

INTERSTATE COMMERCE COMMISSION

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REPORT NO. 3396

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

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ATCHISON, TOPEKA AND SANTA FE RAILWAY

May 28, 1951  
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Accident (boiler explosion) at Canadian, Tex., on April 1,  
1951, caused by overheated crown sheet due to low water.

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

PATTERSON, Commissioner:

On April 1, 1951, about 1:57 p.m., at Canadian, Tex.,  
the boiler of Atchison, Topeka and Santa Fe Railway loco-  
motive 1805 exploded while the locomotive was standing in the  
enginehouse. An engine watchman was killed.

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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

On April 1, 1951, the boiler of Atchison, Topeka and Santa Fe Railway locomotive 1805 exploded while the locomotive was standing in the enginehouse at Canadian, Tex. The locomotive had been tied up at Canadian since March 27, the date on which it was last used. On April 1, about 10:30 a.m., while the locomotive was in an enginehouse stall, under steam and with fire out, the engine watchman was directed to check and fire up the locomotive some time after noon. About 1:57 p.m., the boiler exploded.

The force of the explosion tore the boiler from the frame and hurled it through the roof of the enginehouse and forward. The boiler in its flight cleared power lines 32 feet above the ground and 95 feet forward and alighted in reversed position on its right side and back head, striking the ground 119 feet forward of the point of the explosion and making a depression 4 feet in depth and 12 feet in diameter.

Sixty-one rivets in the connection seam at the smokebox, 5 machine fit bolts in each of the expansion pads at front corners of the mud ring and 12 machine fit bolts in the furnace bearer sheet at the back end of the firebox were sheared. Both steam pipes broke at the flanges to the superheater header and the left steam pipe broke at the bottom end. The superheater header broke through the neck at the boiler flanged joint connection and the header, with the superheater units attached, was hurled from the boiler and came to rest on the floor of the enginehouse beside the tender right gangway step. The draft pan was blown down on the frame and trailing truck axle, pulling the studs from the mud ring. The cab was blown through the roof of the enginehouse and demolished, the greater part of its wreckage coming to rest in the turntable pit 144 feet to the rear of the point of the explosion.

The left locomotive frame was broken between the trailing truck and No. 3 pedestal; through the top rail between Nos. 2 and 3 pedestals and through the rear of No. 2 pedestal, loosening the binder and thus separating the frame in three sections. The right locomotive frame was broken between the trailing truck and No. 3 pedestal; over No. 2 driving box, the binder, shoe and wedge of which were blown into the pit, also separating the frame in three sections.

The right guide yoke outside swing brace was bent, the inside swing brace broken, and the bracket pulled from the boiler,

shearing seven 1-inch studs. The left guide yoke inside and outside swing braces broke at the bottom ends. The bracket was separated from the boiler, shearing seven 1-inch studs, when the boiler struck the ground.

The front end door hinges were broken and the buckled door was blown from under the lugs. The front end door ring was blown open; 40 3/4-inch bolts sheared, but the Okadee hinges held. Various parts and appurtenances blown from the locomotive were scattered within a radius of 581 feet from the point of the explosion.

The enginehouse was constructed of brick, cement and timber and contained 6 stalls, 91 feet in length. At time of the accident locomotive 1805 occupied stall No. 2 and locomotive 1886, also under steam, stall No. 1. The other 4 stalls were fenced off and leased for storage of machinery and building materials.

Hot fire brick, blown from locomotive 1805, started numerous fires in the enginehouse which destroyed transformers on the power line to the pump house and caused failure of the water system.

When the explosion occurred the foreman in charge of the enginehouse was at the main line servicing station. He hurried to the enginehouse and after some difficulty located the body of engine watchman between the Nos. 3 and 4 stalls, 45 feet to the left and rear of the point of the explosion. The body was promptly removed as flames were about to envelop that part of the enginehouse. The fire prevented the removal of locomotive 1886 from the enginehouse.

The fuel oil tanks of both locomotives were full. Oil flowed from the broken fuel lines of locomotive 1805, ignited, and the oil tanks of both locomotives subsequently boiled over increasing the intensity of the conflagration. About 10:00 a.m., April 2nd, the oil tank of locomotive 1805 exploded, broke and blew off the filling hole covers, and forced the square tank into cylindrical shape.

