DCA08MR009

Metrolink and Union Pacific
Collision
Chatsworth, California
September 12, 2008

Metrolink Event Recorder Factual Report

NATIONAL TRANSPORTATION SAFETY BOARD
Vehicle Recorder Division
Washington, D.C. 20594

January 13, 2009

Metrolink Event Recorder Factual Report

Specialist's Factual Report
By Cassandra Johnson

1. EVENT SUMMARY

Location: Chatsworth, CA
Date: September 12, 2008
Company: Southern California Regional Rail Authority (Metrolink)
Train: Metrolink Train
NTSB Number: DCA08MR009

At about 4:23 p.m. Pacific Daylight Time on September 12, 2008, a Southern California Regional Rail Authority (Metrolink) passenger train collided head-on with a Union Pacific Railroad freight train in Chatsworth, California.

2. EVENT RECORDER GROUP

An event recorder group was not convened.

3. DETAILS OF RECORDER INVESTIGATION

The Metrolink passenger train had a locomotive, #855, and a cab car, #617, each equipped with an onboard event recorder. The locomotive was pulling the train and the cab car was at the end of the train. Table 1 provides the details of the Metrolink event recorders.

Metrolink Train	Figure	Event Recorder Information
Locomotive #855 (lead)	1	Bach-Simpson Model TS-403, Seral Number Unidentifiable
Cab Car #617 (trailing)	2	Bach-Simpson Model TS-404, Serial Number 0992BSL003

Table 1: Metrolink Event Recorder Information

On-scene investigators removed the damaged event recorder from the locomotive but due to the severity of the damage (see Figure 1) they were unable to download it. However, the cab car event recorder was in very good condition (see Figure 2) and on-scene investigators downloaded it and saved the data to a CD.

Figure 1: Locomotive Event Recorder

Figure 2: Cab Car Event Recorder

On September 16, 2008, the Safety Board's Vehicle Recorder Division received the damaged locomotive event recorder, the undamaged cab car event recorder, and the CD containing the cab car event recorder's downloaded data.

Safety Board staff removed the memory module from the damaged locomotive event recorder (see Figure 3). On September 18, 2008, Safety Board staff hand carried the memory module to Bach-Simpson, the recorder manufacturer, in London, Canada where Bach-Simpson staff downloaded the memory module by utilizing a similar event recorder set-up in their lab facility (see Figure 4). As a result, the locomotive's event recorder data was downloaded and saved to a CD.

Figure 3: Locomotive Event Recorder Memory Module

Figure 4: Locomotive event recorder memory module being downloaded at Bach-Simpson (the recorder manufacturer).

3.1. Recording Description

The downloaded event data from both the locomotive and the cab car were converted to engineering units utilizing the Bach-Simpson's WinDAS Version 6.0 Program. Wheel sizes of $39^5/_8$ inches for the locomotive and 31½ inches for the cab car were used for the conversions[1]. Subsequently, all 9.6 hours of data recorded on September 12, 2008 from the locomotive and all 11.0 hours of data recorded on September 12, 2008 from cab car

[1] See Section 3.2.1 for more details about wheel sizes with regards to speed calculations.

were exported for further analysis. With the assistance of Southern California Regional Rail Authority (Metrolink), all of the recorded parameters were identified and are provided in this report.

The recorded data from both the locomotive and the cab car are logged data. Logged data are not sampled every second. Instead, a parameter is recorded only when the parameter's value changes. This is accomplished by recording a baseline of all of the parameters every four minutes and, if a parameter's value changes within the four minutes then that parameter is recorded along with the elapsed seconds (in whole seconds) from when the baseline was last recorded. If another parameter's value changes within the same second, then that parameter is recorded along with the same total seconds from when the baseline was last recorded. Unfortunately, this means that data exported from the WinDas Program may have repeated times. Therefore, in order to plot and analyze the data, it was necessary to provide the decimal second for the repeated times. For example, if the time showed up three times then the decimal second was divided evenly to give the decimal places of .000, .333, and .666.

3.2. Parameters

The following two tables, Table 2 and Table 3, list all 49 parameters that were verified where 1M indicates the Metrolink locomotive's parameters and 2M indicates the Metrolink cab car's parameters. Table 2 lists the parameters that are plotted in this report and are also provided in the tabular files. In contrast, the parameters in Table 3 are not plotted in this report and are not provided in the tabular files. The parameters in Table 3 were unchanging (e.g. always 0 state) and were always in the "Off" state.

