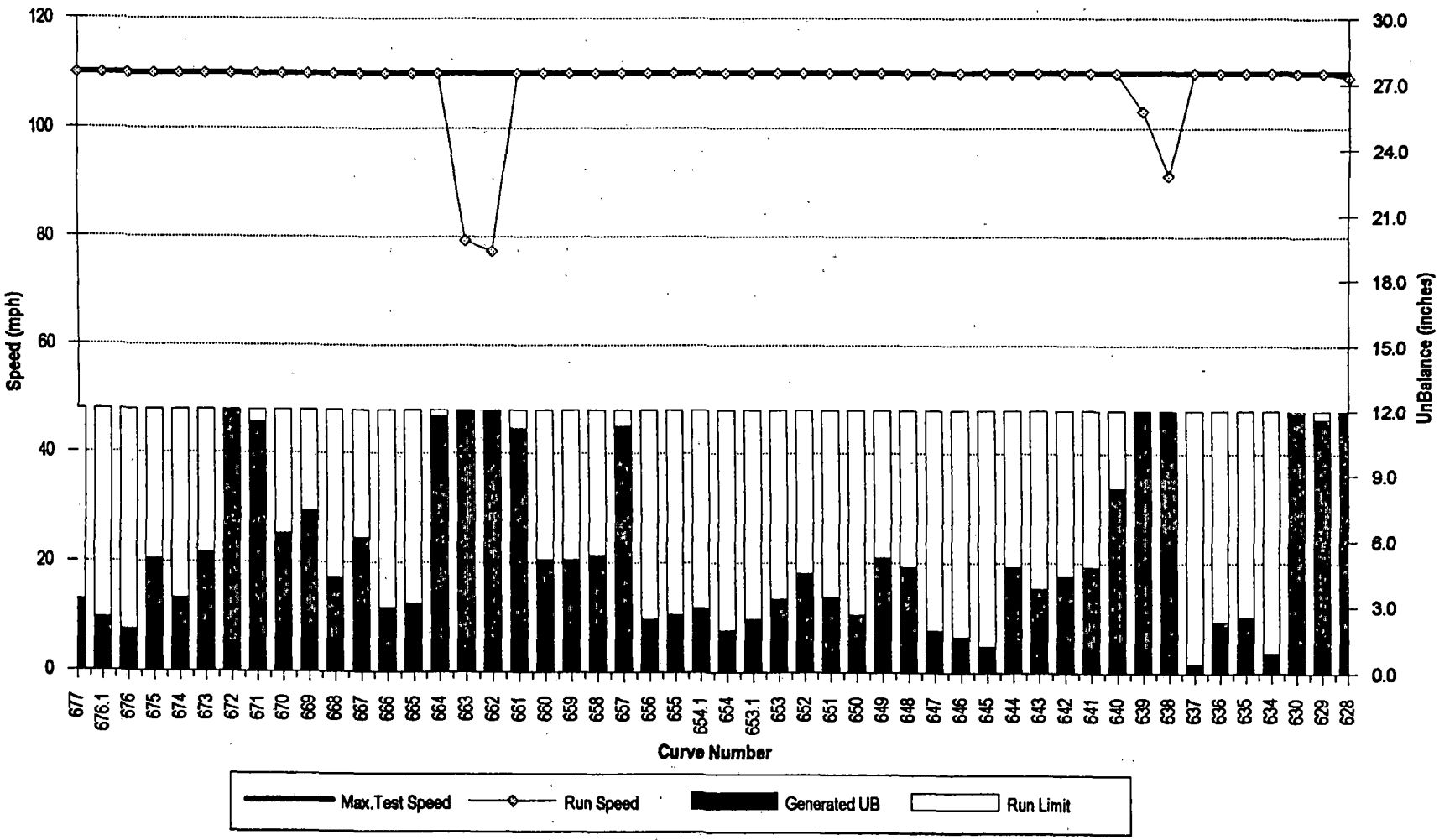
X-2000 TEST PROGRAM
Harrisburg Line - Eastbound - 11" UnBalance



