Ammonia Pipeline Maintenance and Repair

A case history of how one company with a 939-mile line maintains operations and the procedure it followed when a major leak problem occurred.

D.E. Luddeke
Mapco, Inc.
Tulsa, Okla.

This is a description of how an ammonia pipeline is maintained and repaired, including a specific report on emergency procedures followed when a major leak occurred.

The facilities and maintenance/repair organization discussed is that of the Mid America Pipeline System, a division of Mapco Inc. The system consists of about 6,000 miles of 10, 8, 6, and 4-in. line, transporting liquefiable hydrocarbon and anhydrous ammonia from origins in New Mexico, Texas, Oklahoma, and Kansas to distribution outlets in Nebraska, Missouri, Iowa, Minnesota, Illinois, and Wisconsin.

That portion of the pipeline system which is of primary interest in this article is the 939-mile ammonia pipeline from Borger, Texas, to Hutchinson, Kans., where a newly constructed 8-in. pipeline to Farmland Industries' new ammonia plant at Enid, Okla. joins the original system. From these two sources, the pipeline system will transport 2500 ton/day of anhydrous ammonia to processing and distribution facilities in Kansas, Nebraska, and Iowa.

To maintain these pipeline facilities, the system has been sub-divided into four operating districts, and further sub-divided into seven work responsibility areas. The four district headquarters are located near Hobbs, N.M.; McPherson, Kans.; Sanborn, Iowa; and Moberly, Mo. The maintenance crews are strategically located to evenly divide the pipeline mileage and other related facilities to reduce travel time in performance of normal maintenance and to reduce response time in an emergency situation. Maintenance crew headquarters are located near Hobbs, N.M.; Skellytown, Texas; Conway, Kans.; Greenwood, Nebr.; Sanborn, Iowa; and Kearney, Mo.

Each maintenance crew is comprised of a pipeline supervisor and his work group and a technical supervisor and his work group, shown in Figure 1. The technical group is concerned primarily with electrical and mechanical maintenance at pump stations and terminals. The pipeline supervisor's work crew is responsible for such routine maintenance as repairing pipeline washes, installation and painting of pipeline markers, highway and road crossings, block valve maintenance, and other routine maintenance work.

The pipeline is, of course, under cathodic protection. However, this work is performed by a third-party contractor specializing in that field.

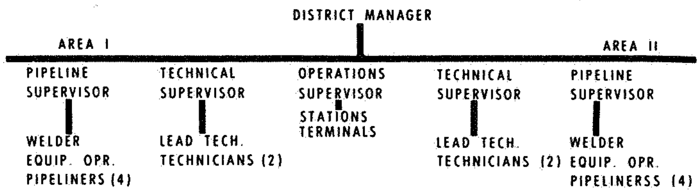

Figure 1. District maintenance organization chart.

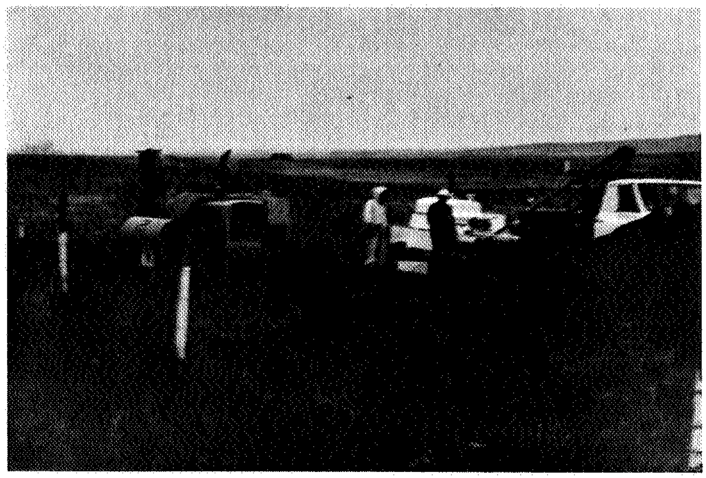

Figure 2. Typical pipeline maintenance operation.