#### DESCRIPTION OF LOCOMOTIVE

Locomotive 1805 was a 2-6-2 type, built by the Baldwin Locomotive Works at Philadelphia, Pa., in October 1906. The

cylinders were 25 by 28 inches; diameter of the driving wheels over new tires 70 inches; weight of locomotive in working order 272,400 pounds; weight on driving wheels 192,100 pounds; tractive effort 42,500 pounds; equipped with Walschaert valve gear, Schmidt type "E" superheater, two Chicago No. 12 non-lifting injectors, and two Crane improved 2-inch manually operated blow-off cocks. The tender was rectangular type with a sloping back end, capacity 12,000 gallons of water and 3,909 gallons of fuel oil.

The boiler, No. BLW-29217, was radial-stayed type with sloping back head and had three shell courses of carbon steel. The first course was  $7/8$  inch thick and tapered;  $74\frac{1}{2}$  inches inside diameter at the smokebox connection and  $80\frac{1}{2}$  inches at the back end. The third course was  $29/32$  inch thick with inside diameter of  $83\text{-}3/4$  inches. The boiler had 195  $2\frac{1}{2}$ -inch and 36  $5\frac{1}{2}$ -inch flues, 19 feet in length. The allowed pressure was 225 pounds per square inch but only 200 pounds working pressure was carried.

The firebox was wide radial-stayed type, 109 inches in length and  $71\frac{1}{2}$  inches in width. When originally applied it was of three-piece construction, the crown and side sheets and the door sheet  $3/8$  inch thick and the flue sheet  $9/16$  inch thick. The firebox wrapper sheet, crown sheet, side sheets, and three-quarter flue sheet were applied new at Albuquerque shops in June 1943. The top knuckle of the flue sheet was again renewed in March 1946. The door sheet was applied new in December 1924 and the top knuckle patched in October 1940. A fire door collar patch was applied in September 1936 and corner patches at the mud ring were applied at various times.

The crown sheet was  $94\frac{1}{2}$  inches in length and sloped with front end 3 inches higher than the back end and was supported by 24 transverse and 16 longitudinal rows of radials and crown stays. The front 4 transverse rows were expansion stays,  $1\text{-}5/16$  inches in diameter and tapered  $1\frac{1}{2}$  inches in 12 inches in the sheet and  $1\text{-}1/8$  inches in diameter and fitted with KN nuts at the top ends. The remainder of the crown stays were rigid type radial stays,  $1\frac{1}{2}$  inches in diameter in the crown sheet and 1 inch in diameter in body and at the roof sheet. The stays were spaced approximately 4 by 4 inches in the crown sheet. The side, door, and throat sheets were stayed with rigid type staybolts, 1 inch in diameter, spaced approximately 4 by 4 inches. Flannery flexible staybolts were used in the breaking zones. Whitworth threads, 12 threads to the inch, were used on all staybolts and crown stays. The flue sheet was riveted to the crown and side sheets, the mud ring riveted to the firebox sheets, and the other seams were electrically welded.

## EXAMINATION OF BOILER AND APPURTENANCES

### BOILER

The entire area of the crown sheet, the top knuckle of flue sheet including the top row of flues, and the top of door sheet down to the top row of stays had been overheated. The highest temperature had been in the central portion of crown sheet, an area supported by 38 radial crown stays directly over the firebox burner, which showed a deep blue color, and where, apparently, the initial failure occurred. The ends of the stays in this area were deep blue in color and cupped as much as 5/16 inch in depth. Measurements of the line of demarcation transferred to similar points on a locomotive of the same class indicated that the water had been 6 inches below the highest part of the crown sheet.

The crown sheet pulled from all crown stays, tore along the calking edge of the riveted flue sheet seam for the entire width of the sheet, and folded downward taking with it the front top parts of both side sheets. One fractured radial stay, the 11th stay in the left No. 7 longitudinal row, broke and remained in the sheet. The crown sheet folded back against the door sheet covering the fire door opening. Along the edge of the tear the crown sheet had been drawn from original thickness of 3/8 inch to 5/16 inch. Some of the crown stay holes were elongated from the original 1 1/4-inch diameter to 1 1/2 inches.

The tear across the front of the crown sheet continued down through the right and left side sheets passing through the 1st staybolt holes in the top longitudinal rows and downward through the 2nd transverse rows of staybolt holes across the longitudinal welded seams, which were between the 10th and 11th longitudinal rows of staybolt holes from the mud ring, and diagonally downward and backward to the mud ring, terminating in the 7th staybolt holes in the bottom row.

