



NATIONAL TRANSPORTATION SAFETY BOARD

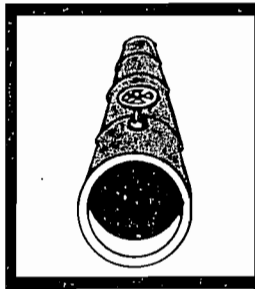
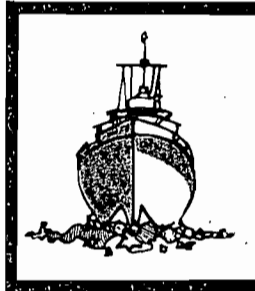
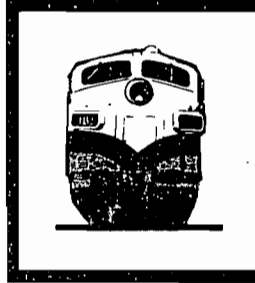
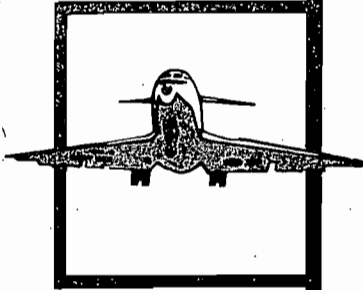
WASHINGTON, D.C. 20594

PIPELINE ACCIDENT REPORT

**COLONIAL PIPELINE COMPANY
PETROLEUM PRODUCTS PIPELINE FAILURES,
MANASSAS AND LOCUST GROVE, VIRGINIA,
MARCH 6, 1980**

NTSB-PAR-81-2

UNITED STATES GOVERNMENT



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16. Abstract About 3:36 p.m. e.s.t. on March 6, 1980, a pressure surge on Colonial Pipeline Company's 32-inch-diameter pipeline ruptured the pipeline in two locations; one near Manassas, the other in Orange County, near Fredericksburg, Virginia. No personal deaths or injuries resulted but thousands of fish and some waterfowl were killed and freshwater sources at the Occoquan Reservoir and the Rappahannock River were threatened with pollution. The National Transportation Safety Board determines that the probable cause of the pipeline rupture was a pressure surge initiated by the automatic shutdown of a pump station caused by the dispatcher's delay in getting it started, followed by his attempt to relieve the surge pressure into a stub-line connection instead of following the company procedure of shutting down all of the pumps on the line. The pipeline failed at two pre-existing defects: one where the pipe had been thinned by corrosion; the other where a crack propagated to failure.			
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Adopted: July 15, 1981

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SYNOPSIS

About 3:36 p.m. e.s.t. on March 6, 1980, a 32-inch-diameter refined petroleum pipeline, owned and operated by the Colonial Pipeline Company, ruptured in two locations simultaneously. The pipe wall had been thinned by corrosion in a casing under a road, causing the pipe to break and 8,000 barrels (336,000 gallons) of aviation-grade kerosene to be released adjacent to Route 234 near Manassas, Virginia. Before it could be fully contained, the kerosene had flowed into Bull Run River and had entered the Occoquan Reservoir, a source of drinking water for several northern Virginia communities.

Simultaneously, a crack in a pipe wall finally propagated to failure, releasing 2,190 barrels (91,980 gallons) of No. 2 fuel oil near Locust Grove, Virginia, a rural area in Orange County near Fredericksburg. Before it could be fully contained, the fuel oil had flowed into the Rapidan River and then into the Rappahannock River, a source of drinking water for the City of Fredericksburg.

There were no fatalities or injuries to persons as a result of either spill; however, thousands of fish and some small animals and waterfowl were killed. The water supply to Fredericksburg was contaminated and the Governor of Virginia declared a state of emergency. Cleanup of streams and river banks continued for months after the accident. The cost of the cleanup was estimated at more than \$1,000,000.

The National Transportation Safety Board determines that the probable cause of the pipeline rupture was a pressure surge initiated by the automatic shutdown of a pump station caused by the dispatcher's delay in getting it started, followed by his attempt to relieve the surge pressure into a stub-line connection instead of following the company procedure of shutting down all of the pumps on the line. The pipeline failed at two pre-existing defects: one where the pipe had been thinned by corrosion; the other where a crack propagated to failure.

INVESTIGATION

The Accident

At 3:17 p.m. e.s.t. on March 6, 1980, the Colonial Pipeline Company's 483 mile-long section of pipeline between Greensboro, North Carolina, and Linden, New Jersey, had been shut down to correct a minor problem created when gasoline, the product to be pumped out of Greensboro, mixed with kerosene, the product being pumped out of Greensboro. (See figure 1.) The contaminated product was drained from the manifold and at 3:22 p.m., the pipeline which normally operates continuously, began pumping again when the dispatcher activated the first of 17 pump stations on the line segment. As the

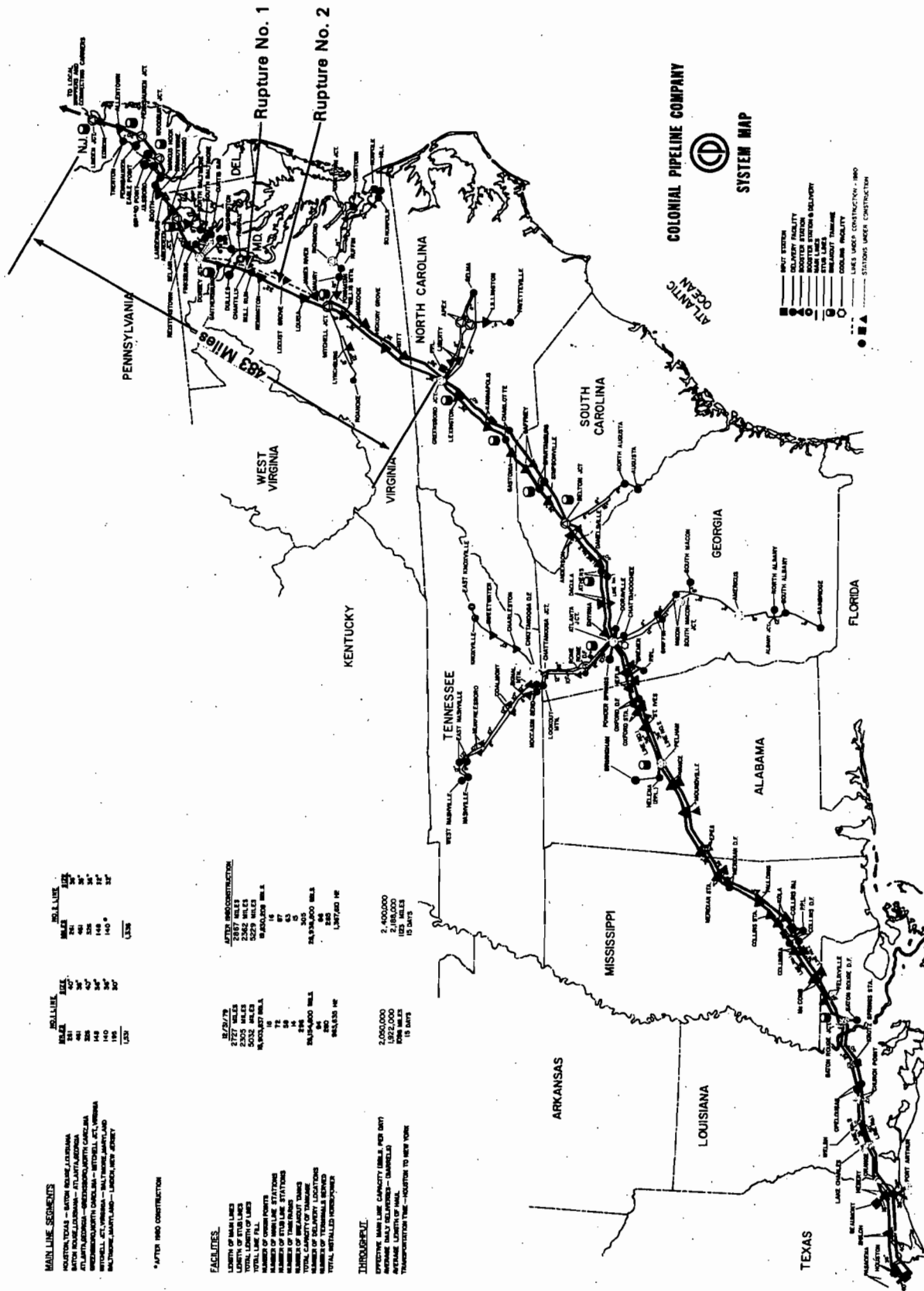


Figure 1.--Map of Colonial Pipeline Company System.

suction pressure increased at each of the 16 pump stations downstream from the originating pump station at Greensboro, each station was started up sequentially. (See figure 2.) When pumping began, the pipeline contained fuel oil in the Fredericksburg, Virginia, area and aviation kerosene in the Manassas, Virginia, area. The pipeline dispatcher successfully started up the Greensboro pump station and then, in sequence, and about 80 seconds apart, began starting up the downstream stations across Virginia and into Maryland. For reasons which he was not able to explain to the Safety Board's investigator, the dispatcher fell behind by about 60 seconds in the timing to bring the pump on the line. By the time the dispatcher started up the pump station at Conowingo, Maryland, the 13th pump station, a high pump suction pressure had already developed at this location. As the pump came up to speed, but before it could effectively begin pumping the stream away from the station, it developed a high case pressure which exceeded the automatic shutdown pressure setting and the pump was shut down. As a result, a pressure surge was created upstream (south) against all the pump stations already pumping in the line and caused them to shutdown automatically and sequentially, like falling dominoes.

As this was happening, the dispatcher elected to open the stream into the Fairfax, Virginia, terminal to relieve the pressure by splitting the stream and creating two outlets; one at Linden, New Jersey, and the other at Fairfax, Virginia. If he had been successful, the pressure would have been relieved from Chantilly to Greensboro, and the dispatcher would only have had to restart 5 pump stations from Gaithersburg to Conowingo instead of all 17 stations from Greensboro to Linden. (See figure 2.)

The valve which opens the main line to the Fairfax delivery line can be opened remotely by the dispatcher in Atlanta, but not until the Fairfax terminal personnel open the line into tankage to provide an outlet. However, when the dispatcher, using a procedure contrary to company policy, attempted to open the valve, he did not open it quickly enough to relieve fully the pressure buildup on the line. The motor-operated gate valve normally takes 2 1/2 minutes to open fully. The pressure surge had already passed and as a result, all of the pump stations from Chantilly to Greensboro shut down automatically. The shutdown procedures established by Colonial are to shut down the pump stations upstream (south) from Conowingo, in sequence, back to Greensboro. This minimizes pump surge pressure and does not rely on finding a quick opening for pressure relief.

At 3:36 p.m. e.s.t. on March 6, 1980, the pressure recording chart for Remington Station, located in the dispatcher's headquarters in Atlanta, showed a pressure drop; Colonial's 32-inch pipeline ruptured in a casing under State Route 234 near Manassas, Virginia, in an area where the pipe wall had been thinned by corrosion. The 32-inch pipe was originally cased in 40-inch casing and later, when a second lane was added to route 234, the casing was extended to protect the pipe from the weight of traffic under this new lane. The pipe ruptured 10 feet inside of the north side of the casing; the pipeline was about 9 feet deep at this point. Eight thousand barrels (336,000 gallons) of aviation-grade kerosene escaped from the 10-foot 10-inch-long rupture. The kerosene poured out of the pipe through the casing into a roadside ditch, through a tributary, and into Bull Run River. From the river, some of the kerosene entered the Occoquan Reservoir, a source of drinking water for more than 500,000 persons in northern Virginia. (See figure 3.)