Table 2: Verified Metrolink Event Recorder Parameters Plotted and Provided in the Tabular Files

Parameter Name	Parameter Description
1. 0 Speed Door Bypass_1M	0 Speed Door Bypass_1M (discrete[2])
2. 0 Speed Door Bypass_2M	0 Speed Door Bypass_2M (discrete)
3. Acknowledge Automatic Train Stop_1M	Acknowledge Automatic Train Stop_1M (discrete)
4. Acknowledge Automatic Train Stop_2M	Acknowledge Automatic Train Stop_2M (discrete)
5. Bell_1M	Bell_1M (discrete)
6. Bell_2M	Bell_2M (discrete)
7. Brake Cylinder Pressure_1M (psi)	Brake Cylinder Pressure_1M (pounds per square inch)
8. Brake Cylinder Pressure_2M	Brake Cylinder Pressure_2M (discrete)
9. Brake Pipe Pressure_1M (psi)	Brake Pipe Pressure_1M (pounds per square inch)
10. Brake Pipe Pressure_2M (psi)	Brake Pipe Pressure_2M (pounds per square inch)
11. Direction of Travel Fwd_1M	Direction of Travel Forward_1M (discrete)
12. Direction of Travel Rvr_2M	Direction of Travel Reverse_2M (discrete)
13. Ditch Light_1M	Ditch Light_1M (discrete)
14. Ditch Light_2M	Ditch Light _2M (discrete)
15. Door Open Override_1M	Door Open Override_1M (discrete)
16. Door Open Override_2M	Door Open Override_2M (discrete)
17. Emergency Pressure Switch_1M	Emergency Pressure Switch_1M (discrete)
18. Emergency Pressure Switch_2M	Emergency Pressure Switch_2M (discrete)

[2] (discrete) indicates that the parameter has no units because the parameter is a discrete. A discrete is typically defined by 1-bit that can be either a 0 state or 1 state where each state is provided a definition. For example, for 0 Speed Door Bypass, a 0 state equals "Off" and a 1 state equals "On".

Table 2: Verified Metrolink Event Recorder Parameters Plotted and Provided in the Tabular Files	
Parameter Name	**Parameter Description**
19. Equalizer Reservoir Pressure_1M	Equalizer Reservoir Pressure_1M (discrete)
20. Equalizer Reservoir Pressure_2M	Equalizer Reservoir Pressure_2M (discrete)
21. Foot Reset_1M	Foot Reset_1M (discrete)
22. Foot Reset_2M	Foot Reset_2M (discrete)
23. Generator Field_1M	Generator Field_1M (discrete)
24. Generator Field_2M	Generator Field_2M (discrete)
25. Hand Reset_1M	Hand Reset_1M (discrete)
26. Hand Reset_2M	Hand Reset_2M (discrete)
27. Headlight_1M	Headlight_1M (discrete)
28. Headlight_2M	Headlight_2M (discrete)
29. Horn_1M	Horn_1M (discrete)
30. Horn_2M	Horn_2M (discrete)
31. Overspeed Magnet Valve_1M	Overspeed Magnet Valve_1M (discrete)
32. Overspeed Magnet Valve_2M	Overspeed Magnet Valve_2M (discrete)
33. Radio Hang Up Switch_1M	Radio Hang Up Switch_1M (discrete)
34. Radio Hang Up Switch_2M	Radio Hang Up Switch_2M (discrete)
35. Sand Magnetic Valve_1M	Sand Magnetic Valve_1M (discrete)
36. Sand Magnetic Valve_2M	Sand Magnetic Valve_2M (discrete)
37. Side Door Status_1M	Side Door Status_1M (discrete)
38. Side Door Status_2M	Side Door Status_2M (discrete)
39. Speed_1M (mph)	Speed_1M (miles per hour)
40. Speed_2M (mph)	Speed_2M (miles per hour)
41. Throttle Position_1M	Throttle Position_1M (discrete)
42. Throttle Position_2M	Throttle Position_2M (discrete)