The left side sheet pulled from all Flannery flexible staybolts in the top and 2nd longitudinal rows and from 227 other staybolts. The right side sheet pulled from all flexible staybolts in the top and 2nd longitudinal rows and from 246 other staybolts. The door sheet knuckle folded downward with the crown sheet, pulling the door sheet from 55 staybolts in the top four horizontal rows and partly pulling from 8 staybolts in the 5th horizontal row. The firebox flue sheet knuckle started to pull downward with the crown sheet and pulled the flue sheet from 5 2 1/4-inch flues in the top row, 6 flues in the 2nd row, and partly pulled from 7 flues in the 3rd row. The threads on the crown stays and staybolts in the firebox sheets were apparently in good condition prior to the explosion.

The roof sheet and back head were indented and the fire-box back end was forced to the left 41 inches out of line which broke the mud ring at all four corners and left the mud ring diamond shaped. From the broken left back corner the door sheet ruptured irregularly from the mud ring to the 4th staybolt hole in the outside vertical row, a distance of 22 inches. There were several other small tears and rips in the door sheet and seams due to bending and buckling.

An interior inspection of the boiler disclosed the shell bracing was bent and damaged but apparently was in good condition prior to the explosion. The flues, firebox sheets, and boiler shell were clean with no indications of pitting or grooving.

### APPURTENANCES

Safety valves: The boiler was equipped with three 3-inch Crane open-type safety valves mounted on a pop dome. One safety valve was broken off and badly damaged. The other two valves had the seals unbroken; were applied on locomotive 1811, same class as locomotive 1805, and tested under steam. The No. 1 safety valve opened at 195 pounds and seated at 191 pounds during several tests. The No. 2 safety valve was sprung and failed to open. Under forced firing the steam pressure could not be raised above 213 pounds with only No. 1 safety valve open. During this test, which was of 10 minutes duration, the water level dropped 5 inches, from 6½ inches to 1½ inches in the water glass.

Steam gage: The boiler was equipped with one American Locomotive Company double-spring, 400-pound dial gage which was found badly damaged, with the dial, hand, and glass missing. The springs and gears were in working order. The siphon cock was broken from the boiler and was found, with siphon pipe attached, under the boiler. The siphon cock was jammed closed with a piece of piping and the siphon pipe crushed and flattened. The siphon cock opening into the boiler was full of loose dirt but apparently it was in good condition at the time of the explosion.

Water level indicating devices: One carrier's standard water column, with tubular type water glass and three gage cocks attached, was mounted on the boiler head 16 inches to the right of center and a tubular type water glass was mounted on the left side of the boiler head 16 inches to the left of center. The water glasses were 8-inch clear reading type. This equipment was applied in accordance with the carrier's specifications.

The water column, with the  $2\frac{1}{4}$ -inch O.D. copper steam pipe attached, was broken from the boiler. The interior of the water column was clean when found. The steam pipe was badly crushed. The 2-inch steam pipe opening in the boiler was found clean. The water-column connection bottom fitting entered the back head between the 4th and 5th rows of staybolts right of center, approximately level with the back end of the crown sheet. This fitting had a  $\frac{3}{4}$ -inch opening which was clean. The nipple was applied horizontally and extended into the water space  $4\frac{1}{4}$  inches; the end was worn to a fine edge and was wasted away about  $\frac{1}{2}$  inch on either side.

The top gage cock was broken from the water column and so badly damaged that its condition could not be determined. The bottom and middle gage cocks were found attached to the water column and in closed position. Both were found with the openings unobstructed and in workable condition. The gage cock dripper was not found.

The top and bottom cocks of right water glass were broken from the water column and the water glass was broken. Both cocks were found in badly damaged condition but in open position with the openings unobstructed. The water-glass gaskets, with the broken ends of the water glass, were found in place in the packing nuts and in good condition.

The top and bottom cocks of left water glass were broken from the boiler and were found in open position with the openings unobstructed. The  $\frac{5}{8}$ -inch O.D. copper steam pipe was found damaged but open. The steam pipe connection fitting, which entered the roof sheet 2 inches ahead of the back head flange between the 1st and 2nd longitudinal rows of stays left of center, had an opening  $\frac{1}{2}$  inch in diameter which was clean. The bottom connection fitting entered the back head between the 2nd and 3rd back head brace brackets on the left side. The opening was  $\frac{1}{4}$  inch in diameter and was clean. The horizontal extension nipple extended into the water space  $\frac{1}{2}$  inch. The water-glass gaskets, with the broken ends of the water glass, were found in place in the packing nuts and in good condition.