Internal corrosion coupons are spaced strategically along the pipeline, and history to date indicates a minimal internal corrosion rate of 0.0134 mil/yr.

In addition to normal maintenance routines, the pipeline crew provides people called upon to repair pipeline leaks.

The equipment necessary to perform normal pipeline maintenance is common to most pipeline systems, but certain unique equipment is required for ammonia pipeline repair. Because of the similarities in certain physical properties of propane and anhydrous ammonia, most of the equipment is interchangeable if certain precautions are followed. Equipment is illustrated in Figures 2, 3, 4, 5, and 6.

Trucks, trailers, tractors, backhoe, welding machine, and various hand tools are common to all pipeline operations. However, specialized equipment such as stopple equipment are required only on volatile liquids as ammonia and LPG, or where evacuation of the pipeline by other methods is impractical. An air blower or air compressor is also helpful

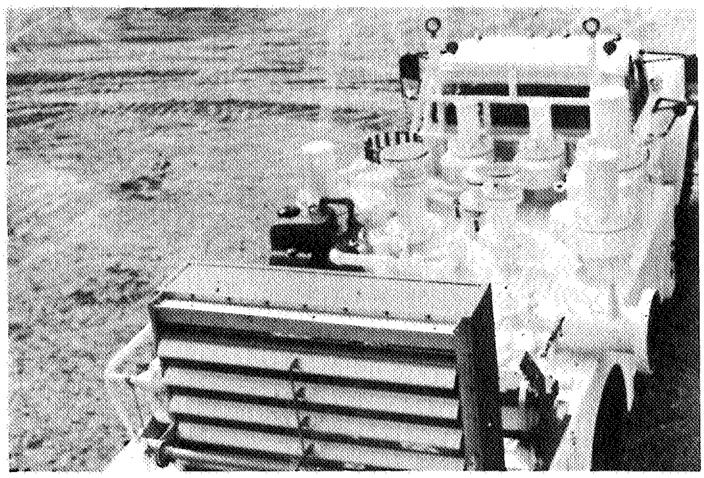

Figure 3. Emergency truck with stopple equipment and air blower.

Figure 4. Unloading equipment at job site.

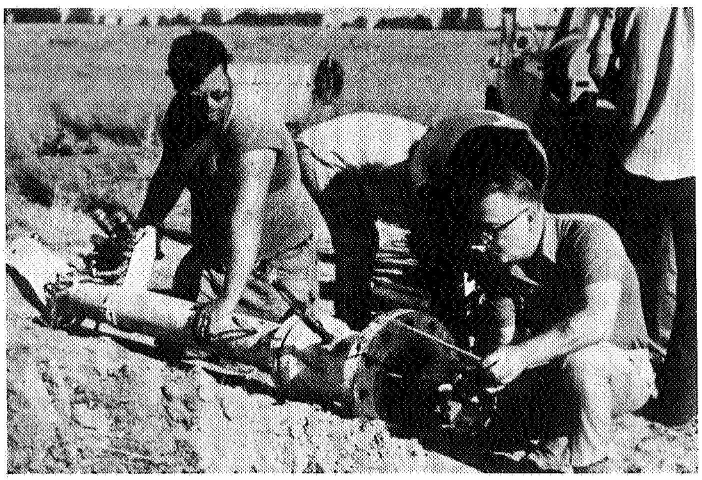

Figure 5. Tapping machine.