Shortly before 3:45 p.m. on March 6, 1980, the Prince William County Fire Department was notified of escaping kerosene by an area resident. The fire department responded and observed a 5-foot-high geyser of kerosene at Route 234. The fire department closed the road, evacuated a nearby shopping center, and notified Colonial. The Colonial dispatcher had already noticed the pressure drop at Chantilly Station and had

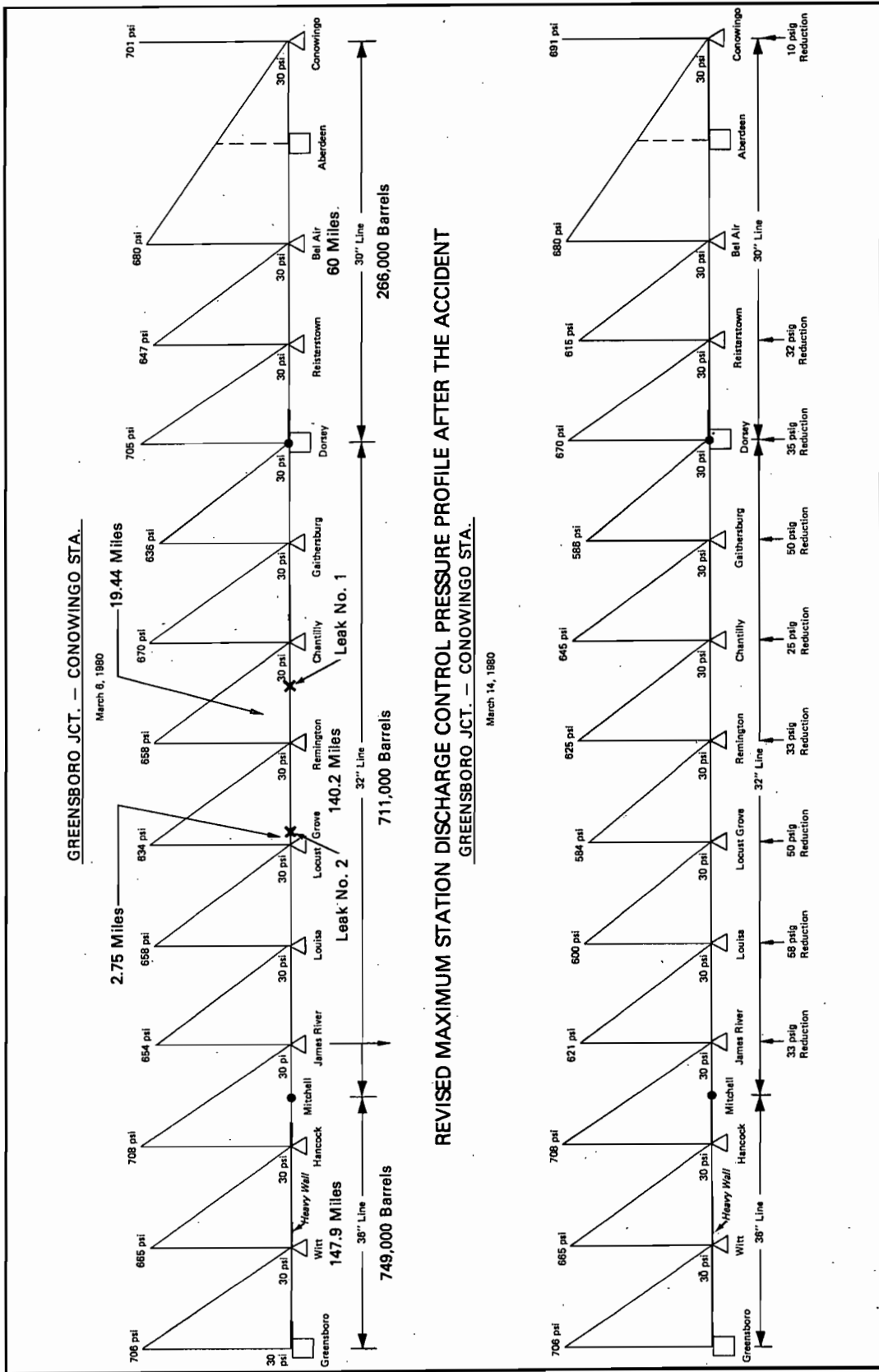
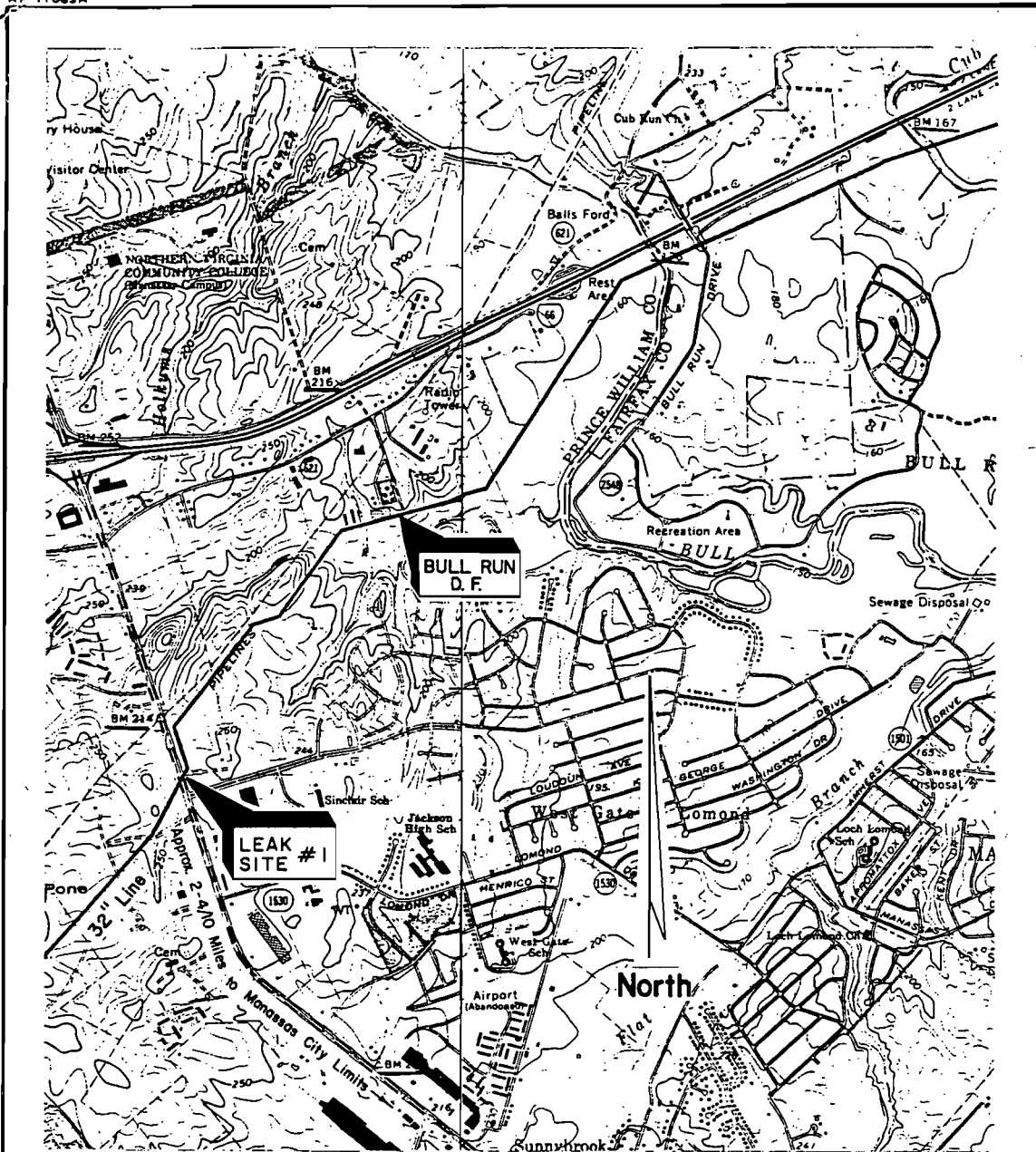


Figure 2.--Maximum Station Discharge Control Pressure Profile.

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NORTHSIDE BLUEPRINT & SUPPLY CO

		COLONIAL PIPELINE COMPANY ATLANTA, GEORGIA		DRAWN	
		MANASSAS LEAK SITE		NOTES	
				SCALE: 1" = 2000'	
		PRINCE WILLIAM COUNTY VIRGINIA		DATE: March 21, '80	
				CHECKED	
REVISION	DATE			2. LK-1	

Figure 3.--Manassas Leak Site.

radioed the pipeline surveillance airplane to fly over the area and check for leaks; by 3:45 p.m. all of the pump stations from Conowingo to Greensboro had shut down automatically. Shortly after 4 p.m., firefighting units began to build containment dams using bales of straw, chicken wire, fire hoses, and absorbent materials in an attempt to contain the kerosene at various locations along the creeks and rivers leading to the reservoir. Pipeline personnel arrived at 4 p.m. and contractors, retained by Colonial for emergency and maintenance work, arrived at the leak site about 5 p.m. They first aided the containment efforts and then the efforts to remove the kerosene from the water by use of vacuum trucks. Three days later, on March 9, some of the kerosene escaped from the flotation booms and entered the Occoquan Reservoir in detectable quantities. On March 18, contamination reached the maximum level recorded in the reservoir, but no contamination was detected in the fresh water leaving the reservoir, which had been treated with activated charcoal. Finally by March 20, no kerosene could be detected in the reservoir.

About 9:30 a.m. on March 7, fishermen on the Rapidan River, 40 miles south of the rupture near Manassas, saw a large sheen and smelled fuel oil on the river and reported their observations to the Virginia State Fish and Game Commission at 10:00 a.m. The leaking material, identified as fuel oil, was located about 17 to 20 miles west of Fredericksburg, on a tributary which entered Mine Run in Orange County. Mine Run flows into the Rapidan River, which flows into the Rappahannock River, a source of drinking water for the City of Fredericksburg. (See figure 4.) Fredericksburg was notified that its water supply might become polluted by the fuel oil, and at 3 p.m. on March 7, the Rappahannock River was closed off from the city's water treatment plant. By 4 p.m., the Colonial helicopter had located the leak and by 5 p.m., Colonial's helicopter detected an oil sheen on the Rappahannock west of Fredericksburg, up the Rapidan River to Mine Run. By 12 p.m., fuel oil had reached the dam and the canal to the Fredericksburg water treatment plant. When some of the fuel oil reached the canal carrying raw water to the water treatment plant, the plant discontinued operation, the city was alerted to a possible water shortage, and water service to some businesses was interrupted temporarily. Dams and containment booms were placed at strategic locations on Mine Run, the Rapidan River, and the Rappahannock River; on March 11, 1980, the Governor of Virginia declared a state of emergency in Fredericksburg, which ended on March 18, when the water treatment plant resumed Rappahannock operations using activated carbon filtration.