X2_HBE11.XLC

AMTRAK ENGINEERING

X-2000 TEST PROGRAM
Harrisburg Line - Eastbound - 12" UnBalance



X2_HBE12.XLC

APPENDIX B

FULL DEFINITION OF PARAMETER CHANNEL ASSIGNMENTS AND SCALE FACTORS

TELEFAX

Date
92 09 08

SJ, Swedish State Railways
Rolling Stock Laboratory

Att. : Mr K Kesler
Fax No. : 009-1-215-349-2767

From : Mr L Kloow
Fax No. : +46 8 762 53 43

No. of pages : 6
(incl. this page)

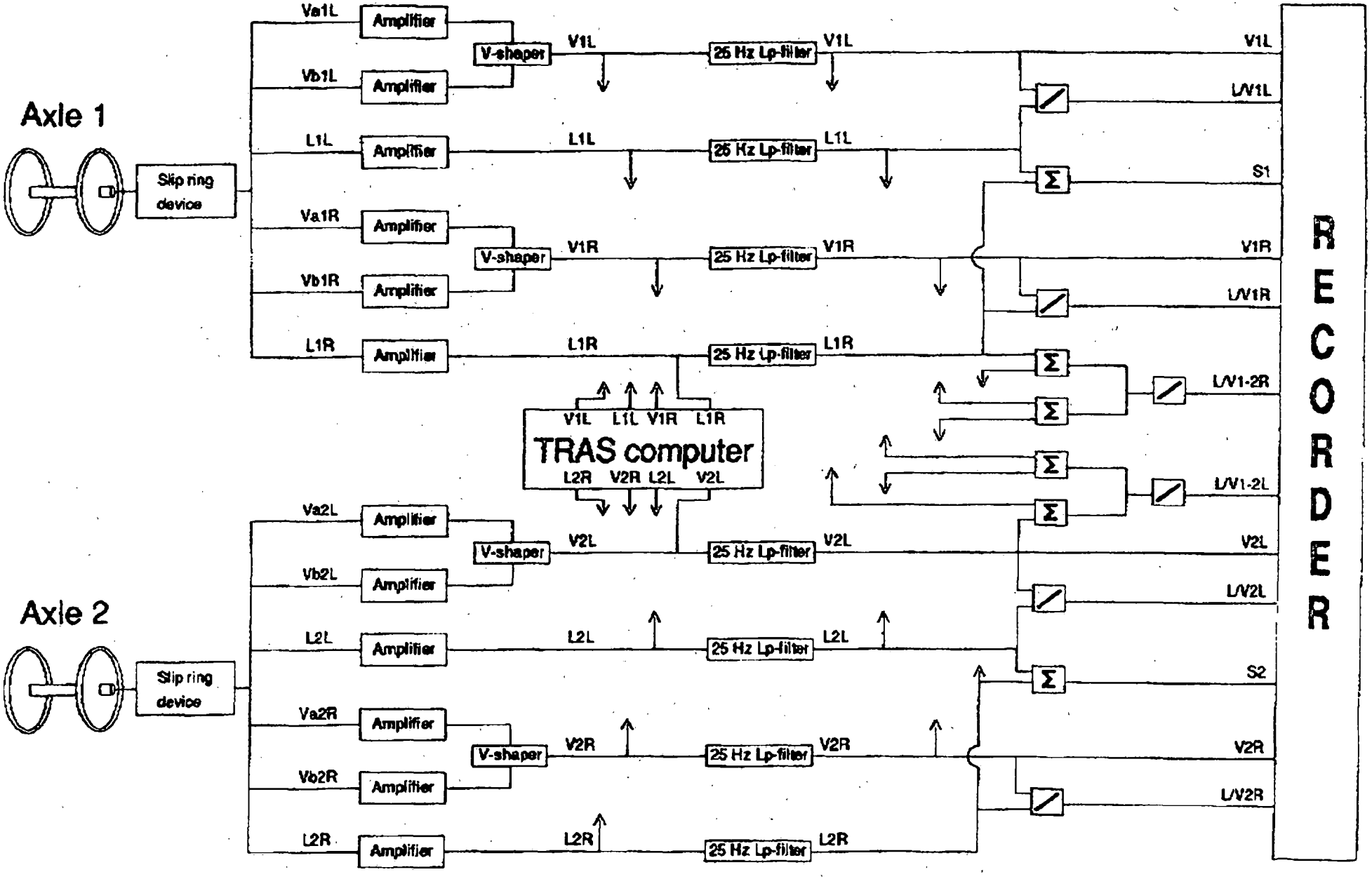
MESSAGE :