The drain valves to the water column and water glasses could not be identified. The water-glass guards were carrier's standard wire netting shields with water glass lights attached and were found in badly damaged condition.

Due to the distorted condition of the boiler the lowest reading of the water glasses and the location of the bottom gage cock above the highest part of the crown sheet could not be determined. According to the carrier's records lowest readings of 4-3/16 inches above the highest part of the crown sheet for both water glasses and the height of the bottom gage cock were established on June 7, 1943, at Albuquerque, N. M.

**Injectors and fittings:** The boiler was equipped with two Chicago No. 12 non-lifting injectors, having rated capacity of 5,500 gallons per hour, mounted on brackets fastened to the frames on each side under the cab with extension rods to overflow and water valves passing through the floor of the cab. The starting valves were located in front of the cab with extension operating rods passing through front wall of the cab. The bent right injector overflow valve stem was broken off above the packing nut, and valve was found in open position. The bent water valve stem was broken off above the packing nut, and valve was found in closed position. The starting valve was not found. The bent left injector overflow valve stem was broken off above the packing nut, and valve was found in closed position. The extension rod had pulled from the clevis on the water valve, sheared the clevis pin, and the valve was found slightly off seat but open not more than 1/8 of a turn. The starting valve was fastened to the boiler, in open position with the operating lever broken off.

The line check in the right injector branch pipe had 5/8-inch lift and the line check in the left injector branch pipe 1/2-inch lift. Both were clean. All sections of the delivery pipes of both injectors were found, and were clean and unobstructed.

**Boiler checks:** The boiler had two carrier's standard boiler checks near the front end on opposite sides of the horizontal center line. The 2-inch check openings were clean and unobstructed. The left check had 3/8-inch and the right check 17/32-inch lift.

**Steam tests:** The injectors, line checks, and boiler checks from locomotive 1805 were mounted on locomotive 1811, same class as locomotive 1805, and tested under steam. Both injectors operated at 35 pounds steam pressure and raised the water level in the boiler but would spill some water at the overflow with the water valve only partly open. At 65 pounds steam pressure both injectors worked with the water valves wide open without spilling any water at the overflow. In a test of 1 minute duration with 90 pounds steam pressure, the left injector raised



the water level in the boiler  $3/4$  inch, from 4 inches to  $4-3/4$  inches in the glass. In a test of 1 minute duration with 100 pounds steam pressure, the right injector raised the water level in the boiler  $3/4$  inch, from 4 inches to  $4-3/4$  inches in the glass. During the tests of the safety valves no trouble was experienced with injectors, line checks, or boiler checks.

Tank, tank valves, hose and strainers: The bottom of the feed water tank was covered with soot and loose soda ash and lime which had been dislodged from the tank sheets during the fire. The tank bracing and splash plates were in place and in good condition. The tank valves were connected and found in full open position. The cylindrical type strainers in the right and left tank wells were securely fastened in place and were clean and unobstructed. At the time of the investigation the tank was dry, however, the effect of overheating during the fire left a water line on the sheets which indicated that there had been approximately 36 inches of water in the tank. The feed pipes were found clean and open. Both tank hose were consumed in the fire.

Main steam fountain and valves: The steam manifold was broken at the boiler flange joint. Some of the valves were broken out of the manifold and all valve stems were broken off above the packing nuts. The main fountain valve, both injector steam valves, and the firing manifold valve were found in wide open position. The air compressor steam valve was found in closed position. The headlight generator turbine valve was not found. The firing manifold was found under the boiler with the valves in damaged condition. The tank heater valve and the blower valve were found in wide open position.

Blow-off cocks: The two 2-inch Crane improved blow-off cocks remained attached to the boiler, one on each side of the fire-box. When dismantled the seats were found in good condition.

#### INSPECTION AND REPAIR REPORTS

Locomotive 1805 received class 4 repairs on February 7, 1951, and subsequently had made 2523 miles in freight, helper, and switching service to the time of the accident. The last monthly inspection was made at Amarillo, Tex., on March 10, 1951, at which time the boiler was washed.

