Feature

For Want of a Nail

The Wreck of the City of New Orleans

By Robert P. Schmidt

"A little neglect may breed great mischief … for want of a nail the shoe was lost; for want of a shoe the horse was lost; for want of a horse the rider was lost."
—Benjamin Franklin

At its beginning on May 1, 1971, newly created Amtrak lacked the resources to equip, operate, and maintain its trains, so such matters were largely left in the hands of the railroads over which the trains operated. Among the trains that continued into the Amtrak era were numbers 1 and 2, the City of New Orleans, Illinois Central's fabled daytime streamliner between Chicago and New Orleans.

Initially under Amtrak operation, the City of New Orleans—shown charging out of Chicago on September 5, 1971—was at the time still a fast, mostly daytime, coach streamliner on Illinois Central's "Main Line of Mid-America."
-Jim Heuer

The derailed City of New Orleans near Tonti, Ill., was a jumbled mess and remains one of Amtrak's worst wrecks.
-Courtesy Luke Purcell, Salem Area Historical Museum

Less than six weeks after Amtrak's start-up, the City of New Orleans jumped the tracks at Tonti, Ill., on June 10, 1971. The crash was the first Amtrak derailment, and for more than 15 years it held the dubious honor of having caused the most casualties (11 dead, 164 injured). The causal chain for the accident was complex, and was filled with many missed opportunities to avoid the result.


Good morning!

Morning Star

The Weather

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10 die, 94 hurt on train

IC-Amtrak wreck is worst in 9 years on U.S. rails

RAILS DRIVEN INTO CARS

'I'm alive--thank God, I'm alive!'