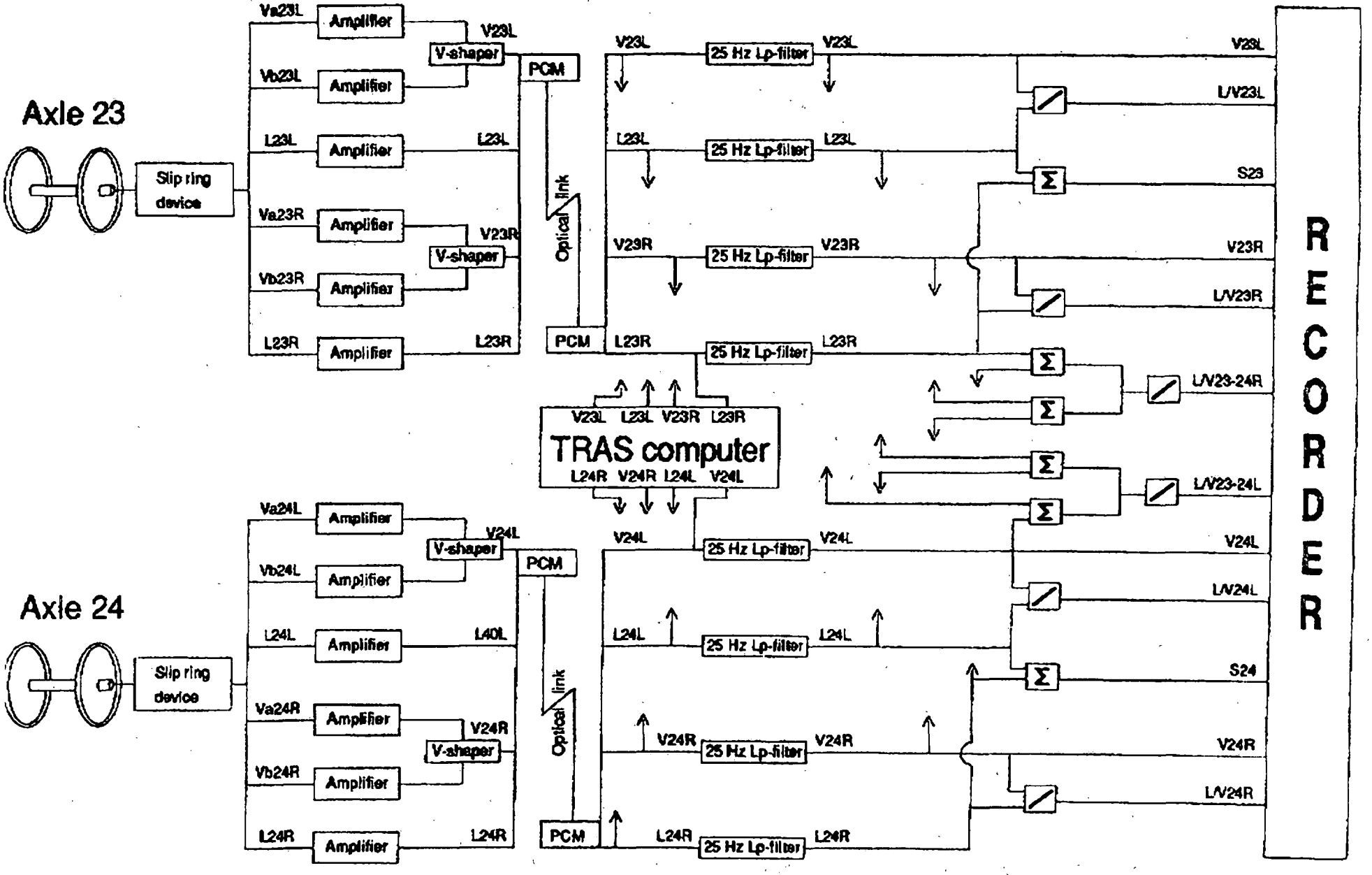
Dear Mr Kesler

The folowing pages include the documentation you requested in your memo of August 14 1992.
Thomas Edwards ABB has reviewed the documentation.
Since the discussion concerning the location and the number of transducers is not completed, this documentation has to be seen as a SJ proposal of transducer location.
When the discussion is completed we will forward you a complete set of documentation including scale factors and calibration values.
If you have any questions on the documentation or test planing please contact Mr M Bäfverfeldt (Fax +46 8 762 53 43, Phone +46 8 762 52 38).

