

INTERSTATE COMMERCE COMMISSION

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REPORT NO. 3279

IN THE MATTER OF MAKING ACCIDENT INVESTIGATION  
REPORTS UNDER THE LOCOMOTIVE INSPECTION ACT  
OF FEBRUARY 17, 1911, AS AMENDED

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PENNSYLVANIA RAILROAD

November 10, 1949

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Accident at Elizabeth, N. J., on September 4, 1949, caused by  
an explosion in the transformer tap switch compartment on  
an electric locomotive unit.

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REPORT OF THE COMMISSION<sup>1</sup>

PATTERSON, Commissioner:

On September 4, 1949, about 9:59 a.m., at Elizabeth, N. J.,  
an explosion occurred in the transformer tap switch compartment  
on Pennsylvania Railroad electric locomotive unit 4848 while the  
unit, en route with a passenger train, was standing near the pas-  
senger station. The engineer and fireman were seriously injured.

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<sup>1</sup>Under authority of section 17 (2) of the Interstate Commerce  
Act the above-entitled proceeding was referred by the Commission  
to Commissioner Patterson for consideration and disposition.

## DESCRIPTION OF ACCIDENT

Pennsylvania Railroad electric locomotive unit 4848 departed from Pennsylvania Station, New York, N. Y., September 4, 1949, at 9:15 a.m., hauling westbound passenger train No. 1073 which consisted of 12 cars. The locomotive was operated from the No. 2 or rear end. The train proceeded without unusual incident, making station stops at Newark and Elizabeth, N. J. When it had moved five or six car lengths after leaving the station at Elizabeth, 15.5 miles from Pennsylvania Station, a partial pantograph relay operation occurred on the locomotive. The engineer reset the relay and by this time the train had stopped. Several attempts were made to start the train and each time a preventive coil relay operation occurred.

It was then thought that the trouble was caused by a stuck transformer tap switch. The pantographs were lowered, three arc chutes were removed and examination indicated all switches were working properly. The locomotive was then reported unserviceable and another locomotive requested; however, shortly afterward the engineer was advised by a road foreman of engines to lower the pantographs, open the motor cut-out switches, and notch out the controller to see if all transformer switches operated properly. He did this without effectual result. Then, without the arc chutes having been replaced, the motor cut-out switches and the transformer tap switch compartment door were closed, the pantographs were raised, and the controller was advanced to about the third notch in an effort to start the train. At this time, about 9:59 a.m., a severe explosion occurred in the transformer tap switch compartment. The compartment door was blown open and a heavy electric flash entered the operating cab, resulting in serious injury of the engineer and fireman.

## DESCRIPTION OF LOCOMOTIVE UNIT

Unit 4848, which was of the 2-C-1-C-2 type, carrier's class designation GG-1, was built by the Pennsylvania Railroad in May 1935; total weight 460,000 pounds, and weight on driving wheels 300,000 pounds. It operated on 11,000-volt 25-cycle alternating current collected from the overhead wire by pantographs. The overhead wire was fed from a substation, located approximately one-half mile west of Elizabeth Station, through a JR high speed circuit breaker which was set to open, under overload or short circuit, at one-fiftieth of a second.

The unit was equipped with a pantograph relay, two small and one large preventive coils, a preventive coil relay, three motor

cut-out switches, and a ground cut-out switch, and with transformer tap switch traction motor control and electro-pneumatic master control. The traction motors were arranged in three series circuits of four motors each.

The main transformer tap switches were connected to the secondary taps of the main transformer. Operation of the transformer tap switches, in proper sequence, progressively increases the voltage impressed on the traction motors, thus causing acceleration of the locomotive.

The transformer tap switch compartment was located on the longitudinal center line at rear of locomotive cab. The rear wall of the compartment was approximately in line with the backs of the engineer's and fireman's cab seats. Access to the compartment was through a steel door located on the rear side. The transformer tap switches were arranged within the compartment in two superimposed transverse rows, 11 switches in each row. The center lines of the top and bottom rows of switches were approximately 4 feet and 2 feet, respectively, above the compartment floor.

When the transformer tap switches operate in proper sequence, No. 1 switch closes on the 1st notch of the controller, remains closed on the 2nd, 3rd and 4th notches, and drops out on the 5th notch. The No. 20 switch closes on the 20th notch and remains closed on the 21st and 22nd notches.

The pantograph relay protects the main transformer against overload or ground in the primary windings and against grounds in the secondary circuits. A ground fault on the secondary side of the transformer would cause the pantograph relay to function. Partial tripping of this relay opens the transformer secondary circuit. In event the partial tripping of the relay did not clear the ground, the relay completely trips, which grounds the overhead wire and causes the substation circuit breaker to function.

The preventive coils provide smoother acceleration of the locomotive by holding the circuits to the traction motors closed when change is made from one transformer tap to another. They also avoid short-circuiting parts of the transformer winding momentarily while changing from one tap to another.

The preventive coil relay (a thermal relay) operates to open all transformer tap contactors, and all motor, blower, and heater contactors. The operation of this relay occurs when there is an unbalance in the current through the small preventive coils, caused either by a transformer tap switch being stuck closed, failing to close, or closing out of sequence.