Table 3: Verified Metrolink Event Recorder Parameters Not Plotted and Not Provided in Tabular Files		
Parameter Name	**Parameter Description**	**Data**
43. ATS Reset_2M	Automatic Train Stop Reset_2M	Always “off”
44. Automatic Train Stop_1M	Automatic Train Stop_1M (discrete)	Always “off”
45. Automatic Train Stop_2M	Automatic Train Stop_2M (discrete)	Always “off”
46. Bail Off Pressure Switch_1M	Bail Off Pressure Switch_1M (discrete)	Always “off”
47. Blended Brake Cut-Out_1M	Blended Brake Cut-Out_1M (discrete)	Always “off”
48. Direction of Travel Fwd_2M	Direction of Travel Forward_2M (discrete)	Always “off”
49. Direction of Travel Rvr_1M	Direction of Travel Reverse_1M (discrete)	Always “off”

3.2.1. Speed

For event recorders, the actual speed and distance values are not recorded but rather the number of drive wheel rotations (or fraction thereof) is stored in memory or on tape. At the time the data is read out, a wheel size is entered into the readout station or computer. The wheel size, number of rotations, and time are then used by the program to calculate speed, where the derived speed does not account for any wheel skidding or slipping that could have occurred. On-scene investigators provided the wheel size of $39^5/_8$ inches for the locomotive and 31½ inches for the cab car.

3.3. Event Recorder Timing Correlation

Each set of event recorder data from the locomotive and the cab car are independently time stamped by the locomotive and the cab car, respectively, and, consequently, the times may not reflect the actual time of the day. To provide a common time base, it was decided to correlate the Metrolink event recorders to the Union Pacific lead locomotive's video recorder[3] data which was referenced to GPS time.

3.3.1. Locomotive Timing Correlation Details

As mentioned above, it was decided to correlate the Metrolink event recorders to the Union Pacific lead locomotive's video recorder data. According to the Union Pacific lead locomotive's video recorder, impact occurred at 16:22:23.3 Pacific Daylight Time. Therefore, the last recorded time on the Metrolink locomotive event recorder should equal 16:22:23.3 Pacific Daylight Time.

The last recorded Metrolink locomotive time in whole seconds was 16:26:11 HH:MM:SS (or 59,171 seconds) and the impact time recorded on Union Pacific lead locomotive's video recorder was 16:22:23.3 HH:MM:SS (or 58,943.3 seconds) local time. Therefore, the correlation is the Union Pacific lead locomotive's video recorder time of 58,943.3 seconds equals the Metrolink locomotive's recorder time of 59,171 seconds minus 227.7 seconds (Union Pacific Video Time = Metrolink Locomotive Time - 227.7 seconds).

3.3.2. Cab Car Timing Correlation Details

Additionally, the Metrolink cab car time needed to be correlated to the Union Pacific lead locomotive's video recorder time. First, the Metrolink cab car data needed to be aligned to the Metrolink locomotive data. This was accomplished by aligning the two sets of speed data from both recorders by adding 154 seconds to the Metrolink cab car data. Therefore, the correlation is the Metrolink locomotive time equals the Metrolink cab car time plus 154 seconds (Metrolink Locomotive Time = Metrolink Cab Car Time + 154 seconds).

Next, the Metrolink cab car time needed to be correlated to the Union Pacific lead locomotive's video recorder time. Using the correlation between the Metrolink locomotive time and the Metrolink cab car time and the correlation between the Union Pacific lead locomotive's video recorder time and the Metrolink locomotive time, the Union Pacific lead locomotive's video recorder time equals the Metrolink cab car time minus 73.7 seconds (Union Pacific Video Time = Metrolink Cab Car Time - 73.7).

3.3.3. Timing Correlation Summary

In summary, the below time offsets were applied to the Metrolink locomotive event recorder data and to the Metrolink cab car event recorder data when these two sets of data were correlated to each other and also correlated to the impact time recorded on the Union Pacific lead locomotive's video of 16:22:23.3 HH:MM:SS local time (Pacific Daylight Time).

- Union Pacific Video Time = Metrolink Locomotive Time - 227.7 seconds.
- Union Pacific Video Time = Metrolink Cab Car Time - 73.7 seconds.

[3] Refer to the National Transportation Safety Board's On Board Video Recording Factual Report.

Therefore, all of the times in this report are referenced as local time (Pacific Daylight Time).