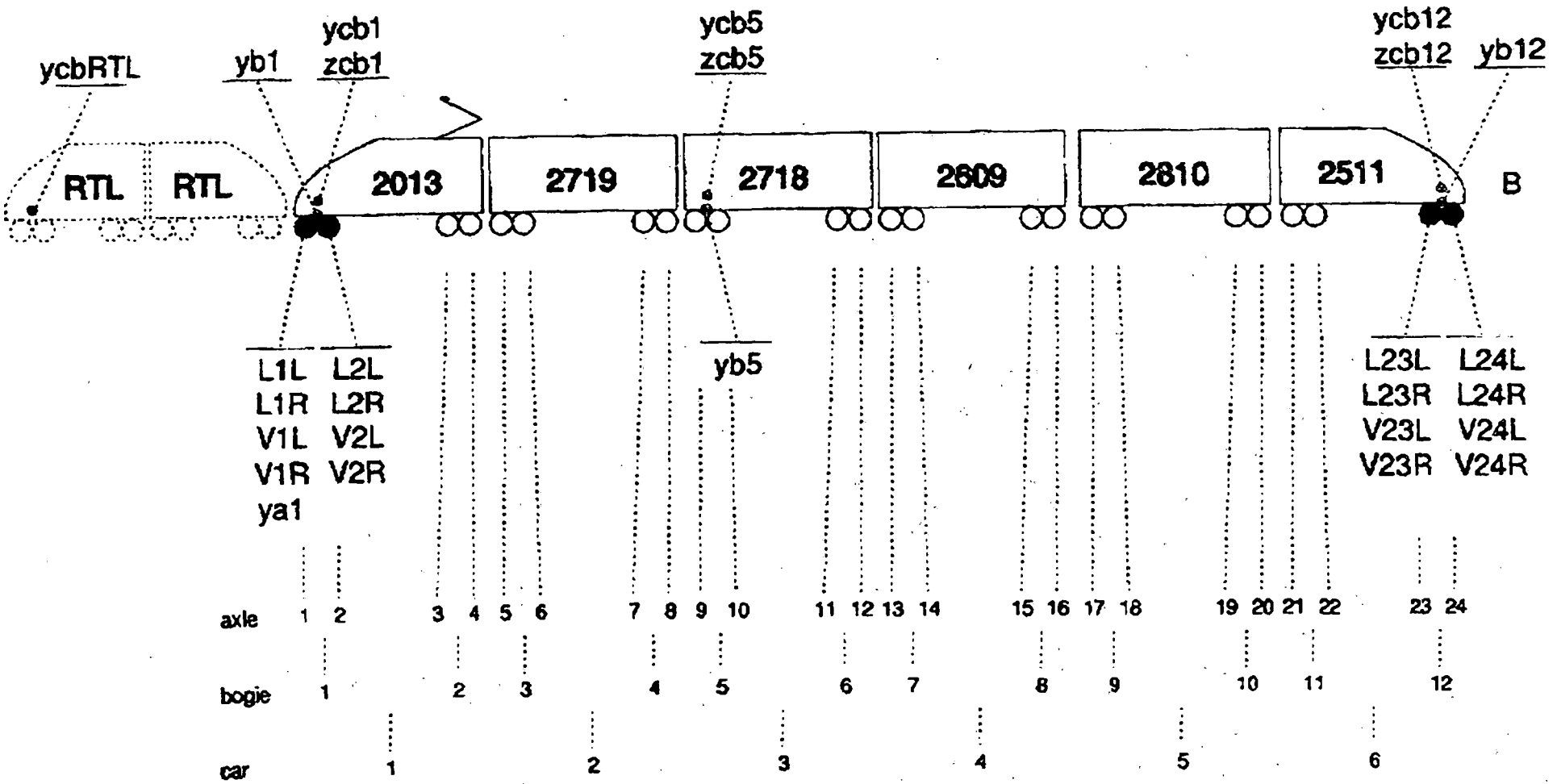
Kind regards

Lennart Kloow


Axle 1
Slip ring device
Va1L
Vb1L
L1L
Va1R
Vb1R
L1R
Amplifier
V-shaper
25 Hz Lp-filter
V1L
L1L
V1R
L1R
TRAS computer
V1L L1L V1R L1R
L2R V2R L2L V2L
Axle 2
Slip ring device
Va2L
Vb2L
L2L
Va2R
Vb2R
L2R
V2L
V2R
Σ
V1L
L/V1L
S1
V1R
L/V1R
L/V1-2R
L/V1-2L
V2L
L/V2L
S2
V2R
L/V2R
RECORDER


Axle 23
Slip ring device
Va23L
Amplifier
V23L
V-shaper
Vb23L
Amplifier
PCM
L23L
Amplifier
L23L
Va23R
Amplifier
V23R
V-shaper
Vb23R
Amplifier
Optical link
L23R
Amplifier
L23R
PCM
V23L
25 Hz Lp-filter
V23L
L23L
25 Hz Lp-filter
L23L
V23R
25 Hz Lp-filter
V23R
L23R
25 Hz Lp-filter
L23R
V23L
L23L
V23R
L23R
TRAS computer
L24R
V24R
L24L
V24L
Axle 24
Slip ring device
Va24L
Amplifier
V24L
V-shaper
Vb24L
Amplifier
PCM
L24L
Amplifier
L40L
Va24R
Amplifier
V24R
V-shaper
Vb24R
Amplifier
Optical link
L24R
Amplifier
L24R
PCM
V24L
25 Hz Lp-filter
V24L
L24L
25 Hz Lp-filter
L24L
V24R
25 Hz Lp-filter
V24R
L24R
25 Hz Lp-filter
L24R
V23L
L/V23L
S23
V23R
L/V23R
L/V23-24R
L/V23-24L
V24L
L/V24L
S24
V24R
L/V24R
RECORDER

Transducer configuration X2000 USA



Signal names:

First letter of signalname indicates type of signal:
V = Vertical wheel / rail force
L = Lateral wheel / rail force
y = Lateral acceleration
z = Vertical acceleration

If the signal is a wheel / rail force position #2 indicates axle and position #3 left [L] or right [R] side.