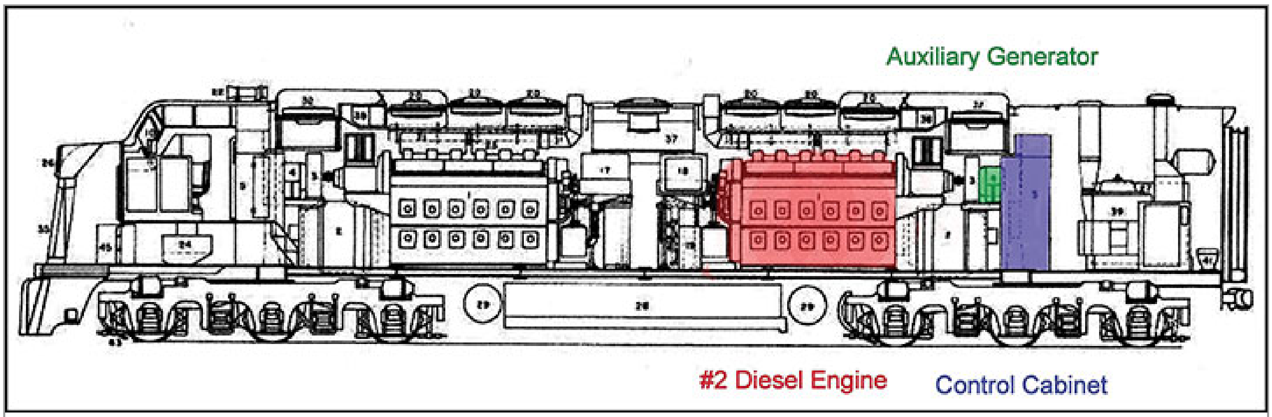
By DAVE GRIMM

Farm group opposes landfill site

School board dismisses

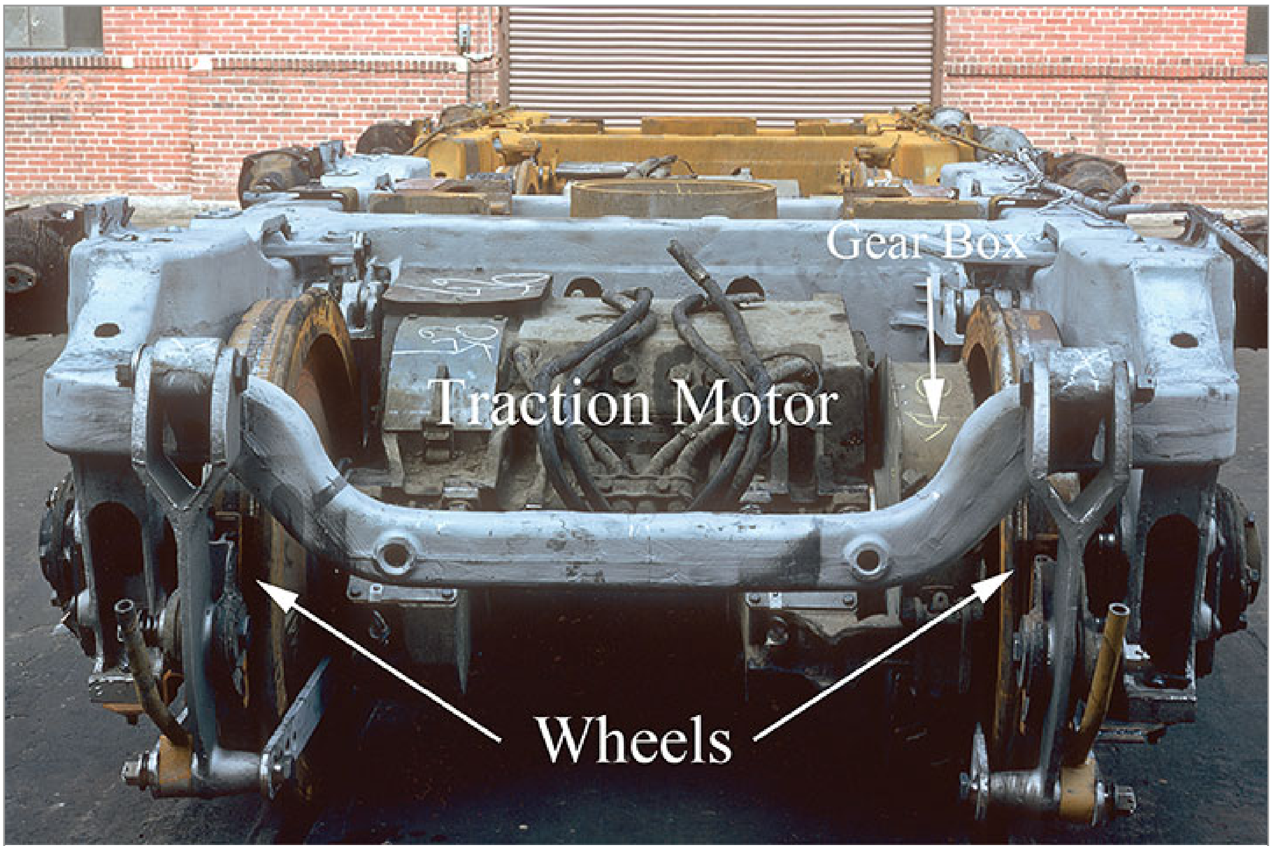
News of the tragic wreck made front-page headlines in newspapers throughout the Midwest, such as this edition of the Rockford (Ill.) Morning Star, an on-line IC city 85 miles northwest of Chicago.
-Mike Schafer collection