3.4. Plots

The five plots provided at the end of this report contain the Metrolink locomotive's event recorder parameters and the Metrolink cab car's event recorder parameters listed in Table 2 for the September 12, 2008 event. All of these plots cover the time from when the Metrolink train began its last movement from Chatsworth Station until the end of the event recorder data. Plots 1 and 2 contain the locomotive's event recorder parameters and has a time frame from 16:20:00 HH:MM:SS local time to 16:22:30 HH:MM:SS local time. Plots 3 and 4 contain the cab car's event recorder parameters and has a time frame from 16:20:00 HH:MM:SS local time to 16:23:05 HH:MM:SS local time. Lastly, Plot 5 contains the event recorder data from both the locomotive and the cab car and covers the same time as Plots 3 and 4.

Near the end of the data, both sets of event recorder data do not have any data recorded between 16:22:04.3 HH:MM:SS local time and 16:22:23.3 HH:MM:SS local time. As mentioned earlier, the event recorder data is logged data and the lack of data not being recorded during this time indicates none of the parameters' values were changing and, therefore, the gap is real. In addition, the Metrolink locomotive data ended at 16:22:24.188 HH:MM:SS local time and 38.612 seconds later, the Metrolink cab car data ended at 16:23:02.8 HH:MM:SS local time.

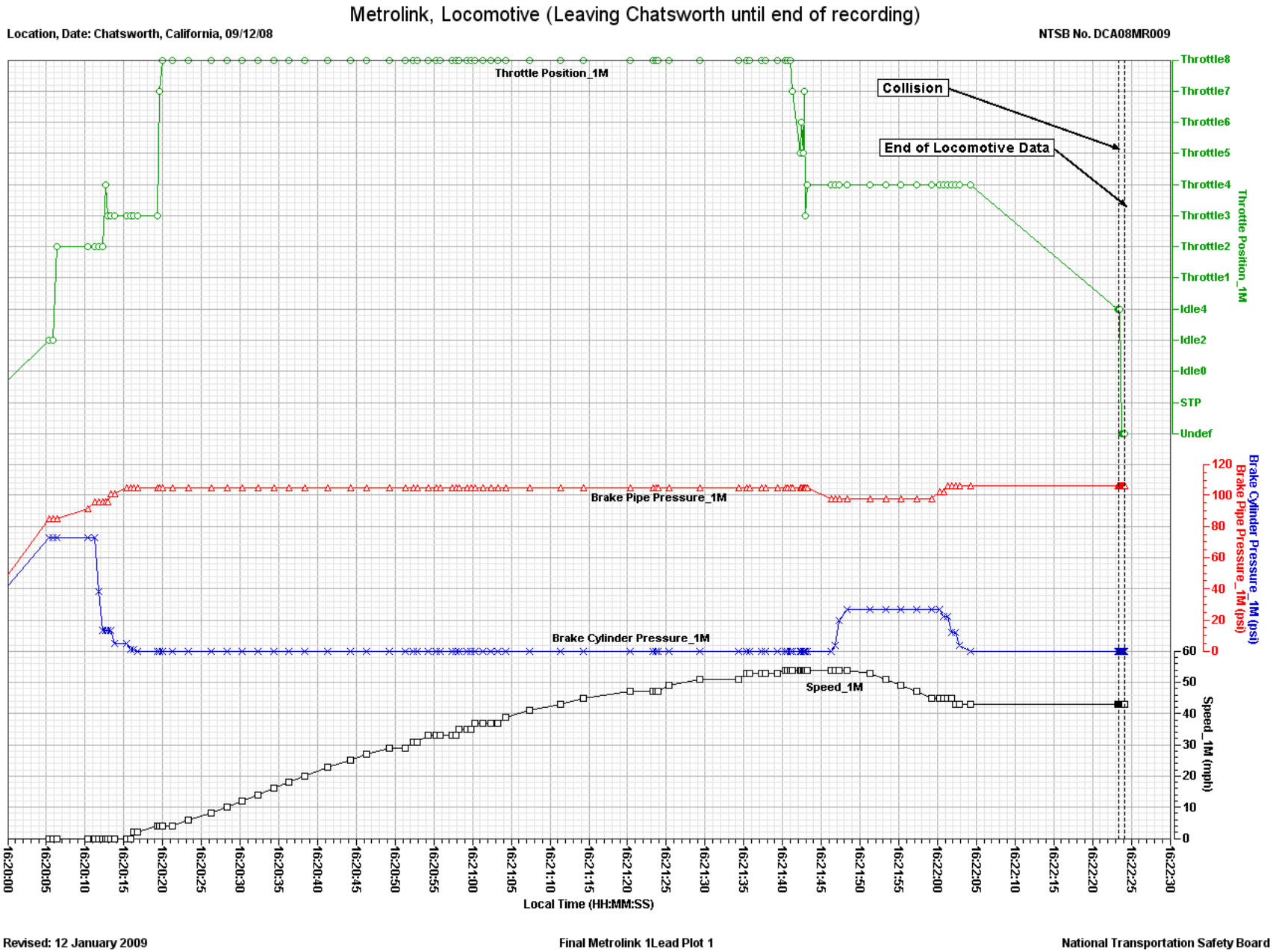
3.5. Tabular Data for the Provided Plots