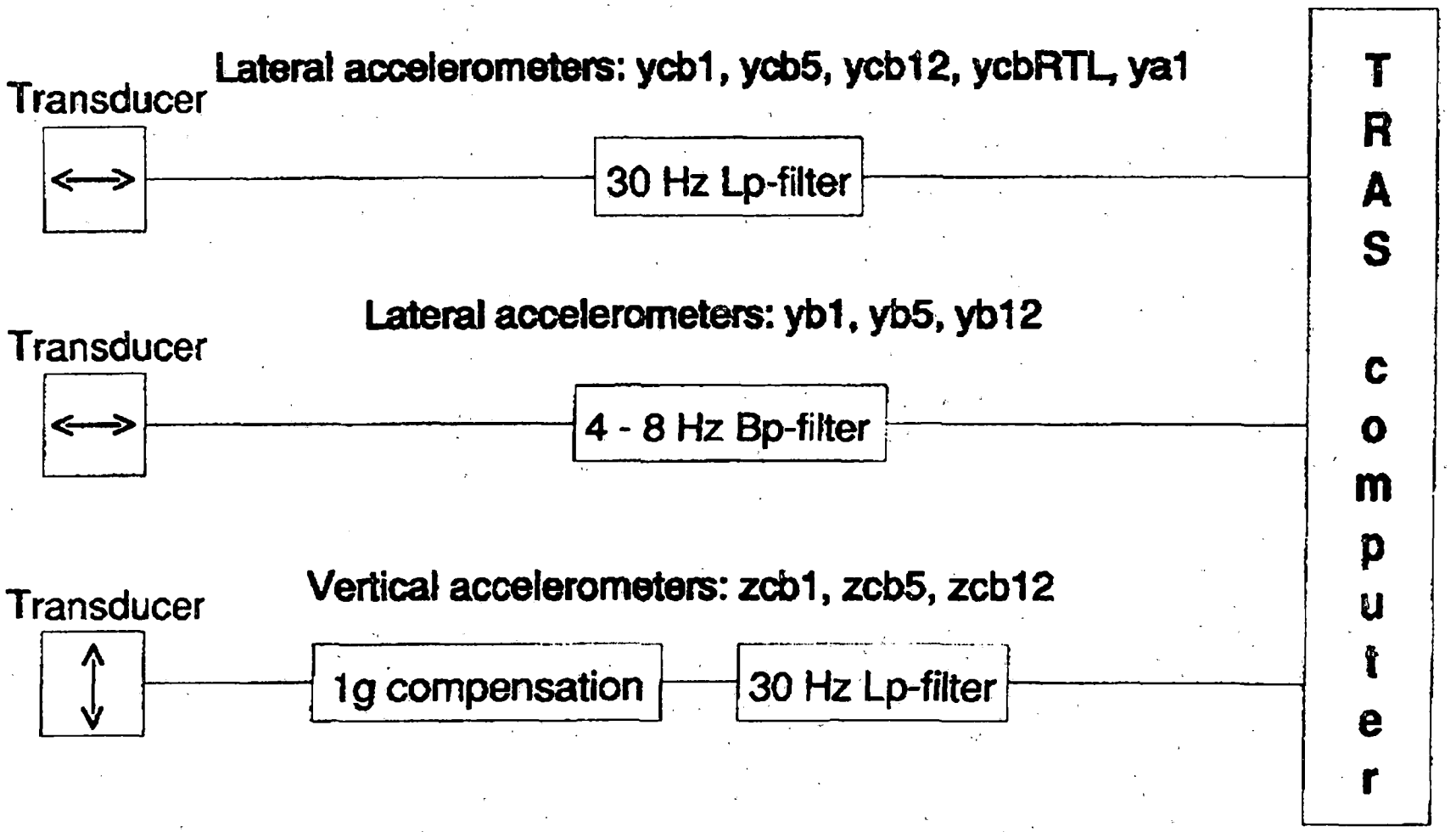
For accelerometers numbers indicate bogie # and letters position in car acording to folowing system:
cb = [car bogie] on floor in car over bogie center
b = [bogie] on bogie
a = [axle] on axle bearing

Filters:

All filters is four pole filters of Butterworth (accelerations) or Bessel (forces) type.

Signals:

Signal #	*Signalname*	*Description*	*Transducer type*
1	L1L	Lat. W/R force axle 1 left	Instrumented wheelset
2	L1R	Lat. W/R force axle 1 right	Instrumented wheelset
3	V1L	Vert. W/R force axle 1 left	Instrumented wheelset
4	V1R	Vert. W/R force axle 1 right	Instrumented wheelset
5	L2L	Lat. W/R force axle 2 left	Instrumented wheelset
6	L2R	Lat. W/R force axle 2 right	Instrumented wheelset
7	V2L	Vert. W/R force axle 2 left	Instrumented wheelset
8	V2R	Vert. W/R force axle 2 right	Instrumented wheelset
9	L19L	Lat. W/R force axle 19 left	Instrumented wheelset
10	L19R	Lat. W/R force axle 19 right	Instrumented wheelset