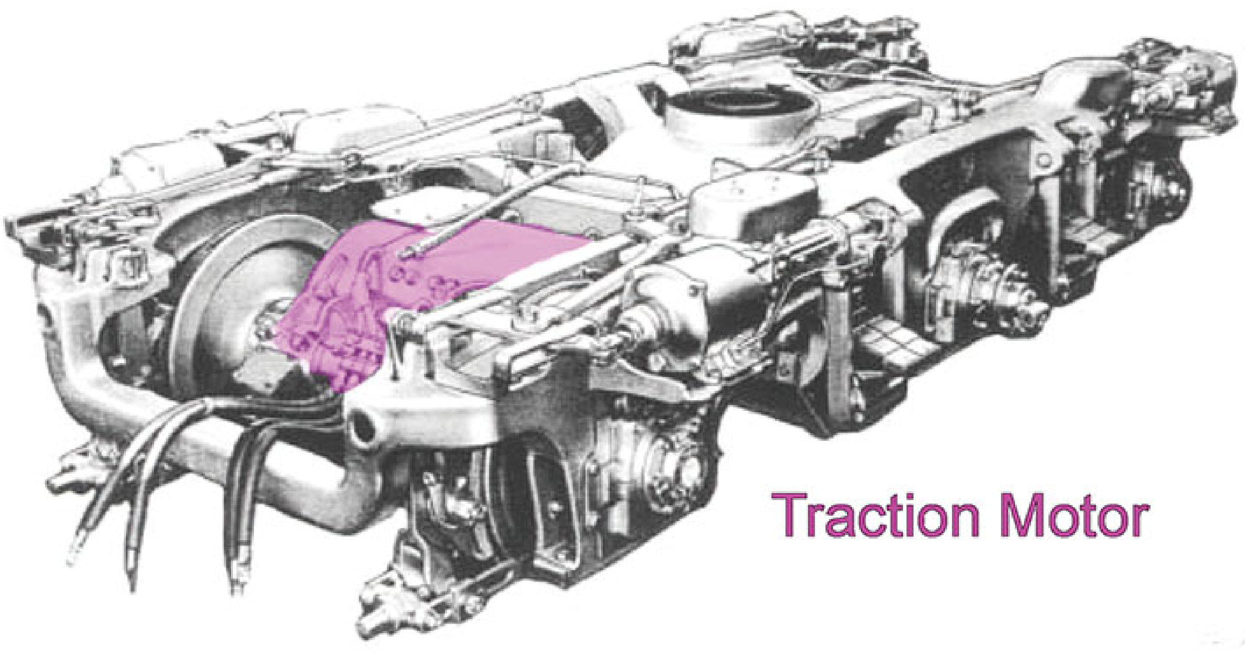
The story centers around E8 locomotive 4031, one of six identical units purchased by IC from EMD in 1952. Like all locomotives of the E-series type of locomotive, 4031 had two diesel engines (prime movers), which drove electrical generators, which delivered electricity to traction motors, which were geared to driving wheels, which propelled the train. Each engine/generator/motor set was wired together in such a way that any one of these sets could be isolated from the rest and the train could continue on with the remaining set(s) if sufficient power remained.



A drawing showing the arrangement of equipment in an E-series Electro-Motive passenger locomotive. The number 2 (rear) diesel engine is shaded in red, the auxiliary generator is shaded in green, and the electrical control cabinet is shaded in blue.
-EMD, Preston Cook collection

The traction motors were installed in the trucks of the locomotive. Each truck had three axles, of which only the first and third had motors attached (referred to as an “A-1-A” arrangement). Traction motors were delivered with the locomotive, but were replaced every 300,000 miles or so with new or rebuilt ones. In April 1971, the traction motor on the lead axle of the trailing truck of 4031 was replaced as a matter of routine maintenance. The replacement traction motor had come from the Missouri-Kansas-Texas Railroad—“The “Katy”—and had been rebuilt at Chandysson Electric Company in St. Louis. The motor was originally classed as having D-37B specs, but in the rebuild was upgraded to D-77 specs.