All of the corresponding tabular data used to create Plots 1, 2, 3, 4, and 5 are provided in electronic (.CSV) format as Attachments 1, 2, 3, 4, and 5 respectively to this report. All of the times in these five attachments are local time.

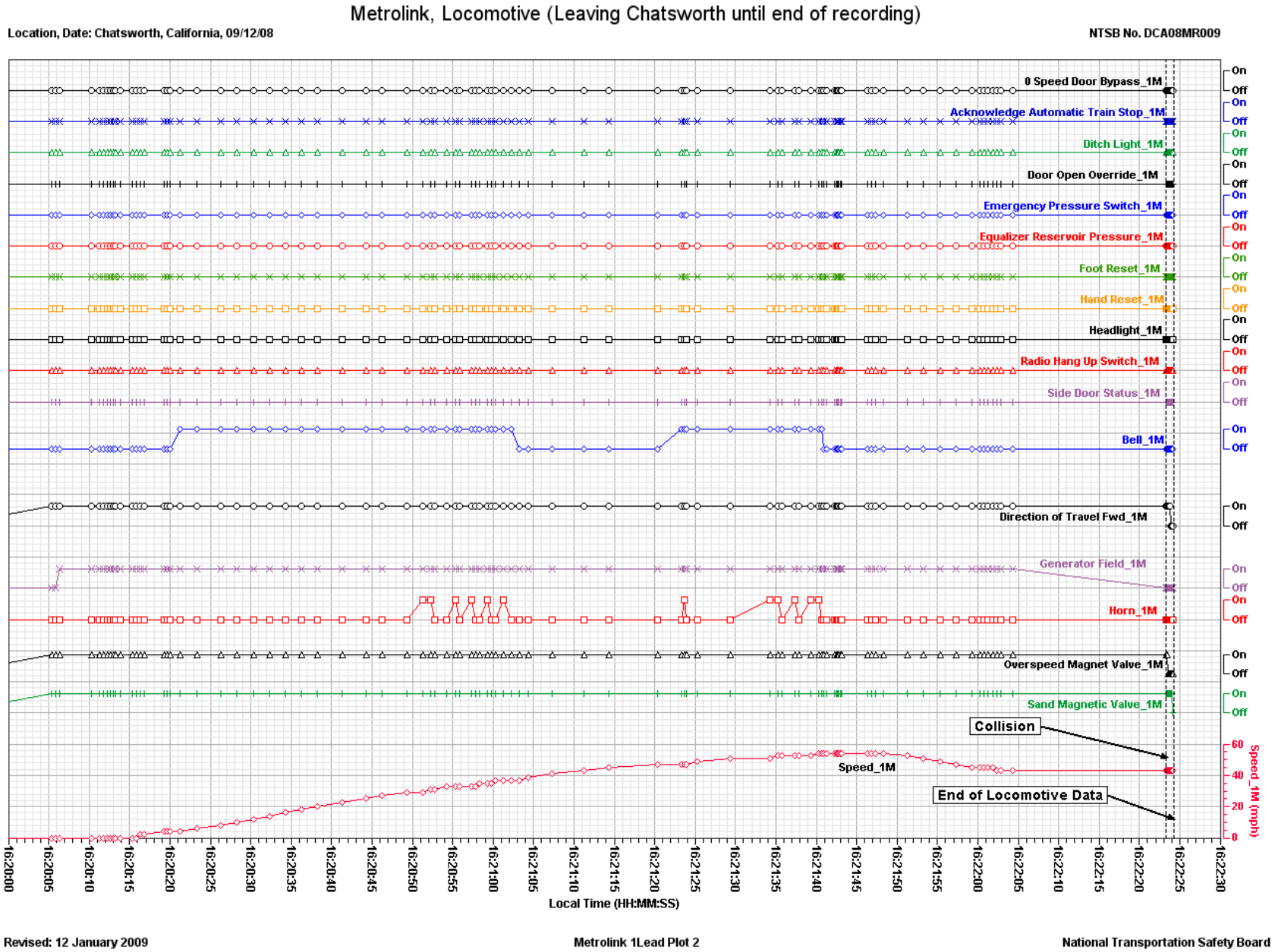
3.6. Tabular Speed Data for Entire September 12, 2008

