EXHIBIT 6-D

Docket No. DCA-08-MR009

NATIONAL TRANSPORTATION SAFETY BOARD
WASHINGTON, D.C. 20594

Time Correlation Study

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

February 18, 2009

Time Correlation Study

NTSB Accident Number
DCA08MR009

By Doug Brazy

A. ACCIDENT

Location:	Chatsworth, CA
Date:	September 12, 2008
Time:	4:22 P.M. Pacific Daylight Time
Train(s) :	Metrolink 111 commuter rail / Union Pacific LOF-6512

B. GROUP

N/A

C. SUMMARY

At about 4:22 p.m. PDT 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. Chatsworth is approximately 33 miles northwest of Los Angeles, California.

Information from 15 different recording devices, including data and video recorders on-board both trains, wayside signal bungalow recorders, dispatch records, and telephone records were provided to the Vehicle Recorder Division. Virtually all of these devices depend on their own internal time of day clock to record when events occur or to timestamp parametric data.

The purpose of this report is to document the efforts to synchronize the clocks (and data) from the pertinent recording devices such that events from one source could be compared to events from another source, in relation to a common time standard. For example, in order to compare telephone records with the Metrolink train's event recorder data, the clock used to "timestamp" the telephone records must be synchronized to the clock used by the Metrolink event recorder. Even small discrepancies between the two clocks can have a profound effect on such a comparison. For example, when calculating the train's location at the time a particular text message was sent, a 10 second discrepancy between the two clocks at a train speed of 41 MPH would result in a train position error of over 600 feet, which is nearly twice the length of the train.

Further, the Metrolink train's event recorders did not record the train's position relative to the track (or any other landmark). The train's position must be computed from recorded speed and elapsed time, and a known geographical reference. Train position must then be referenced to the time of day, according to the same clock used to timestamp the telephone records. [1]

Ultimately, the clock on board the Union Pacific train's lead locomotive unit (UP5485) was used as the "master clock" to reference time of day for the on-board recordings from both trains, train position calculations, as well as those signal system records which indicate the Metrolink train location at various times. This clock utilized the Global Positioning System (GPS) as a time reference. All clocks used by Verizon Wireless to timestamp the telephone records use the same reference.

The geographic reference used to compute the position of the Metrolink train as a function of GPS time was the point of collision (POC). This POC location was established during a postaccident survey as 1384 feet along the track west of the switch at Control Point Topanga.[2] The time of the collision was established by the on-board video recording from the lead locomotive (UP8485) of the Union Pacific Train to be 4:22:23.3 PM, Pacific Daylight Time zone, GPS time base.

D. DETAILS OF INVESTIGATION

Time and Geographic References – Metrolink Position Calculations

In order to determine the position of the Metrolink train over time, at least one known location (and a reference time at that location) must be identified and correlated to the event recorder data. In this case, two options were available;

1) The location of the collision as surveyed along with the GPS time of the collision (as recorded by the UP locomotive)

2) The surveyed location of track signal circuits and the times recorded by the signal bungalows for activation (or deactivation) of those circuits by the train.

Ideally, both of these options could be used together. However as described later in this report, the recorded data (timing) from the signal system recorders were found to be inconsistent and could not be used.

In order to utilize option 1 above, the Metrolink event recorder must provide reasonably accurate distance data, and the collision must be identifiable in the event recorder data from both trains.

[1] Station stops can be inferred from event recorder data by noting when the speed reaches 0 MPH. Station stop locations were used as references in the calculation of train position.
[2] For more details, see the Track Group Chairman's Factual Report.

Event Recorder and Video Recorder Data

Union Pacific Train LOF-6512

The Union Pacific lead locomotive (U8485) was equipped an on-board video recorder which was synchronized in time with its event recorder, using a known time standard (the GPS clock). As such, the moment of collision was readily identified on the video recording as 4:22:23.3, Pacific Daylight Time Zone, GPS time reference.[3] This time coincides with the last recording on the lead locomotive's (UP8485) event recorder.