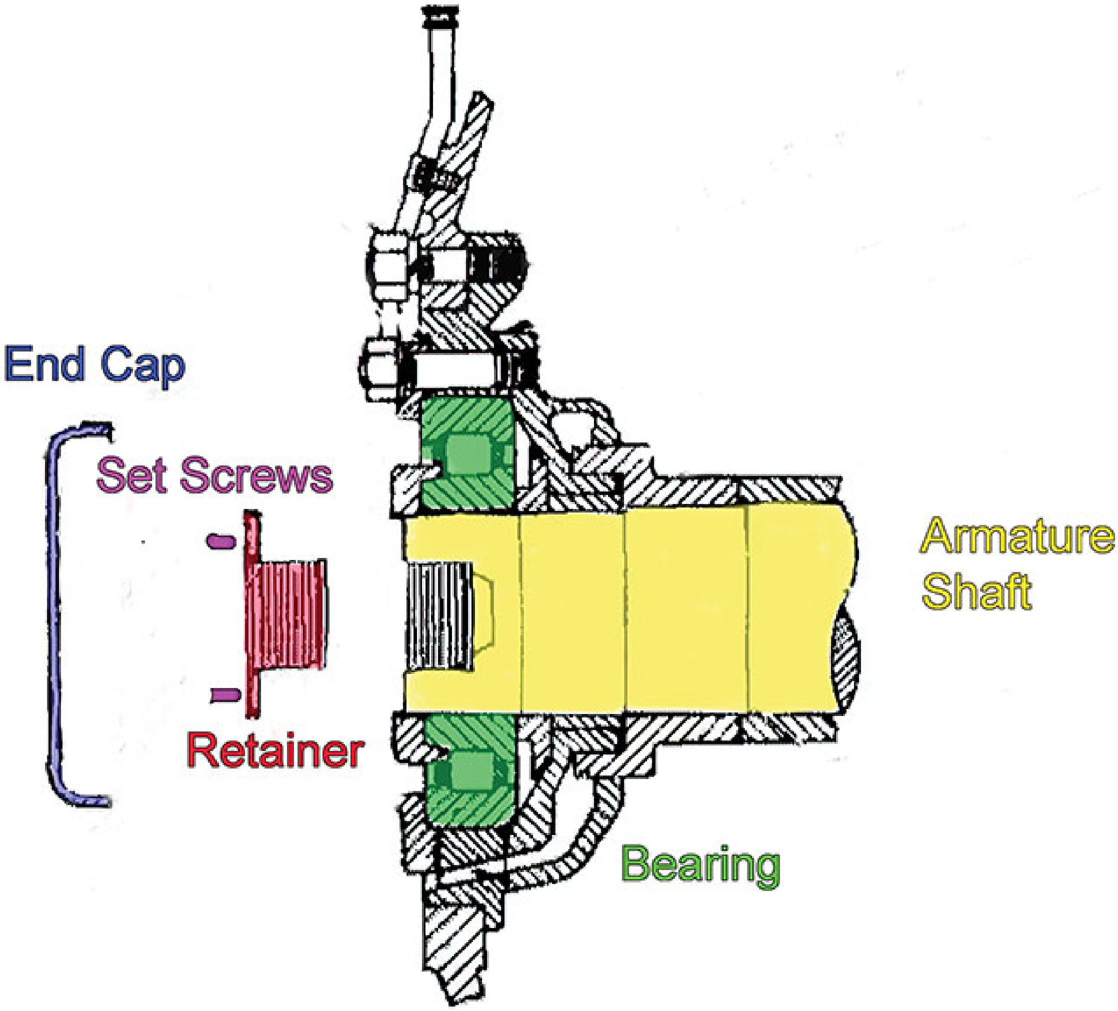


The traction motors are mounted in the locomotive truck as shown in the photo. The “commutator end” is on the left. In the lower image, we see how the closest traction motor (tinted in color) relates to the rest of the truck assembly.

-EMD, Preston Cook collection

A locomotive traction motor has two ends: the “commutator end” and the “pinion end” (the latter is geared to the wheels). The motor itself is wound around the armature shaft, which rotates at up to 2,800 rpm when the motor is being used. The armature is quite heavy, and is supported at both ends by roller bearings. The bearings at the commutator end were held in place by a retainer plate, which in this case was screwed into the end of the armature shaft. (This design was found in only about 10 percent of shafts at the time of the rebuild; the attachment method had been changed for new motors in the early 1950s.) To prevent the retainer plate from accidentally unscrewing, two smaller set screws were placed through the plate and tightened against the end of the shaft. The set screws had sharp O-shaped ends, which would dig into the shaft and keep the plate in place. If properly installed, this plate was not going anywhere. However, in this instance the evidence was clear that the set screws had not been not adequately tightened. The whole area was then covered with a heavy steel cap, so there was no practical way to examine the retainer plate or the set screws. When the motor was installed in the 4031, the only force holding the plate and bearings in place at the commutator end was the friction between the threads of the screw-in plate and the shaft. So long as that condition prevailed, which continued for two months, the train would not experience any problem. But then, a string of events—both related and unrelated to the traction motor—began:

1. Each diesel engine drives an auxiliary generator, producing direct current to charge the storage batteries and supply the low-voltage circuits for lighting, control, etc. While southbound train number 1 was on its way to New Orleans on June 7, the crew had noticed that the auxiliary generator driven by the rear diesel engine of 4031 was not operating properly. Therefore, that engine was shut down and the “Reverse Current Relay” switch in the electrical cabinet relating to that engine was placed in the neutral position, locked in that position by a pin, and given a yellow tag to alert everyone that this engine/generator/motor set was not functioning.