The tabular speed data for both the Metrolink locomotive and the Metrolink cab car for the entire September 12, 2008 are provided as Attachments 6 and 7 in electronic (.CSV) format. The data in these files are the original speed data without any time offsets applied and also without fixing the duplicate logged data time.

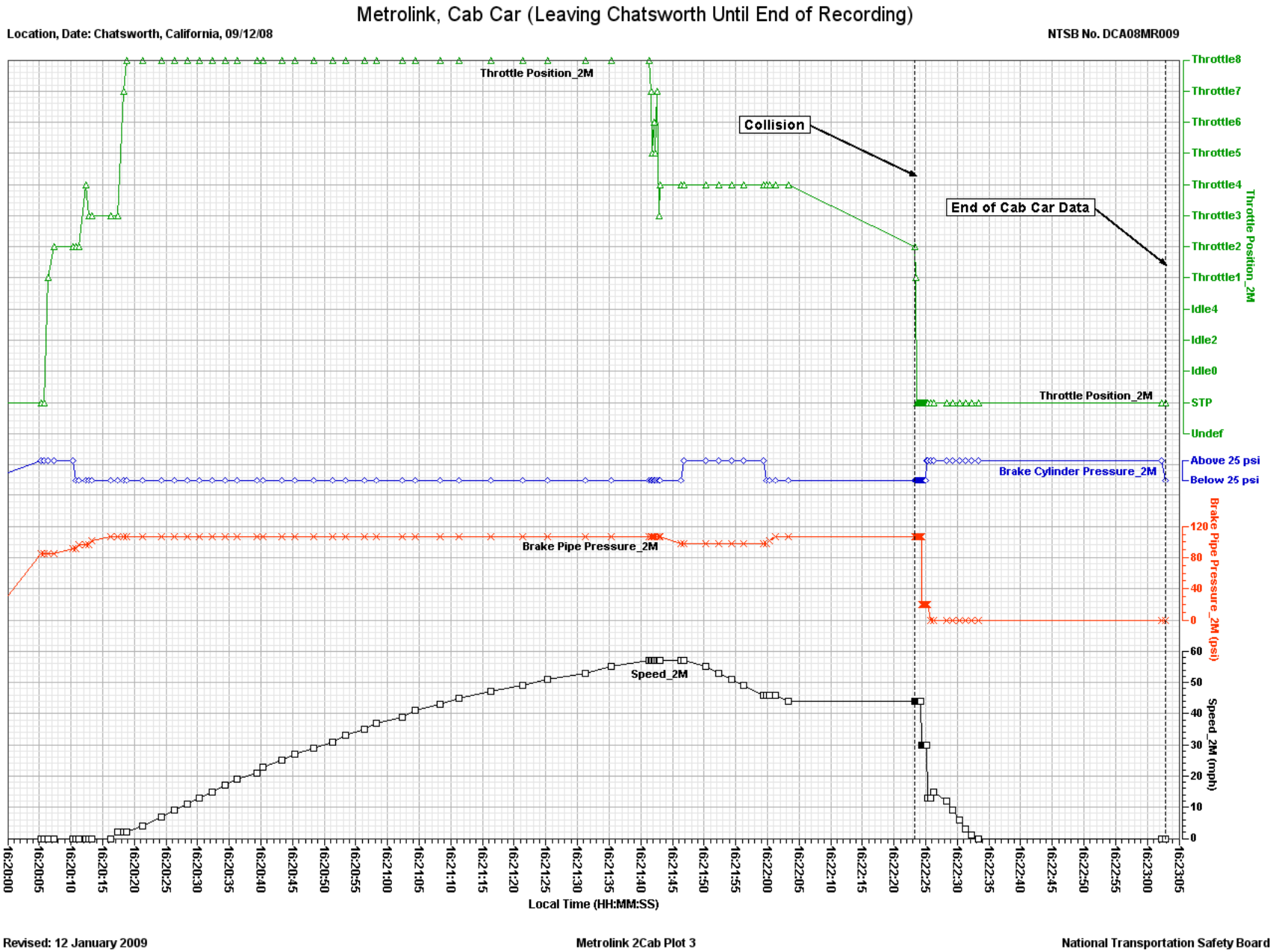
Plot 1 Metrolink Locomotive



Plot 2 Metrolink Locomotive



Plot 3 Metrolink Cab Car

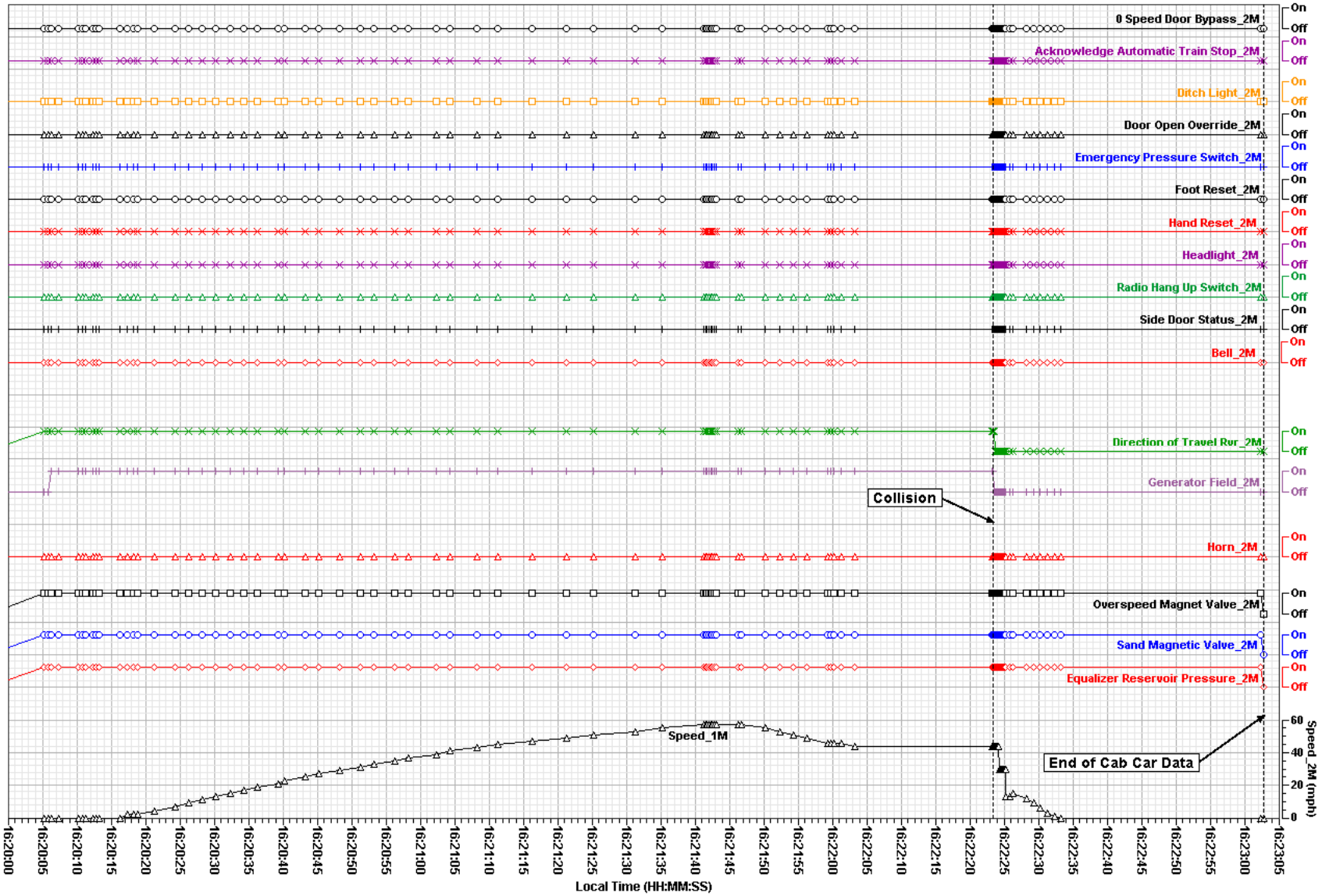


Plot 4 Metrolink Cab Car

Metrolink, Cab Car (Leaving Chatsworth until end of recording)