The data from the 2nd Union Pacific Locomotive (UP8491) event recorder was also GPS time referenced. However, data from this recorder indicate the collision occurred about 2 seconds later than the lead locomotive. The indication is a decrease in recorded speed from 40 MPH to 20 MPH, in one second. This "delay" is not unexpected. According to the locomotive manufacturer, there can be up to a 1 second latency in recorded parameters due to processing by the recording system. Along with the 1 Hz sample rate, and time reporting to the nearest whole second, this 2 second discrepancy is reasonable. This same 2 second latency can be seen several times throughout the recordings, most notably when the throttle position changes.

Metrolink Train 111

Just prior to the end of data, both Metrolink event recorders had a period of about 20 seconds, during which no monitored parameters had changed within that timeframe. At the end of that period, both recorders logged a change in throttle position from "Throttle 4" to "Idle4"/"STP". The locomotive's recorder also noted a change in the "Generator Field" parameter from "on" to "off". The time of these abrupt changes was assumed to be the time of the collision.

[3] For more information about the video recording see the On-Board Video Recording Group Chairman's Factual Report for this investigation.

Neither of the Metrolink event recorders provided a "distance travelled" parameter. Speed and time are provided, from which distance travelled can be calculated. However, these recorders do not record speed (or any other parameters) at one second intervals. Instead, recording occurs only when a parameter changes value. Train speed must change by at least 2 MPH to cause a recording to occur. The integration of speed and time data, and any necessary corrections or assumptions of speed data are discussed in the Rail Collision Vehicle Performance Study report for this investigation.

The synchronization of event recorder data and adjustment of time (as recorded) to the GPS timebase can be found in the Metrolink Event Recorder Factual Report, and the Union Pacific Event Recorder Factual Report.

Signal System Recording Devices

The signal system incorporates recording devices at various wayside locations, as well as at the Dispatch Center. The wayside devices record, among other things, when the train occupies and unoccupies certain circuits. These wayside "signal bungalows" also transmit circuit and signal indications to the Digicon system, located at the Dispatch Center, where the indication messages are also recorded and timestamped. Signal logs were downloaded at CP Topanga, CP Bernson, Intermediate Signal 4451 and Intermediate Signal 4426. [4] Each of these loggers uses its own free running time-of-day clock to timestamp the recorded events.

Upon Download, the Signal Group synchronized each of these clocks by comparing the current indicated time to the telephone time service provided by the National Institute of Standards and Technology (NIST) in Boulder, Colorado. The time difference from each local clock was noted, and applied to each logged event. The time as heard on the NIST telephone time service should match the GPS time reference to

[4] Logs were also downloaded from recording devices located at the Chatsworth Street and Devonshire Avenue Crossings. These logs were not examined for this study.

within ½ of a second, when considering the worst case delay over cellular or satellite telephone connections.[5]

Discrepancy Between Signal Log Clocks and GPS Time Recorded on UP8485

Once corrected, the timing of the signal log events[6] should match the same clock used by the UP8485 on-board recorders. As such, the distance data computed from the Metrolink event recorders should indicate that the train passed the signal locations at the (corrected) times recorded in the signal log, and reach the POC at the same time-of-day as recorded by the UP8485 locomotive. However, this was not the case. Generally, if the integration was referenced to the POC location and time, the train would arrive at the signal locations too late, by about 40 to 46 seconds for most signal locations. Likewise, if the integration was referenced to the majority of the signal log locations and times, the event recorder data would "end" before the GPS time and the location of the collision.

An error in the UP8485 GPS clock (or the processing of the GPS time by the equipment or readout software) alone can not explain the discrepancy between signal log clocks and the GPS clock. Significant error(s) would also have to exist in the recorded speed data from the Metrolink event recorders (and/or the integration of the speed data).

[5] The clock used at NIST and "GPS Time" used by GPS receivers are actually different and come from different sources. However, the difference between these two times is extremely small and negligible for the purposes of this study. The potential delay in relaying the NIST time over the telephone system is much greater than the difference between the NIST and GPS clocks. See http://tf.nist.gov for more information.