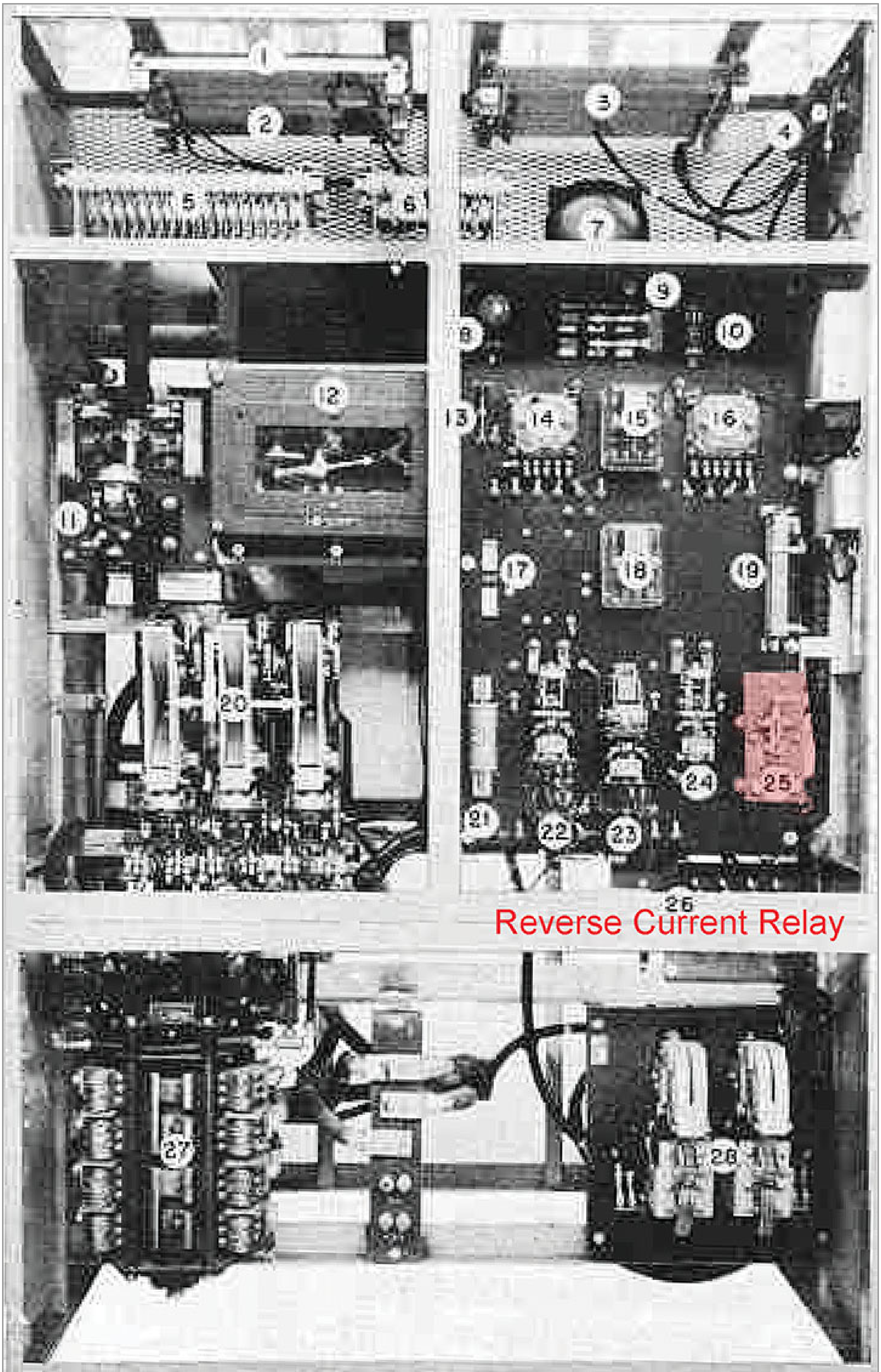
An exploded drawing of the bearing assembly at the commutator end of the armature shaft. The shaft (yellow in the drawing) is supported by the bearing assembly (green), which is held in place by the retainer (red). The retainer is anchored by two set screws (purple) and the whole assembly is covered by the end cap (blue).
-EMD, modified by Bob Schmidt

2. Illinois Central did not have adequate facilities in New Orleans to repair the auxiliary generator, so the locomotive was dispatched back to Chicago as part of train 2, the northbound City, and then sent to Woodcrest Shops. Workers there replaced the auxiliary generator but, somehow, they overlooked the pinned reversing circuit despite the fact that this condition was noted on the

work order. Curiously, the yellow tag that should have alerted the shop forces to this condition was missing; how that happened remains a mystery.