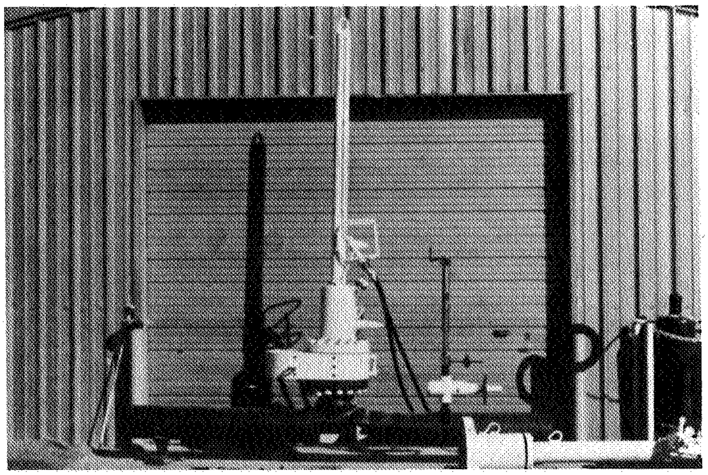

Figure 6. Stopple machine; training demonstration.

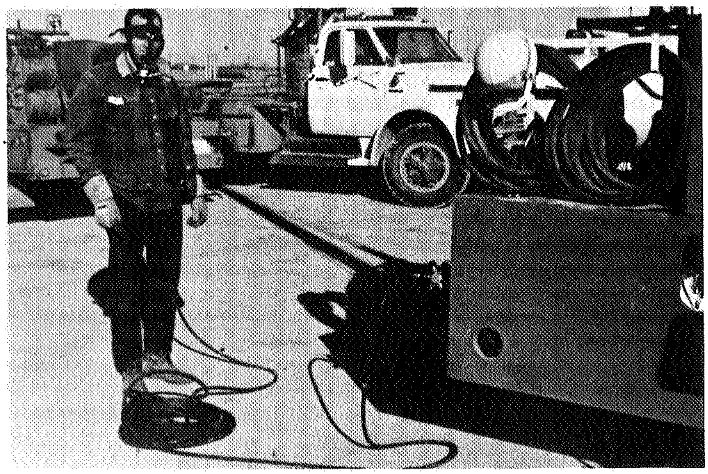

Figure 7. Respiratory equipment.

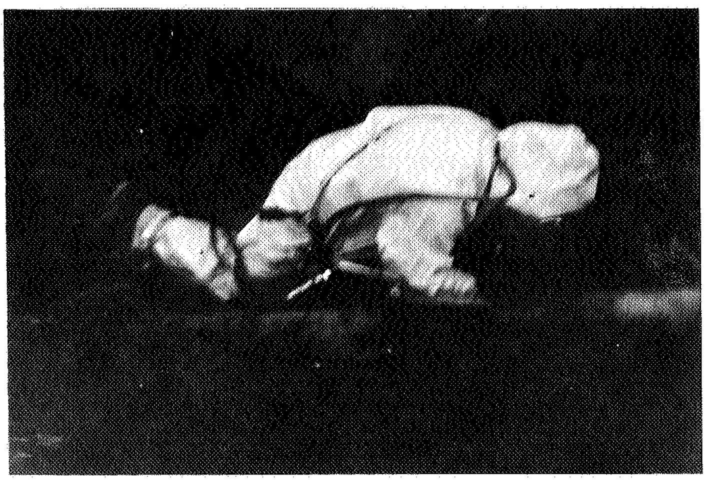

Figure 8. Air purge suit in use.

in keeping the concentration of ammonia vapor at the leak site at a lower level. When this is impossible, special respiratory equipment is required. It is shown in Figures 7 and 8.

Small leaks, such as might occur at a corrosion pit, or a pin hole in a weld, can normally be exposed with a backhoe; and repairs made with only the use of air blowers and conventional face mask. However, if leakage is excessive or liquid ammonia is present in the area, special air-purged suits are required.

Five tasks comprise emergency procedure

Major pipeline breaks or leaks set in motion an emergency procedure, consisting of the following minimum tasks.

1. Shutdown up-stream pumping station.
2. Isolation of leak site by closing remote electrically-operated valves at upstream and downstream stations.
3. Dispatch personnel to nearest upstream and down-

stream hand operated gate valves. (Downstream check valve would normally close automatically.)

4. Notify local residents near gate valve for assistance in isolating leak site. Notify local law enforcement, civil defense or fire department for assistance in isolating and evacuation of area, if necessary.