The motor cut-out switches carry the control circuits for the motor switches.

The purpose of the ground cut-out switch, when opened, is to insert resistance in the ground leg of the pantograph relay ground auto transformer in order to minimize the effect of a ground fault on the pantograph relay operating coil so that in emergency it might be possible to move the locomotive to a terminal.

#### EXAMINATION OF PARTS INVOLVED

The interior of the enginemen's compartment on the No. 2, or rear end, of locomotive was heavily smudged over its entire area. Three undamaged arc chutes were found on the floor on the right side of this compartment. Arc chutes were missing from the Nos. 1, 3, and 11 switches.

The No. 1 transformer tap switch contacts were completely melted and the flange on the right side of the arcing horn was burned away. The No. 19 switch contacts were partially melted. The fiber barriers between the Nos. 15, 19, 1, and 5 switches were burned away at the lower ends and some of the interlocks on these switches were melted. These were adjacent switches located near the middle of the top row.

The No. 20 transformer tap switch, located in the bottom row directly under switch No. 19, was found in closed position. While this switch was being removed, for examination, its contacts opened. Examination of the switch disclosed that its contacts were fused together; the fused area was approximately 3/8 inch in diameter. The switch was tested on the shop air line, which carried 100 pounds per square inch pressure, and functioned properly. The switch was disassembled and its pneumatic and mechanical portions were found in good condition.

The transformer tap switch compartment door, latch, and hinges were in good condition. There was no distortion of the door and the glass in the 6½-inch circular inspection window was intact.

The pantograph relay, preventive coil relay, wheel slip relays, and overload relays were found in normal position.

The Nos. 1 and 2 motor cut-out switches were found in connected position and the No. 3 motor cut-out switch was in disconnected position. The ground cut-out switch was found in open position. The preventive coils and traction motors were in good condition.

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Due to the damaged condition of the transformer tap switches and interlocks a sequence test could not be made.

### INSPECTION AND REPAIR REPORTS

Last monthly inspection was made at Wilmington, Del., on August 19, 1949.

Daily inspection reports from August 20 to September 3, 1949, on file at Sunnyside enginehouse, Long Island City, N. Y., were examined and nothing was found reported having any bearing on the accident.

### SUMMARY OF EVIDENCE

The engineer stated that when the train had moved five or six car lengths after station stop at Elizabeth, a partial pantograph relay operation occurred; he reset the relay and by this time the train had come to a stop; he notched out on the controller to start the train and after it had moved a few feet, a preventive coil relay operation occurred; the relay was reset and he again tried to start the train and again received a preventive coil relay operation; this occurred about four times; he had the fireman open the ground cut-out switch and again tried to start the train but received a preventive coil relay operation; he then thought that a transformer tap switch was probably stuck closed and examined the switches; as three of the switches looked suspicious he removed three arc chutes and examined these switches and found they were not stuck but were working properly. He was not sure about which arc chutes he removed but said it would be about Nos. 1, 3, and 11; he made a thorough examination of the other switches through the arc-chute openings and they appeared to be operating all right; he then decided the locomotive was unserviceable and requested another locomotive; he then was called to the telephone and talked to an assistant road foreman of engines who instructed him to open all of the traction motor cut-out switches and to check the operation of the transformer switches and interlocks by operating the controller with the pantographs down, which he did without results; he then closed Nos. 1 and 2 motor cut-out switches, raised the pantographs, and closed the compartment door leading to the transformer switches; the fireman was standing near the controller, between him and the compartment door, when he (engineer) opened the controller to see if the locomotive would start the train and notched out to about the third notch when there was a very heavy explosion in the transformer tap switch compartment; the compartment door flew open and a heavy electric flash entered the cab, badly

burning the fireman and himself. He further stated that the air compressor was in good condition and that at time of the accident the air pressure was 90 to 110 pounds.

### DISCUSSION

In an effort to start the train prior to the accident the arc chutes had been removed from the Nos. 1, 3, and 11 transformer tap switches, the pantograph had been raised, and the controller notched out to about the third notch.

With the No. 20 switch closed because of fused contacts and the No. 1 switch closed, as result of controller operation, high voltage was impressed across the motor circuits with a resulting high current. Then when the No. 1 switch was opened under this high current, due to movement of the controller, an arc ~~was~~ established across the contacts of this switch which did not break, and, because the arc chute had been removed the arc spread both to ground on the switch mountings and to the No. 19 switch, short-circuiting a portion of the secondary of the transformer. The transformer tap switch compartment door, which may **not** have been properly secured, was blown open and the heavy electric flash entered the operating cab.

The heavy current surge caused the substation JR high speed circuit breaker to trip and deenergized the overhead wire before the protective relays on the locomotive had time to function.

### CAUSE OF ACCIDENT

It is found that this accident was caused by an explosion in the transformer tap switch compartment on an electric locomotive unit when an attempt was made to start the unit because contacts of one of the tap switches were fused together and arc chutes missing from other nearby tap switches.

Dated at Washington, D. C., this 10th day  
of November, 1949.

By the Commission, Commissioner Patterson.

SEAL

W. P. BARTEL,  
Secretary.