3. After being released from Woodcrest, 4031 was placed in the locomotive consist for the June 10, 1971, equipment set of train 1, as the trailing unit of four E8s. However, it was discovered that the headlight on the locomotive unit that was to be in the lead (E8 2024) was not working. The scheduled train departure time was approaching, so rather than spend the time to fix the headlight, the railroad simply wyed the locomotives, putting 4031 in the lead. It is not necessary for a trailing unit to have an operable headlight, but this move did have unforeseen consequences.

4. Train 1 departed Chicago and headed southward with 204 passengers, 15 crew members, and three “deadheads” aboard. Someplace along the way the friction between the threads of the screw-in plate and the armature shaft of the rebuilt traction motor failed to hold, and the retaining plate began to unscrew and back out. As it backed out it came into contact with the inside of the covering cap. Because of the direction the locomotive was traveling, the rotation between the plate and the cap caused the plate to unscrew even more. (If the locomotive had not been wyed, the armature would have been spinning in the opposite direction and the rotation of the armature shaft would have had the effect of trying to screw the plate back into place.) As it was, the plate was trying very hard to unscrew and back out, but had no place to go. This exerted a tremendous lateral force in the direction of the pinion end on the parts relating to the armature shaft, especially the bearings. These bearings are designed to withstand substantial vertical and rotational forces, but lateral forces should be negligible. The normal tolerance for lateral movement was less than 0.011 inches. Quickly, the threads on the plate and the shaft were stripped and the lateral force was released, but in the process the brass cage holding the bearings in place had been damaged and the bearings had become badly misaligned.



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Reverse Current Relay
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The electrical control cabinet for the rear engine of an E8 locomotive. The "Reverse Current Relay" is shaded in red.
-EMD, Preston Cook collection

5. The train crew was blissfully unaware of what was happening to the motor and continued on the way. The IC main line was straight and fast, with speeds of 100 mph allowed in places. But, inside the traction motor the banged-up bearings were beginning to overheat. The first result of the heating was oxidation of the bearings' lubrication, which led to even more heating. The bearings probably reached a temperature as high as 1,800 degrees Fahrenheit at that point, which caused the bearings themselves to lose their solid state, becoming plastic or "like putty."

6. The train then made its regular station stop in Effingham, Ill. During the pause, the bearings cooled enough to return to solid again, but they had become deformed and at this point were useless. When the train resumed its journey, the bearings were locked, which caused the armature shaft to be locked and, because the armature shaft was geared directly to the wheels, caused the wheels on this axle to lock also. Two wheels were now being dragged along the rails.

Some of the displays visible to the engineer, including the “Load Meter” and the “Wheel Slip Indicator.”
-Bob Schmidt

7. But the train crew did not notice the problem. Why not? One might think that the drag caused by the sliding wheels would produce a noticeable train speed loss, but even with 12.5 percent of the nominal 9,000 horsepower being unavailable, the wheel drag was inconsequential and the train handling

appeared to the engineer to be normal. The power discrepancy might have been shown by the “Load Meter” in the cab, except that this gauge was designed to show only power going to the front truck, which was operating normally. The locomotive crew knew that although the number 2 engine was running and “on line,” it was not “loading” (supplying power to the motors), but they did not know why or understand the possible implications. At the controls was Lacy Haney, a 24-year veteran locomotive engineer who testified that in all that time he had never experienced a sliding wheel. The train passed railroad employees on the ground at Effingham Yard and at Edgewood, plus track gangs along the way, but the high sound levels and the cloud of dust around the trucks as the train was traveling more than 90 mph probably obscured the sound of the dragging wheels and the sight of whatever sparks were being thrown off. But the most important device to warn about the possibility of sliding wheels was the “wheel slip indicator,” a light on the stand in front of the engineer that would illuminate if there was a current differential between the traction motors, which would indicate that one set of wheels was either slipping or sliding. However, because the reverser on the Number 2 engine was pinned in neutral, no current was reaching the wheel slip indicator circuits so the indicator was not responsive to the problem with respect to these wheels. The EMD Operating Manual failed to mention this possible condition. In short, the crew in the cab simply did not know what was happening to the motor.