5. Dispatch company equipment and personnel to leak site to make certain area is secure and to begin repair.

Since beginning the operation of the ammonia system in 1968, Mapco has experienced three what would be considered major leaks, requiring at least a portion of the aforementioned procedure. The most recent such leak occurred at 04:30 on December 6, 1973, at the Conway pump station, 12 miles west of McPherson, Kans., immediately north of U.S. Highway 56.

Weather conditions at time of the leak were: ambient temperature, 12°F; wind direction, NNW; wind velocity, 5-10 miles/hr.

For two days prior to the leak, a severe ice storm had been in progress, causing complete power failure at Conway pump station for a period of 18 hr. At 00:30, four hours before the leak, power was partially restored. The ammonia pipeline had been shut down and upon start-up of the system at 04:12, an electrically-operated block valve in Conway station yard failed to open, resulting in increased line pressure and subsequent failure of the pipe at a point of prior construction damage 300 ft. south of the pump station, and approximately 1,000 ft. north of U.S. Highway 56. Prevailing north winds carried a dense cloud of ammonia vapor across Highway 56 at ground level. Sheriff's office, and subsequently the State Highway Patrol, were notified at 04:37, and assistance was requested in isolating and evacuating the residences downwind from the leak.

Six different pipelines in the leak area

The area in which the leak occurred is traversed by six pipelines, five LPG and one anhydrous ammonia. Due to the wind direction, it was not immediately discernible that the escaping product was ammonia. About ten minutes after the leak occurred, two transport trucks, moving west on Highway 56, entered the vapor cloud. One stopped immediately, the driver abandoned his vehicle and escaped on foot to the east. The other vehicle proceeded into the vapor cloud, left the pavement, and stopped in the road ditch. The driver wandered south with the flow of vapor and eventually emerged on the west side of ammonia cloud. Both drivers were hospitalized in McPherson, Kans., the first mentioned for four days and the latter for seven days.

At 04:58 a manual block valve 8.7 miles south of the leak site was closed, thereby isolating a section of pipe with a capacity of approximately 330 ton of ammonia. After line repairs were completed and line refilled with ammonia, it was determined that 230 ton had escaped to the atmosphere.

The nearest occupied dwellings were 3/4 mile south of leak site and 1.0 mile east, directly in the path of the vapor cloud. Sheriff's office and company personnel entered and searched out the entire area evacuating several families, and it is interesting to note, without use of so much as a face mask. After crossing Highway 56, the vapor cloud was on a gradual rise. Along a section line road 3/4 mile south of leak site, only a strong ammonia odor was discernible. Highway 56 was reopened to traffic at 11:58.

As soon as company personnel and equipment could be assembled, stoppling procedure was begun at a site approximately 1/2 mile southwest of leak site. The stopple site could have been closer to the leak, but fear of a wind shift dictated the site selection. Stoppling operations were complete at 16:30 (4:30 p.m.), and replacement of the damaged pipe was begun. Air blowers and water were used to clear the leak site of liquid ammonia and vapor. However, breathing apparatus was required to work in the immediate area. Replacement of the damaged pipe was complete at 09:30 December 7, 1973. As mentioned earlier, the point of pipe failure occurred at a gouge in the pipe caused by ditching equipment when the line was crossed with another pipeline in December, 1972.

Any pipeline leak, no matter what the product, is undesirable. However, from this ammonia leak we feel we gained some information. We believe our emergency procedure worked well in notifying law enforcement personnel and the evacuation and isolation of the area. We feel the affected pipe section was isolated in a reasonable time. The rapid rise of the ammonia cloud above ground level, even in 12°F weather, is encouraging. The time required to stopple the line was too long, and we have a research project in progress which hopefully will produce a system for quick shut-off of escaping product.

Except for the selection of materials and the differences in the physical properties of ammonia (compared to, say, propane) there is little difference in the maintenance and repair procedures. #

LUDDEKE, D.E.