Colonial was not aware of the rupture in Orange County until it was notified by the Virginia State Fish and Game Commission about 23 hours after the rupture--at 2:30 p.m. on March 7, 1980.

The rupture was located in an open field in a rural area of Orange County about 2 3/4 miles northwest of Locust Grove, Virginia. The 32-inch-diameter pipe had been installed in 1963 with 36 inches of cover over it. The rupture measured 7 feet long, with a 6-inch opening at the widest point.

About 2:45 p.m., colonial notified its Richmond, Virginia, field office of the possibility of a rupture and a helicopter was sent to patrol the line. Personnel and equipment contracted by Colonial for emergency work were sent to the Rapidan and Rappahannock Rivers with booms and absorbent materials to control the pollution.

The pressure recording chart at Locust Grove revealed that this pipeline had ruptured at 3:39 p.m. on March 6, 1980, about 3 minutes after the rupture at Manassas. The pressure surge traveled at about 1,100 feet per second; the distance between the failure locations was 36 miles, and the pressure surge took 3 minutes to reach Locust Grove.

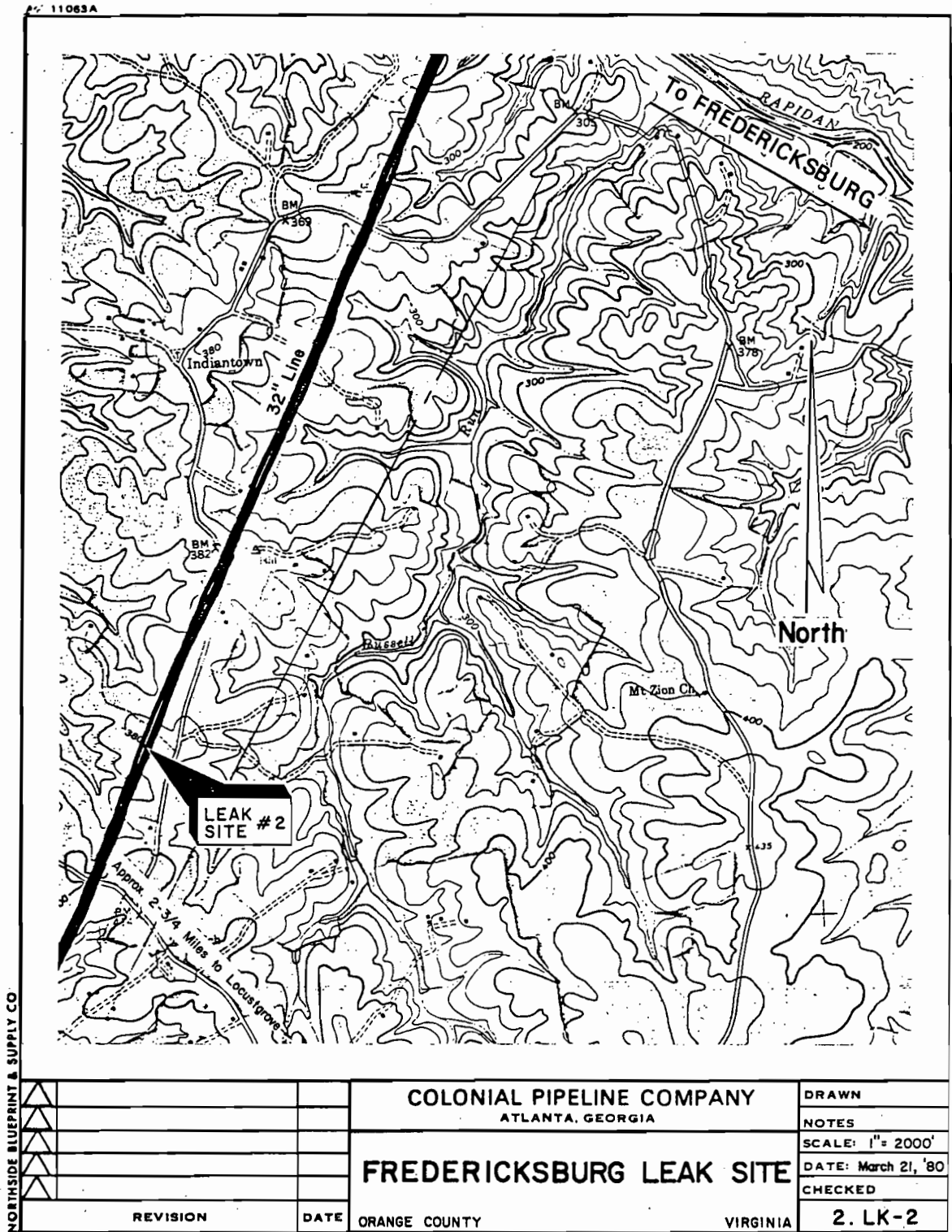


Figure 4.--Fredericksburg Leak Site.

By 10:45 a.m. on March 10, Colonial had repaired both ruptures and the pipeline had resumed operation. Pump station discharge pressures were lowered by 5 percent at eight pump stations north and south of the two failures. (See figure 2.)

In the fall of 1980, Colonial completed the construction of a 36-inch-diameter line parallel to the original 32-inch-diameter line from Greensboro to Dorsey Junction. The 32-inch-diameter line involved in this accident was then used to transport products from Greensboro to Dorsey Junction with only three pump stations on the line.

Damage

Sixteen feet of 32-inch-diameter line pipe and casing seals were replaced at the Manassas location. Eighteen feet of 32-inch-diameter line pipe was replaced at the Orange County rupture.

No one was killed or injured as a result of these ruptures. However, more than 5,000 fish and some waterfowl and small animals were killed because of the Manassas rupture, and between 5,000 and 10,000 fish and some waterfowl and small animals were killed because of the Orange County rupture. Colonial cleaned up the polluted farm land, stream and river banks, and reservoirs; cleanup operations continued for several months after the accident.

Pipeline System

Colonial Pipeline Company operates a refined petroleum products pipeline which transports gasoline, kerosene, fuel oil, and other distillates from the Texas Gulf Coast to New York City, a distance of 1,526 miles. In 1965, when the system was completed and fully operational, the single-line system from Texas to New York consisted of 1,048 miles of 36-inch-diameter pipe from Houston, Texas, to Greensboro, North Carolina; 288 miles of 32-inch-diameter pipe from Greensboro to Baltimore, Maryland; and 190 miles of 30-inch-diameter pipe from Baltimore to the New York City area. The capacity of the system was 792,000 barrels per day (33,264,000 gallons). (See figure 1.)

Colonial, a common carrier pipeline initially formed by nine major oil companies, has experienced six major expansions involving pipe, pump stations, and horsepower to satisfy the needs of its shippers. The pipeline currently has a capacity of 2,400,000 barrels per day (100,800,000 gallons) and serves more than 250 petroleum product marketing terminals along its route. The pipeline is controlled by a dispatcher in Atlanta, Georgia; the system utilizes computers for surveillance and operational control.

Colonial maintains an aerial surveillance of its entire pipeline system on a weekly basis. In addition, Colonial personnel walk the line in some of the more densely populated areas.

Colonial conducts an annual cathodic protection program survey as required by Federal regulations 49 CFR 195.416 External Erosion Control.

The pipe involved in both failures was installed in 1963, when it was hydrostatically tested to 90 percent of its specified minimum yield strength. The test pressure at both locations was 823 psig and was held for 24 hours. The maximum allowable operating pressure (MAOP) for the pipe at both failure points was 72 percent of the specified minimum yield strength, or 658 psig, which is in accordance with Federal regulation 49 CFR 195.106. (See appendixes A and B.)

The pressure of the Manassas pipe when it failed was 702 psig, which was 44 psig, or 6.7 percent above its MAOP. This was indicated on the pressure recording chart from Chantilly Pump Station.

The pressure on the Orange County pipe when it failed was 670 psig which was 12 psig, or 1.83 percent above its MAOP. This was indicated on the pressure recording chart from Locust Grove Station. Colonial calculated the pressure at both leak locations.

Federal regulation 49 CFR 195.406(b) allows a pipeline to experience a pressure surge of not more than 10 percent of its MAOP. Both the pipe at Manassas and the pipe at Orange County failed below 10 percent. 1/

The specifications for the pipe at both failure locations were:

- 32 inches diameter
- .281 inch wall thickness
- API 5LX-52 double submerged arc-welded line pipe
- 920 psig internal pressure at minimum yield strength
- 1260 psig ultimate bursting pressure
- 95.28 pounds per foot, weight

Personnel Information

The dispatcher had been hired by Colonial in 1973, and had worked in their Atlanta terminal. In September 1979, he entered the dispatcher training program where he had 16 weeks of training on other sections of the Colonial system. Upon completion of the 16 weeks training, he was assigned 8 weeks of training on the 32-inch system involved in this accident. He had completed the 8 weeks training and had completed 2 weeks of regular dispatcher duties when the accident happened.

The Colonial Pipeline Company dispatchers are usually persons selected from within the company and usually someone having worked in a pump station or terminal area of the pipeline. The training is on-the-job type instruction where the trainee works alongside of a seasoned dispatcher and learns by experience. There were no formal, written tests given to the trainee, but he was rated as a dispatcher if he showed that he could handle the job to the satisfaction of the supervisor.

After the accident, Colonial initiated a formal dispatcher training program including a dispatcher's manual and hydraulic handbook. The total training time is 6 months and includes training in the four pipeline segments: Houston to Greensboro gasoline line; Houston to Greensboro fuel line; Greensboro to Dorsey Junction and Linden; and stub-lines from Atlanta. The dispatcher trainees are also sent to different pump stations and terminals to observe operations. After each dispatcher completes each phase of his training (the four pipeline segments), he is given a written proficiency test.

Meteorological Information

Data provided by the Fairfax County Water Authority showed that stream velocities for the Occoquan River at the Occoquan Reservoir were generally decreasing from a February 25, rate of 608 cubic feet per second to a low of 249 cubic feet per second on March 4. On March 5 and 6, high velocities of 1,043 and 2,093 cubic feet per

1/ Colonial's specified minimum yield strength and MAOP are about 4 to 6 psig lower than the steel mill specifications.

second, respectively, were noted. These high velocities increased the difficulty of containing the kerosene on the streams and rivers. The normal stream velocity at the Occoquan for this time of year is about 1,000 cubic feet per second.

Data provided by the city engineer of the City of Fredericksburg showed that the stream velocities for the Rappahannock River on March 6, 7, and 8 were 4060, 2820, and 2,120 cubic feet per second, respectively. The normal steam velocity in this area at that time of year is about 1,130 cubic feet per second.

Tests and Research

The failed pipe from both locations was sent to Battelle Institute in Columbus, Ohio, for inspection, testing, and analysis; a Safety Board metallurgist observed the proceedings and concurred with the findings.

Regarding the pipe from the Manassas rupture, Battelle concluded that:

... the failure occurred at an area near the bottom of the pipe that had been thinned by corrosion. Apparently the corrosion resulted from ground water leakage past the pipe-to-casing seal and into the annular space between the pipe and casing, where the shielding effect of the casing would mitigate against obtaining adequate cathodic protection in this area ...