A greatly enlarged photo of the rear truck of Locomotive 4031, lying on its side, taken at the crash site. This extreme magnification is not tack-sharp, but the flat spot and “false flange” on the wheel attached to the leading axle of this truck can be seen.
-Richard Reiff

8. Train 1 continued southward in this condition for 27 miles at an average speed of 97 mph. During this time, the friction between the two locked wheels and the rails quickly caused extreme wear, close to ten inches long, of the wheels. The wear changed the geometry of the wheels and caused the build-up of a “false flange” on the field side of the wheels. When the false flange encountered a switch at Tonti, the wheels tried to go both ways, could not, and wound up off the rails.

The wrecked City of New Orleans, as seen in this southwesterly view taken from Interstate 57 looking toward the village of Tonti. Both the photographer and a truck driver witnessed the derailment as it happened, with both exiting the Interstate and returning to the scene to help.
-Richard Reiff

At this point all hell broke loose. Dick Gordon, of nearby Salem, Ill., was an eyewitness. “I was driving my truck over the Interstate viaduct across the tracks, and I looked down at the train passing beneath me. All of a sudden the engine started to weave back and forth, harder and harder, and then they all started to flip off the track, the cars piling up in a big cloud of dirt … it was all over in ten seconds.”

A fire—likely from leaking fuel—started in the second (of four) locomotive and spread to the lead E8, number 4031. Three or four E-units were commonly assigned to the City to maintain the train's impressive overall schedule, which had the train departing Chicago at 8am and arriving at New Orleans shortly after midnight.
-Richard Reiff

The locomotives and the front half of the string of passenger cars turned on their sides and skidded along the ground for distances up to 400 feet. By some miracle the engineer and fireman survived, but the engineer was buried up to his waist in ballast materials that entered the cab. A fire started in the second diesel locomotive unit (E8B 4109), and spread to the 4031. The passenger cars headed in various directions, and the people inside were violently thrown about. Rails broke and penetrated the cars. One of these rails trapped a woman inside the car by pinning her dress, which had to be cut to free her. Windows were broken and several persons, including Conductor C. R. Fletcher, were thrown out; many of the fatalities wound up under the sides of the cars as they careened into a jumble.

Richard Reiff, then a college student who was traveling to Kentucky to start a summer job (ironically, with IC), was also driving over the highway bridge and saw the train derail. Realizing something was not right, and seeing the train "zig zagged" across the tracks, Richard drove to the next exit and stopped at a gas station to get someone to call for help. (In 1971, cell phones were non-existent.) A skeptical group at the gas station eventually called the "first responders." In the meantime, Richard drove back to the wreck and took photos.

First responders, nearby townspeople, and "just folk" all pitched in to rescue victims from the wreck. Some passengers were sheltered in area homes.
-Richard Reiff

By all accounts, the first responders did a magnificent job. Both professionals and ordinary people in Salem, and from other nearby communities, rushed to the scene to render assistance. Various local people helped rescue survivors and take them to hospitals in Salem, Mount Vernon, and Centralia. Many Salem residents opened their homes to the injured. The gymnasium and cafeteria of the Salem high school served as a dispensary and gathering place for separated families. The Salem Times-Commoner later published an open letter from Alan S. Boyd, president of Illinois Central (and future Amtrak president), thanking the local citizens for "all the instances of unquestioning help that came to our passengers and the Illinois Central at that terrible moment." IC also presented a memorial plaque to Salem as another form of thanks.

Illinois Central presented this plaque to the people of Salem, Ill., in gratitude for their help in dealing with the tragedy. The gift includes a

damaged spike recovered from the site, and is on display at the Salem Area Historical Museum.
-Bob Schmidt

The injured were treated and most of the dead were returned to their families, though one body never could be identified. The unidentifiable remains are buried at a corner of the cemetery in Salem, under a headstone donated by the funeral home director.

Grave of the “unidentified victim” of the wreck.
-Bob Schmidt

If any of the eight mishaps listed above had not happened, this catastrophe would not have occurred. Each by itself was highly improbable—together they were deadly. “Murphy’s Law” states, “Anything that can go wrong, will go wrong.” In this instance, Murphy was an optimist. But the principal proximate cause of the tragedy was someone’s failure to tighten just two little set screws.

Acknowledgments

Many thanks to the following for assistance in preparing this account: Preston Cook, formerly with EMD; Richard Reiff, formerly with the U.S. Department of Transportation at Pueblo, Colo.; and Luke Purcell, for the Salem (Illinois) Area Historical Museum.