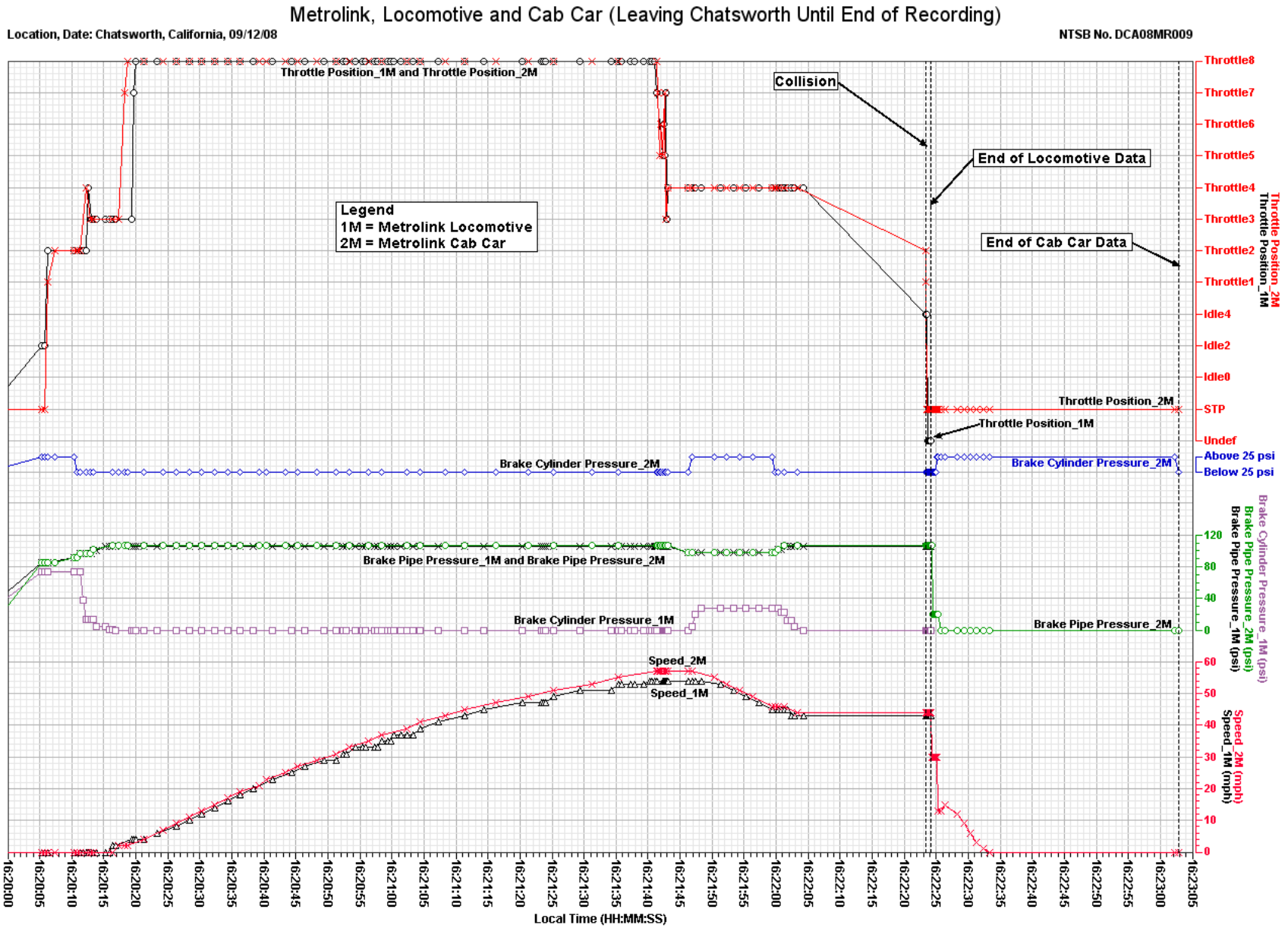
Location, Date: Chatsworth, California, 09/12/08

NTSB No. DCA08MR009



Revised: 12 January 2009

Metrolink 2Cab Plot 4

National Transportation Safety Board

Plot 5 Metrolink Locomotive and Cab Car