[6] A total of 8 signal log events had "location" information for the Metrolink train. i.e. the train either occupied or unoccupied a circuit at a known (surveyed) location, and the time the train was at each location was recorded in the signal logs.

The signal equipment has some expected delays from the time an event occurs until it is logged and relayed to dispatch. However, the discrepancies noted here result in the signal timing data indicating that events were being recorded *before* they are expected to occur. Delays in the signal system recording function would cause events to be recorded *after* they actually occurred.

During the week of November 3rd 2008, a follow up test of the signal logging equipment and the Digicon recordings was conducted. Track circuits were closed and opened (simulating a train occupying and unoccupying circuits) at known times using a GPS receiver. GPS times were also noted when each circuit indication was detected by the wayside equipment, and when an operator at the Dispatch Center received the indications on the Digicon display. Each wayside recorder and the Digicon logs were subsequently downloaded, and the current time at each device was compared to GPS time.[7]

The results of this test did not explain the discrepancies noted in the logs from the accident day. However, it was demonstrated that the signal timing data logged for CP Topanga appear to be unreliable. The current time at the Topanga bungalow was checked against the GPS receiver time twice, ten minutes apart. The comparisons differed by 7 seconds from one check to the next. When comparing the elapsed time from one signal event to the next, the Topanga logs agreed with the detection times once, but disagreed by 3 and 7 seconds the other two times.

[7] During the On-Scene downloads, the current time reported by each signal bungalow was examined using a laptop computer connected to the bungalow equipment. During the November testing, current time was examined on the bungalow's LCD display.

During the test, the Digicon system clock as seen on the Dispatch Center display matched GPS time exactly. The difference between the GPS time that the Digicon operator noted for all events, and the time in the Digicon download data was timestamped, differed by 0 to 2 seconds. However, the test showed that the delay from the time an event is detected by the wayside equipment in the field until the time it's recorded by the Digicon system, can vary significantly. During the test, the delay was fairly short. All test elements were within 1 and 5 seconds from the GPS time that an indication is seen at the wayside equipment, until the time the event is recorded in the Digicon download. On the day of the accident, CP Bernson events showed one delay of 197 seconds and another of 32 seconds.[8] As a result, the recorded time of day for the 8 signal log events which indicate the location of the Metrolink train were ignored. These times were adjusted to reflect the GPS time provided by the UP8485 locomotive recorders.

Other than the timing discrepancies, the Signals Group noted no other deficiencies in the recorded signal log data.

Telephone Records

According to Verizon Wireless, the text message "sent" and "received" times reported in the records reflect the GPS time reference. However, the times as seen the in records are the times that the network equipment either receives or delivers any particular message. The reported "sent" time for a message transmitted by a Verizon customer's wireless device reflects the GPS time that the message arrived on the Verizon Wireless network. This is not necessarily the time that a customer presses the "send" button on their wireless device. Network load and the proximity of the wireless device to the coverage area are two factors that can affect the amount of time it takes from the moment a user presses the "send" button, until it arrives on the network and is logged. "Received" times are more likely to reflect the actual GPS time that the

[8] Only logged times exist for the day of the accident. The two delays cited here represent the difference in elapsed time between events as indicated by the CP Bernson logger records, and the elapsed time between the same events as indicated in the Digicon records.

message arrives on the recipient's wireless device. This is because messages are "delivered" only after the network first checks to see if the recipient's wireless device is "alive and well", meaning that it is turned on and within the coverage area and can communicate with the network.[9]

