

CENTRIPETAL FORCE ON TURNS

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Metro-North Train Sped at 82 M.P.H. Ahead of Curve in Fatal Crash

By MATT FLEGENHEIMER DEC. 2, 2013

The Metro-North Railroad train that hurtled off the rails on a sleepy holiday weekend morning (**was traveling 82 miles per hour**) as it approached one of the sharpest curves in the region's rail system, federal investigators said on Monday — **nearly three times the speed permitted through the turn.**

The throttle was still engaged — giving the engine power — until six seconds before the locomotive, in the rear of the train, came to a stop around 7:20 a.m. Sunday after the train careered toward the Harlem River, killing four people and injuring more than 70, north of Spuyten Duyvil station in the Bronx, officials said.

The National Transportation Safety Board is leading the investigation, and a board member, Earl Weener, said the train's sudden power shift came "very late in the game." The board cautioned that it remained unclear if the speed was the result of human error or faulty equipment.

But the extraordinary speed shed new light on the deadliest New York City train derailment in more than two decades and heightened the focus on the veteran engineer at the center of the investigation. **The maximum allowable speed through the curve is 30 m.p.h.**; even the straightaway north of the crash site permits speeds no greater than 70 m.p.h.

Asked if the safety board was looking into the possibility that the engineer, William Rockefeller, fell asleep, was using his cellphone or was otherwise distracted, a spokesman for the board, Keith Holloway, said, "Part of our investigation, as in all investigations, is to look at human performance factors."



INTRODUCTION: The centripetal force needed to make turns Successfully must be at least $F_c = m v^2/R$.

QUESTIONS: (a) Find centripetal force needed at 30 mph for any m & R ? , (b) Find centripetal force needed at 82 mph For any m & R ?, (c) How much bigger is the centripetal force Needed at 82 mph vs 30 mph?, (d) Find how big in % the centripetal force is at 82 mph vs. 30 mph? (e) Comment on the results?

ANSWERS: (a) $900 m/R$, (b) $6724 m/R$, (c) 82 mph F_c is 7.47 bigger than legal 30 mph, (d) $[F_c 82 \text{ mph}] = 747\%$ bigger than $[F_c 30 \text{ mph}]$. (e) One can see why this train went off the track since not enough centripetal force was available to make this sharp turn.