Regarding the pipe from the Orange County rupture, Battelle concluded that:

... an initial flaw existed in the pipe at the time it was put into service. This flaw was a fatigue crack on the outside surface of the pipe at the toe of the double submerged arc seam weld caused by the rail shipment. This crack grew in service through a corrosion fatigue mechanism; the fatigue being caused by the pressure cycles experienced by the pipeline. The final fracture was initiated by a surge pressure in the pipeline due to the shutdown of a downstream pump station.

Other Information

After the accident, the Safety Board requested a survey of all of the pipe installed in casing in Colonial's entire system. There were 2,511 road or railroad crossings where casing was used, 277 or 9 percent of which were found to be shorted or partially shorted electrically. These 277 locations were considered to be areas where corrosion could occur. Colonial is now either repairing or replacing the pipe at these locations.

The valve on the stub-line into Fairfax terminal was tested after the accident and found to work correctly.

On May 13 and June 16, 1979, Colonial experienced two ruptures on its 36-inch-diameter line near Spartanburg, South Carolina, similar to the Orange County failure. The first failure occurred 4.6 miles northeast of the Simpsonville pump station and the second failure occurred 2.7 miles northeast of the Simpsonville pump station. Both failures occurred as a result of the pipe being subjected to higher-than-normal pressure.

Metallurgical tests of both failures at Simpsonville revealed the following:

Both failures were caused by fatigue cracks that started on the outside surface at the toe of the longitudinal weld. There were no cracks in the weld or pipe associated with the fatigue cracks. The wall thickness, chemical composition, and tensile properties of both pipe lengths that ruptured met the requirements of API specification 5LX for new pipe.

The Safety Board's metallurgical laboratory analyzed the metallurgical reports on the failures at Simpsonville and Orange County and concluded that both were caused by cyclical cracking induced during shipment of the pipe by rail. The cracks propagated to failure during the operation of the pipeline. Colonial reviewed all its past pipe failures on the 32-inch sector between Greensboro Station and Dorsey Station, to see how many have failed as the result of fatigue cracks. The search revealed that there were no other failures either during testing or operation of the 32-inch segment of the pipeline which related to fatigue cracking.

After this accident, the Materials Transportation Bureau of the Research and Special Programs Administration contacted the American Petroleum Institute about the initiation of a jointly sponsored program to determine the extent of fatigue cracking initiated by the rail shipment of pipe. No further action has been taken.

As a result of this accident, the Safety Board released two Hazardous Materials Accident Spill Maps for Manassas and Orange County, Virginia, (NTSB-HZM-80-5 and 80-6). These maps showed the location and extent of the oil spill.

ANALYSIS

The startup of a large-diameter, high-volume pipeline with 17 pump stations to be energized sequentially requires the full attention of the dispatcher until all stations are operating and line pressure and flow have stabilized. Startup is critical during the first few minutes. Case pressures can become high, because each pump, as it comes on stream, is trying to move its proportional share of a static column of liquid, 483 miles long in this case, from a static condition to full-flow condition. Because the dispatcher fell behind in the time sequence required to bring the pumps on the line, he encountered the high suction pressure at the Conowingo pump station which was not able to move the static column of liquid ahead of it as fast as liquid was being pumped into it.

The Conowingo pump station's automatic controls functioned properly and as the pressure surged upstream each station shut down on high-discharge or high-case pressure settings. The surge itself never exceeded the MAOP at any time by more than the 10-percent margin allowed by Federal regulations for liquid petroleum pipelines, and it was less than that for which the pipeline had been tested when installed in 1963. However, there were two weak points in the pipeline--one where the pipe coating had been damaged when it was encased under a road crossing and the resultant corrosion had thinned the pipe wall thickness, and the other where small cracks in the pipe, caused by cyclical motion during rail shipment, had propagated until the pipe failed. These two weak points could not withstand the surge of pressure and they failed simultaneously.

Corrosion resulting from damaged coating on a carrier pipe inside its casing is, unfortunately, common in pipeline systems. An electrical shorting of the pipe can occur when the pipe coating has been damaged and the separators which position the pipe away from the casing have been broken. This allows the pipe metal to touch the casing metal and a short-circuit results. The cathodic protection applied to the pipe by anodes or rectifiers cannot effectively protect the pipe under this condition and with the entrance of water in the casing an electric cell is formed and corrosion results. However, periodic

inspection and testing can usually reveal these anodic locations, and the pipe can be repaired or replaced. In some cases, the casing annulus can be filled with an inert material; in other cases, the pipe and casing can be bonded together electrically and the combination can then be protected cathodically; in still other cases, the affected pipe can be replaced. On the other hand, cracking resulting from shipment is not commonly found and is far more difficult to detect and correct.

In the late 1950's and early 1960's, hundreds of miles of large-diameter, high-strength, thin-wall pipe was shipped by rail before the cyclical cracking problem was discovered and the shipment method modified. The American Petroleum Institute (API) addressed this problem in 1965 by publishing, "API Recommended Practice for Railroad Transportation of Line Pipe" (API RP 5L1) which read:

These supplementary recommendations have resulted from experience by the shippers of large-diameter line pipe in damage to the pipe during rail shipment of three principal types, viz., fatigue cracks, abrasions, and damaged ends, as follows:

1. Longitudinal fatigue cracks found adjacent to the weld of welded pipe and also, in scene instances, in seamless pipe. Fatigue cracks are caused by vertical vibrations and forces, repeated many times during long rail trips, with no apparent local abrasions or denting. They are the result of cyclic stresses produced by the weight of upper layers of pipe giving a static load, and a cyclic load due to the vertical movement of transportation equipment.

* * * * *

The API made recommendations regarding the positioning, bracing, blocking, and separating of pipe in rail gondola cars. These recommendations supplemented the minimum mandatory rules governing the loading practices as prescribed by the Association of American Railroads, Sections 1 and 2. (See appendixes C and D.)

The Safety Board is not aware of any practical, dependable, and economical equipment that can be used to detect defects, such as pipe wall cracks in operating pipelines. However, the system can be hydrostatically tested to a pressure of at least 90 percent of its specified minimum yield strength (SMYS) to find such defects. If the hydrostatic tests are performed properly and the pipeline operated at 72 percent of SMYS thereafter, the problem should be mitigated. Hydrostatic testing may not completely solve this problem because the testing may cause some small cracks to propagate, but not to the point of failure. However, when the cracks are large enough, the test will usually cause them to fail. These tests are undertaken only when there is evidence of a potential major problem. The test would include a large, clean, freshwater source, State and local permits, and site selections for water disposal, as well as an alternate method of supplying petroleum products to the shippers in the affected area. In this case, the test would require more than 29,862,000 gallons of water, and the pipeline would probably be shut down for 2 weeks. In the 18 years of operation in this 32-inch line segment, Colonial has experienced only this one leak as a result of cyclical cracking.

Since the leaks at Manassas and Locust Grove, Virginia, Colonial has eliminated 9 pump stations on this 32-inch line segment (from 12 to 3) and has reduced the operating pressure on the 3 remaining pump stations by over 5 percent. Under these reduced pressures, Colonial believes the system will function without further crack propagation problems. The Safety Board believes that more research and analysis is needed in this area of pressure reduction as a remedy for this problem.

CONCLUSIONS

Findings

1. Before the accident, two weak spots existed in the pipeline; one in a casing under a road where the pipe coating had been damaged during installation and corrosion had thinned the pipe wall, and the other, a crack resulting from cyclical motion during rail shipment.
2. The dispatcher fell behind in starting up the pump stations sequentially. This caused one station to shut down unexpectedly, which created a sudden pressure surge.
3. The sudden pressure surge was not relieved into the delivery line because the dispatcher did not open the valve fast enough. The motor operated valve required 2 1/2 minutes to open fully and the pressure surge by that time had passed upstream.
4. Colonial's normal procedure of shutting down the upstream pump stations sequentially to relieve the pressure was not followed.
5. After the accident, the valve was tested and operated correctly.
6. Corrosion in pipelines can usually be detected and eliminated and the affected pipe repaired or replaced.
7. Fatigue cracks in pipelines initiated by cyclical motion of the pipe during rail shipment are difficult to detect before installation and can be detected after installation only by hydrostatic testing.
8. Additional fatigue cracks initiated by the cyclical motion of the pipe during rail shipment, but which have not yet propagated to failure, may still exist in the Colonial Pipeline system.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the pipeline rupture was a pressure surge initiated by the automatic shutdown of a pump station caused by the dispatcher's delay in getting it started, followed by his attempt to relieve the surge pressure into a stub-line connection instead of following the company procedure of shutting down all of the pumps on the line. The pipeline failed at two pre-existing defects: one where the pipe had been thinned by corrosion; the other where a crack propagated to failure.

RECOMMENDATIONS

As a result of its investigation of this accident, the National Transportation Safety Board made the following recommendations:

--to the Research and Special Programs Administration:

Expedite, in cooperation with the American Petroleum Institute and the American Gas Association, the jointly sponsored program to determine the extent of pipe failures in existing pipeline systems with a diameter-to-thickness ratio of 70 or greater, due to fatigue cracks initiated during the rail shipment of the pipe. (Class II, Priority Action)
(P-81-13)

If it is determined that pipe failures in existing pipeline systems with a diameter-to-thickness ratio of 70 or greater due to fatigue cracks initiated during the rail shipment of the pipe are a continuing problem, develop operating and testing guidelines to assist pipeline operators in minimizing pipe failures. (Class II, Priority Action) (P-81-14)

--to the Colonial Pipeline Company:

Conduct an analysis of previous pipe failures throughout its entire system caused by cracking initiated during the rail shipment of the pipe and report to the Safety Board the results and the intended actions to minimize pipe failures. (Class II, Priority Action) (P-81-15)

--to the American Petroleum Institute and the American Gas Association:

Work with appropriate industry groups and other pipeline companies to advance the state of the art in the development of internal pipeline inspection equipment for the detection of stress cracks in operating pipelines. (Class II, Priority Action) (P-81-16)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD

/s/ JAMES B. KING
Chairman

/s/ ELWOOD T. DRIVER
Vice Chairman

/s/ PATRICIA A. GOLDMAN
Member

/s/ G. H. PATRICK BURSLEY
Member

FRANCIS H. McADAMS, Member, did not participate.