11	V19L	Vert. W/R force axle 19 left	Instrumented wheelset
12	V19R	Vert. W/R force axle 19 right	Instrumented wheelset
13	L20L	Lat. W/R force axle 20 left	Instrumented wheelset
14	L20R	Lat. W/R force axle 20 right	Instrumented wheelset
15	V20L	Vert. W/R force axle 20 left	Instrumented wheelset
16	V20R	Vert. W/R force axle 20 right	Instrumented wheelset
17	ycb1	Lat. acc. in car over bogie 1	Servo accelerometer
18	zcb1	Vert. acc. in car over bogie 1	Servo accelerometer
19	yb1	Lat. acc. in bogie 1	Servo accelerometer
20	ya1	Lat. acc. axle 1	Variable capacitance accelerometer
21	ycb5	Lat. acc. in car over bogie 5	Servo accelerometer
22	zcb5	Vert. acc. in car over bogie 5	Servo accelerometer
23	yb5	Lat. acc. in bogie 5	Servo accelerometer
24	ycb10	Lat. acc. in car over bogie 10	Servo accelerometer
25	zcb10	Vert. acc. in car over bogie 10	Servo accelerometer
26	yb10	Lat. acc. in bogie 10	Servo accelerometer
27	ycbRTL	Lat acc in car over first bogie in leading RTL-unit	Servo accelerometer
28	v	Speed	


