

in their own "Emergency Directory" regarding notification of outside, affected agencies, prevention of personal injury and property damage; use of fire foam to prevent vaporization; clearance of the repair area of hazardous vapors; and location of equipment in relation to vapors and air movement.

11. Contractors' work crews had received no formal training or indoctrination in pipeline maintenance work. The instruction received was "on-the-job" type training, with "seasoned" men working alongside "green" men.
12. The Federal regulation on pipeline repairs, 49 CFR 195.422(a), is vague, nonobjective and does not provide for any specific action on the part of carriers.
13. Contractors' work crews were improperly dressed to work in and around a hazardous vapor area.
14. Unnecessary personnel were allowed to stand over the ditch, watching the activity after they had been relieved by other workers.
15. The diesel engine backhoe did not have any exhaust protective equipment which might have prevented the vapor ignition.

V. PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of the leak was a flaw of undetermined origin in the pipe wall, which failed after a period of constantly fluctuating pumping pressures.

The probable cause of the explosion and fires was the ingestion of the gasoline vapor-rich atmosphere by the diesel engine in a backhoe which resulted in the speeding up and backfiring of the engine, igniting the atmosphere. The backhoe was working downhill and downwind of a ditch partially filled with gasoline.

Contributing to the ignition of the vapor-laden atmosphere was the lack of planning and precaution in the operation and positioning of the backhoe without the use of any vapor-detecting device.

Contributing to the amount of accumulated gasoline was the long period of dry weather preceding the accident (which had dehydrated the soil in the area), the existing rock strata which underlaid the pipeline from the leak site down to the accident area, and the more than usual amount of backfill over the pipeline which kept the gasoline from surfacing. The large underground column of entrapped gasoline, which was released suddenly by digging operations, deluged the work area with gasoline fumes.

VI. RECOMMENDATIONS

The National Transportation Safety Board recommends that:

1. The Federal Railroad Administration of the Department of Transportation initiate an amendment to the Code of Federal Regulations, Title 49, Section 195.206, Material inspection, requiring specific inspection criteria. This recommendation is not intended to delete or mitigate any visual, mechanical, or nondestructive inspection practices already in existence, but to prescribe a system of inspection at strategic points in the manufacture, transportation, and further processing of the pipe before it is buried in the ground.
2. The Federal Railroad Administration undertake a study of the current metering practices in the liquid pipeline industry, with the possible assistance of qualified pipeline groups, to determine the existing state of the art in detecting small pithole-type leakage by meter variance with particular regard to large diameter pipelines operating at high volumes. The study should

include those pipelines whose pumping operations are regulated by the use of recording meters which monitor the receipts and deliveries and are set to shut down or otherwise inform the pipeline dispatcher upon the occurrence of a specified amount of input/output variance. The study should include meter accuracies with the intent to establish certain minimum standards regarding receipt and delivery variances within which liquid pipelines shall operate. Based upon the results of this study, the number of barrels-per-hour variance allowable between the input and output of liquid petroleum pipelines should be included in 49 CFR 195. P72-2

3. The Federal Railroad Administration formulate and add to 49 CFR 195 the requirement that all pipeline companies formally notify appropriate State and local civil agencies of the route the pipelines follow in detail, the type of material they carry, and the lines of communication to be used in an emergency. P72-3
4. The Federal Railroad Administration incorporate by reference in 49 CFR 195.422, Pipeline Repairs, the American Petroleum Institute Petroleum Safety Data Sheet - Repairs to Crude Oil, Liquefied Petroleum Gas, and Products Pipelines, PSD 2200 - June, 1964. P72-4
5. The Colonial Pipeline Company provide maps of the pipeline route in sufficient detail to establish clearly the system location with regard to the various affected

civil agencies and residents along the right-of-way. These maps should be kept current by the notation of pipeline additions or route changes as required. Specifically recommended to receive this information are fire departments, both civil and volunteer; State, county, and local police departments; departments of water resources; and any agency concerned with hazardous materials. P72-5

6. The Colonial Pipeline Company meet with appropriate State safety agencies to coordinate safe working rules and regulations and hold periodic pipeline safety meetings with fire departments and other interested agencies, to familiarize their personnel with basic pipeline operations, materials pumped, hazards encountered, and the procedures to be followed when encountering pipeline leaks or other emergencies. P72-6
7. The Colonial Pipeline Company compose a formal, in-depth manual or procedure depicting the step-by-step method of handling petroleum spills, combating fires, notifying the various agencies, and the guidance of contractors' crews in safe working procedures. Incorporate in this manual the American Petroleum Institute Petroleum Safety Data Sheet, PSD 2200, June 1964, as a minimum so as to comply fully with the Federal regulation 49 CFR 195.422. A list of hospitals and first aid units, complete with addresses and telephone numbers, should be included. P72-7