Conclusion

Derailment of Amtrak train 1 in Salem Township, Ill., on June 10, 1971, was investigated by the National Transportation Safety Board, resulting in the issuance of a 68-page accident report. This report covered the original equipment problems that resulted in the wheel-slip detection circuit on the number 2 engine being inoperative, and the mechanical failure that resulted in the number 3 traction motor armature seizing and locking up the wheelset on E8A 4031. Findings of the report included a number of recommendations relating to locomotive and train equipment inspection rules, the inclusion of an independent locked-wheel detection system in locomotives, improvements in passenger tire design and safety features, and suggestions for improving coordination and communication between agencies responding to an accident.

Illinois Central E9 number 4031 is the trailing unit on the westbound Land O' Corn at the Rockford, Ill., station in 1967. Advancing ahead to that tragic day in 1971, the 4031 was also set to be a trailing unit on the City of New Orleans, but at the last minute, the City's locomotive set had to be turned, thus putting the 4031 in the lead—and the rest is history.
-Mike Schafer

Report findings relating to the locomotive inspection, repair, and post-repair testing issues identified a breakdown in communication between mechanical maintenance and the operating personnel. Post-repair testing had not been adequate to fully confirm operability of the locomotive. Accurate information about the previous problems and current condition of the locomotive had not been conveyed between departments with sufficient detail to clearly explain what had been done on the locomotive. All of these issues would result in a myriad of changes to the federal 49 CFR (Code of Federal Regulations) locomotive inspection requirements, that would be incorporated and implemented in subsequent reissues of the rules.

The report also addressed issues relating to the design of the then-current fleet of railroad passenger equipment. Many of the injuries had been the result of ballast, ties, and roadbed debris being thrown into the passenger coaches through the large side windows. Large windows were a design feature of many railroad passenger coaches built in the late 1930s through the 1950s, originally intended to provide a panoramic view of the landscape when the railroads were most concerned with competing with air travel. The NTSB recommended that the size of windows on passenger coaches be reduced, but this had relatively little impact on Amtrak at the time, due to the large fleet of existing equipment that could not be altered by any practical program. Over a period of time, the issue would resolve itself, since the new Amfleet cars entering the equipment pool were based on the previous Metroliner carbody, and had much smaller windows. The window size in the Metroliners had been reduced in order to avoid the phenomenon of having windows sucked out of the sashes by the pressure wave created between trains passing at high speed. This in effect satisfied the recommendation of the NTSB report, but for different reasons than those the report had identified.

The issue of providing adequate independent wheel slip/slide detection for locomotives proved to be more difficult. In order to be most effective, it required a solution separate from the previous technology. This was particularly true for situations where the locomotive or one engine of a twin-engine locomotive might be shut down en route due to equipment problems, thus rendering the traction motor dependent wheel-slip detection inoperative. The accident report made note of an existing loophole in the federal regulations at that time, by which the powered axles of a locomotive were not considered to be powered anymore, if the engine providing the power was shut down en route. This curious contradiction created a situation where there was, in effect, no actual rule requiring working wheel slip/slide protection for a cut-out traction motor or unpowered axles.

The situation dictated the need for a new form of wheel slide protection that would be functional in all situations and would be completely independent of the powered transmission system of a locomotive. EMD developed such a device for the incoming Dash-2 electrical system that would be subsequently employed in the Amtrak SDP40F and F40PH locomotives. The LW (Locked Wheel) detection system continuously compared signals generated by magnetic pickups monitoring the rotation of a toothed wheel on each traction motor armature. If the difference in signal between the motors exceeded a threshold that allowed for minor differences in wheel size and temporary wheel slip conditions, the locked wheel detection system would initiate a trainlined alarm to alert the operating crew of the condition. This system was continued in various forms in subsequent EMD locomotive production, and similar systems were developed by other locomotive manufacturers to suit the application needs of their products.

The final section of the NTSB report addressed issues in the coordination and training of emergency responders, learned from the derailment. Many provisions of modern emergency response practice were developed in the wake of this event. Advance planning for coordination of resources between local communities was one concern. Improved training for first responders to familiarize them with the unique features of railroad equipment was another topic of concern. In the years since the derailment these issues have been addressed through enhanced periodic training for first responders and emergency management personnel.
-Preston Cook