Locomotive daily inspection reports, since February 7, 1951, on file at Albuquerque, Belen, Vaughn and Clovis, N. Mex., Amarillo and Canadian, Tex., and Waynoka, Okla., were examined and the following items were found reported:

February 24, at Amarillo, Tex., reported by engineer:  
"Check flues and front end - engine not steaming."  
Notation "Serviceable condition." Report approved by foreman.

February 25, at Amarillo, Tex., reported by engineer:  
"Engine steams poor. Bad leak in firebox." Repairs signed for by boilermaker. Report approved.

March 8, at Amarillo, Tex., reported by inspector:  
"Redrive leaky staybolts right side of firebox. Redrive leaky staybolts right side of throat sheet. Redrive and snap staybolts in both side sheets about 5 rows high." Repairs signed for. Report approved by foreman.

March 17, at Amarillo, Tex., reported by engineer:  
"Look front end over for leaks." Repairs signed for. Report approved by foreman.

March 26, at Canadian, Tex., reported by engineer:  
"Replace right water glass." Repairs signed for. Report approved by foreman.

The boiler inspector who reported the items on March 8 stated that the leaky staybolts he reported were leaking around the heads on the outside of the firebox but not enough to run down the sheets. He reported re-drive and snap staybolts in both side sheets not because they were leaking but on account of the heads curled and heads extra large, and it was necessary that they be bobbed and snapped.

The boilermaker who signed for the repairs reported on February 25 stated that he performed and signed for work on locomotive 1805, but at the time of this investigation he did not recall making repairs to anything in the firebox that would be considered a bad leak.

#### SUMMARY OF EVIDENCE

The men who worked with the watchman on the day of the accident were interviewed and stated that on the morning of April 1

locomotives 1886 and 1805 were standing in the enginehouse under steam with the fires out. About 8:30 a.m. the enginehouse foreman and a rod cup filler went to the enginehouse to fire up and re-fill the boilers of both locomotives. At that time there was about 90 pounds steam pressure on the boiler of locomotive 1805. The foreman checked the water in the water glasses and gage cocks while the other employee re-lit the fire. They left the locomotive about 9:00 a.m with a full glass of water, 200 pounds of steam, the fire extinguished and returned to the power plant. About 10:30 a.m. the foreman again went to the enginehouse and had a short conversation with the watchman. Before leaving he instructed the watchman to check and fire-up these locomotives some time after noon. While in the enginehouse at this time he checked the steam and water in both locomotives and found them in satisfactory condition before he left for the yard office.

The foreman stated he passed in sight of the enginehouse about 12:30 p.m. and saw smoke coming from the smokejacks on the enginehouse. He saw the watchman's automobile parked near the enginehouse. While he was servicing a locomotive on the main line the explosion occurred. He hurried to the enginehouse but it was about 10 or 15 minutes before he was able to locate the engine watchman because the enginehouse was in flames and he was hampered by heavy smoke. He found the watchman's body between Nos. 3 and 4 stalls and he hurriedly had the body removed as the flames were about to envelop that part of the enginehouse. It was then too late to remove locomotive 1886 from the enginehouse. An attempt was made to use the fire hose but there was no water in the line.

An engine foreman and an engineer who were in switching service within sight of the enginehouse noticed smoke coming from the smokejacks on the enginehouse about 1:45 p.m. and assumed that the locomotives were being fired up. They also noticed steam escaping from under the eaves of the enginehouse which they thought might be coming from the safety valves of one of the locomotives. They saw the boiler blown through the roof of the enginehouse. They then saw the fire in the enginehouse and summoned an ambulance and the fire department.

Every one who came in contact with the watchman prior to the accident reported that he was in normal condition and good spirits. There is no evidence that he took time out for lunch.

The carrier's instructions require that two men be present when the water level is checked, the Fire Builder's Record signed

and the amount of water showing in the glass recorded before a locomotive is fired up. No record of water level in boiler of locomotive 1805 at time fire was last lit was found and there was no evidence to show that a second employee was present as required by the carrier's regulations.

#### CAUSE OF ACCIDENT

It is found that this accident was caused by an overheated crown sheet due to low water.

Dated at Washington, D. C., this 28th day  
of May, 1951.

By the Commission, Commissioner Patterson.

SEAL

W. P. BARTEL,  
Secretary.