July 15, 1981

APPENDIXES

APPENDIX A

PIPELINE CARRIER ACCIDENT REPORT: MANASSAS

DEPARTMENT OF TRANSPORTATION FEDERAL RAILROAD ADMINISTRATION PIPELINE CARRIER ACCIDENT REPORT				FORM APPROVED OMB No. 00485601																																																	
<p>Instructions</p> <p>Complete in duplicate. If the space provided for any question is not adequate, attach an additional sheet. Definition of a reportable accident is stated in the Code of Federal Regulations, Title 49, Chapter 1, Part 195. File both copies of this report within 15 days after discovery of the accident with the Administrator, Federal Railroad Administration, Department of Transportation, Washington, D. C. 20591 (Re: Sec. 195.54). Detailed instructions for preparing this form are found in Part 195. Specimen copies of this form will be supplied upon request without charge. Additional copies may be reproduced using the same format and size.</p>																																																					
<p>A Carrier Information</p> <p>1. NAME OF CARRIER Colonial Pipeline Company (02561)</p> <p>2. PRINCIPAL BUSINESS ADDRESS 3390 Peachtree Road, N.E., Atlanta, Georgia 30326</p>																																																					
<p>B Time and Location of Accident</p> <p>1. DATE (MONTH, DAY, YEAR) 2. HOUR <input type="checkbox"/> AM <input checked="" type="checkbox"/> PM March 6, 1980 3:36</p> <p>4. PART OF CARRIER'S SYSTEM INVOLVED <input checked="" type="checkbox"/> LINE PIPE <input type="checkbox"/> PUMPING STATION <input type="checkbox"/> DELIVERY POINT <input type="checkbox"/> TANK FARM <input type="checkbox"/> OTHER (SPECIFY)</p> <p>3. LOCATION (STATE, COUNTY, CITY) Virginia, Prince William</p> <p>5. PHYSICAL LOCATION (IF LOCATION IS NEAR PUBLIC OR PRIVATE BUILDINGS, OR OTHER SIGNIFICANT LANDMARKS SUCH AS HIGHWAYS OR RAILROADS, ATTACH A SKETCH OR DRAWING SHOWING RELATIONSHIP OF ACCIDENT LOCATION TO THESE LANDMARKS) See attached map.</p>																																																					
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<p>F Property Damage</p> <p>1. CARRIER'S DAMAGE (PHYSICAL PROPERTY DAMAGED) \$ 934.00</p> <p>2. ITEMS DAMAGED 16' - 3" of 32" line ptp, coating and casing seals.</p> <p>3. OTHER PROPERTY DAMAGE Unknown at Present</p> <p>4. ITEMS DAMAGED Fish, birds & animals. Vegetation at site, waters of Virginia water supply for Fredericksburg.</p>																																																					
<p>G General Information</p> <p>1. COMMODITY BEING TRANSPORTED AT TIME OF ACCIDENT Av. Kerosene</p> <p>2. ESTIMATED LOSS DUE TO ACCIDENT 8,000 BARRELS</p> <p>3. YEAR FACILITY INSTALLED (EXCLUDING PIPE) 1963</p> <p>4. WAS THERE A FIRE? <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO</p> <p>5. WAS THERE AN EXPLOSION? <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO</p>																																																					
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Form FRA F 39 (2-72)
(Formerly DOT 7000-1)

LXXXVI

I. Caused by Corrosion	1. TYPE OF CORROSION <input type="checkbox"/> INTERNAL <input type="checkbox"/> EXTERNAL	2. FACILITY UNDER CATHODIC PROTECTION <input type="checkbox"/> YES <input type="checkbox"/> NO	3. TIME BETWEEN CORROSION TESTS MONTHS	4. TYPE OF TEST USED
J. Caused by Equipment Rupturing Pipeline	1. DISTANCE TO CLOSEST LINE MARKER	2. INFORMATION ON MARKER		3. LENGTH OF TIME BETWEEN PATROL ON SECTION DAYS
<p>ACCOUNT OF ACCIDENT BY RESPONSIBLE OFFICIAL OF CARRIER</p> <p>At 3:36 p. m. an unscheduled shutdown occurred at the Conowingo, Maryland Pump Station on the Greensboro to Baltimore 32" diameter main line. The line condition resulted in the sequential shutdown of several pump stations upstream of Conowingo. The pressure increased momentarily because of the pressure surge; it did not exceed the maximum allowable pressure including a 10% surge allowance permitted under the Department of Transportation Code of Federal Regulations, Part 195.406(b). The condition was further aggravated by human error on the part of the controller in the Atlanta Control Center when he attempted an alternate method of relieving the situation rather than following the prescribed practice of initiating an orderly shutdown of remaining pumping stations on this segment of the pipeline system.</p> <p>A split in the pipe 11' - 1" long with a gap of 4" at the widest point located in the pipe at about the 7 o'clock position and 180° from the longitudinal seam. Visual inspection revealed the presence of corrosion on the pipe in the area of the failure.</p> <p>The pipe specimen has been sent to a metallurgical laboratory for analysis to determine the cause of failure.</p> <p>Repair required removal of 16' - 3" of the pipeline and replacement with a like amount of 32" 5LX52, 0.281" prehydrostatically tested pipe. Tie-in welds were x-rayed to the satisfaction of Part 195.</p> <p>A total of 6,130 barrels of the 8,000 barrels of kerosene lost from the system were recovered.</p> <p>The DOT, USCG, EPA and State of Virginia were given notice by telephone.</p>				
NAME AND TITLE OF CARRIER OFFICIAL FILING THIS REPORT <i>J. S. Sorrow</i> J. S. Sorrow, Administrator-Regulatory Affairs			TELEPHONE NO. (INCLUDE AREA CODE) 404/261-1470	DATE 3/21/80

APPENDIX B

PIPELINE CARRIER ACCIDENT REPORT: LOCUST GROVE

DEPARTMENT OF TRANSPORTATION FEDERAL RAILROAD ADMINISTRATION PIPELINE CARRIER ACCIDENT REPORT		FORM APPROVED OMB No. 004R5601				
Instructions	Complete in duplicate. If the space provided for any question is not adequate, attach an additional sheet. Definition of a reportable accident is stated in the Code of Federal Regulations, Title 49, Chapter 1, Part 195. File both copies of this report within 15 days after discovery of the accident with the Administrator, Federal Railroad Administration, Department of Transportation, Washington, D. C. 20591 (Re: Sec. 195.54). Detailed instructions for preparing this form are found in Part 195. Specimen copies of this form will be supplied upon request without charge. Additional copies may be reproduced using the same format and size.					
A Carrier Information	1. NAME OF CARRIER Colonial Pipeline Company (02561) 2. PRINCIPAL BUSINESS ADDRESS 3390 Peachtree Road, N. E., Atlanta, Georgia 30326					
B Time and Location of Accident	1. DATE (MONTH, DAY, YEAR) March 6, 1980	2. HOUR 3:36 <input type="checkbox"/> AM <input checked="" type="checkbox"/> PM	4. PART OF CARRIER'S SYSTEM INVOLVED <input checked="" type="checkbox"/> LINE PIPE <input type="checkbox"/> PUMPING STATION <input type="checkbox"/> DELIVERY POINT <input type="checkbox"/> TANK FARM <input type="checkbox"/> OTHER (SPECIFY)			
	2. LOCATION (STATE, COUNTY, CITY) Virginia, Orange County 3. PHYSICAL LOCATION (IF LOCATION IS NEAR PUBLIC OR PRIVATE BUILDINGS, OR OTHER SIGNIFICANT LANDMARKS SUCH AS HIGHWAYS OR RAILROADS, ATTACH A SKETCH OR DRAWING SHOWING RELATIONSHIP OF ACCIDENT LOCATION TO THESE LANDMARKS) See attached map.					
C Origin of Liquid or Vapor Release	<input checked="" type="checkbox"/> PIPE <input type="checkbox"/> GIRTH WELD <input type="checkbox"/> LONGITUDINAL WELD <input type="checkbox"/> PUMP <input type="checkbox"/> VALVE <input type="checkbox"/> SCRAPER TRAP <input type="checkbox"/> METER OR PROVER <input type="checkbox"/> TANK <input type="checkbox"/> WELDED FITTING <input type="checkbox"/> BOLTED FITTINGS <input type="checkbox"/> SAMPLE HOUSE <input type="checkbox"/> HAY TANK <input type="checkbox"/> STRAINER OR FILTER <input type="checkbox"/> OTHER (SPECIFY)					
D Cause of Accident	<input type="checkbox"/> CORROSION <input type="checkbox"/> DEFECTIVE WELD <input checked="" type="checkbox"/> INCORRECT OPERATION BY CARRIER PERSONNEL <input type="checkbox"/> DEFECTIVE PIPE <input type="checkbox"/> EQUIPMENT RUPTURING LINE <input type="checkbox"/> OTHER (SPECIFY)					
E Death or Injury	1. NUMBER OF PERSONS KILLED CARRIER EMPLOYEES NON-EMPLOYEES None None		2. NUMBER OF PERSONS INJURED CARRIER EMPLOYEES NON-EMPLOYEES None None			
F Property Damage	1. CARRIER'S DAMAGE (PHYSICAL PROPERTY DAMAGED) \$ 729.00		2. ITEMS DAMAGED 18' - 7" of 32" pipe and coating			
	3. OTHER PROPERTY DAMAGE Unknown at Present		4. ITEMS DAMAGED Fish, birds and animals, vegetation at spill site.			
G General Information	1. COMMODITY BEING TRANSPORTED AT TIME OF ACCIDENT No. 2 Fuel Oil	2. ESTIMATED LOSS DUE TO ACCIDENT 2,190 BARRELS	3. YEAR FACILITY INSTALLED (EXCLUDING PIPE) 1963	4. WAS THERE A FIRE? <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO	5. WAS THERE AN EXPLOSION? <input type="checkbox"/> YES <input checked="" type="checkbox"/> NO	
Instructions	Answer sections H, I or J only if they apply to the particular accident being reported.					
H Occurred in Line Pipe	1. NOMINAL DIAMETER 32 IN.	2. WALL THICKNESS 0.281 IN.	3. GRADE 5LX52	4. YEAR OF INSTALLATION <input type="checkbox"/> BEFORE 1920 <input type="checkbox"/> 1920-30 <input type="checkbox"/> 1930-6 <input checked="" type="checkbox"/> AFTER 1930 (SPECIFY YR.)	5. CONDITION WHEN INSTALLED <input checked="" type="checkbox"/> NEW <input type="checkbox"/> RECONDITIONED	6. TYPE OF JOINT INSTALLED <input checked="" type="checkbox"/> WELD <input type="checkbox"/> COUPLED <input type="checkbox"/> THREADED
	7. CONFIGURATION AT POINT OF ACCIDENT <input checked="" type="checkbox"/> STRAIGHT <input type="checkbox"/> SAG <input type="checkbox"/> OVERBEND <input type="checkbox"/> SIDEBEND			8. PIPE WAS <input checked="" type="checkbox"/> COATED <input type="checkbox"/> NOT COATED	9. PIPE WAS <input type="checkbox"/> ABOVE GROUND <input checked="" type="checkbox"/> BELOW	
	10. COVER, IF BELOW 36 IN.	11. DESIGN PRESSURE 72% minimum yield pressure 658 PSIG	12. PRESSURE AT TIME & LOCATION OF ACCIDENT 670 PSIG	13. HAD THERE BEEN A PRESSURE TEST ON SYSTEM? <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO		
	14. IF 13 IS YES, MEDIUM USED <input checked="" type="checkbox"/> WATER <input type="checkbox"/> PETROLEUM <input type="checkbox"/> AIR	15. DURATION OF TEST 24 HRS	16. MAXIMUM TEST PRESS. 823 PSIG	17. DATE OF LATEST TEST 1963		

Form FRA F 39 (2-72)
(Formerly DOT 7000-1)

L XXXVII

I Caused by Corrosion	1. TYPE OF CORROSION <input type="checkbox"/> INTERNAL <input type="checkbox"/> EXTERNAL	2. FACILITY COATED <input type="checkbox"/> YES <input type="checkbox"/> NO	3. FACILITY UNDER CATHODIC PROTECTION <input type="checkbox"/> YES <input type="checkbox"/> NO	4. TIME BETWEEN CORROSION TESTS MONTHS	5. TYPE OF TEST USED
J Caused by Equipment Rupturing Pipeline	1. DISTANCE TO CLOSEST LINE MARKER	2. INFORMATION ON MARKER		3. LENGTH OF TIME BETWEEN PATROL ON SECTION DAYS	

ACCOUNT OF ACCIDENT BY RESPONSIBLE OFFICIAL OF CARRIER

At 3:36 p.m. an unscheduled shutdown occurred at the Conowingo, Maryland Pump Station on the Greensboro to Baltimore 32" diameter main line. The line condition resulted in the sequential shutdown of several pump stations upstream of Conowingo. The pressure increased momentarily because of the pressure surge; it did not exceed the maximum allowable pressure including a 10% surge allowance permitted under the Department of Transportation Code of Federal Regulations, Part 195.406(b). The line condition was further aggravated by human error on the part of the controller in the Atlanta Control Center when he attempted an alternate method of relieving the situation rather than following the prescribed practice of initiating an orderly shutdown of remaining pumping stations on this segment of the pipeline system.