Lateral accelerometers: ycb1, ycb5, ycb12, ycbRTL, ya1
Transducer
30 Hz Lp-filter
Lateral accelerometers: yb1, yb5, yb12
Transducer
4 - 8 Hz Bp-filter
Vertical accelerometers: zcb1, zcb5, zcb12
Transducer
1g compensation
30 Hz Lp-filter
TRAS computer

APPENDIX C

CANDIDATE CURVES ON THE HARRISBURG LINE BETWEEN MP 13 TO MP 95 FOR DYNAMIC ANALYSIS

Approx. Location (Cntr of Curve)	Track	Degree	Crosslevel	Posted Speed	Conditions
mp 94.9	2	2	?	70	Rough Spiral
mp 93.3	2	2	?	?	Rough Gage; Long Wave Length Alignment
mp 52.2	4	4	6"	50	Rough Spiral (West End)
mp 51.0	4	4	5 1/2"	50	Switch at Tangent Reverse Curve

A tangent site was elected for analysis

mp 87.3	1	--	--	60	Interlocking w/150 ft sine wave alignment deviation 10.7 inch amplitude

COMMISSIONING TEST PLAN

DRAFT - PART THREE

3.1 GENERAL

The purpose of this plan is to define in what order the commission activities will take place, who is responsible for what and roughly how much time will be needed for each activity.

3.2 DEFINITION

"Commissioning" refers to all test activities not related to cant deficiency and running dynamics measurements or revenue service. Any public relation activities are to be covered elsewhere.

3.3 ACTIVITIES

3.3.1 Inspection After Shipping — SJ/Amtrak - 1/2 day

It is to be verified that none of the units is damaged after delivery. Customs clearance etc. No instruction needed.

3.3.2 Joining of Train — SJ/Amtrak/ABB - 1/2 day

The cars are to be coupled up together. All trainlines and hoses are to be connected. Instruction: ABB

3.3.3 Transport to Ivy City — Amtrak - 1 day

The X2000 train is to be hauled dead to Ivy City where the commissioning will start.

Amtrak will need to arrange some special permission since the train will not be commissioned at this time but still hauled over "public" track. Instruction: Amtrak (with any ABB input)

3.3.4 Commissioning of Complete Train — ABB/SJ - 1 day

The power unit was commissioned in Sweden, however, trainline functions are to be checked again after the train is coupled up. Instruction: ABB Instruction USTK 11001-AZC

3.3.5 Check of Brakes on Complete Train — ABB/SJ

Brakes will be checked in accordance with ABB instructions including parking brakes. Instruction: ABB Instruction USTK 11001-ASR, sections 8, 9, 10

3.3.6 AAR Single Car Brake Test **Amtrak - 1/2 day**

Brakes will be tested in accordance with any requirements by AAR, FRA, or Amtrak. Instruction: AAR Instruction # ?????

3.3.7 Cab Signal System **ABB - 1 day**

The cab signal system is to be checked out stationary. Instruction: US&S Instruction # ?????

3.3.8 Safety Appliances **ABB Amtrak - 1/2 day**

Check of horn, fire extinguishers, emergency brake, head lights... To ensure that no one will get hurt by anything. Important, need Amtrak input. Instruction: ABB

3.3.9 Transformer in-rush current **ABB - 1/4 day**

The transformer in-rush current as a result of the MCB closing when the catenary voltage has reached its maximum is to be measured. Instruction: ABB

3.3.10 EMI-Tests **ABB - 3/4 day**

EMI will be measured prior to any on-track tests; this is with X2000 only, without any RTL at this time.

3.3.11 Tight Curve Negotiation Test **Amtrak - 1/2 day**

The X2000 train is to be moved through the worst curve found in the yard area. Instruction: Amtrak

3.3.12 Preliminary Clearance Test **Amtrak - 1/2 day**

Check out platforms or known bad spots nearby Ivy City. Check out the section that will be used for acceleration and retardation tests at low speed. Instruction: Amtrak

3.3.13 Installation of Cant Deficiency Instruments??
ABB/SJ - ?? days

Would this be the proper time? Shakedown tests would follow below.