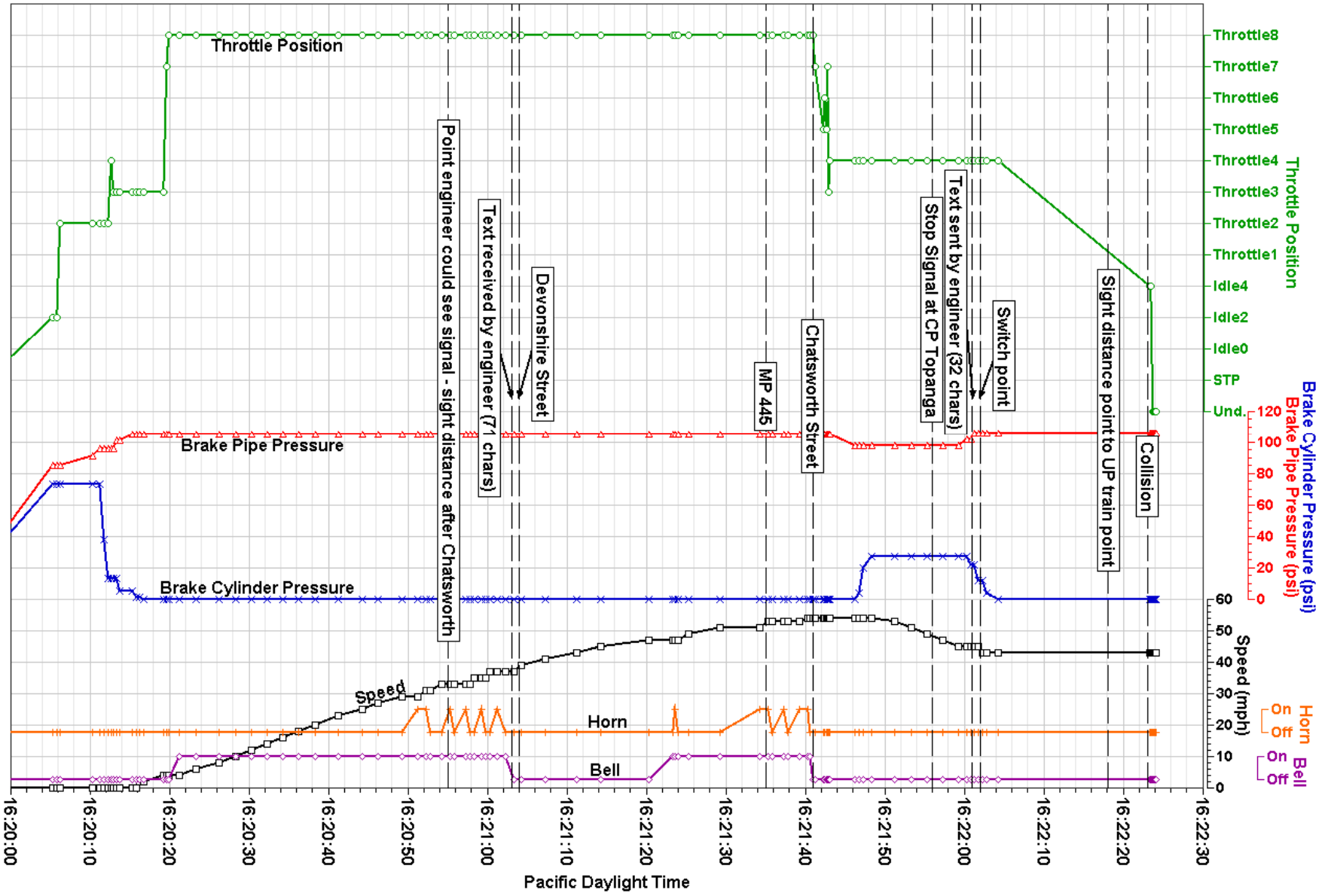
Correlation of Select Information

Figure 1 is a chart showing event recorder data from the Metrolink locomotive train, along with select events from the telephone records, and location references from the scene survey and sight distance tests.[10]

[9] For more information, see the Cellular/Wireless Device Records – Metrolink Engineer Factual Report for this investigation

[10] The sight distance tests are documented in the Track Group Chairman's Factual Report.

Figure 1: Correlation of Select Information



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