A split in the pipe 7'-1" long with a gap of 8-1/2" at the widest point occurred adjacent to the longitudinal seam in the base metal at the toe of the weld. The pipeline was repaired by removing 18'-7" of pipe and replacing it with a like amount of 5LX52, 0.281" wall prehydrostatically tested pipe. Both tie-in welds were x-rayed to the satisfaction of Part 195.

The pipe specimen has been sent to a metallurgical laboratory for analysis to determine the cause of failure.

This incident occurred simultaneously with the failure reported at Manassas, Virginia, which occurred at 3:36 p.m. on March 6, but this failure was not discovered until March 7, 1980.

A total of 1,527 barrels of the 2,190 barrels lost from the system were recovered from the waters of the State of Virginia.

Notice by telephone was given to the DOT, EPA USCG, the State of Virginia, and other local officials.

NAME AND TITLE OF CARRIER OFFICIAL FILING THIS REPORT <i>J. S. Sorrow</i> J. S. Sorrow, Administrator-Regulatory Affairs	TELEPHONE NO. (INCLUDE AREA CODE) 404/261-1470	DATE 3/21/80
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APPENDIX C

**AAR GENERAL RULES ON LOADING COMMODITIES
ON TOP OF CARS AND TRAILERS**

SECTION No. 1

Association of American Railroads

**OPERATIONS AND
MAINTENANCE DEPARTMENT**

MECHANICAL DIVISION

PART 1

GENERAL RULES GOVERNING
THE
Loading of Commodities
On Open Top Cars and Trailers

Adopted by the
Former Master Car Builders' Association
as Recommended Practice, 1896
Advanced to Standard 1908

PUBLISHED FEBRUARY 1, 1960
REPUBLISHED JANUARY 1, 1976
REVISED SEPTEMBER 1, 1977

Published by the Association of American Railroads
1920 L Street N.W. Washington, D.C. 20036

1977

Printed in U. S. A.

Sec. 1—General Rules (Rev.—9-1977)

7

PREFACE

The Rules Governing The Loading of Commodities on Open Top Cars and Trailers are covered under the following Sections of this manual:

<u>Section No.</u>	<u>Description</u>
1	General Rules (Applicable to Sections 1 to 6).
2	Steel Products, Including Pipe.
3	Road Grading, Road Making, and Farm Equipment Machinery.
4	Miscellaneous Commodities, Including Machinery.
5	Forest Products.
6	Department of Defense Materiel.
7	Open Top Trailers in TOFC Service (General Rules and Figures).

These rules have been formulated for the purpose of providing uniform, safe and economical methods of loading in open top cars and the material specified in these rules for securing the loads are minimum requirements.

All of the General Rules and the requirements for blocking and securing of loads as outlined under the individual figures are mandatory and must be used unless their omission is specified in the individual figures.

When the dimensions and kind of materials to be used for securing the load are not specified under the figures, the General Rules, Section No. 1 or Section No. 7, which are to carefully observed in connection with all loading, will govern.

GENERAL RULES

Rule 1. Inspection and Compliance.

(a) General Requirements.

- (1) The responsibility for properly preparing a load for movement by rail is defined for the shipper by the Uniform Freight Classification Rule 27, Section No. 3.
- (2) The responsibility of the rail carrier, when accepting open top loads is governed by Rule 89, Section "B", paragraph 1, sub-paragraph (a) of the AAR Interchange Rules "Field Manual."
- (3) Shippers must observe the drawings and specifications of an applicable figure where a figure is involved, as well as all applicable rules regulating the safe loading of freight as published herein; and must also inspect shipments to see that they are properly and safely secured and that all applicable details in Rules 1 to 21 inclusive, as well as all applicable figures, where figures are involved, have been complied with in all cases, before shipments are tendered to carrier.
- (4) Drawings depicting specific figures are provided for guidance in the preparation of loads. When such loads are prepared or offered in interchange, the application or placement of securement items may vary from the detailed drawings. In all instances, the specifications of the specific figure will govern allowing for minor variances in placement of securement details and provided no securement items have been omitted.
- (5) Loads of hazardous materials must conform to the regulations of the agency of authority of the countries within which the shipment will move.
- (6) Unless otherwise specified, all of the figures in Section Nos. 3, 4 or 6, covering various types of vehicles, are applicable only when vehicles are empty.
- (7) Unless otherwise specified, shippers must implement all new figures, revisions to figures, or instructions covered by circulars within but not later than three months from the date shown on such releases. This period is to allow for the dissemination of information and to permit for depletion of securement and blocking materials that may be on hand to provide for the procurement of new securement materials. When it is necessary to correct a hazardous practice, a circular letter will be issued stating that the specifications of a new figure or revisions to an existing figure are effective immediately. When this occurs, the three month provision is nullified and will be implemented as soon as received by the shipper and originating carrier. In such cases, the shipper and originating carrier will be notified by wire or by other expeditious means. Where clarification of the intent of a rule or specifications of a figure is requested and no change is made to the securement details or where editorial changes in a rule and/or figure is required, the Open Top Loading Rules Committee has the prerogative to inform the industry of such clarifications and/or editorial changes with a circular letter, which may specify an effective date, to be no later than three (3) months after the date of the circular letter.
- (8) In the loading of such cars the hazards connected with speed, multiple track railroads, tunnels, bridges, overhead structures, electric conductors and the necessity of protecting human life and property should be borne in mind.
- (9) When ordering cars for loading concentrated weights of heavy commodities, shippers have the responsibility of notifying serving carriers of this purpose.
- (10) Floors and all supporting details of cars selected for the loading of commodities of heavy concentrated weight must be of sufficient strength to prevent load breaking through floor while shipments are enroute.
- (11) Fixed supports, brackets or other appurtenances on lading, must be of sufficient strength to safely support unit in transit or body of same must be adequately supported for rail transportation.
- (12) All cars - All items described under the figures for securing loads must be applied as specified, except when otherwise indicated under each figure.
- (13) Unless otherwise specified in the figures, the securements are shown for loads on flat cars not exceeding 60 ft. in length. When lading requires flat cars longer than 60 ft., the shipper and originating carrier are to confer as to additional securement required.
- (14) Loads of dimensions and weight which make it necessary to handle them under restricted speeds must be reported by the originating carrier to the carriers over whose lines they are to be transported.
- (15) Piles or units, loaded on one car may be secured to different specific figures or General Rules and located not closer than two feet to the adjacent pile or unit.
- (16) In regard to the matter of applying protective material, the AAR Loading Rules which govern the loading of various commodities on open top cars are primarily intended for the safe movement of the car and load from point of shipment to destination. In preparing these loading rules, no attempt is made for the protection of the commodities involved either from the elements or from other forms of damage. Where additional protection from damage is necessary, this then becomes a matter to be decided between the shipper and receiver of the commodity.
- (17) When tarpaulins or other type covers are used to cover or protect the lading during transit, they must be adequately secured in such a manner as to prevent them from working loose and thus becoming an operational safety hazard.

(18) Cards bearing advertisements or trademarks or banners must not be attached to cars, nor to permanent stakes which are a part of the car, nor to temporary stakes supplied by shipper solely for the purpose of carrying such advertisements. They may, however, be applied to the load or to temporary stakes used to secure load provided they are safely secured to such stakes or lading. Paper or cloth banners or size requiring supporting frames, metal or wooden banners with or without supporting frames, must be securely fastened by bolts, wires or bands.

(b) Special Authority.

(1) Special authority must be procured by the shipper from the originating carrier for shipments of any commodity on open top cars not covered by a specific figure in Sections 2 to 6 inclusive; also, for shipments of any commodity unless covered by a specific figure in Sections 2 to 6 inclusive, when loaded on a well hole, depressed floor or specially designed cars. Consistent loading of a commodity on a conventional or specially designed car places an obligation on the shipper to request promptly, approval of a specific figure to cover. Originating carriers involved with commodities consistently shipped have the responsibility of notifying the AAR Open Top Loading Rules Committee and informing shipper they must submit appropriate proposal to cover new methods of loading.

(2) Loading on specially equipped open top cars incorporating either integral or special tie-down securement, unless covered by a specific figure in Sections 2 to 6 inclusive, is not covered by these rules insofar as securement details are concerned; where not covered, the loads and securement must conform with General Rules 1 through 21.

(3) Originating carrier and shipper must confer as to appropriate blocking and bracing methods for loads not covered by a specific figure and consideration must be given to such details as the topography, distance travelled, multiple track system, grades, curves, train speeds, etc., which the shipment will incur over its entire route from origin to destination. When in the interchange of such shipments, exceptions are taken by receiving carrier to method of securement, carriers participating in the movement of controversial shipment are to be contacted by receiving carrier in an effort to resolve an acceptable method of loading the commodity in question. Where differences of opinion arise between or among carriers which they cannot resolve amongst themselves or with the assistance of local interchange bureaus or similar associations, then the dissenting carrier may request the Chairman of the Open Top Loading Rules Committee to appoint three neutral members of this committee, preferably from the same region over which the controversial shipments will move, to decide which side of the dispute should be upheld, having full authority to render an immediate decision after an on-the-ground investigation is made at the originating point. In cases where this neutral group decides that the existing loading method is adequate and safe, any intermediate or destination carrier would thereafter have to make at its own expense any changes or additions pertaining to items of securement, which it might deem necessary, upon receipt of such shipments on its line.

(4) Gondola cars with removable roofs or hoods, without special load retaining fixtures, are subject to the mandatory requirements of the Open Top Loading Rules.

(5) The loading and bracing of ground servicing units, used with the various Missile Systems shipped by the Department of Defense, because of the very specialized nature, are covered by individual drawings. When approval of these methods of loading is acknowledged jointly by the Department of Defense Subcommittee of the A.A.R. Committee on Loading Rules and U.S. Army Transportation Engineering Agency, Military Traffic Management Command, a letter of authorization, is issued by the Director, Rules and Inspection, of the A.A.R. Mechanical Division which designates the drawing reference and unit classification. Copies of these drawings are maintained in a special file in the office of the Secretary of the A.A.R. Mechanical Division and they are also available at Department of Defense military sites where these units are loaded.

(c) Instructions - New Submissions - Experimental Loads.