3.3.14 Acceleration and Electrical Retardation Tests
ABB 2 days

These tests will be run in five steps and it is assumed that Amtrak have received necessary approvals for 125 mph test runs at this time.

a) 0 - 50 - 0 mph
b) 0 - 70 - 0 mph
c) 0 - 90 - 0 mph
d) 0 - 110 - 0 mph
e) 0 - 125 - 0 mph

During the acceleration and retardation runs, will the following be recorded:

- Distance travelled
- Speed
- Tractive effort
- Braking effort
- Motor current
- Line current
- Line voltage
- Further EMI or psofometric current measurements

Instruction: ABB

3.3.15 Stop Distance Tests Air Brakes, Instrumented Wheels - ABB 1/2 day

The stop distance as a result of using the air brakes only will be verified:

125 mph - 0 mph using full service brake
125 mph - 0 mph using emergency brake
(= full service + track brakes)

Any additional air brake tests requested by Amtrak or FRA may be carried out at this time.

Instruction: ABB

3.3.16 Pantograph Uplift Forces ABB - 1/2 day

The train will be running with both pantos raised but one held just under the catenary by means of a fishing line and a load gauge.

The behavior of the pantograph head will be supervised by using a roof-mounted video camera. The uplift forces will be adjusted if necessary. Note! This may have to be repeated at 150 mph??? Instruction: ABB

3.3.17 Final Clearance Verification Amtrak 2-days

The entire route Washington - New York will be checked out at some jointly decided upon speed. The third rail areas in New York and a specific tunnel in Baltimore, MD, will be concentrated on. Instruction: Amtrak

3.3.18 X2000 + RTL Commissioning ABB/Amtrak 5-10 days

3.3.18.1 Installation of equipment in RTL.

This activity can start independently of the X2000.

3.3.18.2 Single board computer tests.

Check-out of interface between single board computer and RTL. It is to be verified that the single board computer can control the RTL by means of a lap top. This activity can be performed independently of the X2000.

3.3.18.3 Brake control X2000 - RTL, Stationary

Need X2000 at this time to hook up the emergency stop trainline and BP + MR hoses. Haul RTL from X2000, apply and release brakes. Haul X2000 from RTL, apply and release brakes.

3.3.18.4 Auxiliary power from RTL

Select "Turbine mode" and feed the X2000 aux. converter DC-link from RTL. Start up X2000 auxiliary inverter.

3.3.18.5 Run turbine mode

Run consist in turbine mode in yard at low speeds, control the consist from X2000 cab car.

3.3.18.6 Electric mode

Run consist in electric mode in yard at slow speeds, control the consist from RTL.

3.3.18.7 Return current

Any return current from X2000 to RTL via the track in turbine mode is to be measured.

3.3.18.8 Brake function and brake distance test, X2000 + RTL

3.3.18.9 North East Corridor runs

Run the consist in different modes on NEC at high speeds. Instruction: ABB

3.3.19 Cant Deficiency Test FRA/SJ Days: N/A

To be carried out in line with Mr. Kesler's test plan. Instruction: SJ

In parallel with this will following tests be carried out:

- Ride quality
- High speed vehicle stability
- (Amtrak may, if they wish, record noise levels)

3.3.20 Removal of Cant Deficiency Test Instruments FRA/SJ

All instruments inside coach 2719 are to be removed along with all cables connecting instruments with sensors. Instrumented wheelsets are to be removed. At this time the train shall be reconfigured to suit revenue service which also includes re-installation of seats and tables inside 2719. Brakes on the two leading trucks are to be re-installed.

3.3.21 Stop Distance Test, Air Brakes Only, Revenue Service Config. ABB 1-day

After replacing the instrumented wheel sets by normal wheel sets the brakes can be used also on the two leading axles in both directions. A complimentary stop distance test shall now be carried out:

125 mph - 0 mph full service brake, air brakes only
125 mph - 0 mph emergency brake (= full service brake + track brakes)

Instruction: ABB


Test Plan for X2000 Evaluation, 1992
ENSCO, Inc.