(1) These rules are based on many years of exacting studies and requirements, however the railroads stand ready at all times to cooperate with the shippers for betterments. Suggestions made to the Director, Rules and Inspection Mechanical Division, Association of American Railroads, American Railroads Building, 1920 L Street, N.W., Washington, D.C., 20036, will be given prompt attention.

(2) Shippers of Department of Defense material desiring new revision or additions to the present rules or specifications must submit such proposals to the Military Traffic Management Command, Transportation Engineering Agency, 12388 Warwick Boulevard, P.O. Box 6272, Newport News, Virginia 23606, through the appropriate channels for handling with the Mechanical Division of the Association of American Railroads.

(3) Shippers desiring to deviate from the AAR Open Top Loading Rules or desiring approval of a method not now covered by these rules, must submit to the Director, Rules and Inspection, Mechanical Division, Association of American Railroads or the Chairman, Open Top Loading Rules Committee, twenty (20) drawings, size 17 in. x 22 in., giving plan, end and side views, with all items of securement identified with capital letters similar to drawings as presently shown in the rules, also twenty (20) copies of specifications in similar form to those likewise contained in the Open Top Loading Rules.

(4) On receipt of any submission in the above form, the matter will be transmitted to the Open Top Loading Rules Committee for their review and comments, after which the issuance of experimental load cards will be dependent on the decisions rendered by this Committee.

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(5) When an impact test is deemed necessary for evaluation of a new submission, there will be no charge for expenses incurred by the Open Top Loading Rules Committee for conducting these tests. There will be a charge of \$700 to the proponent to cover the Committee's expenses when a impact test is needed to evaluate a request for revision of existing figures, when in the Committee's opinion, the load securement is lessened by either a reduction of the size or number of securement items or an increase in weight or volume of the commodity. The charge will be payable to the Association of American Railroads when an agreement is reached on the time and place to conduct the impact test.

(6) Shipper, after having received authority for experimental shipments, will be furnished stickers worded as outlined below. He will affix one to bill of lading and attach another to be affixed to waybill by agent. This to insure proper handling of experimental load cards.

ASSOCIATION OF AMERICAN RAILROADS
EXPERIMENTAL LOAD

The Association of American Railroads, through the Committee on Loading Rules, has authorized the application of experimental load cards to Car.

(Initial)

(Number)

APPENDIX D

**AAR GENERAL RULES ON LOADING OF PIPE
ON OPEN TOP CARS**

SECTION No. 2

PART 2

RULES GOVERNING

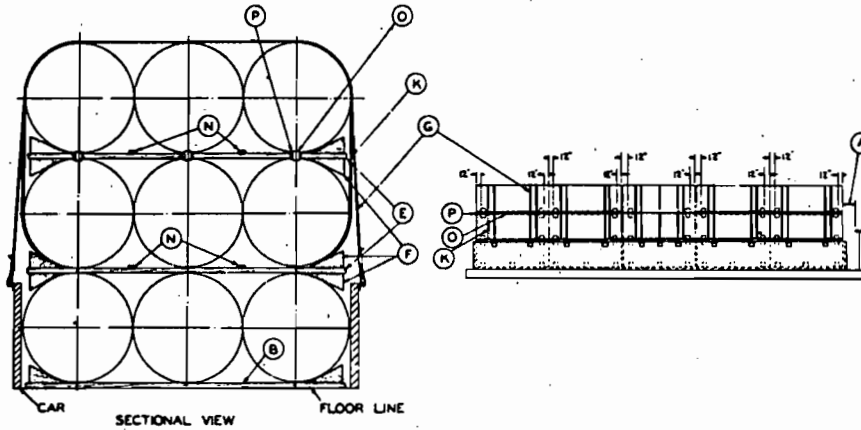
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**Loading of Pipe
On Open Top Cars**

Sec. 2—Fig. 130 (Rev.—12-1969)

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WROUGHT IRON AND STEEL PIPE, OVER 26 IN. IN DIAMETER, 8 FT. TO LESS THAN 12 FT. IN LENGTH, WITH 2 IN. X .050 IN. HIGH TENSION BANDS—GONDOLA CARS



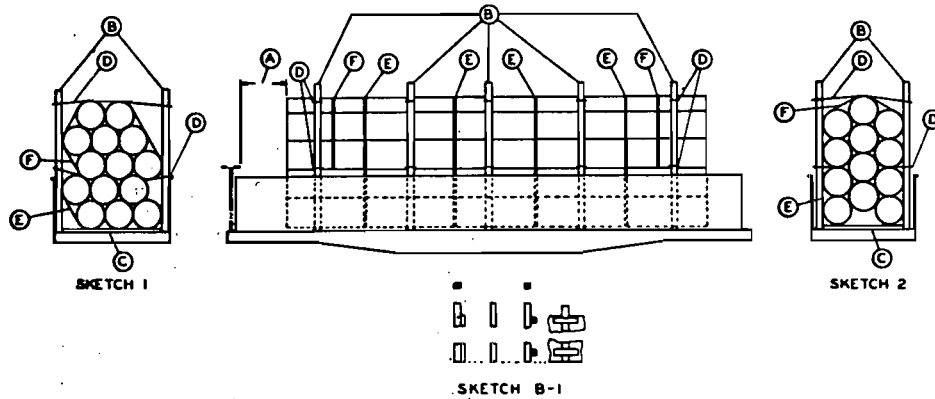
Item	No. of Pcs.	Description
A		Brake wheel clearance. See Fig. 2, Sec. 1.
B	8 per pile.	2 in. x 4 in., hardwood, length equal to width of car, suitably spaced. Locate end pieces approximately 12 in. from each end of pile and third piece at center.
O		VACANT.
D		VACANT.
E	2 per pile between ea. successive layer.	2 in. x 6 in., hardwood, long enough to apply Items "F" but short enough to clear bands. Locate approximately 12 in. from each end of pile. Not required beneath top layer when top layer is nested.
F	2 ea. Item "B". 4 ea. Item "E".	4 in. x 6 in. x 8 in., hardwood, wedge shaped, nailed to top of Items "B" and to top and bottom of Items "E" with five 16-D nails in each, three in tapered face and two in outside face.
G	2 on ea. of the 2 outer piles ea. end. 3 on intermediate piles.	Bands. Pass over top of load and attach to opposite car sides.
H		VACANT.
J	2 ea. Item "G".	4 in. wide, 1/2 in. radius, metal filler of suitable design and strong enough to maintain this radius. Required only when necessary to protect bands.
K	2 per pile.	Bands encircling top portion of pile above bottom row. Locate approximately 12 in. from outside Items "G".
L		VACANT.
M		VACANT.
N	As required.	1 in. x 2 in., hardwood, longitudinal strips, long enough to tie Items "E" together. Locate as shown and nail to Items "E" with two 8-D nails at each location.
O	As required on ea. of the 2 outer piles on ea. end, above bottom row.	Bands, longitudinally, tying the first two piles together, as shown.
P	2 ea. Item "O".	Protection clips, 20 gage, 4 in. wide, applied so as to prevent displacement.

When more than one-half the diameter of top layer of pipe is below top of car sides, Items "G", are not required. Longitudinal welds on pipe must not contact bands. Pipe less than 8 ft. long must be loaded below top of car sides. See General Rules 4, 5, 9, 10, 14 and 15 for further details.

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Sec. 2—Fig. 131 (Rev.—12-1969)

WROUGHT IRON AND STEEL PIPE, 24 IN. AND OVER IN DIAMETER, 63 FT. LONG OR LESS, WITH HIGH TENSION BANDS OR WIRES—GONDOLA CARS



Item	No. of Pcs.	Description
A		Brake wheel clearance. See Fig. 2, Sec. 1.
B	4 pr. per pile 41 ft. long or less. 5 pr. per pile over 41 ft. long.	Stakes, hardwood, equally spaced, extending above load to permit application of Item "D". Stakes may be lower than top of load providing top portion of load is nested in pyramidal form and stakes extend minimum of 4 in. above the top of the second highest row of pipes. Fill space between stakes and car sides by nailing fillers to stakes, per Sketch B-1.
C	1 ea. pr. Items "B".	2 in. x 4 in., length to suit. Locate between Item "B".
D	2 ea. pr. Items "B".	8 strands No. 11 gage wire. Locate at top of load and one midway between top of car side and top of load. Substitute, if desired at each location, one 1 1/4 in. x .035 in. high tension band. When stakes are lower than top of load use one set of 6 strands No. 11 gage wire between each layer extending wholly or partly above car sides.
E	8 per pile 41 ft. long or less. 4 per pile over 41 ft. long.	2 in. x .050 in. high tension bands encircling entire pile, equally spaced over length of pile.
F	2 per pile.	2 in. x .050 in. high tension bands, encircling all pipe extending wholly or partially above car side. Locate near end Items "B".

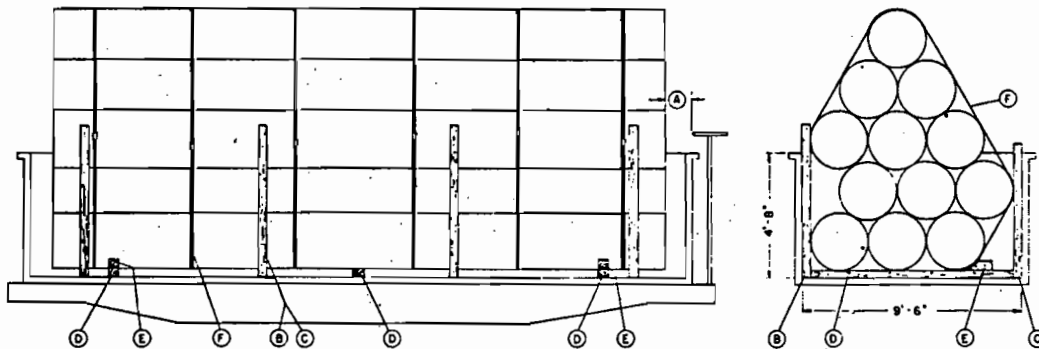
Use Sketch 1 or Sketch 2 as diameters of pipe and car widths permit.

Pile must be located centrally on car.

See General Rules 4, 5, 7, 9, 10, 14 and 15 for further details.

Sec. 2—Fig. 131-A (New—10-1960)

STEEL PIPE, 30 INCHES IN DIAMETER, 40 FT. LONG OR LESS, 12 PIECES PER CAR, WITH HIGH TENSION BANDS—HIGH SIDE GONDOLA CARS



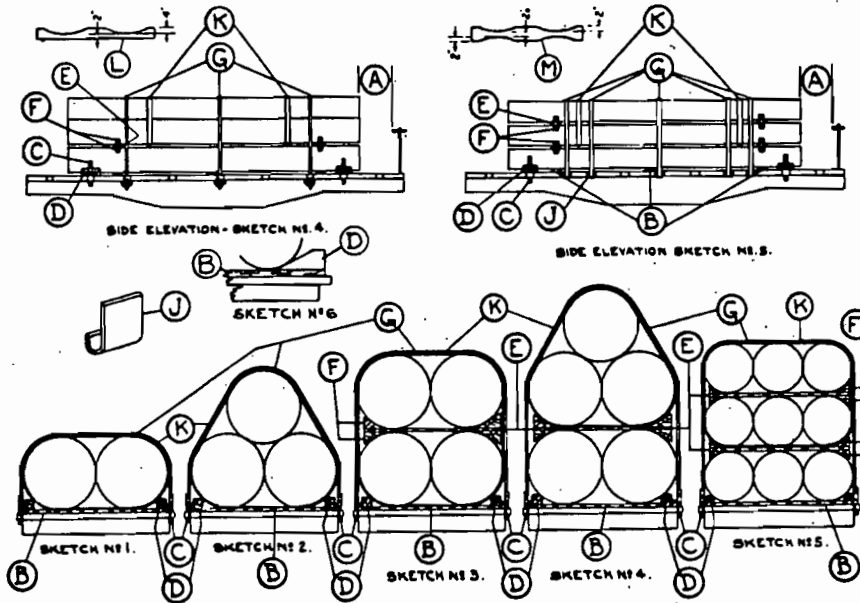
Item	No. of Pcs.	Description
A		Brake wheel clearance. See Fig. 2, Sec. 1.
B	4 per pile.	Stakes, hardwood, 4 in. x 4 in. x 6 ft., spaced as shown.
C	4 per pile.	Stakes, hardwood, 4 in. x 4 in. x 5 ft., width of car permitting, otherwise use 2 in. x 4 in., spaced as shown.
D	3 per pile.	Bearing pieces, 2 in. x 4 in. x 9 ft., spaced as shown.
E	2 per pile.	4 in. x 4 in. x 12 in., wood chock blocks, cut to fit contour of pipe. Locate on top of two end Items "D" against outside face of pipe as shown. Secure with four 60-D nails.
F	6 per pile.	2 in. x .050 in. high tension bands, encircling entire pile, suitably spaced as shown.

Suitable end bulkheads, below top of car ends, may be used to prevent pipe contacting ends of car. Use optional.
 Pile must be located centrally lengthwise on car.
 See General Rules 4, 5, 9, 10, 14 and 15 for further details.

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Sec. 2—Fig. 133 (Rev.—12-1969)

WROUGHT IRON AND STEEL PIPE OVER 26 IN. IN DIAMETER, 12 FT. LONG OR OVER, WITH 2 IN. X .050 IN. HIGH TENSION BANDS—FLAT OR GONDOLA CARS



Item	No. of Pcs.	Descriptor
A		Brake wheel clearance. See Fig. 2, Sec. 1.
B	8 per pile.	2 in. x 4 in., hardwood, length equal to width of car, suitably spaced. Not required when Items "L" are used.
C	Pile 20 ft. long or less, 2 pr. per pile. Pile over 20 ft. long, 3 pr. per pile.	Stakes, extending 9 in. above floor. Not required for gondola cars.
D	Pile 20 ft. long or less, 4 per pile. Pile over 20 ft. long, 6 per pile.	8 in. x 8 in. x 16 in., hardwood, for pipe to 56 in. in diameter, 8 in. x 10 in. x 16 in., hardwood, for pipe over 56 in. in diameter. Cut top edge to provide a 2 in. bearing against pipe. Nail to floor with 60-D nails. Substitute if desired 4 in. x 6 in. x 8 in. wood, wedged shaped blocks. Nail to Items "B," (Sketch 6) with 5 - 16-D nails, 3 through tapered surface and 2 through vertical end surface. Not required for gondola cars when pipe completely fills inside width of car. Space between Items "C" and "D" must be filled in with suitable blocking nailed to floor.
E	Pile 20 ft. long or less, 2 per pile between ea. successive layer. Pile over 20 ft. long, 3 per pile between ea. successive layer.	2 in. x 6 in., hardwood, long enough to apply Items "F", but short enough to clear bands. Not required beneath top layer when top layer is nested. Not required when Items "M" are used.

Sec. 2—Fig. 133 (Rev.—12-1969)

WROUGHT IRON AND STEEL PIPE OVER 26 IN. IN DIAMETER, 12 FT. LONG OR OVER, WITH 2 IN. X .050 IN. HIGH TENSION BANDS—FLAT OR GONDOLA CARS

Item	No. of Pcs.	Description
F	4 ea. Item "E".	4 in. x 6 in. x 8 in., hardwood, wedge shaped, nailed to Items "E" with five 16-D nails in each, three in tapered face and two in outside face. Not required when Items "M" are used.
G	Sketches 1 and 2. Pile 20 ft. long or less, 2 per pile. Pile over 20 ft. long, 3 per pile. Sketches 3, 4 and 5. Pile 20 ft. long or less, 3 per pile. Pile over 20 ft. long, add one additional band for ea. 10 ft. or less in length over 20 ft.	Bands. Pass over top of load and attach to opposite stake pockets or car sides.
H		VACANT.
J	2 ea. Item "G".	4 in. wide, 1/2 in. radius, metal filler of suitable design and strong enough to maintain this radius.
K	Sketch 1. Pile 20 ft. long or less, 1 per pile. Pile over 20 ft. long, 2 per pile. Sketches 2 and 3. Pile 20 ft. long or less, 2 per pile. Pile over 20 ft. long, 3 per pile. Sketches 4 and 5. Pile 20 ft. long or less, 2 per pile. Pile over 20 ft. long, add 1 additional for ea. 10 ft. or less in length over 20 ft.	Bands encircling entire pile. When one band is used, apply at center. When two are used, apply one about one-fourth length of pile from each end. Not required for gondola cars. Bands encircling entire pile. When two are used, apply one about one-fourth length of pile from each end, third band, when used, to be located at center of pile. Bands, encircling top portion of pile above bottom row, suitably spaced.
L	3 per pile.	6 in. x 6 in., hardwood, cradle blocks on floor, cut to fit contour of pipe. Not required when Items "B" are used.
M	Pile 20 ft. long or less, 2 per pile between ea. successive layer. Pile over 20 ft. long, 3 per pile between ea. successive layer.	6 in. x 6 in., hardwood, cradle blocks—intermediate, cut to fit contour of pipe. Not required beneath top layer when top layer is nested. Not required when Items "E" and "F" are used.

1/4 in. dia. rods may be substituted for bands, Items "G", in like number. When rods pass through floor, use 4 in. x 4 in. x 18 in., hardwood, or 1/2 in. x 4 in. x 18 in. plate under floor. When rods pass through stake pockets, use 1/2 in. x 4 in. x 10 in. plate under stake pockets.

When more than one-half the diameter of top layer of pipe is below top of car sides, Items "G" are not required.

Longitudinal welds on pipe must not contact bands.

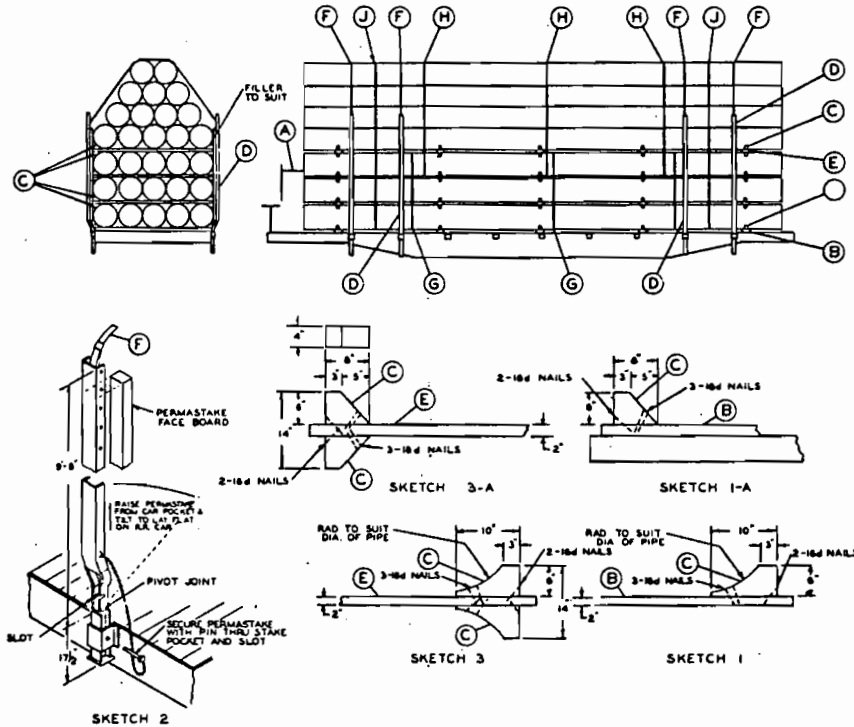
*Vertical separators may be used between pipes. When used, separators must be applied to prevent their displacement. Separators must consist of material, such as plywood or hard rubber, that will not easily compress. Use a minimum of 2 separators or sets of separators in each longitudinal row. Use optional.

See General Rules 4, 5, 9, 10, 14 and 15 for further details.

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Sec. 2—Fig. 134-C (New—10-1973)

WROUGHT IRON AND STEEL PIPE, 20 IN. TO 40 IN. INCLUSIVE, IN DIAMETER, WITH 2 IN. X .050 IN. HIGH TENSION BANDS—FLAT CARS EQUIPPED WITH PERMA-STAKES*



Item	No. of Pcs.	Description
A		Brake Wheel clearance. See Fig. 2, Sec. 1.
B	5 per pile.	Bearing Pieces, 2 in. x 6 in. hardwood, length equal to width of car, suitably spaced. Secure to car floor.
C	2 ea. Item "B". 4 ea. Item "E".	4 in. x 6 in. x 8 in. wood chockblocks, cut to fit contour of pipe. Locate against pipe and nail to Item "B", Sketch 1 and Item "E", Sketch 3, with five 16-D nails, 3 through contour surface and 2 through vertical surface. Substitute if desired, 4 in. x 6 in. x 8 in. wood, wedge shaped blocks. Nail to Item "B", Sketch 1-A and Item "E", Sketch 3-A, with five 16-D nails, 3 through tapered surface and 2 through vertical surface.
D	4 Pair per pile.	Perma-stakes, fabricated from metal channels equipped with suitable appurtenant apparatus for securing to stake pockets of car and securing Items "F" to top of stake, suitably spaced (Sketch 2). Filler boards, hardwood, secured to inside face of stakes.
E	5 between each layer located below nested portion of pile.	Separators, 2 in. x 6 in. hardwood, length equal to width of load, with four 4 in. x 6 in. x 8 in. wood chockblocks (Item "C"). See Sketch 3 or 3-A.
F	4 per pile.	2 in. x .050 in. high tension bands, passed over top of load and secured at the top of Perma-stakes.
G	3 per pile.	2 in. x .050 in. high tension bands, suitably spaced, encircling separated portion of pile.
H	3 per pile.	2 in. x .050 in. high tension bands, suitably spaced, encircling top layer of unit secured by Items "G" and nested portion of pile.
J	2 per pile.	2 in. x .050 in. high tension bands, suitably spaced, encircling entire pile.

Notes.—On pipe 20 to 26 inch diameter, add two 2 in. x .050 in. bands, one near each end of bottom two layers. Pipe must be loaded centrally on car and longitudinal welds on pipe must not contact bands. Vertical separators may be used between pipes. When used, separators must be applied to prevent displacement. Separators must consist of material, such as plywood or hard rubber, that will not easily compress. Use a minimum of 2 separators or sets of separators in each longitudinal row. Use optional. See General Rules 1, 2, 3, 4, 5, 9, 14 and 15 for further details. *U.S. Patent No. 3,091,193.

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